Flags for future disease: postpartum cardiometabolic risk and prevention by understanding the contribution of breastfeeding and the influences of the COVID-19 pandemic

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

The Reproduction and Perinatal Centre

Faculty of Medicine and Health

The University of Sydney

2024

Thesis Abstract

Cardiovascular disease is a global leading cause of mortality in women. Pregnancy has been called a 'stress test' due to pathological indicators such as gestational diabetes (GDM) that can 'flag' increased risk for cardiometabolic disease. Of concern is the global rising prevalence of type 2 diabetes (T2DM) and cardiometabolic disease, with pandemics identified to increase population risk for both. There are measures to reduce cardiometabolic disease risk such as exercise and diet. Breastfeeding has also been identified to reduce T2DM risk, however the impact on next pregnancy GDM risk is unknown. It is also unknown how changes in maternity care during the COVID-19 pandemic impact cardiometabolic risk. The aim of my thesis was to investigate cardiometabolic risk for women during the pandemic with a focus on gestational diabetes and breastfeeding.

Quantitative and qualitative studies were undertaken for this thesis. An initial novel quantitative pilot study identified that high intensity breastfeeding (HIBF) was associated with a lower glucose level on the OGTT (published). In my follow-up study of 5,374 participants, HIBF was associated with 47% reduced odds of an abnormal fasting glucose in a subsequent pregnancy OGTT (aOR 0.53; 95%CI 0.38-0.75; $p<0.01$).

A mixed methods approach examined potential influences on cardiometabolic health in the first year of the pandemic during the low COVID-19 prevalence period (three publications). A quantitative retrospective cohort study was conducted investigating pre-COVID-19 to pandemic period for obstetric outcomes including breastfeeding. I identified factors that will impact ongoing cardiometabolic risk. Further qualitative methodology was used to explore the disruption to maternity care and identified disrupted social support and vulnerable groups in the high migrant population. Importantly, a text message healthy lifestyle program was well accepted.

This thesis presents novel findings identifying optimal breastfeeding patterns can have direct metabolic benefits in a subsequent pregnancy therefore potentially reducing both maternal and infant morbidity. The results of our COVID-19 research provides unique insights into how service and community changes alone impact obstetric outcomes and potential cardiometabolic risk in a high migrant population.

Acknowledgements

I would like to dedicate this thesis to my father Dr John Melov, a post-war graduate of The University of Sydney Medical school. He spent more than four decades as a General Practitioner advocating for primary prevention and an active anti-tobacco campaigner. He did not quite see me finish this journey; however, he laid the foundation of my success by instilling a respect for life-long learning and tenacity. He was a non-English speaking migrant, the first in his family to graduate from university and an avid reader throughout his 99 years – a wonderful role model. I also thank my mother for her support and imparting a formative sense of social justice that is reflected in my ongoing interest in social equity and migrant health.

This thesis highlights the importance to health of family and social support. I really appreciate and thank my family and wonderful friends for their support. My brothers Tony and Simon, I thank you for your staunch sister support and Tony's graphic rescues. My children Thomas and Jacob, you are everything to me – I hope I am as good a role model as your grandfather for tenacity and dogged pursuit of your goals. I thank you both for your support.

To my primary supervisor Prof Dharmintra Pasupathy, I am extremely grateful for your amazing generous encouragement, mentorship, and guidance. I certainly could not have wished for a better supervisor while walking down this rocky road of personal and professional difficulties during the COVID-19 pandemic. I would like to give sincere thanks and gratitude to my thesis supervisory team for their support and expertise. I am particularly grateful to Dr Justin McNab for guiding me from a qualitative fence-sitter to an enthusiast.

I feel humbled by the resilience of the participants and staff during the COVID-19 pandemic who I have interviewed for this thesis. I sincerely thank them for their precious time and openness participating in the research presented. I also thank my wonderful collaborators for their invaluable knowledge and input to the projects presented and ongoing.

I am grateful to the Westmead Charitable Trust for the PhD Career Development Grant 2021-2022 that has been immensely helpful to complete this thesis.

Statement of Originality

This is to certify that to the best of my knowledge, the content of this thesis is my own work. This thesis has not been submitted for any other degree or other purposes. I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged. I further declare that I was the lead author of the conceptual work underpinning this thesis and led the analysis and writing of all publications included. Author contributions are outlined in Chapters 3-8.

Sarah J Melov

As supervisors for the candidature upon which this thesis is based, we can confirm that the authorship attribution statements included in Chapters 3-8 are correct.

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Publications

- **First-Author publications arising from this thesis**

2021

1. **Melov SJ**, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D, McNab J: Exploring the COVID-19 pandemic experience of maternity clinicians in a high migrant population and low COVID-19 prevalence country: qualitative study. **Women and Birth** 2021.Nov 5:S1871-5192(21)00185-2.doi:10.1016/j.wombi. 2021.10.011; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8570406/

2022

2. **Melov SJ**, White L, Simmons M, Kirby A, Stulz V, Padmanabhan S, Alahakoon TI, Pasupathy D, Cheung NW. The BLIiNG study - Breastfeeding length and intensity in gestational diabetes and metabolic effects in a subsequent pregnancy: A cohort study. **Midwifery** 2022, 107, 103262. https://doi.org/10.1016/j.midw.2022.103262.

2023

3. **Melov SJ**, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D, McNab J. Women's experience of perinatal support in a high migrant Australian population during the COVID-19 pandemic: a mixed methods study. **BMC Pregnancy Childbirth** 2023. **23**, 429 https://doi.org/10.1186/s12884-023-05745-9

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- **Publications associated with this thesis**

1. Cheung NW, Simmons D, Marschner S, Thiagalingam A, Pasupathy D, Smith BJ, Flood V, McLean M, **Melov SJ**, Hogan R, Padmanabhan S, Duke A, Ching C, Min H, McNab J,Chow CK. Randomized Controlled Trial of Customized Text Messaging And Activity Monitor Use For Lifestyle Improvement After Gestational Diabetes **(Submitted for publication)**

2. Marschner S, Chow C, Thiagalingam A, Simmons D, McClean M, Pasupathy D, Smith BJ, Flood V, Padmanabhan S, **Melov SJ**, Ching C, Cheung NW. Effectiveness of a customised mobile phone text messaging intervention supported by data from activity monitors for improving lifestyle factors related to the risk of type 2 diabetes among women after gestational diabetes: protocol for a multicentre randomised controlled trial (SMART MUMS with smart phones 2). **BMJ Open** 2021; **11**(9): e054756.

- **Published conference abstracts arising from this thesis**

1. **Melov SJ,** White L, Elhindi J, McNab J, Lee V, Donnolley K, Alahakoon TI, Padmanaban S, Cheung NW, Pasupathy D, The association of previous pregnancy high intensity breastfeeding and subsequent pregnancy glucose tolerance; **Journal of Paediatrics and Child Health**, March 2023; 59: 54.

2. **Melov SJ**, Elhindi J, McGee T, Lee V, Cheung NW, McNab J, Alahakoon TI, Pasupathy D. Investigating Perinatal Outcomes During the Low Prevalence First Year of COVID-19 in a Multiethnic Australian Population. **Journal of Paediatrics and Child Health**, May 2022; 58(S2). https://doi.org/10.1111/jpc.15945

3. **Melov SJ**, Padmanabhan S, Simmons M, Smith B, Flood V, Pasupathy D, Chow C, Cheung NW. Acceptability and Utility of an Opportunistic Adaption of Digital Health Intervention Research During the COVID-19 Pandemic for Service Delivery to Optimise Postnatal Care: SmartMums to HealthyMums@Westmead. **Journal of Paediatrics and Child Health**, May 2022; 58(S2).

4. **Melov SJ**, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Exploring the COVID-19 Pandemic Experience of Maternity Clinicians in a High Migrant Population and Low COVID Prevalence Country. **Journal of Paediatrics and Child Health**, May 2022; 58(S2).

- **Additional peer reviewed publications completed during PhD candidature**

2023

1. Jones RA, Elhindi J, Lowe G, Henry L, Maheshwari R, Culcer MR, Pasupathy D, **Melov SJ**. Investigating short-stay admission to a neonatal intensive care unit as a risk factor for reduced breast feeding at discharge in infants ≥36 weeks' gestation: a retrospective cohort study. **BMJ Open** 2023; **13**(10): e075658.

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9. Silveira C, Kirby A, **Melov SJ**, Nayyar R. Placenta accreta spectrum: We can do better. **Australian and New Zealand Journal of Obstetrics and Gynaecology** 2022; 62(3): 376-82. doi: 10.1111/ajo.13471. Epub 2022 Jan 4. PMID: 34984671.

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The following presentations arose directly from research conducted as part of the PhD candidature

2023

Workshop and Information Day: Implementation Science and Research Translation in Reproductive, Maternal and Newborn Health, Sydney University 17 February 2023
Melov SJ, From BLIiNG To BLISS: Implementing a novel antenatal breastfeeding assessment tool. Sydney Health Partner's Reproductive, Maternal and Newborn Health Clinical Academic Group

PSANZ: Perinatal Society of Australia and New Zealand, Melbourne 5–8 March 2023
Melov SJ, White L, Elhindi J, McNab J, Lee V, Donnolley K, Alahakoon TI, Padmanaban S, Cheung NW, Pasupathy D. The Association of Previous Pregnancy High Intensity Breastfeeding and Subsequent Pregnancy Glucose Tolerance **(Prize: New investigator Award)**

Australian College of Midwives NSW state conference, Hunter Valley 24–26 March 2023
Melov SJ, White L, Elhindi J, McNab J, Lee V, Donnolley K, Alahakoon TI, Padmanaban S, Cheung W, Pasupathy D; The Association of Previous Pregnancy High Intensity Breastfeeding and Subsequent Pregnancy Glycaemic Control

International Confederation of Midwives
33rd ICM Triennial Congress, Bali, Indonesia, 11–14 June 2023
Melov SJ, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D, McNab J. Women's Experience of Perinatal Support in a High Migrant Australian Population During the COVID-19 Pandemic: a Mixed Methods Study

Women's Healthcare Australasia Webinar series, 25 July 2023 (virtual)
Melov SJ Investigating reduction of cardiometabolic risk: Breastfeeding and Subsequent Pregnancy Glucose Metabolism

Reproduction and Perinatal Centre Launch, The University of Sydney 28 August 2023
Melov SJ PhD journey and key research

LCANZ Education Seminar Westmead Hospital 31 August 2023
Melov SJ From BLIiNG to BLISS: using a breastfeeding assessment tool in routine data – the benefits to clinical care and research

2022

PSANZ: Perinatal Society of Australia and New Zealand, Adelaide May 16–18 2022
Melov SJ, Elhindi J, McGee T, Lee V, Cheung NW, McNab J, Alahakoon TI, Pasupathy D. Investigating Perinatal Outcomes During the Low Prevalence First Year of COVID-19 in a Multiethnic Australian Population

Presentations arising from this thesis continued

Melov SJ, Padmanabhan S, Simmons M, Smith B, Flood V, Pasupathy D, Chow C, Cheung NW. Acceptability and Utility of an Opportunistic Adaption of Digital Health Intervention Research During the COVID-19 Pandemic for Service Delivery to Optimise Postnatal Care: SmartMums to HealthyMums@Westmead

Melov SJ, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Exploring the COVID-19 Pandemic Experience of Maternity Clinicians in a High Migrant Population and Low COVID Prevalence Country

Australian College of Midwives NSW state conference, Orange 17–18 June 2022
Invited speaker
Melov SJ, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*Women's experience of perinatal support in a high migrant Australian population during the COVID-19 pandemic

The St George & Sutherland Hospitals Maternity and Breastfeeding Conference 5–6 October 2022
S J Melov & Lisa White, From BLIiNG to BLISS

2021

PSANZ: Perinatal Society of Australia and New Zealand, Sydney, 29–31 March 2021 (virtual)
Melov SJ, White L, Simmons M, Kirby A, Padmanabhan S, Cheung W, Stulz V, Pasupathy D, Alahakoon TI; Greater Breastfeeding Length and Intensity After Gestational Diabetes is Associated with Improved Glucose Tolerance Test in a Subsequent Pregnancy: The BLIiNG Study

Chapter 1

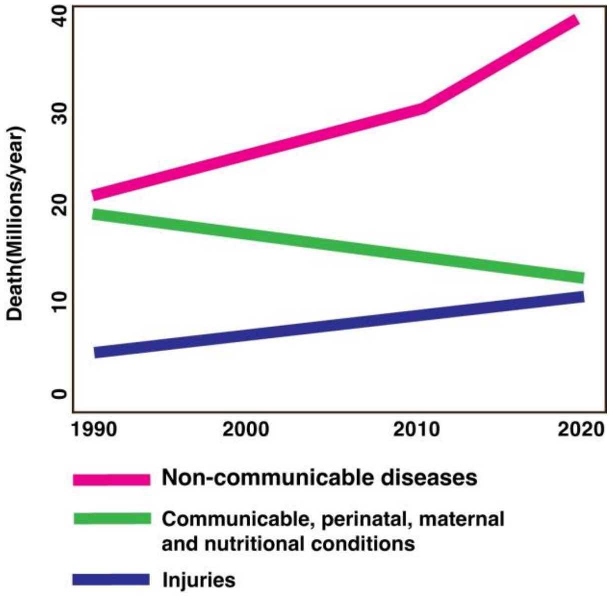
Background

This thesis investigates cardiometabolic risk during the peripartum period with a focus on diabetes and breastfeeding during the COVID-19 pandemic. The introduction chapter provides contextual background for the results chapters 3-8. Understanding the complex interplay of both unidirectional and bidirectional factors associated with cardiometabolic risk for women is imperative to improve outcomes. This thesis explores both disease interactions and disease-social interaction within a defined high-migrant population and the role breastfeeding may have to mitigate risk using a novel breastfeeding assessment tool – the Sydney BLISS check. This thesis provides unique insight during the COVID-19 pandemic into the multi-layered picture of cardiometabolic risk for women during the peripartum.

1.1 Non-communicable disease

There has been a shift over the last few decades in global mortality from communicable to non-communicable diseases (NCD) which include Alzheimer's disease, chronic respiratory conditions and cardiometabolic diseases.[1] Cardiovascular disease is the current leading cause for global mortality.[3,4] The personal and global economic cost of the rise in NCD is staggering, with total financial impact estimates between 2010 and 2023 to be US$47 trillion.[1] In 1990 the majority of global deaths in low resourced settings were attributed to infectious diseases, injuries and malnutrition. However, there were projections up to the year 2020 for NCD rates to potentially rise and cause 7 in 10 deaths (Figure 1).[2]

Figure 1. The 1990 projected trends for cause of death in low resourced regions



- In 1990 the global burden of disease study estimated that in 2020 global mortality attributable to NCD would be 70% in low resourced settings
- In 2020 the actual total global mortality rate for NCD was higher – 74%[1]

Source: Global Burden of Disease Study[2]

The mortality projections, a growing body of literature and epidemiological evidence, focused global attention on this issue and resulted in the World Health Assembly in 2012 endorsing the goal to reduce by 25% avoidable NCD mortality by 2025.[5] However, despite gains in some areas, the projection of continued global rise in NCD remain on track. In fact, disturbingly accurate prior to the pandemic, with total global mortality reports in 2020 to be 74% for NCD (Figure 1).[1,6] Changing the global mortality trajectory of NCD has been difficult despite the last decade of health publications and governmental policies peppered with numerous calls to action, as well as more goal setting in both high and low resourced regions.[7-10] The global rise in cardiometabolic disease has been particularly sharp, with mortality percentage increase in mortality due to diabetes rising 70% since 2000.[11]

One significant gain that has accompanied global initiatives to reduce NCD and increase awareness, has been improved surveillance and data availability and the establishment of the Sustainable Development Goals (SDG) by the United Nations.[12] However, significant and multifaceted barriers exist to achieving goal 3.4.

Sustainable Development Goal 3.4 – World Health Organisation

"…***by 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment…"*** [12]

The complexity of barriers to achieving the SDG's have led to calls for a more multisectoral response that encompasses addressing the long list of biosocial drivers behind the rise in NCD. The drivers to be addressed include government health policy, racism, access to food, health systems, obesity, food and drink industries, access to medicine, modification to sedentary behaviour, and importantly civic planning.[5,8,13,14] But clearly to date, there has been too few effective coordinated interventions to slow the complex drivers for NCD mortality in both high and low resourced settings, despite the strong case for financial investment in this area as well as the impact on individuals and families. Cardiovascular disease in Australia is the second highest disease group for health system expenditure, with estimates in 2019-20 to be 9.1% ($14.6 billion) of total health expenditure.[15] There are published estimates of US$230 billion in economic gains for reducing global NCD, US$7 gained for every dollar spent but still global change has been slow.[1]

Barriers to achieving SDG have only become more challenging with both added disease and financial burden of the COVID-19 pandemic at both an individual and region level including service delivery barriers.[1,16-18] The COVID-19 pandemic of the severe respiratory SARS-CoV2 virus, commenced in China December 2019, with rapid global spread and impact.[19] The World Health Organisation (WHO) declared a Public Health Emergency of International Concern only one month later on the 30th January and a global pandemic on the 11th of March. Australia closed its international borders on 30th of March 2020 and implemented extensive public health measures in pandemic responses including lockdowns.[20-22] The COVID-19 pandemic has increased NCD hospitalisations and mortality due to increased vulnerability of people living with a NCD.[23-26] Vulnerable populations include people living with diabetes and particularly those in low resourced settings with overburdened health services because of the pandemic.[25,27] The relationship is bidirectional between cardiometabolic disease and COVID-19, both increasing risk of severity of infection with COVID 19 and increased risk of progression to cardiometabolic disease post-COVID-19 infection.[26,28] Pregnancy has been highlighted as a vulnerable period. Recent meta-analysis studies have identified that during pregnancy women were more likely to be admitted to intensive care, women with pre-existing cardiometabolic disease experienced increased severity of COVID-19 infection and infection was also associated with worse pregnancy outcomes such as preterm birth and fetal death.[29,30]

There have been calls for more multisectoral action and moving away from thinking and planning for individual diseases with siloed methodology, to conceptualising global NCD within a Syndemic framework.[14] A change in approach to understand the interplay and bidirectionality of NCD and influence of developmental exposures, is gaining greater attention and increased research efforts.[31-33] This multi-pronged approach has been identified as the only way to slow the global cardiometabolic epidemic.[14] One such approach is understanding risk groups and convergence of risk and prevention to inform collective strategies to improve outcomes and reduce disease burden of NCD including within perinatal care.

1.2 Cardiometabolic diseases

Cardiometabolic disease includes both metabolic and cardiovascular pathology. It is relatively new nomenclature, emerging into common usage a from about the year 2000.[34,35] Cardiometabolic disease encompasses interrelated NCD conditions of obesity, dyslipidaemia, insulin resistance, diabetes and cardiovascular disease.[36] Cardiometabolic risk presentation and management is increasingly recognised as different for men and women.[37,38]

It is important to optimise care and intervention strategies to understand the gender differences in drivers and barriers to care, presentation and aetiology. A recent systematic review identified that women at risk for cardiovascular disease (CVD) were less likely than men to be appropriately prescribed aspirin (41% vs 56%), statins (60% vs 63%) or any hypertensive medication (68% vs 69%), but in pooled prevalence ratios more likely to be prescribed diuretics (1.27; 95%CI 1.17–1.37).[39] Lim et al[37] for the Joint Asia Diabetes Evaluation Program of patients with diabetes, concluded that Asian women with diabetes had poorer quality of care compared to men in Asian countries with men successfully achieving ≥three treatment targets (including HbA_{1c} < 7% and BP < 130/80 mmHg) more than women (aOR 1.63; 95%CI 1.51–1.74).[37] This is of particular concern given the global prevalence of diabetes and that women with diabetes are more likely to develop medical co-morbidities than men.[40,41] A large systematic review of 775 385 participants, identified women with diabetes were at a 27% higher relative risk (RRRs 1·27, 95%CI 1·10–1·46) of stroke than men with diabetes.[41] This research team also identified a sex-difference for coronary heart disease (CHD) risk greater by 44% in women compared to men (RRR 1.44; 95%CI 1.27–1.63).[40]

Understanding factors that can support a reduction in cardiometabolic disease is ever more urgent. Evidence is essential to underpin structural and societal changes to improve health equity and outcomes for women. Perinatal care may be where significant understanding of drivers for cardiometabolic risk and opportunities for prevention can be identified (Figure 2).

Figure 2.

Bidirectional factors associated with pregnancy and cardiometabolic risk

- **Hypertensive disorders of pregnancy**
- **Gender inequity**
- **Poverty**
- **Stress**
- **Inactivity**
- **Diet**
- **Social isolation**
- **Breastfeeding**
- **COVID-19**
- **BMI**
- **Kidney disease**
- **Cardiovascular disease**
- **Gestational diabetes**
- **Type 2 diabetes**
- **COVID-19**

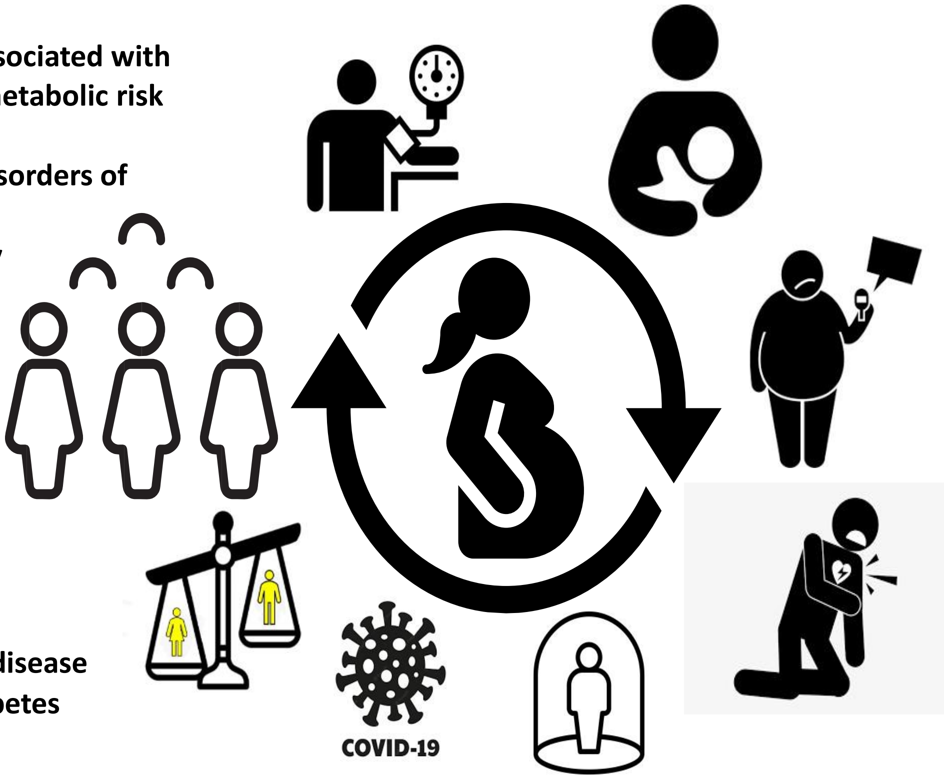


Figure by SJ Melov 2023

1.3 Pregnancy and cardiometabolic disease

Pregnancy has been identified as a flag for future disease, an 'ultimate stress test' for cardiometabolic disease, either uncovering underlying predisposition or driving disease process.[31,42-45] This has led to increasing calls for attention to be paid to risk reduction strategies for women around preconception care, social determinants and obstetric adverse events to improve targeted prevention programs for cardiometabolic disease.[31,45,46] The recent scientific statement by The American Heart Association has advocated for a more systematic multilevel societal approach to pre-pregnancy cardiovascular health planning.[31] This is inclusive of advocacy for equitable access to contraception to optimise cardiometabolic health prior to pregnancy as mechanisms to improve long term maternal and infant health outcomes.[31]

Pregnancy confers unique cardiometabolic gender specific risk, including increased life-long risk after experiencing an adverse pregnancy outcome.[47] A recent systematic review identified cardiovascular risk was highest for women after preeclampsia (OR 2.7; 95%CI 2.5–3.0), a history of stillbirth (OR 1.5; 95%CI 1.1–2.1), or gestational diabetes mellitus (OR 1.7; 95%CI 1.1–2.5). Placental abruption or preterm birth were also identified to increase risk.[48] Therefore, these events are recognised contributors to the global NCD burden.

➢ 1.3.1 Gestational Diabetes Mellitus

Gestational diabetes mellitus (GDM) is a NCD and a common pregnancy complication that has significant maternal and infant health implications. It is defined as glucose intolerance first diagnosed in pregnancy and impacts 4%-28% of pregnancies depending on the population and diagnostic criteria.[49-53] GDM is not a condition that has a long historical understanding and clear management plans, it was first described in scientific literature as case studies in 1824.[54] In the early 1900's further descriptions were made identifying glycosuria as of some concern, but obviously management and diagnosis at this point were inadequate. Williams describes in the English 'The Hospital' publication in 1910, the clinical significance of glycosuria in pregnant women as 'unclear' but an indication for higher surveillance stating:

> *'…the prognosis is not so alarming as is frequently stated; many patients do perfectly well, while a smaller proportion die in coma, or collapse at the end of pregnancy, or during or shortly after labour.' (p.658)* [55]

Reports were made at this time for the first diagnostic criteria for transient glycosuria in pregnancy.[55,56] It was not until 1964 that O'Sullivan et al introduced a regime for diagnosis and screening of GDM based on progression to type 2 diabetes (T2DM).[57] The cut-off values were further validated by O'Sullivan et al in an eight-year follow-up of a group of 1013 women divided by severity into three groups with good correlation to conversion to T2DM by oral glucose tolerance test (OGTT) result severity (1 SD Level I 6.9%; 2 SD Level II 16.1 %; 3 SD Level III 40.3%–progressed to T2DM).[57] From such modest evidence, the criteria and diagnostic regimes for GDM remained surprisingly stable for the next half a century (Table 2). At a similar time as O'Sullivan & Mahan introduced their criteria, the World Health Organisation (WHO) introduced a testing regime that was maintained until 2013, the defined values were the same as for the non-pregnant population.[58,59]

Despite great gains in clinical management of GDM since medical literature described potential death or coma as 'not so alarming', the continued efforts more recently have still not resulted in global consensus on diagnosis and management. A women may or may not be diagnosed with GDM dependent on the country or region within which she resides, due to the varied glucose loading regimes and blood glucose acceptable parameters (Table 2). Therefore, it is important to understand when reviewing GDM outcomes for women that criteria are varied, and results are not always comparable (Table 1).

Table 1. Blood glucose values for GDM screening 24-28 weeks gestation
Diagnosis varied for early screening criteria with glucose challenge loads of either 75g for one step or 50g and 100g for two step or 100g and 75g challenge loads.
One step: fasting blood glucose followed by glucose load and subsequent hourly testing of blood glucose usually at 1 and 2 hours post glucose load.
Two step: non-fasted glucose load challenge and only second step fasting regime required for women who do not meet normal blood glucose range at step one.

Diagnosis of GDM criteria[60-64]	One or two step	Fasting mmol/L	1-hour mmol/L	2-hour mmol/L	3-hour mmol/L
1964 O'Sullivan & Mahan ≥2 abnormal	2-step 50gm 100g	≥5.0	≥9.2	≥8.0	≥6.9
BLIiNG pilot study (Chapter 3) 1998 Australasian Diabetes in Pregnancy Society criteria ≥1 abnormal	1-step: 75g	≥5.5	-	≥8.0	-
BLISS and GTT study (Chapter 4) Australia International Association of Diabetes and Pregnancy Study Group (IADPSG), WHO criteria (2013) ≥1 abnormal	1-step 75g	≥5.1	≥10.0	≥8.6	-
UK NICE, 2015	1-step 75gm	≥5.6		≥7.8	
USA - Varied Carpenter and Coustan criteria 1982 ≥2 abnormal	2-step 50gm 100g	≥5.3	≥10.0	≥8.6	≥7.8
ADA 2019: 1-step	75gm	≥5.1	≥10.0	≥8.5	
2-step(NDDG) a.	50gm	-	≥7.2	-	
b. ≥2 abnormal	100g	≥5.8	≥10.6	≥9.2	≥8.0
China - Varied dependent on region and resources ≥1 abnormal	One step 75g	≥5.1	≥10.0	≥8.5	-
India - no consensus Recommended: Diabetes in Pregnancy Study Group of India	One step 75g non-fasting	-	-	>7.8	-

NICE = National Institute for Health and Care Excellence ADA = American Diabetes Association
NDDG = National Diabetes Data Group

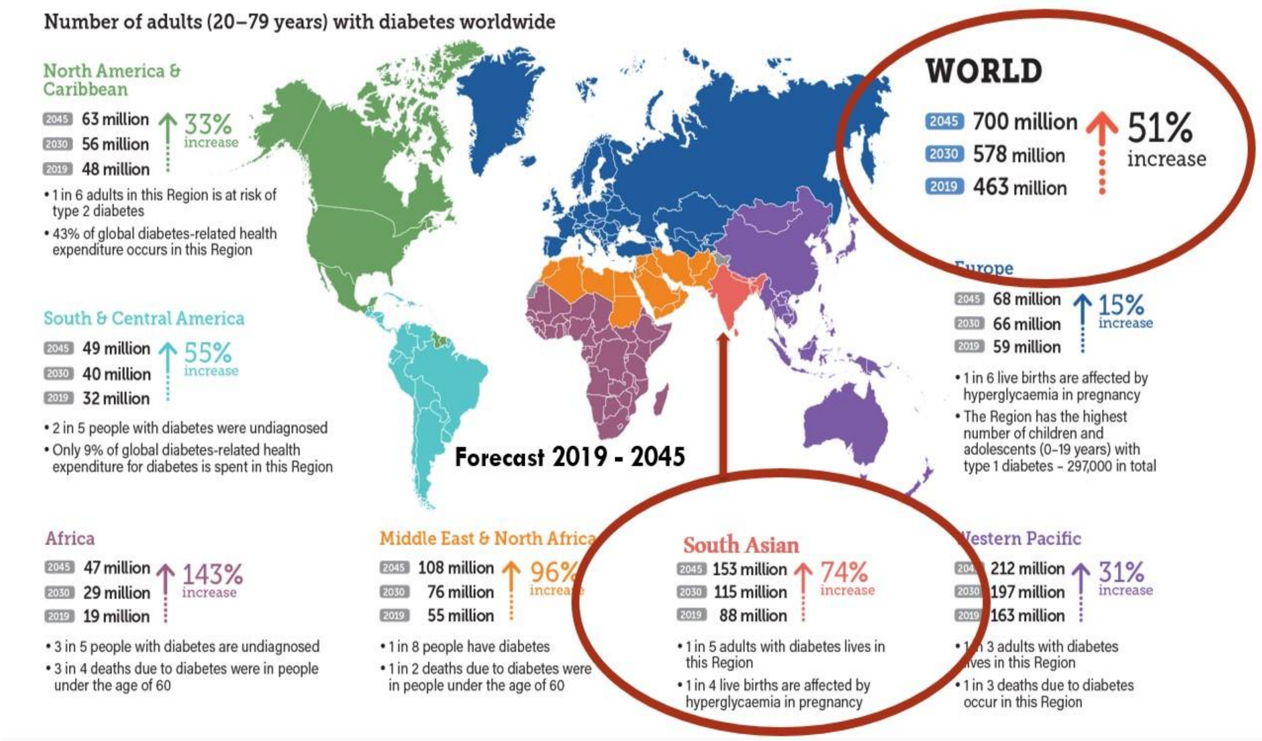
In the year 2000, an international group made a bold attempt to provide evidence to address the lack of global consensus regarding GDM diagnosis through undertaking a large international randomised control trial in ethnically diverse populations. The Hyperglycaemic

The Adverse Pregnancy Outcome study (HAPO) enrolled over 25,000 nondiabetic pregnant women at 15 hospitals in nine countries. The four primary outcomes were fetal hyperinsulinemia, primary caesarean section birth, neonatal hypoglycaemia and birth weight >90 centile. The results were published in 2008 informing the International Association of Diabetes and Pregnancy Study Group (IADPSG) GDM diagnostic criteria.[65]

The large HAPO cohort has the potential for understanding subgroups and longer-term implications of varied levels of blood glucose exposures for both mother and infant. One HAPO study has followed up over 4000 women who had not been diagnosed with GDM. After 10-14 years postpartum, they identified higher rates of prediabetes or T2DM in women who had birthed a large for gestational age (LGA) infant compared to appropriate for gestational age (AGA) (24.5% vs 19.3 % $p < 0.01$; aOR 1.21, 95% CI 1.02–1.44).[66] This may indicate long-term consequences for any dysglycemia during pregnancy. It may also be a reflection of the HAPO arbitrary cut-off values with no clear demarcation of a disease state but rather adverse fetal outcomes clearly identified to be on continuum for immediate adverse birth outcomes.[67] It is also of note that the HAPO cut-off values may not be reflective of long-term consequences of hyperglycaemia in pregnancy.

The global rise in diabetes and GDM is well recognised and independent of criteria used for diagnosis (Figure 3). Ethnic or regional differences are apparent, but all countries are experiencing rising rates of GDM. Shah et al[68] identified that Asian Indian populations had the highest overall rate ratios in 2011 (2.06; 95%CI 1.94–2.18) and also 2019 (2.24; 95%CI 2.15–2.33). This is of concern as the health district where the research for this thesis was conducted has the highest maternal South Asian population in NSW.[69]

Figure 3. Global forecast rise in adult diabetes 2019-2045 International Diabetes Federation



Source: International Diabetes Federation. IDF Diabetes Atlas, 9th edn.2019. http://www.diabetesatlas.org Reproduced with permission.

1.3.2 Impact on pregnancy outcomes

The impact of GDM on immediate pregnancy outcomes for infant and mother as well as future health is significant.[70,71] GDM increases pregnancy risks including preeclampsia, caesarean section birth and adverse neonatal outcomes including LGA, birth injury and neonatal hyperglycaemia.[71] The risk of maternal hyperglycaemia in pregnancy is continuous with graduated increased risk of adverse outcomes associated with increasing dysglycemia.[65] The fetal impact and potential epigenetic changes associated with maternal dysglycemia have been identified, including increased risk in offspring for dyslipidaemia, obesity, diabetes and metabolic syndrome.[72-74] GDM can then be cyclical with increased risk of next pregnancy GDM and 10-fold maternal future risk of T2DM.[75,76] A recent meta-analysis identified the risk of a cardiovascular event was increased twofold for women after a pregnancy affected by GDM.[75]

This risk was still greater than 50% for women who had not developed T2DM but had a history of GDM.[75]

Within the context of research, it is important to understand the history of pregnancy glucose range criteria, for study design and applicability to both local and international populations. Research investigating outcomes and associations need to be cognisant of the cut-off values and the continuum of adverse events associated with varied blood glucose levels in pregnancy. The interaction of diagnosis of GDM and behaviours such as exercise, diet and breastfeeding, as well as events such as the pandemic, may be less important, and more emphasis should possibly be placed on absolute changes in blood glucose due to the shifting diagnostic criteria for GDM.

GDM confers an increased risk of T2DM and underlies the urgent need to reduce GDM rates as a mechanism for reducing population diabetes. This urgency is underpinned by evidence as previously stated, that women with T2DM compared to men have a greater risk of some types of cardiovascular disease.[77,78]

1.4 Other cardiometabolic risk factors

Traditional risk factors for cardiometabolic disease include smoking, high cholesterol, hypertension, physical inactivity, and obesity.[36,79] Recently, increasing attention has been paid to understanding other drivers of cardiometabolic disease including disturbed sleep, stress, poor social support and risk associated with pregnancy.[77,78,80] Exposure to pandemics and disasters have also been identified as increasing cardiometabolic risk in the general population,[81-84] for women who are pregnant,[85,86] and their offspring.[87,88]

- **1.4.1 Disasters and cardiometabolic risk.**

The association of exposure to natural disasters and increased cardiometabolic risk has been identified for numerous and diverse events including earthquakes, tsunami, hurricanes and severe storms. The great East Japan earthquake of 2011 that resulted in over 18,000 deaths and mass evacuations from the area surrounding the affected Fukushima nuclear plant, has been extensively studied.[83,84,89] Ohira et al[89] identified that Fukushima evacuees had worse metabolic outcomes than non-evacuees including higher rates of diabetes, increased BMI, dyslipidaemia and hypertension. Those in temporary housing were more adversely impacted. The authors conjectured that reduced physical activity due to job loss, and prolonged psychological stress, may contribute to the evacuees' poor cardiometabolic health. The physical impact of stress has also been identified in a disaster impacted diabetic population after the devastating 2005 hurricane Katrina in New Orleans. Comparing pre to 6-16 months post-Katrina, cardiometabolic risk factors all increased for this population.[82]

Along with the general population, women who are pregnant and have exposure to natural disasters also have negative cardiometabolic outcomes which affect both the mother and infant.[85,90] Recent systematic reviews and meta-analysis have identified the impact of prenatal exposure to disasters. The adverse outcomes associated with disasters include LGA, increased BMI and offspring with negatively impacted cognitive, and behavioural outcomes and long-term increased cardiometabolic risk.[81,88] Little information is available on what mitigates cardiometabolic risk for exposure to disasters or pandemics.[81]

➢ 1.4.2 Pandemic and cardiometabolic risk – COVID-19

Bidirectional interaction of cardiometabolic disease and the COVID-19 pandemic has been increasingly identified, with cardiovascular and diabetes having the highest attributable risk for COVID-19 morbidity and mortality identified in the United States.[24,26,28,91,92] COVID-19 infection imparts a direct insult to the cardiovascular system and has long term implications that as yet are not fully understood. Understanding potential adverse perinatal outcomes in a very low COVID-19 prevalent area are of importance to help understand the impact of social drivers alone, without addition of factors relating to high disease prevalence. The pandemic reduced access to both clinician review and ongoing management of existing problems such as appropriate medication.[93] How these events, including the ongoing exposure to stress, will impact long term CVD morbidity and mortality is unknown.[87,90,94] Although not all studies agree, most research identifies the impact disasters and pandemics have on increased cardiometabolic risk in varied populations and the potential for impact on already global rising rates of cardiometabolic disease.[81]

➢ 1.4.3 Social support, stress and cardiometabolic risk

The exposure to pandemics or natural disasters impairing cardiometabolic health may be partially attributed to stress and disrupted social support. Social isolation has been shown to increase cardiometabolic risk as well as all-cause mortality risk.[95,96] A systematic review indicated a 29% increased risk of incidence of heart disease for socially isolated individuals (pooled RR 1.29; 95%CI 1.04–1.59).[96] Larrabee Sonderlund et al also identified, in their recent systematic review, that high social connection was generally protective against the physical burden resulting from exposure to chronic stress – allostatic load.[97] High quality social support is hypothesised to act as a buffer to stressful life events. Three primary elements are suggested to maintain the protective buffer: informational (provide advice), emotional (understanding and empathy) and instrumental/tangible/practical (physically available for tasks) (Figure 4).[98-100] However, even if equipped with resilience, it may be difficult to mount a defence to exposure of long-term chronic stress such as experienced during the ongoing pandemic.[96,101] Understanding defined populations' experience of support, particularly during the peripartum, is essential to understanding long term cardiometabolic risk.

Figure 4. High quality social support buffer bubble[99]

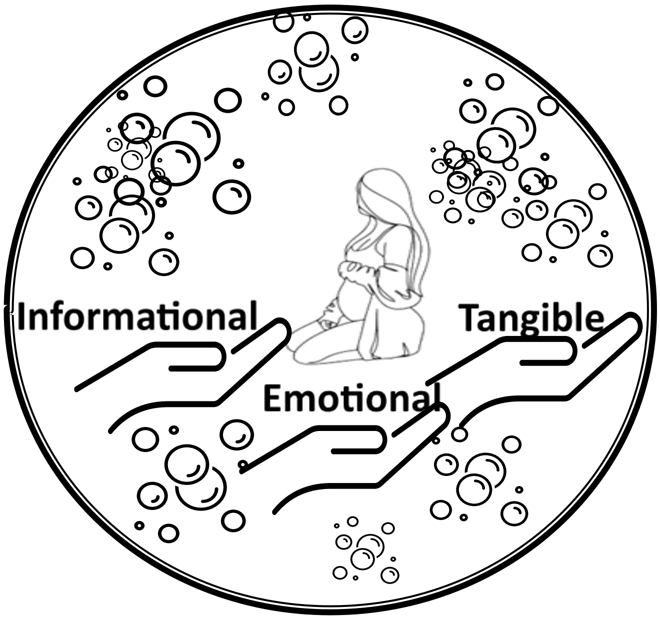


Figure by SJ Melov 2023 based on three elements of support described by Cyranowski 2013

The biological response to stress is mediated by the adrenal hormones that include importantly cortisol, through hypothalamic-pituitary-adrenal (HPA) axis activity. Dysregulation of the HPA axis is associated with dyslipidaemia, disrupted sleep, increased weight, diabetes, heart disease and hypertension, impacting long-term cardiometabolic health.[100,102,103]

Endothelial damage may also contribute to poor outcomes due to plasma catecholamines damage from excess HPA axis activation potentiating cardiovascular disease.[100,104] High quality social support is associated with reduced HPA axis activity, a down-regulation shield to stressful events.[97,100]

An interesting study by Leher et al identified that greater resilience or lower perceived stress, was linked to lower hair cortisol measurement and reduced symptoms of metabolic syndrome.[105] The measured association of stress through hair cortisol has also been undertaken during the COVID-19 pandemic. Of note, for long-term cardiometabolic risk, a study identified increased alcohol use during a COVID-19 lockdown period. Alcohol use increased only with participants who had raised cortisol levels. At one year later, higher alcohol use had continued for this group as had their increased health risks.[106]

Pregnancy is a time of often complex change, and is sometimes referred to as requiring a 'village' of support. In a cohort of 1356 women postpartum, Faleschinin et al identified cardiometabolic risk improving behaviours were enhanced with stronger social support postpartum, particularly quality partner support was associated with more exercise (aOR 1.36; 95%CI 1.01–1.82) and improved diet (aOR 1.43; 95%CI 1.06–1.91).[107] Robust perceived social support during this time benefits maternal mental health and therefore provides cardiometabolic protection for mother and fetus.[108,109]

➢ 1.4.4 Social support and COVID-19 pandemic

The COVID-19 pandemic has disrupted social connections and support globally, including for families during pregnancy and interaction with healthcare facilities.[110-114] The reduced social support during the peripartum throughout the pandemic has been linked to increased mental health concerns particularly among marginalised communities such as migrants.[109,115-119] As mental health and stress increases risk for current and future cardiometabolic risk, services may need to consider increased surveillance post-pandemic for this group. However, experience of the pandemic has varied greatly between countries and within countries. In Australia international borders were closed for nearly two years and did not fully reopen until February 2022. This significantly impacted available social support for Australia's migrant population, particularly during the peripartum.[120,121] Within Australia, experience also has varied, metropolitan Victoria experienced extended lock-down periods however, regional area experienced scant restrictions. In NSW, Sydney metropolitan residents' lockdown experiences varied by postcode or health district. Stress, exposure to pandemics and disturbed social support all impact cardiometabolic outcomes for populations, healthcare providers and women during pregnancy. Understanding and contextualising granular experience at a local level will assist in providing information for planning and shed light on future cardiometabolic disease patterns.

An important factor to also consider in high migrant areas, is that during the pandemic social isolation and poor community connection may be compounded with existing social determinants of health. These include social inequities and structural racism that may further contribute to poor cardiovascular outcomes.[122]

1.5 Factors to mitigate cardiometabolic risk

As previously discussed, targets and strategies to reduce NCD including cardiometabolic disease, have been difficult to achieve. The overwhelming impact of the COVID-19 pandemic on global health resources is a further substantial barrier. Current estimates for global death attributable to COVID-19 range from 7 – 17 million and the International Monetary Fund forecasts the cost to the global economy to be US$12.5 trillion.[3,123] Funding for intervention strategies will be difficult in a post pandemic economy. However, some interventions to reduce cardiometabolic risk are not reliant on expensive treatments, but on behaviour change and institutional support such as exercise, improving diets and supporting breastfeeding.[124-126] It is well recognised that significant barriers exist for new mothers to engage in behaviour change and the evidence of improved health outcomes for health intervention programs is mixed.[127] Studies find adherence rates to interventions are often low, with high drop-out rates.[128,129] Appropriate consumer engagement, and investigating barriers and enablers to health interventions will assist in providing programs that meet the needs of individual populations.

1.5.1 Breastfeeding and cardiometabolic risk reduction

Among the many health benefits to infants, breastfeeding is also associated with maternal reduced cardiometabolic risk including T2DM and cardiac protection.[130-132] Breastfeeding confers cardiometabolic risk reduction for both maternal and infant health.[133,134] A recent meta-analysis of greater than a million parous women comparing no breastfeeding to lifetime breastfeeding of up to one year and found breastfeeding reduced cardiovascular disease including fatal cardiac events (pooled aHR 0.83; 95%CI 0.76–0.92).[131] The benefits of breastfeeding are also well established for infant health, these benefits include reduced risk of childhood obesity, both type 1 and type 2 diabetes and overall mortality.[135,136]

A variety of mechanisms have been postulated that may drive improved cardiometabolic outcomes for women who breastfeed for greater duration and more intensely (Figure 5). No one mechanism has been identified as the primary driver, which is not surprising, given the complex biosocial factors that surround breastfeeding, and the difficulty of capturing the individual nuances associated with breastfeeding behaviours. There are some key biological factors put forward to explain the association of improved cardiometabolic outcomes for breastfeeding women. These include weight loss, increased glucose consumption, improved insulin sensitivity, and reduced activity of the HPA-axis (Figure 5).[137,138]

Figure 5.

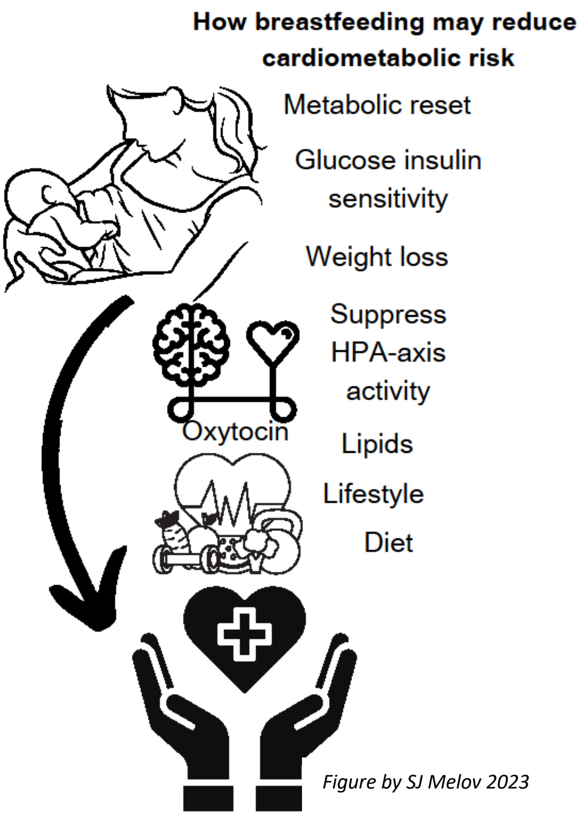


Figure by SJ Melov 2023

➢ 1.5.2 Metabolic reset and weight loss

There is biological plausibility to the explanation that disruption of the normative biological lactation process is a driver for long-term metabolic disease.[139] The insulin resistant state during pregnancy relies on placental separation and postpartum mechanisms to normalise metabolic processes postpartum. Lactation and optimal utilisation of energy stores may assist with a metabolic normalisation and increased weight loss. Greater weight loss postpartum among breastfeeding mothers is both apocryphal and researched.[140,141] Some studies have identified a lower BMI in later life for women who had breastfed[142], however other studies have not confirmed these results.[143] The meta-analysis by Jiang et al found BMI was modestly improved for breastfeeding women by -0.38kg (95%CI -0.64, -0.11kg) and the greatest benefits were in women aged under 30 years, primigravida, and who had a normal BMI pre-pregnancy.[144]

A more recent meta-analysis identified poor quality of evidence in this area.[140] A higher BMI is associated with poorer breastfeeding due partially to impaired lactogenesis.[145] Biosocial factors make it difficult to provide robust evidence with significant influence of pre-pregnancy BMI, gestational weight gain and behaviour traits such as disinhibition and dietary restraint influencing postpartum BMI.[146] Therefore, although there may be some weight loss for high intensity breastfeeding, the evidence is inconclusive that weight loss is the primary mechanising for improved cardiometabolic outcomes for breastfeeding women. However, a recent systematic review and metanalysis identified that the evidence for breastfeeding associated with a reduction in childhood obesity was clear and lower offspring cardiometabolic risk.[147]

1.5.3 Improved insulin-sensitivity lower circulating glucose

Breastfeeding, particularly high intensity, has been identified to improve postpartum insulin resistance and improve blood glucose levels.[130,148] Glucose is diverted to support milk productions in lactocytes lowering insulin requirements and demands on pancreatic β-cells.[138] Therefore, lactation reduces circulating glucose postpartum with research also identifying the importance of exclusivity of breastfeeding, as higher intensity has improved outcomes.[130,149,150] Kjos et al in 1990 demonstrated improved fasting and 2-hour blood glucose on OGTT postpartum in a cohort of 809 Hispanic women 4-10 weeks after a GDM pregnancy, comparing breastfeeding women to formula feeding.[149] Two decades later, the SWIFT study was published. This study provided the first evidence in a multiethnic GDM cohort of 522 women (310/522 [59%] exclusively or mostly breasting) at 6-9 weeks postpartum, that it was high intensity (mostly or exclusively) breastfeeding that improved fasting glucose and lowered insulin levels.[130] Several studies since and a systematic review have confirmed that women with recent gestational diabetes have improved blood glucose postpartum and reduced risk for T2DM associated with both longer duration and higher intensity of breastfeeding.[151,152]

1.5.4 Oxytocin and reduced stress

Another mechanism that may contribute to the protective impact of breastfeeding is higher levels of oxytocin in this group of women. Oxytocin modulates HPA axis activity and reduces sympathetic reactivity to stress.[153] Grewen et al identified in a group of postpartum women that were exposed to stress – public speaking and a cold stress exposure – that higher oxytocin levels improved the cardiovascular stress response.[154] A systematic review of oxytocin levels and breastfeeding, found higher levels of oxytocin were associated with longer duration of breastfeeding as well as raised prolactin, lower cortisol levels and lower levels of stress and anxiety.[155] Oxytocin is released every time a woman breastfeeds her baby, providing a mechanism to reduce stress and lower blood pressure. This may contribute to lower cardiometabolic risk long-term.

- **1.5.5 Unmeasurable other health promoting behaviours and breastfeeding**

Breastfeeding is dependent on a multitude of interacting biosocial factors that may not be easily captured in research. Factors that may not be adequately adjusted for in research include hospital policies that do not support keeping the mother infant dyad together, access to postpartum care, free or low-cost lactation support, partner attitude to breastfeeding, breastfeeding friendly workplace or pressures of social media and predatory formula companies advertising.[136] It is suggested that women who breastfeed for longer may engage in other health promoting activities or choices that promote improved cardiometabolic health. This may be true; however, evidence suggests even early postpartum benefits of breastfeeding and greater intensity can be measured with improved glucose and insulin resistance markers.[130]

Despite increasing evidence that breastfeeding reduces cardiometabolic disease risk, there remains little coordinated support from major organisations within Australia to promote breastfeeding to reduce the burden of cardiometabolic disease. Exclusive breastfeeding trends continue to decline with significant societal barriers including predatory advertising and influence of social media content undermining public health messaging.[136] This thesis provides further research of the importance of promoting, protecting and supporting breastfeeding as a foundational pillar for improving public health. Systematically assessing all women's breastfeeding history antenatally to address lactations problems should be an integral part of antenatal care. There is no available antenatal tool that scores and assesses breastfeeding intensity history. The Sydney Breastfeeding Length Intensity Scoring System (Sydney BLISS) was developed for this thesis to address this need. The BLISS check will assist in improving clinical care by providing systematic routine antenatal breastfeeding assessment and contemporaneous data to support antenatal breastfeeding education.

- **1.5.6 Implications – breastfeeding and cardiometabolic risk reduction**

Irrespective of uncovering the primary mechanisms regarding breastfeeding and improved cardiometabolic outcomes, greater duration and intensity of breastfeeding has been shown to benefit cardiometabolic health. Given the well documented infant benefits and current poor exclusive breastfeeding rates, more clearly needs to be done to support breastfeeding. Women are generally willing to engage with healthcare providers to optimise their pregnancy outcomes. Uncovering more immediate cardiometabolic gains for breastfeeding, such as reduced risk of GDM in a subsequent pregnancy, may assist with maternal understanding for exclusive breastfeeding and provide evidence for the economic benefits to provide increased funding for lactation staff.

1.6 Cardiometabolic interventions and acceptability

Risk reduction programs have attempted to address ongoing cardiometabolic consequences for women after a high-risk pregnancy including GDM. There has been varied success for interventions and recognised issues with compliance or completion of intervention programs.[128,156] Pursing an effective lifestyle intervention may have more benefit in women than men,[157] certainly postpartum is an opportune time to engage with health intervention programs for women and is often desired by women.[45,158]

The ubiquitous presence of smart phones provides an opportunity to potentially provide a lower cost health program, leveraging smart phone technology for lifestyle intervention.[126] Understanding barriers and enablers to improving long term health is important for all women postpartum, and also among a culturally diverse community who may experience social isolation and other cultural barriers.[158,159]

1.7 A summary and current gap in evidence

Cardiometabolic disease prevention is a global area of concern, and prevention strategies are supported by major health organisations. COVID-19 has presented significant barriers to health care delivery and impacted perinatal care and outcomes. Understanding the interactions of health service delivery and social interactions in our high migrant population will assist in planning for future pandemics as well as provide some understanding of drivers of cardiometabolic disease.

Increasing evidence has identified the importance of breastfeeding for maternal cardiometabolic health. However, no research has investigated the potential benefits of breastfeeding to optimise glycemic control in a subsequent pregnancy, potentially benefiting both maternal and infant health outcomes. This thesis addresses this gap in evidence.

There is a gap in the literature regarding the impact of COVID-19 on a high migrant population during the social disruption of international border closures in Australia. It is important to investigate how the disruption to international social support was perceived by migrant women and the ongoing potential bidirectional interactions with future risk of cardiometabolic disease including the impact on breastfeeding. This thesis addresses this gap in evidence.

No literature is available on breastfeeding intensity or duration and next pregnancy glycaemic control, as well as factors associated with reduced intensity and duration to provide evidence based targeted culturally competent interventions and support. This thesis addresses this gap in evidence.

1.8 Thesis hypothesis

The chapters presented will inform the overall thesis hypothesis that complex biopsychosocial factors around pregnancy influence cardiometabolic risk and can be identified to inform public health policy and guide clinical care.

1.9 Aim of thesis

There is increased awareness of the importance of exploring biosocial interactions to effectively understand disease drivers and plan health interventions. This thesis aims to explore biosocial cardiometabolic risk, focused on gestational diabetes and the protective effect of breastfeeding including factors associated with the COVID-19 pandemic.

Chapters on Breastfeeding and gestational diabetes

1. Determine the association between previous breastfeeding duration and intensity on next pregnancy oral glucose tolerance test results and recurrent gestational diabetes. (Chapter 3, 4)

2. Identify specific groups of women at risk for suboptimal breastfeeding who may then be at increased risk for cardiometabolic disease. (Chapter 4)

Chapters on cardiometabolic impact and pregnancy during the pandemic:

Interventions & acceptability - individual & service level

3. To explore the experience of maternity clinicians serving a high migrant population during the COVID-19 pandemic, including investigating perceptions of patient experience, service delivery and personal experience of living in the pandemic. (Chapter 5)

4. To explore the experience of peripartum support for women during the first year of the COVID-19 pandemic in a high migrant population. (Chapter 6)

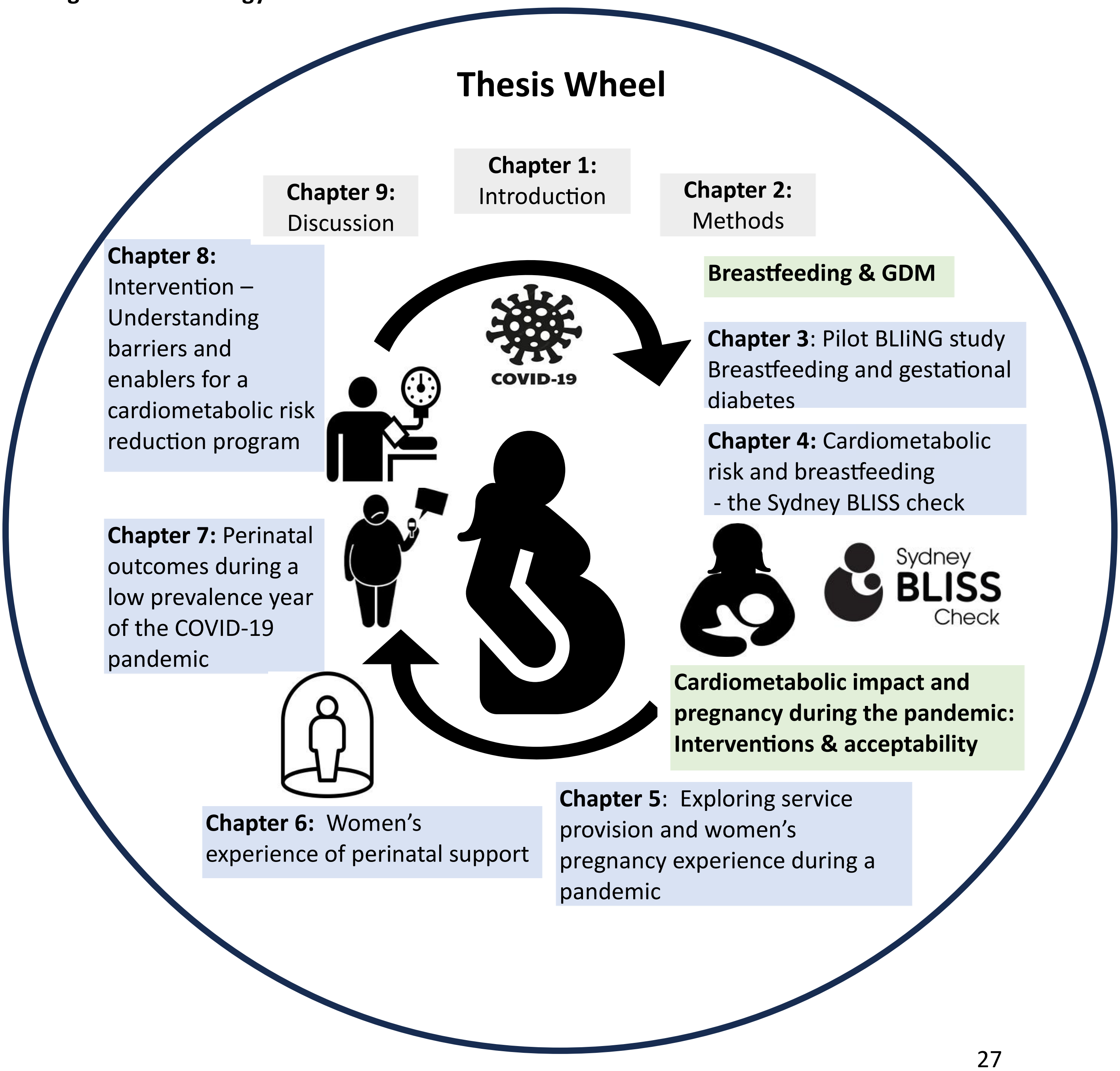
5. To identify indirect and direct pandemic-related morbidity in our large multi-ethnic Australian population and uncover potential drivers for both improved and adverse maternity care outcomes. (Chapter 7)

6. To evaluate barriers and enablers to engaging with a postpartum eHealth lifestyle intervention program to reduce cardiometabolic risk. (Chapter 8)

1.10 Chronology of thesis

This thesis has nine chapters including introduction, discussion and six research chapters (Figure 6). Chapters 3, 5, 6 and 7 are published in peer-reviewed journals and chapter 4 has been submitted for publication. Chapter 8 contains the qualitative analyses of a submitted larger randomised control trial Smart Mums2 submitted for publication. Published chapters are presented and formatted as per journal requirements and accompanied by a preface for each study.

Figure 6. Chronology of thesis



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Chapter 2
Methods

A mixed methods approach was utilised for this thesis (Table 1). This approach was chosen as optimal to provide greater understanding of the lived experience of participants to better contextualise cardiometabolic risk. This approach was particularly relevant given the considerable unknown challenges encountered during the COVID-19 pandemic. This chapter will provide an overview of the methods used in the thesis in addition to the detailed methods and analysis information provided for each study in the individual thesis chapters.

2.1 Data Sources

Data sourced to address the research aims included routine maternity information extracted after ethics approval from the electronic data system eMaternity. Due to a lack of an existing tool, data was also generated from a novel antenatal breastfeeding history assessment tool. The Sydney BLISS (Breastfeeding Length Intensity Scoring System) check was developed for this thesis and is now embedded into the eMaternity data system for routine clinical care in Western Sydney Local Health District (WSLHD). Other data sources included qualitative interview data and study specific survey instruments (Table 1).

Table 1. Summary of methods for results chapters

	Result Chapter 3 Breastfeeding: Pilot BLIiNG	**Result Chapter 4** Breastfeeding: BLISS check and GDM risk	**Result Chapter 5** COVID: Clinician experience	**Result Chapter 6** COVID: Patient experience	**Result Chapter 7** COVID: Perinatal outcomes	**Result Chapter 8** Reducing risk: SmartMums program
Aim	In a high risk for GDM population, we investigate the relationship of previous breastfeeding duration and intensity with the recurrence of gestational diabetes, and subsequent oral glucose tolerance test (OGTT) results.	In an unselected population, we investigate associations between previous pregnancy duration and high intensity breastfeeding and subsequent OGTT. We also identify populations at risk for suboptimal breastfeeding.	During the COVID-19 pandemic, we investigate maternity clinicians' perceptions of patient experience, service delivery and personal experience in a high-migrant population.	We explore women's experience of peripartum social support during the COVID-19 pandemic in a high-migrant population. We quantify type and frequency of support to identify characteristics of vulnerable perinatal populations for future pandemic preparedness.	We identify indirect and direct pandemic-related morbidity in a large multi-cultural Australian population and uncover potential drivers for both improved and adverse maternity care outcomes.	During the COVID-19 pandemic, we investigate barriers and enablers for participants receiving a text message program postpartum supporting healthy lifestyle and parenting, with feedback from an activity monitor.
Method	**Quantitative**	**Quantitative**	**Qualitative Thematic analysis**	**Qualitative Thematic analysis**	**Quantitative**	**Qualitative Thematic analysis**
Data Source	**eMaternity BLISS check[1] Survey[1] Appendix 1, 2**	**eMaternity Sydney BLISS Appendix 1**	**Interviews**	**Interviews Survey[2] Appendix 3**	**eMaternity**	**Interviews**
Participant number	**210 Participants**	**5 374 Participants**	**14 Interviews & participants**	**40 Interviews with 24 participants**	**34 103 Participants**	**14 Interviews & participants**

➢ **2.1.1 Ematernity data**

The maternity electronic information system for the WSLHD is eMaternity. This system collects data for all public hospital patients who have a pregnancy greater than 20 weeks gestation in WSLHD. Routine baseline health data is collected from the first comprehensive hospital pregnancy booking visit and further data is entered contemporaneously throughout pregnancy, birth and postpartum until discharge from the public hospital maternity service.

Access to the system and data entry is only by midwives, neonatal nurses and obstetricians and used for clinical care.

The state of New South Wales (NSW) has approximately 100 000 births per year, the eMaternity data base is used for 58% of birth records for the state.[3] Ematernity data informs the NSW state government mandatory Perinatal Data Collection (PDC) statewide monitoring for perinatal outcomes and provides data to the Australian perinatal surveillance data. [3,4] Data checks are made at a local level by an eMaternity data custodian and at a state level for all PDC mandatory fields.[4] The hospital level data and the PDC is relied on for public health planning and service delivery.

Data reports are written by the health district data custodian for local service delivery benchmarking, quality and safety committee reports. The eMaternity data custodian writes and extracts data reports for research only after approval by the district Human Research Ethics Committee (WSLHD HREC).

- **2.1.2 Interview data**

Complementing quantitative data with qualitative methodology is beneficial to understand events and to capture the 'unknown' and 'invisible' data that may exist in a research project. [5] This is of particular importance during 'unprecedented' events in current times such as those encountered during the COVID-19 pandemic. Exploring the largely unknown interactions of service delivery, social determinants and biological events are optimally captured through mixed methodology.[6]

The qualitative interview data for this thesis was audio recorded after confirming consent with all participants. A professional transcription service was employed after a one-way confidentially agreement was signed by WSLHD Research Director and the transcription provider. Interviews were transcribed verbatim and checked for errors by the interviewer (PhD candidate). Data was uploaded to the NVivo software for coding and analysis.

- **2.1.3 Breastfeeding Length Intensity Scoring System – Sydney BLISS check data**

A pilot study (Chapter 3) was undertaken to investigate the association of breastfeeding and gestational diabetes (GDM). A survey tool was administered antenatally to assess previous breastfeeding duration and intensity. No appropriate breastfeeding recall tool could be identified; therefore one was developed. Breastfeeding recall has been identified as accurate by studies to 20 years postpartum.[7,8]

The development and scoring system of the BLISS check is detailed in Chapter 3 and included consumer and expert consultation.[1] During the conduct of the pilot study a clear clinical application for the Sydney BLISS check became apparent. No assessment tool for women antenatally was available to systematically assess breastfeeding history. I was able to present the novel Sydney BLISS check tool to key stakeholders in WSLHD as a proposed triaging method to identify women with a history of breastfeeding difficulties. Stakeholder support was gained, negotiations were undertaken with the state data eMaternity data manager and private software provider. The electronic version of the tool was implemented into usual care together with a new lactation clinic and triage pathway. The Sydney BLISS paper version is included in Appendix 1. The implementation process was accelerated after I was successful in an application for a NSW Health Department Innovation Grant ($15,000) to assist with education and implementation. After reduction of district COVID-19 restrictions and a dedicated staff member was employed through the support of the Innovation Grant, uptake of the BLISS check improved.

With the assistance of a graphic designer and the Intellectual Property Manager for the Research and Education Network WSLHD, I was able to register the BLISS logo with the Australian Government as a trademark logo with a subsequent update (Figure 1).

Figure 1. The Breastfeeding Length Intensity Scoring System (Sydney BLISS) logo

Original registered **Updated registered**

https://search.ipaustralia.gov.au/trademarks/search/quick/result?q=Melov

- **2.1.4 Study specific survey data (Appendix 2 and 3)**

Two ethics approved study specific surveys (Chapter 3 and 6) were used to provide information that was not available from routine data or an established survey tool. Data collected included variables that may impact primary outcomes. The developed surveys were then reviewed and edited by the expert investigator team. Further review and editing for content and readability was undertaken in consultation with culturally diverse consumers (BLIING study chapter 3: 12 consumers, COVID patient experience study chapter 6: 8 consumers).

2.2 Variable definitions

Breastfeeding variables

Breastfeeding intensity is defined as the ratio of breastfeeding and or expressed breastmilk to formula feeding, with high intensity breastfeeding (HIBF) mostly or exclusively breastfeeding.[9] HIBF in all presented studies has been quantified through the Sydney BLISS tool. Predetermined optimal breastfeeding patterns were determined by the expert investigator team, inclusive of an International Board Certified Lactation Consultant (IBCLC). Optimal breastfeeding was defined as a Sydney BLISS score of ≥19/25 in the first three months postpartum (Appendix 1).

Breastfeeding duration is the length of time postpartum any breastfeeding or expressing and breastmilk feeding occurs. The focus is on provider (mother) not receiver (infant) benefit, therefore it is not inclusive of donor milk feeding.

The variable **'breastfeeding at discharge'** has no fixed definition. I recognised a gap in breastfeeding terminology. This is a commonly used term to assess early breastfeeding and often used for research and benchmarking breastfeeding levels between services. As a senior author during candidature, I investigated this variable for a research project conducted to improve breastfeeding terminology, this research has been presented and is submitted for publication.[10] Therefore, the definition for 'feeding at discharge' will be based on the results of this study. The term 'feeding at discharge' is defined as reflecting infant feeding patterns in the 24 hours prior to discharge.

Other variables

The socioeconomic status (SES) is assessed in the thesis studies by area level. The SES is calculated by the Australian Bureau of Statistics (ABS) data, calculated by Socio-Economic Indexes for Areas (SEIFA). The scoring is determined by information on social and economic indicators gained through the Australian census information provided by each household. The ABS SEIFA index used in this thesis is the Relative Socio-economic Advantage and Disadvantage (IRSAD) index, with a low score indicating greater social disadvantage.[11] The IRSAD was used as it is the index that includes 'Percent of people who do not speak English well', an important indicator in the high migrant population of WSLHD.

Although some researchers will use postcode-level assessment of SES this thesis has based SES level on suburbs-level data. The use of suburb area-level was determined to improve granularity as there are a greater number of suburbs in the districts than postcodes. Therefore, suburb level SES reflects a smaller geographical area and is of greater accuracy for determining SES.

Ethnicity has been used throughout this thesis, it should be acknowledged that this variable is a self-assigned designation by participants and required for all patients as part of routinely collected demographic information requested at booking or hospital admission.

Further variables are defined in each of the results chapters.

2.3 Sampling

Sampling techniques can contribute to bias and therefore require careful consideration during protocol development. Factors that contributed to the sampling approaches in this thesis included statistical power, generalisability, privacy, ethical guidelines of both the

Australian National Statement on ethical conduct in research and local ethics committee guidelines as well as feasibility.[12] Sampling methods are detailed in each chapter and further detailed below.

- **2.3.1 Quantitative sampling methods Chapters 3, 4 and 7**

Quantitative Chapter 3 The BLIiNG study: 210 participants

Convenience sampling is the most common form of non-probability population sampling.[13] Convenience sampling was chosen to recruit participants for the pilot BLIiNG study. Participants were approached in the antenatal clinics or within the first two days postpartum and invited to participate. Bias was reduced through methods such as random days for recruitment. During planning, feasibility was a key consideration in selecting convenience sampling methodology to ensure as large a sample size as possible could be obtained.

Quantitative Chapter 4 BLISS and OGTT: 5,374 participants

Feasibility and bias were the primary considerations to facilitate the largest sample from the introduction of the Sydney BLISS check. Pilot data was available from the patient population of the BLIiNG study, providing guidance. However, no data was available for an unselected population, therefore a power calculation was not possible. Pragmatic sample dates were utilised from the commencements of the BLISS check in March 2020 to the date analysis could be undertaken. To reduce bias after slow implementation at two of the participating hospitals, facility inclusion criteria was determined to be after 50% of eligible participants had completed the Sydney BLISS check.

(Chapter 5 and 6 qualitative studies)

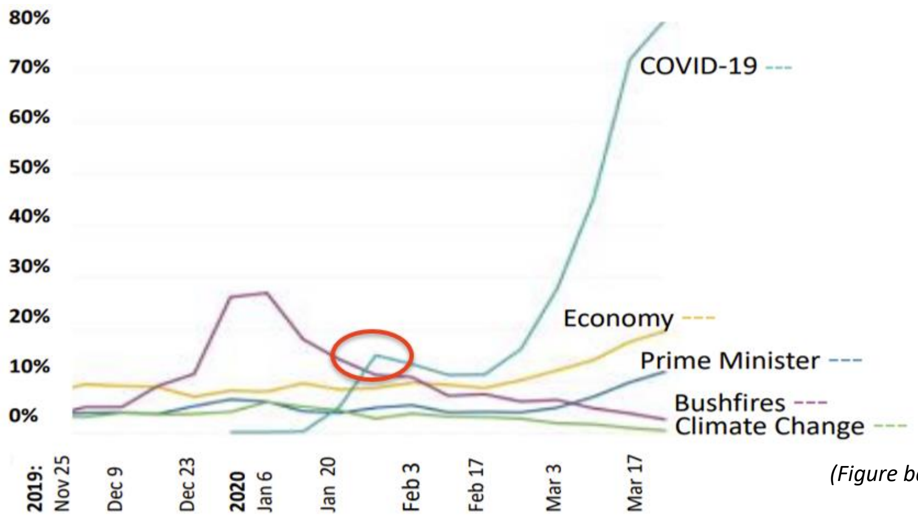
Quantitative Chapter 7 COVID perinatal outcomes: 34,103 participants

Sample periods were pre-COVID-19 complete two years to ensure adequate comparator to the first full year of the pandemic. The commencement of the COVID-19 pandemic year was determined by the high-public awareness of the evolving global crisis reflected in the documented dominance and saturation of COVID-19 news in the Australian media from 1st February 2020 (Figure 2). The COVID-19 response health service changes in WSLHD also commenced at this time. However, the full first year had a low-COVID-19 prevalence throughout the WSLHD and no COVID-19 related hospital admission for any women who was pregnant.

Pre-COVID = 1st January 2018 – 31stJanuary 2020

COVID-19 =1st February 2020 – 31st January 2021

Figure 2.
Percentage of weekly increase in Australian media online news coverage of COVID-19



(Figure based on Nolan 2021[14])

- **2.3.2 Qualitative sampling methods Chapter 5, 6 and 8:**
  52 in depth interview participants

Sampling in qualitative methodology is not usually random but purposive, selected to provide contribution of participants' data of the most appropriate rich lived experience to answer the research questions (Figure 2).[15-17]

Selection of clinician participants (Chapters 5) was purposive, from diverse areas of primary clinical engagement and models of care: antenatal clinic, postnatal ward, caseload continuity of care, postnatal home care and birth unit. Purposive sampling was also undertaken for data collection in Chapter six. The primary aim was to understand the impact of the COVID-19 restrictions inclusive of closed borders, therefore patient participants were selected from both Australian born and migrant participants, the latter from a diverse range of countries of birth.

Convenience sampling was employed for Chapter eight, a qualitative study on barriers and enablers to healthy lifestyle text messages with a step count input intervention. To reduce potential interference or bias in the SmartMums2 randomised control trial, the qualitative interviews only commenced after all participants completed the study intervention. To assist with recall of experience of the intervention, a convenience sample of the most recently completed trial participants were contacted and invited to participate in the interviews.

Figure 3.

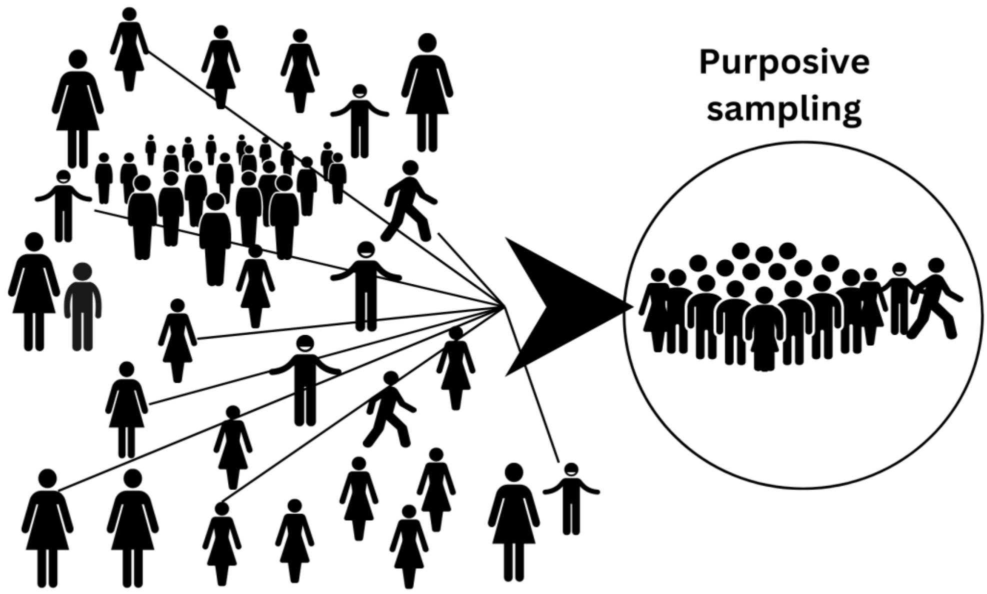


Figure by SJ Melov 2023

2.4 Analysis

Quantitative

Detailed description of statistical approach and analysis is provided in each chapter specific to research aims. Summary statistics for demographic and clinically relevant variables are presented in Table 1 of each study as percentages for categorical variables, with median and interquartile range for variables not normally distributed or mean and standard deviation if normal distribution. Multivariate regression analysis was used in quantitative studies adjusted for clinically and statistically significant confounders. The statistical approach for the three quantitative studies are detailed in chapters 3, 4 and 7.

Qualitative methodology

Exploring the largely unknown interactions of service delivery, social determinants and biological events can only really be captured through mixed methodology, therefore qualitative methodology is an essential component of this thesis. Reflective thematic analysis underpinned the qualitative methodological approach for chapters 5, 7 and 8 and utilised the six non-sequential steps as set out by Braun and Clarke.[17,18] This approach was chosen in consultation with my primary qualitative supervisor (J McNab). This approach aligned with requirements for diverse studies to be undertaken and was considered a feasible approach as I commenced candidature as a novice qualitative researcher. This approach also provided a flexible framework that was appropriate to the constant changing health services and 'unknowns' among the lived experience of health workers and patients during the pandemic.[19] Further methodological details of specific studies are described in the results chapters.

2.5 Ethical considerations

All studies in this thesis were conducted in accordance with the Australian National Statement on Ethical Conduct in Human Research (the National Statement) and were approved by the Western Sydney Local Health District Human Research Ethics committee (WSLHD HREC) (Table 2).[12] I have completed certification with Good Clinical Practice and training, and this together with my membership of the local HREC committee has underpinned theoretical understanding of ethical conduct during this thesis. Further details of ethical considerations are presented in chapters 3-8.

Table 2. Ethical approvals: Lead Human Research Ethics Committee (HREC) Western Sydney Local health District

Chapter 3 Breastfeeding: Pilot BLIiNG	**Chapter 4** Breastfeeding: BLISS check and GDM risk	**Chapter 5** COVID: Clinician experience	**Chapter 6** COVID: Patient experience	**Chapter 7** COVID: Perinatal outcomes	**Chapter 8** Reducing risk: Smartmums 2 program
HREC LNR/16/ WMEAD /404	HREC 2022/ ETH00604	HREC 2020/ ETH02074	HREC 2020/ ETH02074	HREC QA2101-15	HREC 2019/ ETH13240

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Breastfeeding and Gestational Diabetes

Chapter 3

The BLIiNG Study - Breastfeeding Length and Intensity in Gestational Diabetes and Metabolic Effects in a Subsequent Pregnancy: A Cohort Study

3.1 Preface

In Chapter 3, I commenced my investigation of sex-specific factors that may contribute to cardiometabolic disease. The investigating team was chosen to be multidisciplinary to adequately inform the complex factors affecting cardiometabolic disease. This chapter has been published and is formatted as per the journal guidelines. In this chapter I present the novel findings of a pilot study to investigate the association of breastfeeding history and glycemic control in a subsequent pregnancy. No research I am aware of has investigated the impact of breastfeeding and the benefits in a subsequent pregnancy for glycemic control as measured by routine pregnancy oral glucose tolerance test (OGTT) results. Multiparous participants were recruited during antenatal hospital visits in Western Sydney. Participants were at high risk for cardiometabolic disease as they had one previous pregnancy affected by gestational diabetes. The novel results in Chapter 3 present evidence for the first time, that both greater breastfeeding duration and intensity improved glycemic control in a subsequent pregnancy. This may potentially reduce lifetime risk of cardiometabolic disease.

Midwives are the primary health profession to deliver breastfeeding information and support. I selected a midwifery journal for submission of the manuscript to ensure the greatest opportunity to disseminate the information to the target audience. The journal 'Midwifery' is a Q1 journal for Maternity and Midwifery as well as for Obstetrics and Gynaecology.

The published manuscript is presented as Chapter 3 structured as per the journal guidelines with minor changes for thesis clarity and consistency. Published version in Appendix 4.

3.2 Dissemination of research

Peer reviewed and published

Melov SJ, White L, Simmons M, Kirby A, Stulz V, Padmanabhan S, Alahakoon TI, Pasupathy D, Cheung NW, (2022). The BLIiNG study - Breastfeeding length and intensity in gestational diabetes and metabolic effects in a subsequent pregnancy: A cohort study. Midwifery 107, 103262. https://doi.org/10.1016/j.midw.2022.103262. .

Published abstract

Melov SJ, White L, Simmons M, Kirby A, Padmanabhan S, Cheung W, Stulz V, Pasupathy D, Alahakoon TI; Greater Breastfeeding Length and Intensity After Gestational Diabetes is Associated with Improved Glucose Tolerance Test in a Subsequent Pregnancy: The BLIiNG Study (2020), Oral Abstract. **J Paediatr Child Health**, 56:54. https://doi.org/10.1111/jpc.14831

Presentation

PSANZ, Perinatal Society of Australia and New Zealand, Sydney, 29-31st March, 2021 virtual

Melov SJ, White L, Simmons M, Kirby A, Padmanabhan S, Cheung W, Stulz V, Pasupathy D, Alahakoon TI; Greater Breastfeeding Length and Intensity After Gestational Diabetes is Associated with Improved Glucose Tolerance Test in a Subsequent Pregnancy: The BLIiNG Study

3.3 Author attribution statement

I, Sarah Melov, was responsible for designing the study, project administration, survey tools, ethics submission, revision responses, consenting patients, data curation, directing analysis, interpreting the data, writing initial draft manuscript, coordinating revisions, submission of manuscript as corresponding author, drafting responses to reviewer comments and co-ordinating co-investigator comments and edits to finalise manuscript and submission.

My co-authors White L, Simmons M, Kirby A, Stulz V, Padmanabhan S, Alahakoon TI, Pasupathy D, Cheung NW, all contributed significantly to aspects of the study including study design, analysis, interpretation of findings and critical review of the manuscript.

Primary supervision for this published manuscript thesis chapter was from Prof N Wah Cheung and Prof Dharmintra Pasupathy.

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statement above is correct.

Signature:

Prof Dharmintra Pasupathy

3.4 Manuscript

3.5 The BLIiNG study - Breastfeeding length and intensity in gestational diabetes and metabolic effects in a subsequent pregnancy: A cohort study

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3.6 Abstract

Background: Gestational diabetes mellitus is associated with higher risk for developing type 2 diabetes. Breastfeeding is protective against the development of type 2 diabetes after gestational diabetes. There are no data regarding the effect of breastfeeding on the development of recurrent gestational diabetes.

Objective: Investigate the relationship of previous breastfeeding duration and intensity with the recurrence of gestational diabetes, and second pregnancy glucose tolerance test results.

Methods: We conducted a questionnaire-based pilot cohort study, enrolling 210 women during a subsequent second pregnancy, after a gestational diabetes-affected first pregnancy. Models for length and intensity of breastfeeding as predictors of the oral glucose tolerance test and for diagnosis of gestational diabetes in second pregnancy were fitted and then adjusted for possible confounders.

Results: Recurrent gestational diabetes rate in the study cohort was 70% (n=146). In a fully adjusted model high intensity breastfeeding was associated with a lower 2-hour glucose level on the oral glucose tolerance test (by .66 mmol/L, 95% CI [0.15-1.17]; p=0.01) and breastfeeding greater than six months with a lower 1-hour glucose on the oral glucose tolerance test (by .67 mmol/L, 95% CI [0.16-1.19]; p=0.01), compared to women who breastfed less intensively or for a shorter duration respectively. There was an 18% reduction in the risk of gestational diabetes if a woman breastfed for more than six months (RR 0.82, 95% CI [0.69–0.98]; p=0.03). The association was attenuated in the fully adjusted model (RR 0.89, 95% CI [0.78–1.02]; p=0.09).

Conclusions and implications for practice: We found the risk of recurrent gestational diabetes was reduced by both increased duration and intensity of breastfeeding. Antenatal

lactation education should be embedded into care pathways for women diagnosed with gestational diabetes.

3.7 Introduction

There is a global rise in the incidence of gestational diabetes mellitus (GDM), with current rates documented to be between 5–36% of pregnant women, dependent on the population, screening and diagnostic criteria.[1-3] GDM is associated with a significant burden for women and their families including adverse perinatal outcomes, psychological impact and long-term cardiometabolic health consequences.[4,5] It is important to identify modifying factors that can reduce GDM and improve pregnancy outcomes for women and infants through targeted use of health resources.

Women who have GDM in their first pregnancy have up to a 13-fold increased risk of GDM in their second pregnancy.[6,7] Every subsequent pregnancy after a GDM-affected pregnancy has a compounding risk of GDM and progression to type 2 diabetes.[7] Strategies to reduce recurrent GDM and type 2 diabetes are important public health measures for the community.

The benefits of breastfeeding to infants are well documented[8] and have resulted in ongoing programs worldwide to improve breastfeeding rates. Less attention has been given to the maternal benefits. Increasing evidence indicates that breastfeeding intensity and the total length of time a woman breastfeeds during her life can positively influence her health and result in an improved cardiometabolic risk profile.[9-13]

There is a growing body of evidence demonstrating the association between breastfeeding and a reduction in type 2 diabetes.[12,14,15] Stuebe hypothesized that early, high intensity lactation may be crucial in the "resetting" of an endocrine balance from an insulin-resistant state in pregnancy, and, without the lactation-mediated reset, there may be long-term cardiometabolic health consequences.[16] Researchers have demonstrated that with a greater lifetime-years of maternal breastfeeding there is a corresponding risk reduction for type 2 diabetes. [11,17] Research using data from the Nurses' Health Study found that for every extra lifetime-year of breastfeeding, there was a 15% reduction in the risk of type 2 diabetes for women who had a pregnancy in the last 15 years.[14] However, there are as yet no data regarding any potential protective effect of breastfeeding reducing the development of recurrent GDM.

The primary aim of this study of women who had GDM during their first pregnancy**,** was to determine the association between previous breastfeeding duration and intensity on recurrence of gestational diabetes. We also sought to determine the effect of breastfeeding duration and intensity on the parameters of the glucose tolerance test results in the second pregnancy.

3.8 Methods

This was a multisite pilot cohort study in Western Sydney, Australia with retrospective and prospective data collection. The study was approved by the Western Sydney Local Health District (WSLHD) Human Research and Ethics Committee (LNR/16/WMEAD/404), all participants provided informed consent.

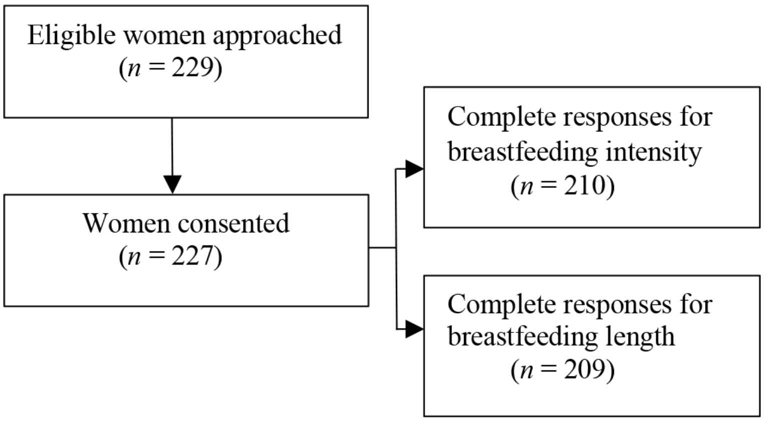
Sample

Women who were over 20 week's gestation in a second pregnancy after a first pregnancy that had been affected by GDM were our target population for this pilot study. Recruitment occurred from 2017 to 2019. Inclusion criteria were GDM in a first pregnancy, greater than 20 week's gestation, over 18 years of age and able to give informed consent. Exclusion criteria were pre-existing diabetes, pre-term first pregnancy (< 37 weeks), multiple birth first pregnancy, a history of more than three miscarriages, fetal anomaly or stillbirth. Women who had care in their first pregnancy in a country other than Australia were also excluded from the study to improve homogeneity of GDM screening, diagnosis and treatment.

Eligible women for this study were identified through the electronic maternity database from information provided at their booking visit. All participants were recruited prior to the results of the oral glucose tolerance test (OGTT) being accessed by the researchers. A total of 229 eligible women were approached with a final sample for analysis of 210 women for breastfeeding intensity and 209 available for length of breastfeeding (Figure 1).

There is no previous study on which to base sample size calculations and one purpose of this pilot study was to obtain estimates for length and intensity of breastfeeding and outcomes to inform future studies which could then be appropriately powered.

Figure 1. Sample Size diagram



Measurement

For all participants, details of their current (second) pregnancy and the results of their pregnancy OGTT and booking BMI were collected from their medical record.

First Pregnancy and Demographic Information

Participants provided details about their first pregnancy and demographic information by completing the study-specific BLIiNG (Breastfeeding Length Intensity iN Gestational diabetes*)* questionnaire (Appendix 2). As an existing appropriate and validated antenatal GDM risk and breastfeeding recall instrument was not identified by the researchers, the customised BLIiNG questionnaire was developed. An expert panel, including International Board Certified Lactation Consultants (IBCLC), endocrinologists and a maternal fetal medicine specialist, developed the BLIiNG breastfeeding questionnaire instrument which incorporates the BLISS® (Breastfeeding Length and Intensity Scoring System, Appendix 1). Testing of the questionnaire among our target population was undertaken, and revisions were made based on feedback. The result was a final simple questionnaire design appropriate for our multi-ethnic population. After revision, 92% (11/12) of participants agreed or strongly agreed that the questions were easy to understand and **"**accurately records how I fed my baby**"**.

Terminology of infant feeding research can be separated to receiver/infant or provider/lactation focused. [18] This study's focus was on **"**provider**"** benefit of breastfeeding, therefore researcher's defined exclusive breastfeeding from maternal research participant (provider) perspective. This was explained to study participants by the research interviewer as an infant receiving only the infant's mother's milk by direct breastfeeding or participants expressed milk from a device.

Breastfeeding intensity is a determination of the amount of maternal breastfeeding inclusive of expressing, relative to formula feeding. The highest intensity is mostly or exclusively breastfeeding, and the lowest intensity is mostly formula feeding. The BLISS score gives levels of intensity and these were validated by two IBCLC**s** based on typical optimal feeding patterns. The maximum BLISS score was 25. Assessment of infant feeding by BLISS occurred via maternal recall for the time periods as follows; the first week post-partum (score/6), during the first month (score/7), one to three months (score/6) and at three months (score/6). Breastfeeding only at any time point was given full marks, formula only feeding scored 0, and scores were incrementally reduced for 1–4 formula feeds a week, 1–3 per day, with four or more formula feeds per day scoring similar or equal to full formula feeding. A woman who exclusively breastfed her infant from birth would score 25. High intensity breastfeeding was classified as a score between 19–25, moderate intensity 7–18, and a low-intensity score was defined as between 0–6.

At the participating hospitals, GDM was diagnosed on the basis of a 75g OGTT using the 1998 Australasian Diabetes in Pregnancy Society criteria. [19] GDM was diagnosed if the fasting blood glucose level was ≥5.5 mmol/L and/or the 2-hour glucose was ≥8.0 mmol/L. The glucose level at 1 hour was also routinely collected but not used for diagnostic purposes. All pregnant women were tested for GDM at 24–28 weeks' gestation, and earlier if clinically indicated.

Standard treatment for GDM included blood glucose monitoring, dietician review, and insulin treatment if glucose targets were not met. One hospital also used metformin. All women were advised to maintain a similar healthy diet after the birth of their baby and have follow-up with their family doctor.

Data collection

Eligible women were approached in the antenatal clinic or in hospital during the first two days postpartum, after completion of their second pregnancy. Participants who had been identified as eligible were approached and provided with written and verbal information about the study prior to signing a consent form and then completing the study self-administered questionnaire.

Data analysis

Demographic and clinical variables were summarized and compared between GDM groups, with percentages for categorical variables and median and interquartile range (IQR) for continuous variables, as not all were normally distributed. The relationships between length of breastfeeding and the BLISS score with the development of GDM in the current pregnancy, and each glucose time point of the OGTT, were analysed using a linear regression model. The risk of the development of GDM did not increase linearly with either increasing length of breastfeeding or BLISS score so these predictors were dichotomised for these models. Both the models for OGTT and for diagnosis of GDM were fitted unadjusted and then adjusted for medical treatment of GDM in the first pregnancy, BMI as ≥30 kg/m^2 or <30 kg/m^2, age at current pregnancy ≥30 or <30 years old, and ethnicity as self-identified Caucasian, South Asian or other. Family history of any diabetes was assessed but did not contribute to any model so was excluded. There was no imputation of missing data and no adjustment for multiple comparisons. All analyses were done with SAS 9.4 SAS Institute Inc., Cary, NC, USA.

3.9 Results

Recurrent GDM was diagnosed in 146 (70%) of the 210 women in the study cohort. For the total cohort the majority of women were born overseas with 39 (19%) born in Australia and most of self-identified ethnicity was stated as South Asian (52%), with Caucasian the next most frequently identified group (16%). Demographics were similar between women diagnosed with GDM and those in the non-GDM group (Table 1). The mean (SD) age for participants in the GDM group at second pregnancy was 34 (3.6), higher than the age of the participants in the non-GDM group which was 33 (4.4). There was no difference between the two groups in years between first and second pregnancy (both means = 3 (2)). There was also no difference between the two groups in BMI at second pregnancy booking, with median BMI 26 (IQR = 22-27) for women in the GDM group and 25 (IQR = 23-30) in the non-GDM group. However, there was a significant difference for obesity (BMI ≥30), greater in women with recurrent GDM (Table 1).

There was no difference in median first pregnancy breastfeeding duration between women diagnosed with GDM and those in the non-GDM group (non-GDM median = 11 months, IQR = 3–17; GDM median = 7 months, IQR = 3-15; $p = 0.16$). All women commenced breastfeeding after their first pregnancy. Of the 209 women who provided length of breastfeeding data, 43 (21%) breastfed for less than three months, between 3 – 6 months 49 (23%) women stopped breastfeeding and 117 (56%) of the cohort breastfed longer than six months. In the total cohort, 49 (23%) had a low intensity BLISS score and 36 (73%) of these women breastfed for less than three months (Table 2).

The most common reason women gave for stopping breastfeeding was “I didn’t think I had enough milk” (34%).

The relationship between previous breastfeeding duration and intensity and recurrent gestational diabetes

Women who breastfed ≤6 months were more likely to have GDM (71/92, 77%), compared to women who breastfed >6 months (74/117, 63%). This equates to an 18% risk reduction associated with breastfeeding >6 months (RR 0.82, 95% CI [0.69–0.98]; $p = 0.03$) (Table 3). Duration of breastfeeding greater than six months remained a significant predictor for reduced GDM diagnosis when adjusted for age (RR 0.79, 95% CI [0.67–0.94]; $p = 0.01$) or BMI (RR 0.84, 95% CI [0.70–1.00]; $p = 0.05$). After adjusting for both age and BMI there remained a 19% reduction in the risk of GDM if a woman breastfed for more than six months (RR 0.81, 95% CI [0.68–0.96]; $p = 0.01$). The association was attenuated in the fully adjusted model with the following confounders, medical treatment of GDM in the first pregnancy, BMI, maternal age and ethnicity (RR 0.89, 95% CI [0.78–1.02]; $p = 0.09$) (Table 3).

Table 1. Characteristics of women who were diagnosed with recurrent gestational diabetes in their second pregnancy (*N* = 210)

		GDM 2nd Pregnancy		
		GDM Not Diagnosed *n* = 64 (30%)	GDM Diagnosed *n* = 146 (70%)	
Outcome		*n (%)*	*n (%)*	*p-value*
Mean age (SD)		33 (4.4)	34 (3.6)	0.09
Australian born				
	Yes	16 (41%)	23 (59%)	0.11
	No	48 (28%)	123 (72%)	
Self-identified ethnicity*				
	Caucasian	14 (42%)	19 (58%)	0.08
	South Asian	28 (26%)	81 (74%)	
	Chinese	5 (19%)	21 (81%)	
	Middle Eastern	7 (54%)	6 (46%)	
	Other	9 (33%)	18 (67%)	
First degree family history of diabetes*				
	Yes	31 (28%)	80 (72%)	0.47
	No	30 (33%)	62 (67%)	
GDM first pregnancy details				.
GDM-medicated 1st pregnancy		24/64 (38%)	69/146 (47%)	0.19
Practiced cultural rest[b] 1st pregnancy*		25/63 (40%)	72/142 (51%)	0.14
Caesarean section birth 1st pregnancy*		39/62 (63%)	93/143 (65%)	0.77
Baby admitted Special Care/NICU*		15/63 (24%)	46/145 (32%)	0.25
BMI at second pregnancy booking				
Median (IQR)		25 (23-30)	26 (22-27)	
≥30		8 (17%)	38 (83%)	0.03
<30		56 (34%)	108 (66%)	

GDM = Gestational Diabetes Mellitus
[a]Insulin or metformin: Insulin (n = 82), metformin (n = 10), both (n = 1)
[b]Cultural tradition of resting postpartum for a set number of days
*Missing values on: Self-identified ethnicity (n = 2), First degree family history of diabetes (n = 7), Practiced cultural rest, 1st pregnancy (n = 5), Caesarean section birth 1st pregnancy (n = 5), Baby admitted to Special Care/NICU (n = 2).

Table 2. Relationship between total length of any breastfeeding and breastfeeding intensity score (BLISS) (*N* = 209)

Length of time breastfeeding	Low	Moderate	High
	BLISS 0–6 *n* = 49 *n* (%)	BLISS 7–18 *n* = 49 *n* (%)	BLISS 19–25 *n* = 111 *n* (%)
⩽1 month	26 (53)	2 (4)	0 (0)
<3 months	10 (20)	4 (8)	1 (1)
3–6 months	9 (18)	22 (45)	18 (16)
>6–12 months	2 (4)	11 (22)	30 (27)
>12 months	2 (4)	10 (20)	62 (56)

BLISS = Breastfeeding Length and Intensity Scoring System

Women who breastfed in the high intensity range (≥19 BLISS; 63%) had a 17% reduction in the risk of being diagnosed with GDM compared to lower intensity breastfeeding groups, (<19 BLISS, 71/112 (63%) vs. 75/98 (77%), p = 0.04) (Table 3). In the adjusted model that included age and BMI, there was a 22% reduction in GDM (RR 0.78, 95% CI [0.63–0.96]; *p* = 0.02). However, in the fully adjusted model, the association between BLISS score groups and GDM diagnosis was attenuated (RR 0.90, 95% CI [0.77–1.05]; *p* = 0.17) (Table 3).

Table 3. Association between gestational diabetes and length/intensity of breastfeeding (*N* = 210)

	Length of breastfeeding and percent of GDM (*N* = 209)			
	≤6 months	>6 months	RR (95% CI)	*p*-value
Unadjusted [a]	71/92 (77%)	74/117 (63%)	0.82 (0.69, 0.98)	0.03
Adjusted [a,b]			0.89 (0.78, 1.02)	0.09
	Intensity of Breastfeeding by BLISS score (*N* = 210)			
	<19 (low–medium)	≥19 (high)	<19 vs. ≥19 (95% CI)	*p*-value
Unadjusted	75/98 (77%)	71/112 (63%)	0.83 (0.69, 0.99)	0.04
Adjusted [b]			0.90 (0.77, 1.05)	0.17

Length of breastfeeding and percent of GDM (*N* = 209)
GDM = Gestational Diabetes Mellitus BLISS = Breastfeeding Length and Intensity Scoring System
The full model was adjusted for medical treatment of GDM in first pregnancy, BMI ≥30, maternal age at second pregnancy, ethnicity.
Missing values: [a] length of breastfeeding 1, [b] ethnicity 2.

The relationship between previous breastfeeding duration and intensity with the glucose tolerance test result

After adjusting for confounders (medical treatment of GDM in first pregnancy, BMI, maternal age at second pregnancy, ethnicity), breastfeeding greater than six months was associated with a lower mean 1-hour glucose result on the OGTT (by .67 mmol/L, 95% CI [0.16-1.19] p = 0.01) and women in the high intensity breastfeeding group had a lower 2-hour glucose result of .66 mmol/L (95% CI [0.15-1.17]; p = 0.01) (Table 4). There were no significant associations between any of the other glucose results and duration or intensity of breastfeeding.

Table 4. Relationship between first pregnancy length/intensity of breastfeeding and subsequent Second pregnancy oral glucose tolerance test blood glucose result (*N* = 210)

Adjusted	Length of breastfeeding [a,b]			
	≤ 6mths *M (SD)*	> 6mths *M (SD)*	Mean difference (95% CI)	*p*-value
Fasting	4.9 (0.8)	4.8 (0.6)	0.05 (-0.13, 0.24)	0.56
1 hour	10.5 (2.2)	9.8 (1.9)	0.67 (0.16, 1.19)	0.01
2 hour	8.6 (1.9)	8.1 (1.9)	0.51 (-0.01, 1.02)	0.05
	Intensity of breastfeeding [b]			
	BLISS <19 *M (SD)*	BLISS ≥19 *M (SD)*		
Fasting	4.9 (0.8)	4.8 (0.6)	0.05 (-0.13, 0.23)	0.61
1 hour	10.4 (2.3)	9.8 (1.8)	0.40 (-0.12, 0.93)	0.13
2 hour	8.7 (2.0)	8.0 (1.8)	0.66 (0.15, 1.17)	0.01

Note. Oral glucose tolerance test results were measured in mmol/L CI = Confidence Interval
BLISS = Breastfeeding Length Intensity Scoring System BLISS ≥19: high intensity breastfeeding
[a]1 length of breastfeeding missing: total 209
[b]Missing values: GTT 1 hour 8, 2 hours 1, ethnicity 2.
Adjusted: Maternal age 2nd pregnancy, ethnicity, BMI, treatment of GDM in first pregnancy

3.10 Discussion

We found that both increased duration and intensity of breastfeeding following a GDM-affected pregnancy were associated with a reduction in the risk of developing GDM in a subsequent pregnancy. Furthermore, breastfeeding duration and intensity influenced the glucose levels of the OGTT performed during the subsequent pregnancy.

These novel findings give added significance to the benefits of breastfeeding. Breastfeeding is known to improve long-term outcomes for the mother and child, but our data suggests that it may potentially also improve outcomes for future offspring. By protecting against GDM in subsequent pregnancies, the fetal environment will be more favourable and adverse fetal programming effects will be minimised.

Age and obesity are significant known risk factors for the development of GDM.[1,3] After adjusting for these factors we still found breastfeeding greater than six months led to a 19% reduction in GDM. The attenuation of the association in the fully adjusted model which included GDM treatment medication use in the first pregnancy, may be a reflection of the modest size of the cohort. This may also indicate for women with poorly controlled GDM who require insulin, the impact of breastfeeding may not be as significant. Insulin use for the management of GDM is known to be associated with increased risk of recurrence of GDM and reflects more severe morbidity risk.[20,21] It is plausible that lifestyle interventions and breastfeeding for this group of women are less likely to modify progression to type 2 diabetes or GDM recurrence. This highlights the need for targeted interventions appropriate for subgroups of women. The underlying biometabolic mechanism for increased recurrence risk of GDM among some ethnic groups may well be a stronger driver for dysglycemia than any benefits derived from breastfeeding. There are high estimates of GDM recurrence in some ethnic groups, the highest risk is reported among Asian Indian women.[22,23] This varied risk by ethnicity potentially underlies the attenuation of breastfeeding benefit in the adjusted analysis among a cohort with a high proportion of south Asian women.

There is evidence that there may be a significant interaction between obesity and the effect of breastfeeding on the improvement of insulin sensitivity. One study found women who breastfed at high intensity had a lower homeostasis model assessment (HOMA-IR; Homeostatic Model Assessment of Insulin Resistance) at 6–10 weeks' postpartum, and only evident in obese women.[24] Although research has found all women may benefit with improved long-term cardiometabolic health from breastfeeding[10], further research is required to identify if specific groups of women with GDM receive greater benefit from breastfeeding for protection against recurrent GDM.

Studies to date have largely focused on the association between breastfeeding and non-pregnancy glycaemic outcomes.[15] The SWIFT study was the first prospective investigation of breastfeeding intensity and hyperglycemia.[25] The investigators found an association between higher intensity breastfeeding and improved postpartum OGTT levels. As early as 6–9 weeks postpartum, a greater intensity of breastfeeding in women with GDM resulted in a lower fasting plasma glucose level as measured at their postpartum OGTT and a dose response to improved HOMA-IR. The SWIFT study investigators also demonstrated that there was a dose-protective response of intensity and length of breastfeeding for type 2 diabetes risk two years after the GDM pregnancy.[25]

Although there are benefits of breastfeeding for women who have had GDM, evidence suggests that these women have greater difficulty breastfeeding than unaffected women.[26,27] Women with GDM have more issues establishing breastfeeding, experience delayed lactogenesis, breastfeed for a shorter duration than other women and experienced practices in the hospital that are known to negatively impact on long-term breastfeeding.[28,29] The importance of breastfeeding for women with GDM therefore requires greater understanding for effective, targeted lactation support. Careful consideration should be given to protocols whereby babies of women with gestational diabetes are routinely admitted to special care nurseries as this may negatively impact breastfeeding success.[29] Obese or overweight women are at higher risk of GDM and are more likely to have a reduced prolactin response to infant feeding after birth, negatively impacting milk production and successful breastfeeding.[30,31] Mechanical barriers also exist for obese women with positioning problems attaching a small newborn contributing to greater breastfeeding difficulties together with important psychological barriers that have been identified for this group.[32,33]

All women in our study commenced breastfeeding but 21% stopped before three months, nearly all these women had a low BLISS score. This may indicate that lactation issues existed but were not adequately addressed, with low milk supply the most common reason given for stopping breastfeeding. The majority of women in the study were born in another country, cultural barriers and low health literacy may also be factors that contribute to women not accessing appropriate lactation support and should be investigated to improve service delivery.

Breastfeeding intensity and duration can be improved through appropriate education and consistent advice that ideally includes both antenatal and postnatal care.[34] Novel engagement with the use of text-based support has been investigated, with one group of investigators[35] suggesting the best predictor for exclusive breastfeeding was strong engagement in the first two weeks postpartum using two-way lactation consultant texting support. Stuebe et al. found that woman with GDM were less likely to stop breastfeeding or introduce formula at six weeks when provided with a pre- and postnatal lifestyle intervention program that included breastfeeding text-based support.[36]

Provision of comprehensive lifestyle and breastfeeding support for women with GDM requires investment in additional staff time and resources. However, our study and others have demonstrated that optimal breastfeeding for women with a history of a GDM pregnancy reduces the risk of the mother developing type 2 diabetes and other cardiometabolic disorders. A reduction in hyperglycemia in a subsequent pregnancy also negates some of the maternal and fetal risks associated with GDM. The savings from this are likely to offset the investment in the provision of breastfeeding support. There is a growing awareness of the rising worldwide economic implications for health service delivery associated with GDM.[37] It is a financially judicious use of health resources to support early prevention for cardiometabolic disease and a unique opportunity to engage women in health intervention programs that include breastfeeding support during pregnancy and the postpartum period.

We are not aware of any published methods for the routine assessment of previous breastfeeding intensity. This is important as duration of breastfeeding by itself does not necessarily reflect early breastfeeding issues. Low intensity breastfeeding may occur early postpartum; however a small percentage of mothers will persist despite extreme difficulties

(Table 2). Women who breastfeed more successfully with greater intensity tend to breastfeed longer.[38] The BLISS check is therefore a novel means of assessing breastfeeding intensity through a maternal recall questionnaire. Evaluation of previous breastfeeding is an important component of the pregnancy and postpartum evaluation, and this can easily be established as a routine tool for use by clinicians. The findings of our study suggest that the BLISS® may be a useful clinical tool with routine clinical use under evaluation in our health district (Appendix 1). Further research on the utility of the BLISS check for antenatal triaging to appropriate lactation support and its use in research is warranted. Certainly, capturing both length and intensity routinely can lead to improved personalised targeted breastfeeding support and may elucidate the impact high intensity breastfeeding may have as a metabolic reset on long-term maternal cardiometabolic health.

The high participation rate of women gave our study strength and reduced potential recruitment bias. This suggests that women are interested in breastfeeding and are keen to discuss their breastfeeding history and associated problems. This also suggests the need for more antenatal breastfeeding support that provides an appropriate clinical avenue for breastfeeding counselling and information. Ethnic diversity is an additional strength of our study and informs the capacity to extrapolate the results to other populations.

We have demonstrated that a greater intensity of breastfeeding could potentially reduce glycemia and recurrent GDM in pregnant women who have had a previous GDM-affected pregnancy. Although a randomized controlled trial of breastfeeding will not be possible, prospective studies would be informative and this pilot will inform our larger population study. Breastfeeding may also reduce future type 2 diabetes and cardiovascular disease risk for the mother and is known to provide benefits to the health of the infant. Further routine support for the promotion and facilitation of breastfeeding should be implemented inclusive of early parenting education and antenatal assessment of previous breastfeeding experience.[39]

The limitations of our study include potential recall bias. In the literature, however, maternal recall of breastfeeding history has been validated as a reliable method to determine infant feeding history.[40,41] In a Norwegian study, recall of duration of breastfeeding was found to be accurate after 20 years with a median over-estimation of only two weeks. [41] The recall bias in our BLIiNG study would be less, as all participants had only one previous pregnancy and feeding details to remember. The same recall limitation would exist for both GDM and non-GDM groups and the mean time between births was three years for both groups. Another limitation of this study is the lack of some data that may be potentially important, such as first pregnancy morbidity, current/previous pregnancy diet, BMI and between pregnancy weight gain.

Conclusion

There is concern about the high incidence of GDM and its recurrence. Much of the focus among women who have had GDM is to reduce obesity and improve lifestyle in between pregnancies. However, programs aimed at these risk factors are challenging, resource intensive, and have in general met with little success.[42,43] On the other hand, breastfeeding is already encouraged, and for the majority of women, is acceptable, and can be undertaken successfully. Yet this has largely been neglected in the GDM and diabetes prevention literature.

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Breastfeeding and Gestational Diabetes

Chapter 4

The Association Between Previous Pregnancy Breastfeeding and Subsequent Pregnancy Oral Glucose Tolerance Test

4.1 Preface

In this chapter I present further investigation of cardiometabolic risk reduction in an unselected population through understanding the association of breastfeeding and next pregnancy oral glucose tolerance test (OGTT) results. The consumer's voice is increasingly recognised as important. The multidisciplinary team has been improved with the inclusion of an official district consumer who has a special interest in lactation. I have provided a lay summary of findings at various stages of the project to assist with the consumers contribution to analysis and revisions of the manuscript.

As previously described in this thesis I implemented a novel breastfeeding assessment tool the Sydney BLISS check into routine clinical care and electronic data collection in 2020. This tool was developed as part of this thesis and presented in Chapter 3. This implementation improved antenatal lactation support in our health district and provided data for this chapter. In this chapter I present evidence in a large, unselected population that high intensity breastfeeding reduces the risk of an abnormal fasting OGTT during pregnancy. This provides further evidence that optimal breastfeeding reduces cardiometabolic risk.

The manuscript is presented as Chapter 4 and structured as per the journal guidelines with minor formatting changes for thesis consistency.

4.2 Dissemination of research

Submitted for peer review publication.

Published abstract

Melov SJ, White L, Elhindi J, McNab J, Lee V, Donnolley K, Alahakoon TI, Padmanaban S, Cheung NW, Pasupathy D. The association of previous pregnancy high intensity breastfeeding and subsequent pregnancy glucose tolerance; Journal of Paediatrics and Child Health, March 2023; 59: 54

Presentation

Sydney Health Partner's Reproductive, Maternal and Newborn Health Clinical Academic Group Workshop and Information Day: Implementation Science and Research Translation in Reproductive, Maternal and Newborn Health; 17th Feb 2023; **Melov SJ**, From BLIiNG To BLISS: Implementing a novel antenatal breastfeeding assessment tool

PSANZ: Perinatal Society of Australia and New Zealand, 5th - 8th March Melbourne, 2023

Melov SJ, White L, Elhindi J, McNab J, Lee V, Donnolley K, Alahakoon TI, Padmanaban S, Cheung NW, Pasupathy D The Association of Previous Pregnancy High Intensity Breastfeeding and Subsequent Pregnancy Glucose Tolerance

Prize: New investigator Award

Australian College of Midwives Conference 2023 Hunter Valley NSW, 24-26 March

Melov SJ, White L, Elhindi J, McNab J, Lee V, Donnolley K, Alahakoon TI, Padmanaban S, Cheung W, Pasupathy D; The Association of Previous Pregnancy High Intensity Breastfeeding and Subsequent Pregnancy Glycaemic Control

Women's Healthcare Australasia Webinar series 25th of July 2023

Melov SJ: Investigating reduction of cardiometabolic risk: Breastfeeding and Subsequent Pregnancy Glucose Metabolism

LCANZ Education Seminar – Westmead Hospital 31st August 2023

Melov SJ: From BLIiNG to BLISS: using a breastfeeding assessment tool in routine data - the benefits to clinical care and research

4.3 Author attribution statement

I, Sarah Melov, was responsible for designing the study, project administration, development and implementation of the Sydney BLISS check into the electronic data system eMaternity, ethics submission, revision responses, electronic data extraction, data curation, directing analysis, interpreting the data, writing initial draft manuscript, coordinating revisions with co-authors, submission of manuscript as corresponding author.

My co-authors Elhind J, White L, McNab J, Lee V, Donnolley K, Alahakoon TI, Padmanaban S, Cheung NW, Pasupathy D all contributed significantly to aspects of the study including study design, analysis, interpretation of findings and critical review of the manuscript.

Primary supervision for this thesis chapter was by Prof Dharmintra Pasupathy.

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statement above is correct.

Signature:

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4.4 Manuscript

4.5 The Association Between Previous Pregnancy Breastfeeding and Subsequent Pregnancy Oral Glucose Tolerance Test

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4.6 Abstract

Background

Gestational diabetes mellitus (GDM) is a common pregnancy complication that has significant maternal and infant health implications including increased risk of cardiometabolic disease. Breastfeeding is associated with reduced lifetime cardiometabolic risk, but little is known of the metabolic benefit in a subsequent pregnancy. We aimed to investigate associations between previous pregnancy high intensity breastfeeding (HIBF) and duration and oral glucose tolerance test (OGTT) results in a subsequent pregnancy. Our secondary aim was to identify populations at risk for suboptimal breastfeeding.

Methods

A retrospective cohort study was conducted March 2020–October 2022. Analysis was stratified by risk for GDM. The routine clinical care tool Breastfeeding Length Intensity Scoring System (Sydney BLISS) was used to assess breastfeeding intensity. The association between duration and HIBF and subsequent pregnancy OGTT were assessed with multivariate logistic models adjusted for statistically and clinically relevant covariables.

Results

In 5,374 multiparous participants 61.7% had previously breastfed > 6 months and 43.4% were at high risk for GDM. HIBF was associated with 47% reduced odds of an abnormal fasting glucose in a subsequent pregnancy OGTT (aOR 0.53; 95% CI 0.38–0.75; $P < 0.01$). There was no association between HIBF and the one and two-hour glucose result on the OGTT. Six characteristics were associated with both reduced duration (≤ 6 months) and lower intensity of breastfeeding: Aboriginal/Torres Strait Islander ethnicity, previous cesarean section birth, preterm birth, smoking, obesity and a history of a mental health condition. Women who smoked were the group least likely to breastfeed at high intensity (aOR 0.31; 95% CI 0.21–

0.47; $P < 0.01$). South Asian women had 65% higher odds of HIBF than women who identified as White/European (aOR 1.65; 1.36–2.00; $P < 0.01$). The age group that had the lowest mean duration of breastfeeding was women < 25 years old (6 months: IQR 2–13).

Conclusions

There has been a global rise in cardiometabolic disease, with significant mortality percentage increase due to diabetes. This study highlights the importance of promoting and protecting exclusive or mostly breastfeeding to potentially reduce the prevalence of GDM and may also translate into long-term reduction of cardiometabolic risk.

4.7 Background

Women who breastfeed for a greater duration and more exclusively have a reduced lifetime risk of type 2 diabetes as well as an improved cardiometabolic profile.[1-3] Breastfeeding is supported by groups such as The World Health Organization (WHO) who recommend exclusive breastfeeding as critical for infant health for the first six months of life, and continued breastfeeding to age two and beyond.[4] Further to well-established infant health advantages of breastfeeding, there are recognized global economic cost savings linked to the reduction in maternal and infant mortality and morbidity as well as environmental benefits associated with breastfeeding.[5,6] However, exclusive breastfeeding rates remain obstinately low, with little chance that the WHO global target of 70% exclusive breastfeeding during the first six months will be met by the target year of 2030.[7]

Gestational diabetes (GDM) rates vary according to diagnostic criteria and population; estimates are between 4% and 28% with a documented rising prevalence.[8,9] Women with GDM have a lifetime twofold increased risk of cardiovascular disease (CVD) and an estimated six to tenfold maternal future risk of type 2 diabetes.[10,11] The rise in global mortality from non-communicable disease (NCD) is a global health crisis, recognized by the United Nations Sustainable Development Goal to reduce NCD preventable mortality by one-third by 2030.[12] To help meet these targets urgent preventive measures are required to reduce the incidence of GDM and thereby maternal and infant type 2 diabetes risk. Various strategies have been adopted, aimed at lowering the prevalence of GDM and type 2 diabetes, focusing principally on lifestyle intervention, with inconsistent findings.[13,14] However, breastfeeding as a type 2 diabetes prevention measure has been inadequately supported despite evidence of reducing the relative risk of type 2 diabetes risk by 50%.[15] The impact of previous breastfeeding on GDM risk in the next pregnancy is largely unknown. Breastfeeding studies investigating diabetes risk have concentrated on changes in postpartum cardiometabolic markers, such as lipids or OGTT results during the early postpartum period, and ongoing type 2 diabetes incidence.[16,17] We are not aware of any studies that have investigated breastfeeding and next pregnancy glycemic metabolism except our pilot study.[18] The pilot study was undertaken in a selected high-risk population (previous GDM) and identified that both duration and exclusivity of breastfeeding were associated with improved glucose levels on a subsequent pregnancy OGTT.[18]

For multiparous women it is important to understand previous breastfeeding history to assess cardiometabolic risk and provide an opportunity for lactation support interventions. In recognition of the importance of breastfeeding for both infant and maternal health, the Sydney BLISS check was introduced to improve antenatal breastfeeding support in our health district. The BLISS tool was developed as part of our pilot study[18] and is now used in routine antenatal clinical care to assess breastfeeding during the first 12 weeks postpartum ('fourth trimester') after a woman's previous pregnancy.[19]

In this study we aimed to build on the findings of our pilot study to investigate the association between previous pregnancy breastfeeding intensity and duration, and OGTT results in a subsequent pregnancy for an unselected population. The secondary aim was to understand breastfeeding patterns to identify specific groups of women at risk for suboptimal breastfeeding, who may then be at increased risk for cardiometabolic disease.

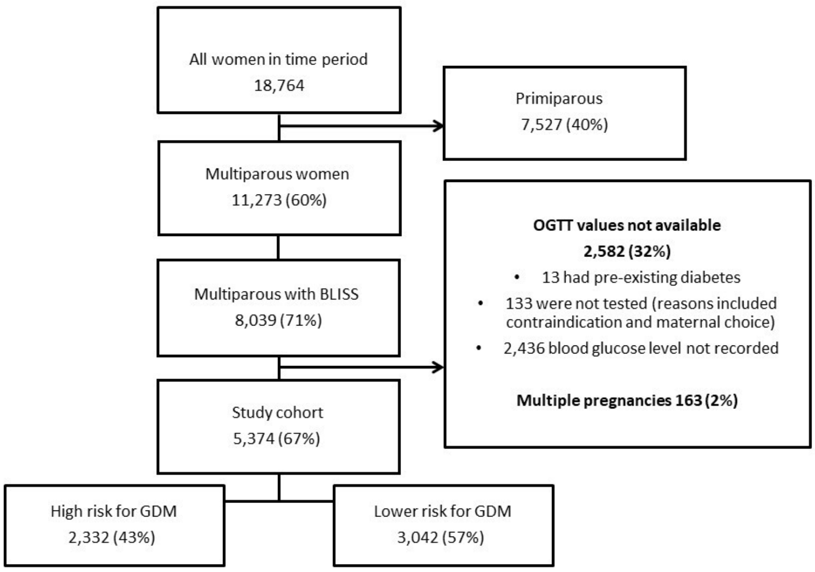
4.8 Methods

Study Population

We conducted a retrospective cohort study of women booked to birth in the Western Sydney Local Health District (WSLHD), Sydney, Australia between March 2020 and October 2022. The study period was determined from the implementation into routine clinical care of the antenatal breastfeeding history and triaging assessment tool, the Sydney BLISS check, introduced to improve breastfeeding support.

The population is culturally and linguistically diverse with approximately 58% of women who birth in the district born in a non-English speaking country.[20] The WSLHD has three maternity care hospitals, with approximately 10,000 births per year.[20] Hospitals in the district were included in the study cohort after > 50% of multiparous women at the hospital received midwifery breastfeeding assessment by the BLISS check at booking. The study period for the health district hospitals were Hospital 1: March 1 2020–October 31 2022, Hospital 2 and 3: January 1 2022–October 31 2022 (S1: Supplementary Figure 1). All women with a singleton pregnancy ≥ 20 weeks' gestation and who had a previous live birth were included in the study. Exclusion criteria included multiple pregnancy, no BLISS check or OGTT result available, or previous diagnosis of type 1 or type 2 diabetes (Figure 1). Incomplete OGTT results were reviewed; reasons included inadequate documentation, patient unable to tolerate glucose drink and patient declined testing (Figure 1).

Figure 1. Flow chart



Measures and Data Source

The data source was the electronic maternity database eMaternity, providing routinely collected information during pregnancy including medical and obstetric history. eMaternity in WSLHD includes the Sydney BLISS check data.

Breastfeeding Measures

The Sydney BLISS was embedded into eMaternity WSLHD on 1 March 2020. COVID-19 interrupted the implementation of the assessment tool at the two smaller of the three district hospitals until 2022. The BLISS check was designed by a panel of lactation experts and assesses breastfeeding intensity (exclusivity) in the first three months after a woman's last pregnancy.[18] Intensity is the ratio of breastfeeding to infant formula feeding, with high intensity breastfeeding mostly or exclusively breastfeeding. Breastfeeding intensity does not have a direct relationship to duration. The BLISS assessment aims to identify a history of breastfeeding issues through a standardized scoring system to triage women for antenatal lactation support. The score is auto-generated as part of routine booking electronic data collection and care. The BLISS check also collects information on total duration of any breastfeeding and the reasons for stopping breastfeeding. Women at booking are routinely offered a telehealth antenatal lactation clinic referral for a low BLISS score or if other breastfeeding issues are identified. HIBF is determined as a BLISS score of ≥ 19 as optimal maternal breastfeeding intensity and equates to approximately > 70% breastfeeding to formula in the first three months postpartum.[18] The Sydney BLISS assessment tool is administered by the booking midwife (S2: Supplementary Sydney BLISS check). We dichotomized breastfeeding analysis to ≤ 6 months and > 6 as this is the recommended time to exclusively breastfeed prior to introduction of family foods.[21] Six months is also a recognized population benchmark time period for assessing any breastfeeding.[22]

Gestational Diabetes Measures

At the study hospitals all women are routinely screened for GDM by a one-step OGTT at 24–28 weeks' gestation, or earlier when clinically indicated. The 24–28 weeks' gestation results in this study were used for analysis if an early test was administered and repeated at 24–28 weeks' gestation. The early gestation results were used if no other OGTT was administered. Pathology results are routinely reviewed by the treating clinician and results entered in electronic records. Diagnosis of GDM in this study used the International Association of Diabetes and Pregnancy Study Group (IADPSG) criteria.[23] IADPSG thresholds: one or more values ≥ thresholds of fasting plasma glucose of 5.1 mmol/L, 1 hour 10.0mmol/L, and/or a 2 hour plasma glucose level of 8.5 mmol/L following a 75 g OGTT. High risk for GDM for the study cohort was defined as per the Australian Diabetes in Pregnancy Society v2 2014 criteria: previous GDM, maternal age ≥ 40 years, family history of diabetes, BMI > 35 kg/m^2, previous baby with birth weight > 4500 g or > 90th centile, polycystic ovarian syndrome, and current use of corticosteroids or antipsychotics.[24]

Demographic Measures

Socioeconomic status (SES) is defined by place (suburb) of residence estimate and derived from information provided during the Australian census (2016), that informs the Index of Relative Socioeconomic Disadvantage (IRSD).[25] Age was calculated at the time of booking the current pregnancy. Ethnicity is self-assigned by women at booking and does not equate to migrant status. We acknowledge that ethnicity may be also described as race, however women are asked to self-identify their ethnicity at hospital admission, therefore we are reporting this variable as ethnicity. Women who are migrants provide details of years lived in Australia and are of varied ethnicities.

Data and Resource Availability Statement

The WSLHD Human Research Ethics Committee approved this study and waived the informed consent requirement (WSLHD HREC approval 2022/ETH00604). The dataset generated and/or analyzed during the current study are not publicly available due to institutional restrictions on patient data but are available from the corresponding author upon reasonable request and institutional approval.

Statistical Analysis

Statistical analyses were completed in Stata SE Version 14.2 and R Studio Version 4. Hypotheses were conducted at a significance level of 0.05 with a two-sided alternative. Breastfeeding intensity and breastfeeding duration were considered co-primary exposures of interest. Breastfeeding duration was considered a linear continuous variable. Our models were adjusted for baseline variables measured at pregnancy booking; maternal age, ethnicity, migrancy, SES, BMI, parity, history of mental illness, history of hypertension, history of GDM, and smoking during pregnancy. GDM diagnosis was assessed with a logistic regression model. Abnormal glucose tolerance by routine OGTT is a set of up to three binary outcomes (fasting, one-hour and two-hour) from repeated measurements from the same woman. Therefore, a generalized estimating equation (GEE) model, equipped with a logistic link function and first order autoregressive correlation structure for within woman covariance, was implemented. Odds ratios, 95% confidence intervals, and *P* values were reported.

To address the secondary aim of our study, maternal characteristics associated with breastfeeding intensity and duration were assessed. In each case a logistic regression model was implemented. As an outcome, breastfeeding duration was dichotomized to breastfeeding

$>$ 6 months versus $\leq$ 6 months. A priori variables were decided on as possible confounders for each exposure of interest and reported individually (S3: Supplementary material).[26] Fasting blood glucose results were further investigated grouped by Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study blood glucose septiles and divided into HIBF or lower intensity breastfeeding plots with separation of curves analyzed for significance.[23] Odds ratios, 95% confidence intervals, and *P* values were reported.

No imputation was made for missing data as missingness of the primary independent variable was plausibly missing not at random. We comment on the extent of characteristic differences that reflect hypothesized associations with mechanisms of missingness in Supplementary Material (S4: Supplementary Material).

4.9 Results

Cohort Characteristics and Exposure

During the study period there were 11,273 multiparous women booked at the study hospitals. There were 5,374 (67%) participants who met inclusion criteria (Figure 1). The mean age was 32.4 (SD 6.8) years and there were 981 (18.3%) diagnosed with GDM. Of all participants, 4,074 (75.8%) were documented to be HIBF, 3,558 (66.2%) had exclusively breastfed at 3 months and 3,222 (61.7%) of the total cohort breastfed > 6 months. The median duration of breastfeeding was 9 months (IQR 4–16).

Women classified in the HIBF group by the Sydney BLISS check breastfed for a median duration of 12 months (IQR 6–18, n = 4,074, 75.8%) compared to those in the lower intensity group who had a median duration of 3 months (IQR 1–7 months, n = 1,300, 24.2%; $P < 0.01$) (S5: Supplementary Material Figure 2). There were 2,332 (43%) of the total cohort who were at high risk for GDM (Figure1). There was no difference in the breastfeeding duration or intensity for women in either the GDM high or GDM low-risk groupings (Table 1).

There was a graduated decline in the median breastfeeding duration associated with lower age groupings (Table 1). Women < 25 years old had the lowest median duration of breastfeeding (6 months: IQR 2–13) compared to the other age groups; women aged > 39 years had the longest median duration (12 months; IQR 6–18). This graduated decline with younger age groups was also evident for HIBF (Table 1).

Table 1.
Cohort characteristics by exposure of breastfeeding duration and intensity (*N* = 5,374)

Maternal Characteristics	Duration of Breastfeeding Median Months (IQR)	*P* Value	High Intensity Breastfeeding (n = 4,074, 75.8%)	Low Intensity Breastfeeding (n = 1,300, 24.2%)	*P* Value
Maternal age		< 0.001			< 0.001
< 25	6 (2–13)		69.46% (232)	30.54% (102)	
25–34	8 (4–15)		74.30% (1,772)	25.70% (613)	
35–39	11 (6–18)		77.96% (1,765)	22.04% (499)	
> 39	12 (6–18)		78.01% (305)	21.99% (86)	
Ethnicity		< 0.001			< 0.001
South Asian	12 (6–18)		81.73% (1,302)	18.27% (291)	
South-East Asian	10 (5–14)		74.35% (661)	25.65% (228)	
White/European	9 (4–14)		73.09% (690)	26.91% (254)	
Middle Eastern	7 (3–14)		71.73% (789)	28.27% (311)	
Aboriginal & Torres Strait Islander	4 (2–9)		58.14% (50)	41.86% (36)	
Other	8 (4–14)		76.38% (582)	23.62% (180)	
Migrant status		< 0.001			< 0.001
< 5 years	12 (6–18)		78.68% (1,011)	21.32% (274)	
5–10 years	12 (6–18)		78.57% (759)	21.43% (207)	
> 10 years	9 (4–15)		75.64% (798)	24.36% (267)	
Australian-born	7 (3–14)		71.31% (1,213)	28.59% (488)	
Socioeconomic status		< 0.001			< 0.001
Least advantaged Q1	8 (3–15)		71.28% (1,184)	28.72% (477)	
Q2	9 (4–14)		75.83% (549)	24.17% (175)	
Q3	11 (6–18)		77.56% (923)	22.44% (267)	
Q4	10 (5–17)		80.09% (531)	19.91% (132)	
Most advantaged Q5	11 (5–16)		78.06% (715)	21.94% (201)	
Parity		0.006			0.024
1	10 (4–17)		74.63% (2,544)	25.37% (865)	
2–3	8 (4–15)		78.10% (1,323)	21.90% (371)	
> 4	8 (4–18)		76.38% (207)	23.62% (64)	

Table 1 continued

Cohort characteristics by exposure of breastfeeding duration and intensity (N = 5,374)

Maternal Characteristics	Duration of Breastfeeding Median Months (IQR)	*P* Value	High Intensity Breastfeeding (n = 4,074, 75.8%)	Low Intensity Breastfeeding (n = 1,300, 24.2%)	*P* Value
Current pregnancy					
Smoking	4 (2–12)	< 0.001	47.06% (48)	52.94% (54)	< 0.001
No smoking	10 (5–17)		76.80% (2,655)	23.20% (802)	
Comorbidities					
Polycystic ovary syndrome	8 (4–16)	0.23	73.11% (223)	26.89% (82)	0.26
No polycystic ovary syndrome	10 (4–16)		75.97% (3,850)	24.03% (1,218)	
History mental health issue	7 (3–14)	< 0.001	68.39% (541)	31.61% (250)	<0.001
No history mental health issue	10 (4–18)		77.08% (3,532)	22.92% (1,050)	
History of hypertension	8 (4–14)	0.071	71.53% (206)	28.47% (82)	0.081
No history of hypertension	10 (4–16)		76.05% (3,867)	23.95% (1,218)	
BMI kg/m^2		< 0.001			<0.001
< 18.5	8 (4–14)		82.94% (141)	17.06% (29)	
18.5–24.9	11 (5–17)		77.77% (1,907)	22.23% (545)	
25.0–29.9	9 (4–17)		77.04% (1,258)	22.96% (375)	
^{3} 30.0	7 (3–15)		68.63% (768)	31.37% (351)	
High risk GDM*	9 (4–16)	0.859	74.61% (1,740)	25.39% (592)	0.073
Lower risk GDM	10 (4–16)		76.73% (2,334)	23.27% (708)	
Previous pregnancy complications					
History of GDM	9 (4–16)	0.635	74.96% (518)	25.04% (173)	0.578
No history of GDM	9 (4–16)		75.93% (3,556)	24.07% (1,127)	
Previous birth cesarean section	9 (4–18)	0.851	72.94% (949)	27.06% (352)	0.006
Previous birth vaginal	9 (4–16)		76.72% (3,125)	23.28% (948)	
Previous birth preterm	7 (4–14)	0.003	67.89% (258)	32.11% (122)	< 0.001
Previous birth term	10 (4 – 17)		76.41% (3,816)	23.59% (1,178)	

GDM, gestational diabetes mellitus
*High-risk GDM criteria: previous GDM, age > 40, family history of diabetes, BMI > 35, previous large for gestation baby, polycystic ovary disease, corticosteroid medication use.

Australian-born women had a lower median duration of breastfeeding (7 months; IQR 3–14) compared to all migrants. Participants who had lived in Australia > 10 years breastfed for a shorter duration than newer migrants (9 versus 12months) (Table 1). Two factors were associated with the lowest median duration of breastfeeding: current smoking status (4 months; IQR 2–12) and women who identified as Aboriginal or Torres Strait Islander (4 months; IQR 2–9) (Table 1). For previous pregnancy complications, preterm birth was the only factor associated with shorter duration of breastfeeding (7 versus 10 months; $P = 0.003$) and this also was a factor for less intensity (67.9% versus 76.4%; $P < 0.001$) (Table 1). Other factors associated with duration and HIBF are detailed in Table 1.

Primary Aim: Association Between Breastfeeding and OGTT Results in a Subsequent Pregnancy

Compared to women who breastfed at a lower intensity, women who had breastfed at high intensity in the first three months after their previous birth had a 47% reduced odds of an abnormal fasting blood glucose on the OGTT in their subsequent pregnancy (aOR 0.53; 95% CI 0.38–0.75; $P < 0.01$). The association between HIBF and improved fasting glucose was greater in women at a lower risk of GDM, with a 52% reduced odds of abnormal fasting blood glucose (aOR 0.48; 95% CI 0.27–0.86, $P = 0.01$) and 45% reduced odds for the women in the high-risk group (aOR 0.55; CI 0.36–0.83, $P = 0.01$) (Table 2). There were no associations between the OGTT results at one and two hours with HIBF or duration of breastfeeding (Table 2).

HIBF was not associated with diagnosis of GDM in all women (aOR 0.91; 95%CI 0.75–1.10, $P = 0.34$); women at reduced risk of GDM diagnosis (aOR 1.02; 95%CI 0.75–1.37, $P = 0.92$) or at high risk of GDM (aOR 0.84; 95%CI 0.65–1.08, $P = 0.18$) (Table 2). Breastfeeding duration was not associated with risk for GDM diagnosis overall (aOR 1.01; 95%CI 0.99–1.02, *P* = 0.06) or in the different risk categories (Table 2).

When fasting blood glucose results were viewed as a continuous graph for the two groups of HIBF and lower intensity, separation of groups occurred at the AIDPSG blood glucose cut-off 5.1 mmol/L, displaying HIBF participants with lower fasting blood glucose (*P* = 0.01) (S6: Supplementary Material Figure 3).

Table 2.
Association between breastfeeding (BF) in a previous pregnancy and odds ratio (OR) of a gestational diabetes (GDM) diagnosis and/or of an abnormal OGTT blood glucose result in current pregnancy. Total cohort *n* = 5374 High intensity breastfeeding *n* = 4074

a. High intensity breastfeeding (HIBF)–mostly or exclusively breastfeeding

Outcome Cohort		HIBF % (n)	LIBF % (n)	Unadjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Elevated Fasting	Total Cohort	5.99% (243)	8.02% (104)	0.53 (0.38, 0.73)	< 0.01	0.53 (0.38, 0.75)	< 0.01
Fasting	High Risk	8.93% (154)	12.24% (72)	0.56 (0.38, 0.83)	0.01	0.55 (0.36, 0.83)	0.01
Fasting	Low Risk	3.81% (89)	4.52% (32)	0.47 (0.27, 0.83)	0.01	0.48 (0.27, 0.86)	0.01
Elevated 1 Hour	Total Cohort	10.72% (376)	8.83% (100)	1.14 (0.85, 1.52)	0.37	1.20 (0.89, 1.63)	0.23
1 Hour	High Risk	16.43% (236)	14.57% (73)	1.04 (0.73, 1.47)	0.84	1.05 (0.72, 1.52)	0.81
1 Hour	Low Risk	6.75% (140)	4.28% (27)	1.52 (0.90, 2.59)	0.12	1.58 (0.92, 2.71)	0.09
Elevated 2 Hour	Total Cohort	10.38% (420)	10.78% (139)	0.96 (0.73, 1.26)	0.77	1.01 (0.76, 1.33)	0.97
2 Hour	High Risk	16.07% (276)	15.92% (93)	0.91 (0.66, 1.26)	0.57	0.92 (0.65, 1.29)	0.62
2 Hour	Low Risk	6.18% (144)	6.52% (46)	1.18 (0.73, 1.93)	0.50	1.23 (0.75, 2.01)	0.42
GDM	Total cohort	18.09% (737)	18.77% (244)	0.87 (0.73, 1.03)	0.11	0.91 (0.75, 1.10)	0.34
GDM	High Risk	26.72% (465)	27.87% (165)	0.86 (0.68, 1.07)	0.18	0.84 (0.65, 1.08)	0.18
GDM	Low Risk	11.65% (272)	11.16% (79)	0.95 (0.71, 1.27)	0.75	1.02 (0.75, 1.37)	0.92

Table 2 b. Breastfeeding duration as a continuous variable and elevated glucose

Outcome	Cohort	Normal Glucose BF Months (IQR)	Elevated Glucose BF months (IQR)	Unadjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Fasting	Total Cohort	9 (4–16)	11 (4–18)	1.03 (1.01, 1.04)	< 0.01	1.02 (1.00, 1.04)	0.04
Fasting	High Risk	9 (4–16)	9 (4–18)	1.02 (1.00, 1.04)	0.02	1.02 (0.99, 1.04)	0.15
Fasting	Low Risk	9 (4–16)	12 (6–19)	1.04 (1.01, 1.07)	0.01	1.03 (0.99, 1.06)	0.06
1 Hour	Total Cohort	9 (4–16)	12 (6–18)	1.02 (1.00, 1.03)	0.01	1.01 (0.99, 1.02)	0.34
1 Hour	High Risk	9 (4–15)	11.5(6 –18)	1.02 (1.00, 1.04)	0.02	1.05 (0.72, 1.52)	0.81
1 Hour	Low Risk	9 (4–16)	12 (6–18)	1.01 (0.99, 1.04)	0.23	1.00 (0.98, 1.03)	0.84
2 Hour	Total Cohort	9 (4–16)	11 (5–18)	1.01 (1.00, 1.02)	0.12	1.00 (0.99, 1.02)	0.86
2 Hour	High Risk	9 (4–15)	11 (5–18)	1.02 (1.00, 1.04)	0.01	1.01 (0.99, 1.03)	0.62
2 Hour	Low Risk	9 (4–16)	11 (5–18)	0.99 (0.97, 1.02)	0.50	0.98 (0.96, 1.01)	0.14
GDM	Total Cohort	9 (4–16)	11 (5–18)	1.02 (1.01, 1.02)	< 0.01	1.01 (0.99, 1.02)	0.06
GDM	High Risk	9 (4–16)	11 (5–18)	1.02 (1.00, 1.03)	0.01	1.01 (0.99, 1.02)	0.15
GDM	Low Risk	9 (4–16)	12 (5–18)	1.02 (1.00, 1.03)	0.03	1.01 (0.99, 1.02)	0.21

High risk = high risk for GDM; previous GDM, maternal age ≥ 40 years, family history diabetes, BMI > 35 kg/m^2, previous baby with birth weight > 4500 g or > 90th centile, polycystic ovarian syndrome and current use of corticosteroids or antipsychotics.
Adjusted covariables: maternal age, ethnicity, migrancy, socioeconomic status, BMI, parity, history of mental illness, history of hypertension, history of GDM, and smoking during pregnancy.
GDM, gestational diabetes diagnosis; HIBF, high intensity breastfeeding; LIBF, lower intensity breastfeeding
AIDPSG criteria, one or more values ≥ thresholds of fasting plasma glucose of 5.1 mmol/L and/or a 2 hour plasma glucose level of 8.5 mmol/L following a 75 g OGTT.

Secondary Aim: Factors Associated with Both Reduced High Intensity Breastfeeding Postpartum and Breastfeeding > 6 Months

There were six factors that negatively impacted both HIBF and breastfeeding > 6 months: Aboriginal/Torres Strait Islander ethnicity, previous birth cesarean section, previous preterm birth, smoking, obesity and a history of mental health illness (Table 3). Smoking conferred the greatest reduction in odds of HIBF (aOR 0.31; 95%CI 0.21–0.47) and being of Aboriginal/Torres

Strait ethnicity the most reduced odds of breastfeeding > 6 months when compared to White/European ethnicity (aOR 0.31; 95%CI 0.19–0.50) (Table 3).

Table 3.
Factors associated with high intensity breastfeeding and breastfeeding duration > 6 months by maternal characteristics. Total cohort *N* = 5374. High intensity breastfeeding *n* = 4,074. Breastfeeding > 6 months *n* = 3,222

Characteristic	High Intensity Breastfeeding				Breastfeeding Duration > 6 Months			
	Unadjusted OR (95%CI)	*P*	aOR (95%CI)	*P*	Unadjusted OR (95%CI)	*P*	aOR (95%CI)	*P*
Maternal age								
< 25	0.79 (0.61, 1.01)	0.06	0.95 (0.73, 1.23)	0.70	0.62 (0.49, 0.78)	< 0.01	0.74 (0.58, 0.94)	0.01
25–34	Ref	-	-	-	Ref	-	-	-
35–39	1.22 (1.07, 1.40)	0.01	1.10 (0.96, 1.27)	0.18	1.40 (1.24, 1.58)	< 0.01	1.25 (1.10, 1.42)	< 0.01
40+	1.23 (0.95, 1.59)	0.12	1.17 (0.89, 1.53)	0.25	1.53 (1.22, 1.93)	< 0.01	1.52 (1.20, 1.94)	< 0.01
Ethnicity								
South Asian	1.65 (1.36, 2.00)	< 0.01	1.65 (1.36, 2.00)	< 0.01	1.81 (1.52, 2.15)	< 0.01	1.81 (1.52, 2.15)	< 0.01
South-East Asian	1.07 (0.87, 1.31)	0.54	1.07 (0.87, 1.31)	0.54	1.27 (1.04, 1.54)	0.02	1.27 (1.04, 1.54)	0.02
White/European	Ref	-	-	-	Ref	-	-	-
Middle Eastern	0.93 (0.77, 1.13)	0.49	0.93 (0.77, 1.13)	0.49	0.79 (0.66, 0.94)	0.01	0.79 (0.66, 0.94)	0.01
Aboriginal/Torres Strait Islander	0.51 (0.33, 0.80)	0.01	0.51 (0.33, 0.80)	0.01	0.31 (0.19, 0.50)	< 0.01	0.31 (0.19, 0.50)	< 0.01
Other	1.19 (0.95, 1.48)	0.12	1.19 (0.95, 1.48)	0.12	0.97 (0.79, 1.18)	0.74	0.97 (0.79, 1.18)	0.74
Migrant status								
< 5 years	1.48 (1.25, 1.76)	< 0.01	1.20 (0.97, 1.48)	0.09	1.94 (1.66, 2.26)	< 0.01	1.60 (1.32, 1.94)	< 0.01
5–10 years	1.48 (1.22, 1.78)	< 0.01	1.18 (0.94, 1.47)	0.16	1.95 (1.65, 2.31)	< 0.01	1.56 (1.27, 1.91)	< 0.01
> 10 years	1.25 (1.05, 1.49)	0.01	1.10 (0.90, 1.35)	0.36	1.51 (1.29, 1.77)	< 0.01	1.32 (1.09, 1.59)	0.01
Australian-born	Ref	-	-	-	Ref	-	-	-

Table 3. continued

Previous complications	High Intensity Breastfeeding				Breastfeeding Duration > 6 Months			
	Unadjusted OR (95%CI)	*P*	aOR (95%CI)	*P*	Unadjusted OR (95%CI)	*P*	aOR (95%CI)	*P*
History of GDM	0.95 (0.79, 1.14)	0.58	0.92 (0.76, 1.11)	0.38	1.05 (0.88, 1.24)	0.60	0.97 (0.82, 1.15)	0.73
History of hypertension	0.79 (0.61, 1.03)	0.08	0.88 (0.68, 1.15)	0.34	0.90 (0.70, 1.14)	0.38	1.03 (0.80, 1.33)	0.80
Previous birth cesarean section	0.82 (0.71, 0.94)	0.01	0.78 (0.67, 0.91)	< 0.01	0.93 (0.82, 1.06)	0.29	0.85 (0.74, 0.97)	0.02
Previous birth preterm	0.65 (0.52, 0.82)	< 0.01	0.61 (0.48, 0.77)	< 0.01	0.73 (0.59, 0.91)	0.01	0.76 (0.60, 0.95)	0.02
Current pregnancy								
Smoking	0.27 (0.18, 0.40)	< 0.01	0.31 (0.21, 0.47)	< 0.01	0.33 (0.22, 0.49)	< 0.01	0.44 (0.29, 0.67)	< 0.01
BMI kg/m^2								
< 18.5	1.39 (0.92, 2.10)	0.12	1.53 (1.01, 2.32)	0.05	0.87 (0.63, 1.21)	0.41	0.96 (0.69, 1.33)	0.79
18.5–24.9	Ref	-	-	-	Ref	-	-	-
25.0–29.9	0.96 (0.83, 1.11)	0.58	0.89 (0.77, 1.04)	0.16	0.87 (0.76, 0.99)	0.04	0.86 (0.75, 0.99)	0.04
≥ 30.0	0.63 (0.53, 0.73)	< 0.01	0.62 (0.52, 0.73)	< 0.01	0.59 (0.51, 0.68)	< 0.01	0.69 (0.57, 0.78)	< 0.01
History of mental health issue	0.64 (0.55, 0.76)	< 0.01	0.69 (0.58, 0.83)	< 0.01	0.67 (0.57, 0.78)	< 0.01	0.78 (0.65, 0.91)	< 0.01

GDM = gestational diabetes, SES = socioeconomic status
Multivariate model may adjusted for: age, ethnicity, time in Australia, SES, BMI, parity, history of mental illness, history of hypertension, history of GDM, history of cesarean section, history of preterm birth, unplanned pregnancy, smoking

Women who had a cesarean section birth had 22% reduced odds to breastfeed at high intensity (aOR 0.78; 95%CI 0.67–0.91; *P* < 0.01) and they were less likely to breastfeed > 6 months (aOR 0.85; 95%CI 0.74–0.97, *P* = 0.02). A history of preterm birth was associated with 39% reduced odds of HIBF (aOR 0.61; 95%CI 0.48–0.77, *P* < 0.01) (Table 2) and reduced odds of breastfeeding > 6 months (aOR 0.76; 95%CI 0.60–0.95, *P* = 0.02).

Compared to women with a healthy BMI (18.5–24.9 kg/m^2), a high BMI ≥ 30 kg/m^2 negatively impacted breastfeeding with 38% reduced odds of HIBF (aOR 0.62; 95%CI 0.52–0.73 *P* < 0.01) and 31% reduced odds of breastfeeding > 6 months (aOR 0.69; 95%CI 0.57–0.78, *P* < 0.01).

The other previous pregnancy characteristic to negatively impact breastfeeding was a history of mental illness, with lower odds of both HIBF (aOR 0.69; 95%CI 0.58–0.83, $P < 0.01$) and breastfeeding > 6 months (aOR 0.78; 95%CI 0.65–0.91, $P < 0.01$).

South Asian ethnicity was the only factor positively associated with both improved HIBF and breastfeeding > 6 months. Compared to White/European ethnicity, women who identified as South Asian had 65% increased odds of HIBF (aOR 1.65; 95% CI 1.36–2.00, $P < 0.01$) and greater odds of breastfeeding > 6 months (aOR 1.81; 95%CI 1.52–2.15, $P < 0.01$).

Factors Only Associated with Breastfeeding > 6 Months

Three characteristics were negatively associated with duration of breastfeeding but not intensity; age < 25 years compared to the 25–34 age grouping (0.74 aOR; 95%CI 0.58–0.94, $P = 0.01$), Middle Eastern ethnicity compared to White/European ethnic groupings (aOR 0.79; 95%CI 0.66–0.94, $P = 0.01$) and a BMI in an overweight range compared to a healthy BMI (aOR 0.86; 95%CI 0.75–0.99, $P = 0.04$). Other positively associated factors only identified for breastfeeding duration > 6 months but not HIBF were for participants over 35 years age (1.25 95%CI 1.10–1.42, $P < 0.01$) or > 40 years (1.52 95%CI 1.20–1.94, $P < 0.01$) compared to 25–34-year-old age groupings. Women who identified as South-East Asian ethnicity were also more likely to breastfeed > 6 months (aOR 1.27; 95%CI 1.04–1.54, $P = 0.02$) compared to White/European participants. Compared to Australian-born, migrant status had no association with HIBF; however, migrant status was positively associated with breastfeeding > 6 months. Compared to Australian-born women, new migrants who had lived in Australia < 5 years had 60% increased odds of breastfeeding > 6 months (aOR 1.60; 95%CI 1.32–1.94, $P < 0.01$). All other associations are detailed in Table 3.

4.10 Discussion

This is the first study we are aware of that has identified that optimal breastfeeding patterns can have direct metabolic benefits in a subsequent pregnancy. Potentially, this may reduce both maternal and infant morbidity. In a large ethnically diverse population, our study has identified that women who breastfed at a high intensity (exclusive or mostly breastfeeding) had improved odds of a normal fasting glucose in their subsequent pregnancy. We identified maternal characteristics that differ between length and intensity of breastfeeding, providing a more comprehensive understanding of women's postpartum breastfeeding behavior. Targeting factors to improve breastfeeding intensity may be one key to improved cardiometabolic health in subsequent pregnancies. Specific groups in this study who were vulnerable to suboptimal breastfeeding intensity and duration include women with a history of preterm birth, those who had a history of a mental health illness, women who identify as Aboriginal/Torres Strait Islander, and smokers.

Women who do not meet the criteria for a diagnosis of GDM may still have some degree of dysglycemia or gestational glucose intolerance (GGI) that places them at greater risk of type 2 diabetes.[27] Berekowsky et al and others have identified that an abnormal fasting OGTT was the value most correlated with a future risk of type 2 diabetes compared to OGTT results at one and two hours.[28,29] Other research has also identified an abnormal fasting OGTT result alone predicts increased risk of a large for gestational age baby and other adverse pregnancy outcomes.[30,31] Supporting HIBF for all women may therefore reduce their risk for both adverse perinatal outcomes in a subsequent pregnancy and improve maternal long-term cardiometabolic risk.

Postpartum HIBF has been described as potentially an essential part of an endocrine reset process after a pregnancy-induced insulin resistant state.[32] Other research has identified that compared to mixed or mostly formula infant feeding, it is HIBF that confers the most benefit for improved postpartum insulin resistance and lipid profiles and may underpin the long-term improved risk for metabolic disorders associated with breastfeeding.[33]

Our study provides further evidence of the importance that early exclusive or mostly breastfeeding may be vital for long-term cardiometabolic health, and crucial for an endocrine 'reset' postpartum. Routinely collected breastfeeding data inclusive of intensity information through tools such as the Sydney BLISS check, will assist uncovering drivers for optimal health outcomes for women. Incorporation of the BLISS check into routine data across all health districts can inform healthcare policies and programs to fund targeted interventions to vulnerable populations.

Breastfeeding support programs are effective to improve breastfeeding and generally acceptable to women.[34] However, minimal research has integrated lifestyle programs with breastfeeding support interventions aimed at reducing type 2 diabetes risk.[35] At a national level, government funded targeted support is particularly important for populations identified in this research who may experience suboptimal breastfeeding. Understanding the metabolic impact during pregnancy of previous breastfeeding duration and exclusivity, as well as identifying groups at risk for suboptimal breastfeeding, will assist in designing targeted interventions to improve lifetime cardiometabolic risk. Targeted intervention for vulnerable populations requires government policy and importantly discrete funding support. Health promotion programs and activities at State and local levels may also be developed by State and local public health and health promotion units. These programs should align and be integrated with national level approaches.

A limitation of this study is that there was no available information on some factors that may influence both breastfeeding and dysglycemia. These factors include lack of available information in routine data on education level, exercise, diet, interpregnancy weight gain, time period between pregnancies or important baseline metabolic risk factors including lipid levels. The only available weight was for the current pregnancy. Potentially there are factors such as exercise that participants who breastfeed for a greater duration are less likely to engage in.

Another limitation was the missing BLISS and OGTT values in the routine data. The COVID-19 pandemic may have influenced women attending to routine OGTT investigations. Local research identified that some women who were pregnant experienced fear of public places due to the COVID-19 pandemic and this may have contributed to reduced attendance for pregnancy OGTTs, as well as lockdowns.[36] However, noncompliance with testing has been documented in various populations to be from 10–50% of women, therefore our missing OGTT data is consistent with other population level data.[37] The missing BLISS should not be biased by patient selection but was impacted through slow implementation due to staff shortages and lack of time to complete the new breastfeeding triage tool. Women who had chosen to formula feed in their previous pregnancy and did not breastfeed at all were often not given a BLISS score and therefore our results do not fully capture the lowest intensity of no breastfeeding.

A strength of this cohort was the diversity of ethnicity, and therefore the results are potentially more applicable to other culturally mixed populations. The use of routine clinical data of both duration and intensity of breastfeeding for the entire health district was also a strength resulting in a large sample size. The Sydney BLISS check is applied to a non-selected clinical care population that is reflective and generalizable, as the participants were not a motivated breastfeeding research cohort. The high intensity BLISS check scoring is affirmed as a valid cut-off score through the association with greater duration of breastfeeding. [38] Another strength is the validation of the HAPO cut-off value of 5.1 mmol/L for fasting glucose in our ethnically diverse population. When our results were disaggregated by low and high intensity and glucose levels along a continuum, HIBF participants clearly diverged from the LIBF group at the IADPSG fasting normal cut-off point.[39]

In Australia nearly 40% of women who do not breastfeed state 'unsuccessful' previous experience as the reason.[40] Successful implementation of the antenatal Sydney BLISS check in the study health district assists in addressing this issue for multiparous women as they are given the opportunity for antenatal referral to a new telehealth lactation consultant clinic. Promoting and protecting breastfeeding for short and long-term metabolic health, as well as infant health, requires population level data to underpin appropriate support that the Sydney BLISS check can provide.

Conclusion

This study provides information not only on the important gains for next pregnancy glycemic control, but also identifies vulnerable breastfeeding populations to drive targeted intervention programs. During the pandemic era with constraints on health budgets and staffing, it has been difficult to provide evidence-based lactation support. A recent Cochrane Review identified that at least 4–8 postpartum lactation support contacts were required to improve breastfeeding rates. Targeted support such as this is particularly important for populations identified in this research.[34] Breastfeeding duration is vital for infant and maternal health, but this study has identified the importance of mostly or exclusively breastfeeding as a public health issue to reduce GDM risk in a subsequent pregnancy and potentially improve long-term health. If the WHO Sustainable Development Goal to reduce global NCD is to be met, all health promotion avenues should be pursued. Supporting breastfeeding must be included.

4.11 References

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4.12 Chapter 4 Supplementary Materials

The Association Between Previous Pregnancy Breastfeeding and Subsequent Pregnancy Oral Glucose Tolerance Test

S1: Supplementary Figure 1.
Uptake of breastfeeding length intensity score system (BLISS) by site over time.

S2: Breastfeeding Length Intensity Scoring System (Sydney BLISS check scored).

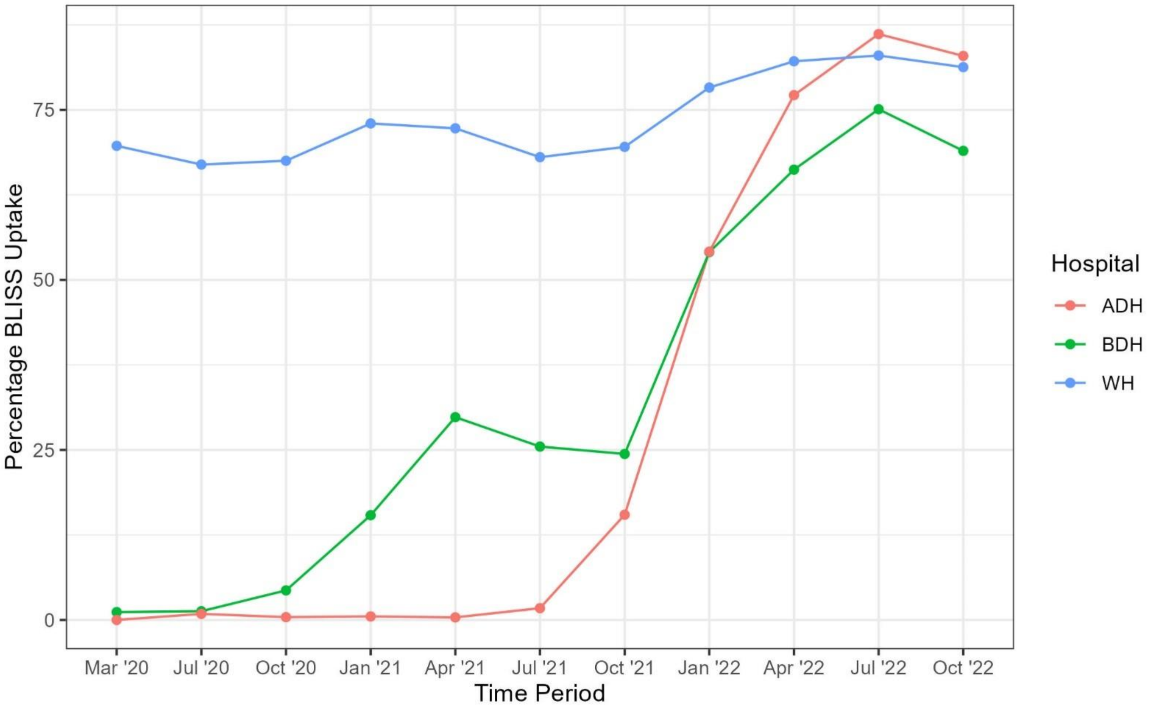
S3: Statistical notes: Possible confounding factors that each exposure was adjusted for.

S4: Statistical notes: More detailed explanation of the mechanisms behind missingness assumptions.

S5: Supplementary Figure 2.
Descriptive statistics of the correlation between breastfeeding intensity and breastfeeding length.

S6: Supplementary Figure 3.
Previous pregnancy breastfeeding and subsequent pregnancy fasting OGTT plasma glucose.

S1: Supplementary Figure 1: Implementation of breastfeeding length intensity score (Sydney BLISS check) by Western Sydney Local Health District site over time.



S2: Breastfeeding Length Intensity Scoring System (Sydney BLISS check scored).

The BLISS check: Breastfeeding Length Intensity Scoring System

How many babies have you breastfed? (*circle*) 0 1 2 3 4 5 6 other____

Please add together all the months you breastfed each of your children.
For example if you have had two children and breastfed the first baby for 4 months and the second for 6 months this equals 10 months total lifetime breastfeeding.
Total months you have actually been breastfeeding all your children? ____Months

How old was your last baby when you stopped breastfeeding? Months____ Days___

1. During your last baby's **first week of life** how did you feed?

a. Breastfeeding only □ 6 c. Formula feeding only □ 0

b. Breastfeeding and formula □ 1

If you ticked **b. did you give:** **Only** 1-4 formula feeds in **first week** □ 4
Most **days** 1-3 formula feeds □ 2
Most **days** 4 or more formula feeds □ 1 __/6

2. During the **first month of life** how did you feed your last baby? (*after first week*)

a. Breastfeeding only □ 7 c. Formula feeding only □ 0

b. Breastfeeding and formula □ 1

If you ticked **b. did you give:** **Only** 1-4 formula feeds **in first month** □ 6
Most **weeks** only 1-4 formula □ 6
Most **days** 1-3 formula feeds □ 2
Most **days** 4 or more formula feeds □ 0 __/7

3. **After the first month** how did you feed your last baby?

a. Breastfeeding only □ 6 c. Formula feeding only □ 0

b. Breastfeeding and formula □ 1

If you ticked **b. did you give:** Most **weeks only 1-4** □ 5
Most **days** 1-3 formula feeds □ 2
Most **days** 4 or more formula feeds □ 0 __/6

4. **At three months** of age how did you feed your last baby?

a. Breastfeeding only □ 6 c. Formula feeding only □ 0

b. Breastfeeding and formula □ 1

If you ticked **b. did you give:** **Most weeks only 1-4 formula** □ 5
Most **days** 1-3 formula feeds □ 2
Most **days** 4 or more formula feeds □ 0 __/6

Are you currently breastfeeding? (circle) No Yes

Why did you stop breastfeeding your last baby? (*can tick more than one reason*)

1. Attachment or Feeding Problems □
2. Baby's Age □
3. Baby Lost Interest □
4. Baby unsettled □
5. Problem's with Baby's Weight gain □
6. Problem's with Expressing □
7. Painful □
8. Low Supply of breast milk □
9. Mastitis □
10. Taking medication couldn't breastfeed □
11. Pregnant or planning pregnancy □
12. Returning to work/study □
13. Other Reason___________________

BLISS Check version 1 7.2.2020

S3: Possible confounding factors that each exposure was adjusted for.

They were, respectively, adjusted for:

- Maternal age: ethnicity, migrancy, SES, BMI, parity, history of hypertension, history of GDM, history of preterm birth, and smoking.
- Ethnicity: none.
- Migrancy: BMI, age, ethnicity, SES.
- History of GDM: age, ethnicity, BMI, parity.
- History of hypertension: age, ethnicity, BMI, history of GDM, smoking.
- Previous Birth CS: age, ethnicity, SES, BMI, parity, history of mental illness, history of hypertension, history of GDM, smoking, migrancy.
- Previous Birth PTB: age, ethnicity, SES, BMI, parity, history of mental illness, history of hypertension, history of GDM, smoking, migrancy.
- Smoking: age, ethnicity, SES, parity, history of mental illness.
- BMI: age, ethnicity, migrancy, parity, history of mental illness.
- History of mental illness: age, ethnicity, SES.

Statistic references:
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S4: More detailed explanation of the mechanisms behind missingness assumptions.

The primary independent variable (breastfeeding intensity) and dependent variable (glucose tolerance) had non-negligible levels of missingness. Neither had substantial levels of missingness. We believe that two mechanisms plausibly explain the missingness of the breastfeeding intensity variable:

1. Women that did not breastfeed in their previous pregnancy were not given a breastfeeding intensity score.

2. The breastfeeding intensity score was a non-essential booking item. On busy or understaffed days, it may not have been collected particularly during pandemic related changing procedures for midwives at booking.

The first mechanism is of greater concern and has been addressed as a limitation of the implementation procedure to date. Importantly, the mechanism (no breastfeeding) is related to the missing variable (breastfeeding intensity) so the missing not at random (MNAR) assumption is plausible. When the MNAR assumption is plausible imputation methods are not appropriate as the missingness cannot be modelled explicitly. [Ref 1]

We believe that two mechanisms plausibly explain the missingness of the glucose tolerance variable:

1. The glucose tolerance values are a non-essential booking item. In many instances, the attending clinician preferred to record “GDM” or “No GDM” instead of the precise values.

2. Some women were not administered a glucose tolerance test, for example those that could not tolerate the glucose drink or those that booked later in pregnancy.

Whilst the first mechanism suggests that the missing completely at random (MCAR) assumption may be plausible, it is difficult to assess an MCAR hypothesis and most believe that in practice it is rarely plausible. [1]

The second mechanism is more difficult to understand. The reasons women do not attend the recommended OGTT or are not able to tolerate the glucose drink, for example, are varied and unknown particularly during the pandemic, therefore so is their relationship with the missing variable (glucose tolerance test result). As a consequence, some instances of the second mechanism may be MNAR whereas some may be missing at random (MAR). Each MAR instance would demand its own imputation model as the factors predictive of one reason for not tolerating the glucose drink may differ from another.

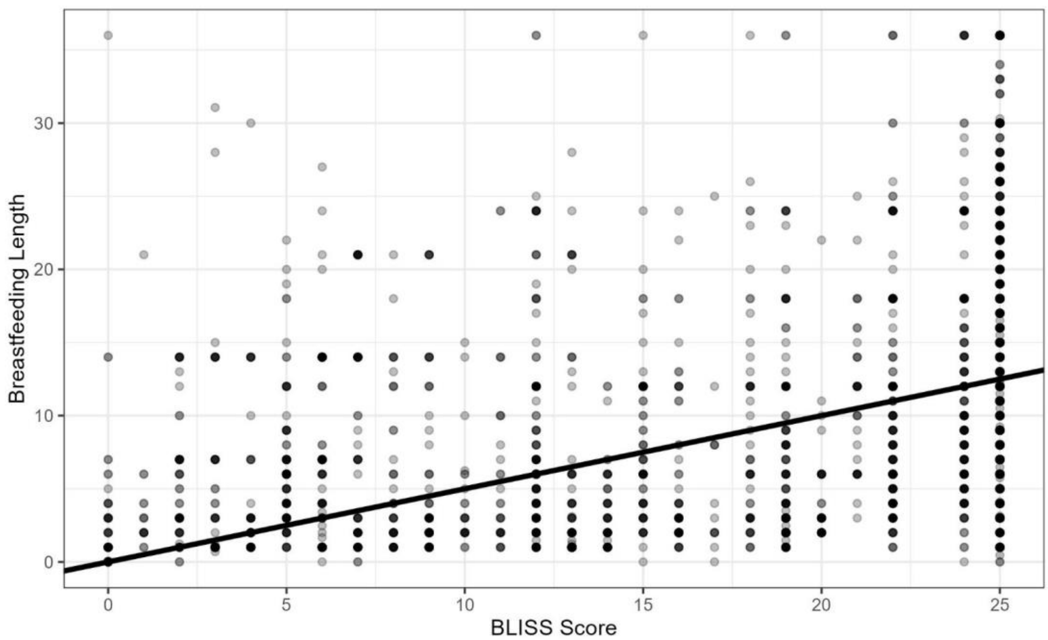
We did not implement a worst-best sensitivity analysis as we believe that the envelope of results it would articulate would be too wide to sensibly interpret. Such an analysis would involve assigning those with missing breastfeeding intensity the best/worst score, those with missing glucose tolerance values the best/worst result (two standard deviations above or below the mean, for example), and permutations thereof. However, that would produce four uniquely 'extreme' analyses that would be difficult to corroborate.

Reference 1: Jakobsen, J.C., Gluud, C., Wetterslev, J. et al. When and how should multiple imputation be used for handling missing data in randomised clinical trials – a practical guide with flowcharts. BMC Med Res Methodol 17, 162 (2017). https://doi.org/10.1186/s12874-017-0442-1.

S5: Supplementary Figure 2.
Descriptive statistics of the correlation between breastfeeding intensity and breastfeeding length.

The raw breastfeeding intensity score is not normally distributed. Therefore, Spearman's rank correlation coefficient is used to estimate the correlation between breastfeeding length and intensity.

The estimated coefficient is 0.50 with a 95% confidence interval of 0.48 to 0.52 and a p-value < 0.01.



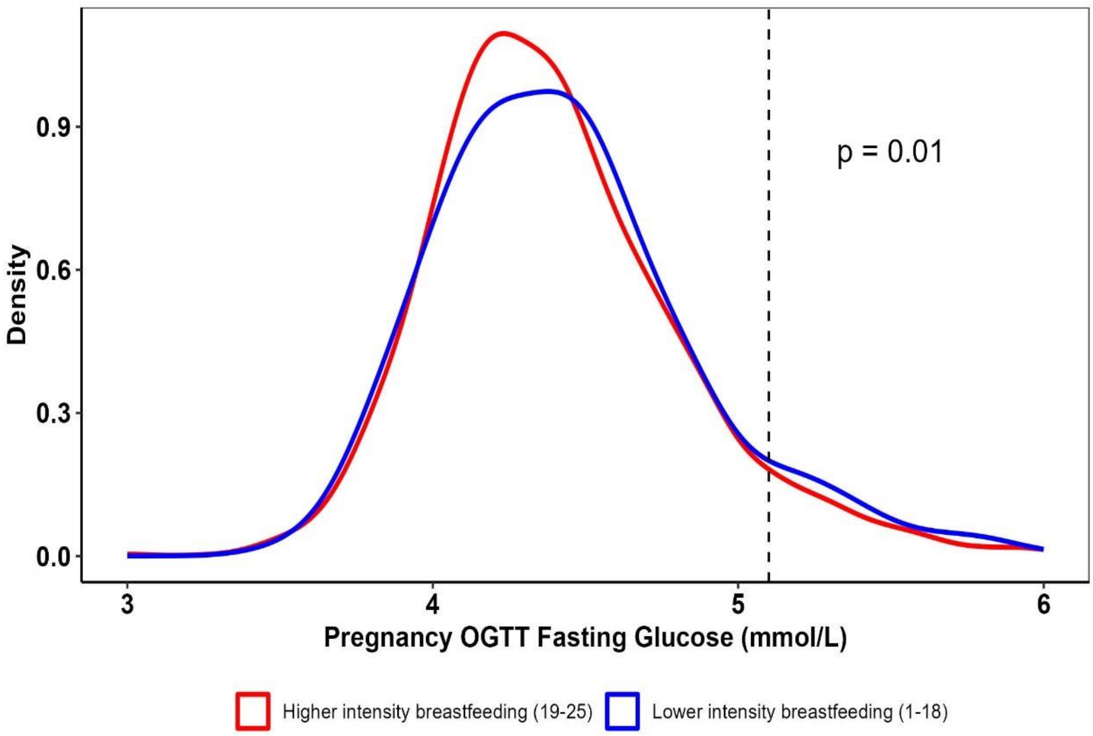
When we partition by high (HIBF) and lower intensity breastfeeding (LIBF), we observe:

- HIBF has median length of 12 months and IQR of 6 – 18 months.
- LIBF has median length of 3 months and IQR of 1 – 7 months.
- This difference is statistically significant (p < 0.01).

S6. Supplementary Figure 3.

Previous pregnancy breastfeeding and subsequent pregnancy fasting OGTT plasma glucose

1. Lower intensity breastfeeding (BLISS 1-18) *n* = 1,300
2. High intensity breastfeeding (BLISS 19-25) *n* = 4,074



Kolmogorov-Smirnov test for the equality of two empirical distribution functions, with calculations based on a Monte Carlo simulation of 100,000 samples, returned a p-value of 0.01. The observed separation of the two curves is statistically significant.

Cardiometabolic Impact and Pregnancy During the Pandemic: Interventions and Acceptability

Chapter 5

Exploring the COVID-19 Pandemic Experience of Maternity Clinicians in a High Migrant Population and Low COVID-19 Prevalence Country: Qualitative Study

5.1 Preface

There are complex social and biological drivers that underpin the findings that pandemics and natural disasters have long term cardiometabolic consequences. This chapter presents a unique opportunity to provide a contemporaneous qualitative exploration of the impact of the COVID-19 pandemic on clinicians and their perceptions of the impact on their patients. Exploration of the pandemic emergency for this thesis as it unfolded in 2020, examines the lived experience that will inform understanding of potential factors that may alter perinatal outcomes during the pandemic and long term cardiometabolic health. In this chapter clinicians identified that there was a shift away from patient centred care to preservation of the health service, they identified a disruption to family support particularly for migrant women. I found that clinicians 'bent the rules' to accommodate distressed patients and optimise clinical care. These findings will assist with preparedness for future pandemics and improve understanding of the cardiometabolic impact of pandemics.

Women and Birth is the official journal for the Australian College of Midwifery. It is a Q1 journal for both Maternity and Midwifery and Obstetrics and Gynaecology. This journal was chosen as the optimal journal to disseminate information regarding primarily the experience of Australian midwifery clinicians. A rapid review was requested and accepted for this manuscript with initial submission to publication of 8 weeks.

The published manuscript is presented as Chapter 5 structured as per the journal guidelines with minor formatting changes for thesis consistency. Published version in Appendix 5. Further unpublished supporting quotes Appendix 5a.

5.2 Dissemination of research

Peer reviewed and published

Melov SJ, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Exploring the COVID-19 pandemic experience of maternity clinicians in a high migrant population and low COVID-19 prevalence country: A qualitative study. Women Birth. 2022 Sep;35(5):493-502. doi: 10.1016/j.wombi.2021.10.011. Epub 2021 Nov 5. PMID: 34774447; PMCID: PMC8570406.

Published Abstract

Melov SJ, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Exploring the COVID-19 Pandemic Experience of Maternity Clinicians in a High Migrant Population and Low COVID Prevalence Country. Journal of Paediatrics and Child Health, May 2022; 58(S2).

Presentation

PSANZ: Perinatal Society of Australia and New Zealand, 2022 Adelaide May 16-18**; Melov SJ**, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Exploring the COVID-19 Pandemic Experience of Maternity Clinicians in a High Migrant Population and Low COVID Prevalence Country.

5.3 Author attribution statement

I, Sarah Melov, was responsible for designing the study, project administration, resources-funding, ethics submission and revision responses, consenting patients, qualitative interviewing of all participants, data curation, interpreting coding the data in NVivo, collaborating in generating themes, qualitative analysis, writing initial draft manuscript, coordinating revisions, submission of manuscript as corresponding author, drafting responses to reviewer comments and co-ordinating co-investigator comments and edits to finalise the manuscript submission. My co-supervisor Dr Justin McNab oversaw all qualitative aspects of analysis and manuscript writing.

My co-authors Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D, McNab J, all contributed significantly to aspects of the study including study design, interpretation of findings and critical review of the manuscript.

Primary supervision for this thesis chapter was by Dr Justin McNab and Prof Dharmintra Pasupathy.

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statement above is correct.

Signature:

Prof Dharmintra Pasupathy

5.4 Manuscript

5.5 Exploring the COVID-19 Pandemic Experience of Maternity Clinicians in a High Migrant Population and Low COVID-19 Prevalence Country: Qualitative Study

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5.6 Abstract

Background: Australia experienced a low prevalence of COVID-19 in 2020 compared to many other countries. However, maternity care has been impacted with hospital policy driven changes in practice. Little qualitative research has investigated maternity clinicians' perception of the impact of COVID-19 in a high-migrant population.

Aim: To investigate maternity clinicians' perceptions of patient experience, service delivery and personal experience in a high-migrant population.

Methods: We conducted semi-structured in-depth interviews with 14 maternity care clinicians in Sydney, New South Wales, Australia. Interviews were conducted from November to December 2020. A reflexive thematic approach was used for data analysis.

Findings: A key theme in the data was 'COVID-19 related travel restrictions result in loss of valued family support for migrant families'. However, partners were often 'stepping-up' into the role of missing overseas relatives. The main theme in clinical care was a shift in healthcare delivery away from optimising patient care to a focus on preservation and safety of health staff.

Discussion: Clinicians were of the view migrant women were deeply affected by the loss of traditional support. However, the benefit may be the potential for greater gender equity and bonding opportunities for partners. Conflict with professional beneficence principles and values may result in bending rules when a disconnect exists between relaxed community health orders and restrictive hospital protocols during different phases of a pandemic.

Conclusion: This research adds to the literature that migrant women require individualised culturally safe care because of the ongoing impact of loss of support during the COVID-19 pandemic.

Statement of significance

Problem or issue

Limited qualitative research exists on the impact of the COVID-19 pandemic on the experience of clinicians providing maternity care to high-migrant populations.

What is already known

Health outcomes in migrant populations can be improved. Research indicates barriers to high-quality maternity care can be a result of rapid changes during the pandemic.

What this paper adds

Clinicians in maternity care are impacted by migrant populations ongoing loss of support. Culturally competent care should facilitate support and promote equitable heath care access.

Maternity care has shifted focus from women-centred to clinician safety. COVID-safe policies should be dynamic and reflect community risk to optimize staff pandemic policy compliance.

5.7 Introduction

'It takes a village to raise a child'… but what happens when the village is locked out.[1] The magnitude and speed of the spread of the COVID-19 pandemic and its impact since the beginning of 2020 has been devastating, including sudden country border closures with Australian international borders closing on March 20, 2020.[2] The impact of COVID-19 is largely due to direct associated morbidity and mortality as well as indirect economic, social and health care delivery disruptions.[3,4] Australia has been fortunate with the early containment of COVID-19 at the start of the pandemic in 2020. Significant loss of life has been avoided through a variety of public health measures including closing international borders, quarantining of overseas travellers, comprehensive contact tracing, and a population that was largely compliant to intermittent movement restrictions and 'lockdown' isolation measures when required.[5-7]

The early containment and management gains of COVID-19 in Australia was tempered with a slow uptake and access to COVID-19 vaccination compared to other OECD (Organisation for Economic Co-operation and Development) countries in 2021, with media documenting the slow progress.[8,9] The Australian community has therefore experienced ongoing vulnerability to COVID-19 outbreaks. This vulnerability has been highlighted by sudden varied population lockdown orders due to state and nation-wide outbreaks of the highly contagious COVID-19 Delta strain in mid-2021. Rolling movement-restriction health orders occurred in 2021 primarily in the metropolitan areas of Sydney and Melbourne, with Sydney experiencing nearly four months of lockdown orders with easing of restrictions from mid-Oct 2021. During this time in 2021, COVID-19 cases occurred among women in Western Sydney who were pregnant and admitted to hospital. The prevalence of COVID-19 in New South Wales (NSW) was greatest in the high migrant population in Western Sydney.[10]

The response to COVID-19 in maternity care across Australia has varied since the commencement of the pandemic. A survey of 620 Australian midwives conducted in May-June 2020 reported a varying response by hospitals in implementing restrictions of visitor and support persons due to COVID-19.[11] These restrictions differed from no visitors or support persons permitted to no restrictions at all implemented. This is possibly a reflection of the varied assessment of risk in the different states and regions of Australia due to the different dynamics and risk profiles of particular outbreaks at various times throughout the pandemic. In the Bradfield et al study, 16 midwives from across Australia were also interviewed about their experience of providing care during the pandemic. Among key findings, clinicians reported experiencing many challenges to providing women-centred care.[11] One of the main themes also identified in this study was 'coping with rapid and radical change', reflecting the situation that, despite a low prevalence of COVID-19 cases, providing maternity care has been problematic due to rapid, and sometimes contradictory, changes in policies.

A Spanish qualitative study of 14 midwives who had cared for COVID-19 positive women during pregnancy and childbirth, explored 'challenges and differences when working in a pandemic'.[12] They found staff were stressed and overwhelmed with constant changes in guidelines. These findings were consistent with the Australian experience of midwives reported by Bradfield et al, that midwives found it challenging to provide consistent supportive practice and that this was a barrier to women-centred care.[13]

Although Australia has not experienced the death rate from COVID-19 that some countries have, significant stress, ongoing risk and impact exist for the community and clinicians. A study of health care workers (nurses, doctors, allied health and non-clinical) in Melbourne in mid-2020, found rates of psychological distress comparable to countries that experienced high prevalence of COVID-19 with 30% of health workers in Melbourne, Australia during the study screening positive for work-place burnout.[14]

The health order restrictions on movement and border closures during the COVID-19 crisis has changed access to family and friends for many women potentially impacting their childbirth experience.[15,16] Women who utilise the maternity services in Western Sydney Local Health District (WSLHD) are predominantly born in a non-English speaking country (58%),[17] with relatives living in countries that are significantly impacted by COVID-19. A previous study at Westmead Hospital found 85% of South Asian or Chinese women planned to have relatives visit from overseas to provide support during pregnancy and the postnatal period.[18] In person support from overseas relatives is no longer available due to government mandated international flight restrictions in Australia. How clinicians have perceived the effect of COVID-19 on social support networks for overseas born and Australian born women and the impact on care in the peripartum period to our knowledge has not been investigated.

Improved understanding of clinicians' experience and difficulties caring for women and their families during the COVID-19 pandemic can assist with enhanced maternity care for families and professional support. This understanding may improve future pandemic planning to deliver care in diverse multiethnic communities. The aim of this study was to explore the experience of maternity clinicians serving a high migrant population during the COVID-19 pandemic, including investigating perceptions of patient experience, service delivery and personal experience of living in the pandemic.

5.8 Methods

Design

A qualitative study design with data generated from semi-structured individual interviews was employed for this study. Reflexive thematic approach was used as described by Braun and Clarke.[19] This approach was chosen as it provided the flexibility of inquiry required to examine the novel lived experiences of clinicians serving a culturally diverse patient population in an evolving pandemic where no previous data was available.

Setting

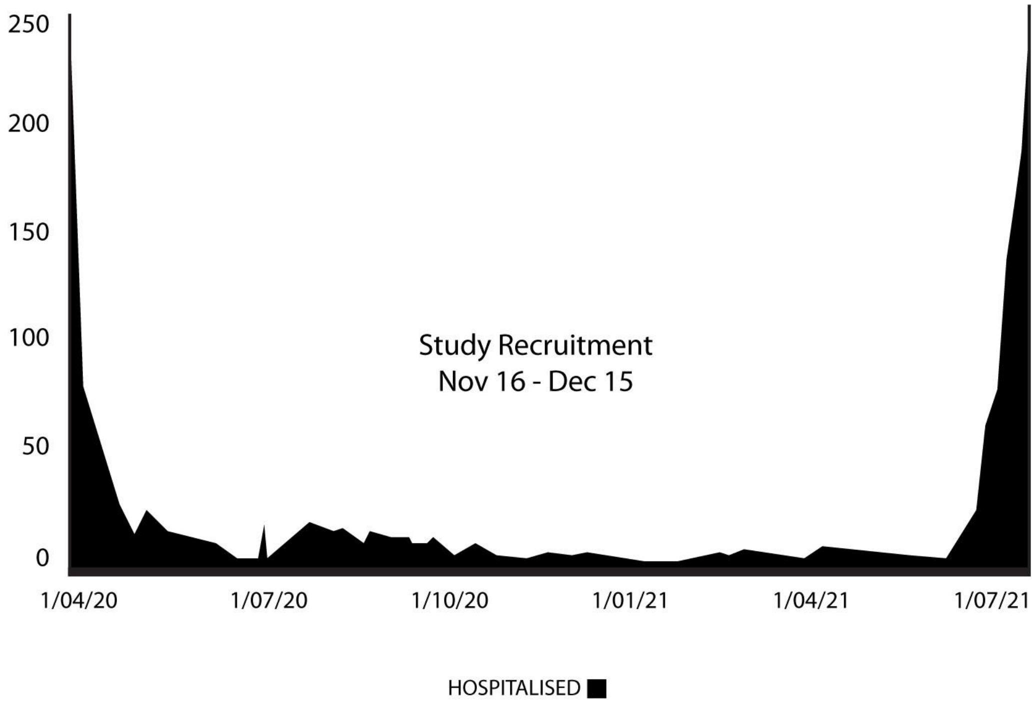
Midwives and medical staff were recruited at a major tertiary referral hospital in Western Sydney Local Health District (WSLHD), NSW, Sydney, Australia. Sydney is the largest city in Australia with a population of 5.4 million. WSLHD has the highest overseas migration gain for the state of NSW.[20] The study hospital is the tertiary referral hospital for the Local Health District population of more than 946,000 residents.[21] This hospital has an average of 5500 births per year. The study hospital is within a health district that has 58% of the mothers born in a non-English speaking country and the highest South Asian maternal population (25%) in the state of NSW.[17]

Recruitment and interviews occurred during a period of no locally acquired COVID-19 cases in the state of NSW, after the first high prevalence COVID-19 case period in March-April 2020 (Figure 1). During this first surge there had been no COVID-19 positive pregnant women admitted at the study hospital. Approval for COVID-19 vaccines did not occur in Australia until 2021 and were not available to health staff or the community during the study period.

Participants

Inclusion criteria for the study required participants to be a registered midwife or medical practitioner who had been employed at the study hospital for greater than 12 months in the Department of Women's and Newborn Health. This inclusion criteria was to ensure participants could discuss their experience since the beginning of the pandemic. Participants were recruited through information posters in maternity care staff areas and routine work maternity staff email pathways. Purposive sampling was utilised to enrich data collection for varied clinical experience of participants from all maternity care areas.[22] Recruitment and interviews occurred over a four-week period from 18th November 2020 to 16th December 2020.

Figure 1. COVID-19 hospitalisation in New South Wales, Australia April 2020–July 2021



Recruitment period for COVID-19 maternity clinician qualitative study: November – December 2020. (*Graphic T Melov based on Source* *https://www.abc.net.au/news/2020-03-17/coronavirus-cases-data-reveals-how-covid-19-spreads-in-australia/12060704#hospitalisation*)

Thirteen clinicians were interviewed face to face and one by a secure video link. All but one of the participants were women and most of the clinicians were midwives, with two participants medical doctors. Approximately 40% of the clinicians in the study were migrants themselves reflecting the local migrant population. Eight of the participants stated they were parents, all with children living at home except one who had adult children not living at home. Further demographic information is presented in Table 1.

Table 1.
Characteristics grouped by years of experience of 14 maternity clinician participants during the COVID-19 pandemic in a tertiary referral hospital Sydney, Australia.

Years of experience	Age group represented	Primary maternity clinical area (n)
1-5	<30	Continuity of Care (1)
		Antenatal Clinic (1)
		Mixed Areas (2)
6-9	30-40	Continuity of Care (1)
		Postnatal Ward (1)
10-20	>40	Birth Unit (1)
	30-40	Mixed Areas (2)
>20	>40	Antenatal Clinic (3)
		Postnatal home Care (1)
		Continuity of Care (1)

Interviews conducted over four weeks: November-December 2020
Registered midwives:11, Student midwife:1, Trainee obstetrician:1, Obstetrician: 1

Data collection

A semi-structured interview schedule was used to collect data consisting of three categories for exploration of the participants understanding of: 1. clinicians' perceptions of patient experience (including support required), 2. service delivery and 3. personal experience of living in the pandemic. The leading question for each category investigated were: 'Can you tell me what your perceptions of changes in women's family support has been like during COVID pandemic?' In exploring service delivery: 'Can you tell me about your experience caring for pregnant women during the COVID pandemic?' And for the final category of personal experience the lead question was: 'How have you felt in yourself during the COVID pandemic?' Questions regarding family support are defined in this study to mean a person's partner, relatives, and people around who can be called on to provide emotional, tangible (instrumental), and informational support.

All interviews were conducted by a single investigator who is an experienced midwife and researcher (SM). The interview progress, transcript coding and analysis were overseen by an expert qualitative researcher (JM). The interviews ranged from 28 to 65 minutes, with eight interviews over 50 minutes, and one interrupted at 15 minutes and unable to be continued. Recruitment ceased at saturation when sufficient rich data from a diverse range of participants was collected to generate insights and meaning for the research question. This was in the context of the recruitment period occurring in a COVID-19 'lull' with loosened restrictions and a stable government COVID-19 response. A total of 665 minutes of interviews with clinicians were recorded and subsequently transcribed.

A professional transcription service provided verbatim text of audio recording. SM reviewed transcriptions against audio for accuracy. To ensure confidentiality of participants all transcriptions were de-identified.

Data analysis

Reflexive thematic data analysis was used within a framework of the three primary areas of clinician perceptions of patient experience, service delivery and personal experience of living in the pandemic.

Analysis was based on the six phases as set out by Braun and Clarke;[23] these were not sequential but commenced with deep familiarisation with the data. This first step of familiarisation was enhanced by the first author completing all interviews, therefore aware of greater context below surface transcription detail. Field notes were also used to assist with the familiarisation process. The other five phases for analysis were generating codes, exploring initial themes, reviewing initial themes, finalising and naming themes and then producing the report.[19]

After familiarisation with data, codes were defined by the two primary authors JM and SJM utilizing both sematic and latent meaning to provide richer understanding and categorisation of participant data by JM and SM. Assumptions and context of code generation were checked through non-discipline social scientist 'outside' voice of senior author (JM) in the analysis process.

Generating final themes were based on central connecting concepts. The five phases of analysis were conducted by authors SJM and JM with all authors reviewing and reaching consensus on final themes. Consensus was reached iteratively for final themes and final report. NVivo was used for data management and analysis (QRS International Pty Ltd 2020).

Investigators addressed reflexivity particularly in consideration of the primary researcher's own position as embedded within both the subject matter and shared participant professional experience as a clinical midwife. A further reflexive consideration was that all investigators were experiencing the pandemic and it is acknowledged this shared experience enhanced insight into the areas under investigation in this study.

The collection, analysis and presentation of in-depth, detailed and contextualised data, paying critical attention to matters of reflexivity from the perspectives of authors SM and JM - in the interview process but also in the rationale and implementation of all phases of the study - enhanced rigour, trustworthiness and quality. Quality of data coding and analysis was further strengthened by author JM evaluating, cross checking, and, where necessary, reassessing both coding frames and coded text in iterative dialogue with author SM.

Ethical considerations

The interviewer is employed in the same institution however has no managerial role and no working relationship with any participant. All participants were provided with written information and signed a consent form that is stored by the interviewing researcher in a locked research room. Audio data was securely deleted after transcription verification. All transcriptions and data were de-identified for analysis and investigator discussions to ensure anonymity of the participants from researchers who may be colleagues. All research data is securely stored with password protection and access only by named investigators. The final manuscript was reviewed for identifiers by an independent study-site midwifery researcher. Approval was granted by Western Sydney Local Health District Human Ethics Committee (2020/ETH02074) 23 September 2020.

5.9 Findings

The three main themes within the areas explored were: COVID-19 related travel restrictions result in loss of valued family support for migrant families; For the greater good, loss of efficient women-centred care; Challenges and difficulties in difficult times- you just dealt with it. The main themes and subthemes are provided in Table 2.

Table 2. Main themes and sub-themes. Exploring the COVID-19 pandemic experience of maternity clinicians in a high migrant population and low COVID-19 prevalence country: a qualitative study

1.	**Clinicians' perceptions of patient experience**
	Main theme
	COVID-19 related travel restrictions result in loss of valued family support for migrant families
	Sub-themes
	Birth and cultural differences: "…they're just by themselves, as opposed to an Aussie couple…"
	The cultural practice of postpartum extended in-house support from overseas
	Loss of support and impact on clinical care
	Changing support from partners: "…the fathers themselves actually did step up"
	Mental health impact of loss of support: "Big time struggling because she's sort of just very isolated"
	Missing out on important life events in the pregnancy journey "…husbands are missing the births of their babies"
	The hospital is not a safe place to be "… we're a big tertiary hospital, and we're the COVID central"
2.	**Maternity care service delivery during COVID-19**
	Main theme
	For the greater good, loss of efficient women-centred care: "it was just a matter of plugging the holes when you could identify them"
	Sub-theme
	Doing your own thing: "This doesn't feel right ..."
3.	**Clinicians' personal experience during COVID-19**
	Main theme
	Challenges and difficulties in difficult times- "you just dealt with it";"… and we came straight off the bushfires"
	Sub-themes
	Guilt- "can I keep everyone safe?"; "…that was the fear. Taking it home and then … them not surviving it."
	Self-care: new activities and work facilitating connection with people

Clinicians' perceptions of patient experience

COVID-19 related travel restrictions result in loss of valued family support for migrant families

In this culturally diverse migrant population, the main theme woven through all aspects of this area of inquiry 'Perception of patient experience' were related to the impact travel restrictions had on family support, which in turn impacted both patients and clinical care. All clinicians described the lack of family support from overseas as one of the biggest challenges they perceived for women during the COVID-19 pandemic at the study hospital. A typical response was:

> *…the most important thing is the inability to have extended family, potentially, travel to be with them to give support around the time of the delivery, and with the newborn baby… that choice has been taken away from them.* (Clinician 11 Obstetrician)

Birth and cultural differences: "…they're just by themselves, as opposed to an Aussie couple…"

Four clinicians identified that there was a difference that separation from traditional family support had on overseas born women when compared to Australian born women. One clinician observed that women from India were highly reliant on relatives, and they had a strong family connection. This midwife explained she found the connection to family was different to Australian born women who often wanted to experience the pregnancy journey with just their partner.

> *…the women seem to be very sad and depressed and lonely because their mother and their mother-in-law can't come from India to support them… I think they feel as though they're being abandoned because of the virus, that they're just by themselves, as opposed to an Aussie couple that feel as though they want to cope by themselves.* (Clinician 1 Antenatal Clinic Midwife)

This midwife, with over 20 years' experience, went on to explain how she found that there was not a reliance or even usually a mention of relatives for Australian born women: "They talk about the couple and themselves, whereas [Indian women] tend to incorporate the whole family into this childbearing support mechanism." Other clinicians also mentioned the individualistic nature of pregnancy for some Australian born families. A young trainee obstetrician observed; "Caucasian families seem to just really want their partner and no one else" (Clinician 10). Two midwives stated that some of the Australian born nuclear family units found COVID lockdown beneficial to isolate themselves from the available but uninvited extended family and visitors, COVID-19 restrictions provided protected time.

> *…for some [Australian born women], they didn't mind it, actually, because that meant less family coming over. And so they could enjoy that time just with their partner and with their baby, … They were like, "Yeah, I prefer it. I can just stay at home, and now I can use COVID as an excuse for them not to come.*
> (Clinician 8 Continuity of Care Midwife)
> *They really liked being isolated and living in their bubble. And I found that for couples, in particular, the dad and the mum and the baby were just this tiny little world …No, the Australian, particularly the Australians have loved it.*
> (Clinician 4 Postnatal Home Care)

Some clinicians stated this contrasted with the deeply felt sense of loss of support from extended family that overseas born women frequently discussed.

The cultural practice of postpartum extended in-house support from overseas

The loss of support for many overseas born women is within the context of a cultural norm. Most clinicians described the importance and common practice among South Asian and Chinese migrant women of in-home family support coming from overseas during pregnancy and for many months postpartum.

> *…it's nearly always the mum, or the mother-in-law, are always there, especially for the first three months, to help out, to cook, to help to clean. And that's just their normal way of life. And if they were back home in their country that's how it would be. They would have even more family, and that's just their way of life. So to be here in a foreign country, and to not have that community that you usually have that's normal to their culture, would definitely … really depress them.* (Clinician 8 Continuity of Care Midwife)

Clinicians described the very practical and tangible nature of support during the postpartum that some cultural groups of women knew they were missing. One clinician stated that relatives:

> *…do everything for these mums; they will cook, clean, they take care of their baby, they do the night shift if mum needs a sleep. Mum really doesn't need to do anything except have the baby handed to her to breastfeed basically.* (Clinician 4 Postnatal Midwife)

The support traditionally provided and now absent from overseas relatives, can be extended and substantial.

> *"they stay for about six months, sometimes longer and then they swop over depending on each side of the family. So, there's a good year or a couple of years that they have support in the home where they're not having that now".* (Clinician 10 Trainee Obstetrician)

Loss of support and impact on clinical care

More than half the clinicians described the impact on clinical care from loss of support from overseas relations as increased time commitment for two primary reasons: providing greater parenting education and increased time required in the clinical encounter to address psychosocial needs. Clinicians stated both new mothers and multiparous women may require extensive help as some multiparous women had previously had live-in assistance from relatives with all baby care needs and therefore required more education support. This lack of support was exacerbated as clinicians felt many women did not attend antenatal classes or were unable to attend due to COVID-19 antenatal education class disruption. As one midwife described it:

> *The primips [primiparous women] in particular with their mother crafting and breastfeeding, they needed more intensive support. Multips [multiparous women] who weren't used to it also needed reminding. Do you remember what it was like before? And they had to stop and think how much their mum did for them, or their mother-in-law.* (Clinician 4 Postnatal Midwife)

The increased time required for patient care by clinicians was also due to greater demand for emotional support for women. Another midwife described a woman from Europe who had a history of postpartum depression and had organised for her relatives to fly-in to provide support, which, because of international flight restrictions, did not happen.

> *… she couldn't get her sister or her mum, or anybody from overseas, really made things worse… you have to take on that added responsibility of being that friend and that family and the clinician at the same time. And that woman was very draining.*
> (Clinician 8 Continuity of Care Midwife)

Changing support from partners: "…the fathers themselves actually did step up"

Nearly all clinicians discussed the changing role of husbands to provide support that would have been provided by overseas relatives. Research has found that during the pandemic partners have felt they were missing out on aspects of the pregnancy journey. [24] However, in our findings clinicians stated some cultural groups may have benefited from more opportunities to be with their partner in protected time to provide support that may have been provided by female relatives traditionally. As one clinician explained:

> *And a lot of the women said that's the expectation in Australia that the husband and the wife or both parents are involved in looking after the baby. Not just the mum and the grandmother or the dad getting a few cuddles at the end of the day. And the husbands were actually pretty happy to be allowed to do that because I think culturally, they are pushed out. They're pushed out by the older women… I think a lot of them actually felt really great that the older women weren't around bossing them around and the couple could actually work it out for themselves.* (Clinician 5 Continuity of Care)

More than half the clinicians discussed in some way how the COVID-19 experience had impacted and challenged traditional male provider role, particularly regarding gender roles and equity, this was perceived as more apparent within migrant couple's experience. The role of male partners engaged with parenting, inclusive of division of household tasks were highlighted as external support network was absent due to restrictions placed by COVID-19 on overseas relatives: "the fathers are doing a lot of it now, and I'll tell you what, they're doing a great job" (Clinician 4 Postnatal Home Care).

Mental health impact of loss of support: "Big time struggling because she's sort of just very isolated"

Almost all clinicians stated they felt COVID-19 had increased migrant women's feeling of isolation. Ten clinicians discussed that the pandemic had increased mental health concerns for all women. Most of the clinician who discussed mental health, specified that they felt that there was an increase in anxiety among women both antenatally and postnatally. This was often attributed to loss of support from relatives unable to travel to stay with migrant women. Some clinician reported cases they recalled of women not coping:

> *…she has no friends, her family are all in the UK, they were going to come support her for the birth, but now they're not. So she's really massively struggling. She's having anxiety attacks. Big time struggling because she's sort of just very isolated*.
> (Clinician 7 Birth Unit Midwife)

Clinician 8 who works within the continuity of care model stated loss of support: 'It's definitely increased levels of anxiety'. This clinician also reported that the fear of COVID-19 also impacted mental health 'there was a lot of questions about how it could affect my baby, how it could affect me, and that increased levels of anxiety for all women'. Another experienced midwife (Clinician 5), who was able to observe women and their families at home throughout their pregnancy journey with continuity of care said: "…some of the women felt sad that their babies were born at this time. They felt that they weren't able to be joyous and weren't able to really celebrate the birth of their children with their family."

Missing out on important life events in the pregnancy journey "…husbands are missing the births of their babies"

Almost all clinicians identified that partners and other important support people for women were missing significant life experiences in the pregnancy journey. Clinicians stated this was felt differently by some cultural groups in the birth unit. As one trainee obstetrician observed*;* "Pacific Islander patients, they often have a lot of family members in birth – like, all the women. So not having that might have been hard for them" (Clinician 10 Trainee Obstetrician).

The rules to provide a COVID-19 safe environment within the hospital appeared to some staff to not be consistent with the flexibility of social distancing rules that NSW state public health orders were allowing for the general population at the time of the study.

> *It's pretty brutal, really. I think even now they're still only allowed one [support person]. But you can have a whole football stadium full of people, but you can only have one person. So a lot of them are choosing not to have their partners at the birth.*
> (Clinician 7 Birth Unit)

This clinician continued that they felt the support person rules were not equitably applied within the hospital: "…if you contacted the [hospital] and gave a reason of some kind, then basically you were approved for two … and it's only the ones that kick up a song and dance that have been allowed to have more than one [support person]." This raises the issue of equity of access for non-English speaking women who find it more difficult to negotiate the healthcare system and actors within it. [25-27]

The hospital is not a safe place to be "… we're a big tertiary hospital, and we're the COVID central"

Seven of the clinicians discussed that woman felt that the hospital environment may be unsafe, a risk for COVID-19 exposure… "I think they just didn't want to risk coming in; either would not ring up or would cancel" (Clinician 3 Antenatal Clinic). Substantial evidence exists that there are barriers for migrant populations to access health care, COVID-19 places another barrier for women during this period. [26,27] Particularly in the first wave of the pandemic when there was more uncertainty, a Continuity Care Midwife (Clinician 5) said; "I think they were just really scared, really, really scared, and just didn't really want to come [to hospital]".

Maternity care service delivery during COVID-19

For the greater good, loss of efficient women-centred care: "it was just a matter of plugging the holes when you could identify them"

All clinicians discussed issues that were essentially rooted in the aim of a health care system attempting to rapidly reorganise to protect the greatest number of staff and patients from the looming threat of COVID-19 infection; 'For the greater good'. Providing optimal care was balanced with providing COVID-19 safe care. Some staff expressed concern that their safety was not prioritised and others that too much concern was given to staff safety and consequently patient care was reduced. Nine clinicians identified unclear and constant changes in practice guidelines as impeding care and creating uncertainty for both clinicians and the families in their care. As one clinician put it:

> *…the rules about one person in the birth unit only, no swapping. And then at one point it became OK, you could swap, but only once. I think now you can swap more than that. I'm not really sure, really... "Maybe ring birth unit when you're closer to term, and I'll ask them." Which, you know, then when you're in birth unit and the phone never stops ringing, you sort of think, "Oh, maybe I shouldn't have said that".*
> (Clinician 10 Trainee Obstetrician)

Some clinicians thought mixed messages to staff resulted as hospital administration assessed changing COVID-19 risks, based on evolving overseas experiences and also the process of interrogating existing clinical practices. "Well, we had five different rules in five days [laughter]. So, it was just a very drastic change, just a different rule every day that was being brought in with all the emails and things' (Clinician 9 Antenatal Clinic). However, other clinicians expressed how well they thought the service had responded:

> *I think there was a lot of people really making an effort to work out the best thing to do. I think it was excellent how quickly they shut down the hospital. I think that made a massive difference to our service capability. I think if we'd left the hospital open for six weeks it would have been pandemonium.* (Clinician 5 Continuity of Care)

Doing your own thing: "This doesn't feel right ..."

Most clinicians in our study have found the shift in clinical care from the centrality of a 'woman-centred' approach to the 'greater good' of safety for both patients and a new higher focus on staff safety, to be problematic. Maternity staff in this study stated they were often making their own judgment about risk and clinical care. A sub-text of 'doing your own thing' expresses the underlying concept of comments by most clinicians to provide optimal care that adjusted to the new rules but also conformed to their individual ethical maternity care standards. This was particularly in the context of low or zero COVID-19 local community prevalence.

> *…they encouraged phone consults. And I tried one. I did do one, but it just didn't feel right. And then also with the women as well. They'll be like "Oh, so you're not going to see me?" And that just – yeah, it was … It was like a wounded soul. They're so hurt by it. They understand but they're hurt, and I'm like – and then I was like, nah, just … This doesn't feel right.* (Clinician 8 Continuity of Care)

Clinicians expressed frustration at following recommendations to reduce exposure risk to COVID-19 to themselves at the expense of providing optimal care. This was discussed by most clinicians regarding the time limitation rule for consultations with women and the perceived impact this had on clinical care. Clinicians found following the short visit rule, of staying with a patient for only 15 minutes to reduce COVID-19 contact risk and maintain social distancing, unsatisfactory. As one clinician said: "you'd find that they had other questions, so we were constantly going over time… it was really difficult, and I could never sort of say to them, uh, 15 minutes is up, I'm leaving" (Clinician 5 Continuity of Care). Another clinician elaborated:

> *You know, say you're talking to a diabetic mother about expressing, and wanting to give her the syringes and the info sheet. If you really stuck to the 15, well, you just wouldn't be able to do that. You'd just get through her diabetic care, check her scan, and send her on her way. But that was really suboptimal.*
> (Clinician 10 Trainee Obstetrician)

Clinicians' personal experience of living through the pandemic

Challenges and difficulties in difficult times- "you just dealt with it";"… and we came straight off the bushfires"

When clinicians discussed their personal experiences of living with the pandemic a central theme was; 'Challenges and difficulties in difficult times- you just dealt with it'. All clinicians expressed that they had experienced adversity personally during the COVID pandemic. Some adversity was psychological with increased stress and anxiety. "I was on hyperalert, but I didn't recognise it at the time … you just dealt with it" (Clinician 4 Postnatal Home Care). Three clinicians who had partners that were either healthcare workers or essential workers stated this situation increased the complexity of issues to deal with, including concerns with risk and safety. This is also within the context of the state of NSW experiencing the worst bushfire season on record with 4.9 million hectares of the state burned over the summer period. [28]

> *It's been tough because my husband's …on the front line as well and we came straight off the bushfires. So he was off attending to those and not at home all the time with that and then we went straight into COVID. …challenging for our kids in that with both their parents being on the frontline.* (Clinician 14 Postnatal Ward)

One in nine adults in Australia are informal carers and these are most likely to be women and often disproportionately take on extra duties of unpaid care. [29] Of the predominantly female group of fourteen clinicians interviewed, five clinicians described COVID-19 as a barrier to providing support to elderly parents. Some of these difficulties are shared by the general public, however, clinicians felt they were more at risk of infecting vulnerable or elderly relatives with COVID-19 "Am I transmitting the virus because I've interacted with so many people during the day?" (Clinician 1 Antenatal Clinic). One clinician who worked in the busy birth unit discussed this in relation to their particularly vulnerable parent: "My dad was unwell with cancer and having treatment, so we couldn't go and see him" (Clinician 7 Birth Unit).

Clinicians from migrant backgrounds had similar stressful experiences to the migrant patient population with forced separation from extended family and restricted international flights. A Continuity of Care Midwife (Clinician 12) experienced the death of their mother during the pandemic who lived overseas: "…in February, when my mum passed away, I was able to go back to my home country to sort out things". She discussed the difficultly as an only child of managing remotely the complexity of caring for their elderly father, with significant health issues, who was left alone after the death of his wife.

> *…so I hire a 24-hour nanny as well. …he has to have 24-hour care. So I just worried about COVID-19, when it's going to stop, because I have to go overseas next year to kind of sort things. So, I'm not sure at this stage. …the relatives visit him quite regularly. … no way to go, so yeah…I have like a webcam, like a kind of camera. I can just talk to them.* (Clinician 12 Continuity of Care)

The difficulties of negotiating international travel and organising ongoing remote care of the clinician's father highlights the complexities that a migrant workforce live with, maintaining connection to family in their country of origin. In our patient population these issues are focused on family and birth. However, in our workforce the issues also include illness and death, as the clinician continued "That's the thing. I haven't buried my mum's ashes yet, so I am hoping next year I can go" (Clinician 12).

Guilt- "can I keep everyone safe?"; "…that was the fear. Taking it home and then … them not surviving it."

'Guilt' was another theme for clinicians living in the pandemic. Feelings of guilt were explicitly expressed by five clinicians. Some of the guilt was based in the personal ethical dilemma of balancing professional beneficence and personal risk to family. Anxiety surrounding the fear of COVID-19 transmission to vulnerable pregnant women or to clinicians' families was expressed by nearly all clinicians. They also talked about stress around potentially not working if a long quarantine was required or when waiting for COVID-19 swab results. As one clinician put it, “You feel like why do I feel guilty. You think- I could be working, I’m really actually OK. But you can’t come in” (Clinician 7 Continuity of Care). Some of the guilt was driven by knowing that there could be extra stress and workload for colleagues in this situation “… there’s always that burden that you’re … because in nursing you’re never replaced, so when you don’t come to work everybody else has to carry your load. So, you’re already feeling guilty” (Clinician 4 Postnatal Home Care). This altruistic concern to keep yourself safe for preservation of the maternity service was expressed by both midwives and medical staff as an obstetrician explained “anxiety around, especially, the vulnerability of yourself. So, if I was to get coronavirus or have to have a test, then it would mean me needing to be absent from work and unavailable for a period of time” (Clinician 11 Obstetrician). Another clinician elaborated the fear and anxiety associated with coming into contact with a potentially COVID-19 positive patient:

> *…the anxiety that I felt was sickening because I thought, uh, my goodness what have I done yesterday. So that was the Tuesday, and she rang me on the Tuesday night, so I was already home. So, I’d seen her. I’d seen other women. I’d seen my team members. I’d been at the hospital. I’d been home. I’d been with both of my children, who worked, and my husband who’s working from home, and I was panic stricken with the number of potential contacts that I could have hit. (Clinician 5 Continuity of Care)*

There were five participants who had school age children, most discussed the importance of keeping their children safe. When discussing the greatest personal concern during the pandemic one clinician described the fear for the survival of her vulnerable children.

> *I think my kids getting it. Because they were high risk and maybe they wouldn’t survive it. I’m pretty healthy. I think if I – hopefully I would survive it. But maybe my kids wouldn’t. So I guess that was the fear. Taking it home and then … Them not surviving it... everyone else is at home and isolating, and you have to come to work and potentially look after these women. And then take that home to your kids. That was scary.* (Clinician 7 Birth Unit)

For most clinicians attempting to ‘keep everyone safe’ to reduce risk manifested in what could be described as ‘coming home rituals’. As a clinician explained:

> *…we allocated this toilet, and my kids put [a sign] there, ‘the Corona room’ [laughs], ‘don’t enter’ They didn't go in that. We told them, we said OK, because we are both parents working in the hospital. OK, now with during this pandemic, we just need to try to protect you, what we can do. So that’s why. So we say OK, mummy and daddy were just changing our uniform in that room, and we will shower, everything in that room.* (Clinician 6 Mixed Areas)

Clinicians discussed keeping safe mentally as part of what could be termed COVID safe rituals: As one clinician put it, “I feel OK, because I have enough toilet paper.”

Self-care: new activities and work facilitating connection with people

Clinicians also described self-care as part of the rituals of keeping safe mentally. New activities that clinicians said they purposefully engaged in for mental health included cooking, online shopping, doing puzzles, sketching and investigating the family tree. Exercise was also described as important. One clinician said she had started jogging and another two had bought bicycles during the pandemic.

Clinicians also described the importance and meaning for them to continue to work for their mental health during the pandemic. As one clinician said: “…being able to still birth with women and have that contact with them was a saving grace” (Clinician 5 Continuity of Care). Most clinicians felt a sense of purpose providing care for women in difficult times. Work was viewed both as anchoring a sense of self and helpful for self-care.

> *[At the beginning of the pandemic] I felt as though we were like crusaders coming to work. We were kind of like on the battlefields, that we deserved bravery medals to come because of this unknown. … were we all going to die? … when you come to work you think what's going to happen kind of thing. So I felt a sense of purpose and – I don't know what the word is, but you felt like a soldier in the battle kind of thing. For the*

greater good, here we are. We're all going to die but it doesn't matter; here we are. (Clinician 1 Antenatal Clinic)

5.10 Discussion

It is estimated worldwide there is over 272 million migrants and in Australia approximately 50% of its population is either a migrant or a child of a migrant. [30,31] Migrant families have unique and more complex needs during pregnancy and birth than non-migrants, these include higher rates of stillbirth, preeclampsia and depression.[32,33] It is important particularly in Australia, to understand in depth the impact that the COVID-19 pandemic has had in this population to optimise care and understand service provision. Our qualitative study aimed to explore the effect of the current pandemic among clinicians providing maternity care in a high migrant population. We identified three main themes in the data collected from maternity clinicians: 'COVID-19 related travel restrictions result in loss of valued family support for migrant families', 'For the greater good, loss of efficient women-centred care' and personal 'Challenges and difficulties in difficult times- you just dealt with it'. This study adds to the limited maternity literature of the impact COVID-19 has had in high-migrant populations.

To our knowledge this is the first in-depth qualitative investigation that has specifically explored maternity clinicians' perceptions of changes to family support including overseas relatives. We have identified loss of the overseas family support as a major and ongoing concern for migrant women during the pandemic which in turn can impact service delivery. It is of interest to note there is supporting evidence for this finding in the Bradfield et al study as midwife participants mentioned the difficulty in providing women-centred care in a culturally safe way. This was to both women from culturally and linguistically diverse backgrounds and to Aboriginal women due to unmet cultural expectations.[11]

High quality and supportive social relationships have been increasingly linked to resilience, well-being, and reduced morbidity and mortality[34-37] High quality social support can be defined to include optimally a combination of structural factors such as strong social networks and living arrangements or functional self-reported measures of support including an internal perception of high-availability of support.[36] Robust social support can be drawn on in times of adversity and can act as an emotional buffer. Access to strong networks of social support have been found to not only impact an individual's health but also influence emotional connection and warmth of a mother and child relationship, with some research finding increased social support lays a foundation for improved parent child connection.[38] Understanding the disruption to this important aspect during pregnancy, birth and early childhood can be viewed as understanding an aspect of healthcare that has immediate impact and implications for both mental and physical health outcomes long-term. Our study has provided clear evidence of the impact of lack of support from overseas relatives has had for pregnant migrant women on the resulting effects for the provision of healthcare by a culturally diverse workforce providing maternity care to this population.

The COVID-19 pandemic is an acutely stressful event that has significant and detrimental impacts across the entire Australian population, particularly due to the uncertainly and swiftly changing capacity for individuals to connect with their usual support networks. In the specific context of perinatal care, networks that would usually provide a buffer against acute stress around significant events such as childbirth were largely absent. In particular, our participants stated that the impact on clinical care of the loss of the expected support network for migrant women included increased time required with women to provide adequate education and increased need for psychosocial support.

However, adding nuance to this finding, clinicians in our study also felt that Australian born women discussed the loss of relative support less or indeed stated they benefited from a family unit 'bubble' without having to interact with intrusive relatives during lockdown periods. These varied perspectives highlight the need for clinicians to refrain from assumptions about patient preferences and the need to individualise care and utilise cultural competency skills to provide optimal care.

The negative impact of mandated restrictions on support people during antenatal care and birth during COVID-19 pandemic is described in our study: as missing out on important life events in the pregnancy journey. This issue has been documented in social media and other supporting research.[13,24,39]

Australian research has identified that partners felt psychological distress primarily concerning COVID-19 hospital restrictions.[24] However, clinicians in our study also described the adaptation and positive aspects for partners to the loss of support from overseas relatives. Clinicians felt husbands and partners were 'stepping-up' and filling the support-gap left by overseas relatives. The perceived benefit was that partners were more involved with newborn care, whereas previously they may have not had as much opportunity due to the cultural traditions of mothers and mother-laws inhabiting this space. Concepts about gender equity, or the lack of it, in the country of origin and within the migrant population is important to understand for service provision and the subsequent impact on women's health. The risk of negative physical and mental health outcomes is associated with gender inequality, often because of reduced decision making within an intimate partner relationship.[40,41] The changing male role due to the impacts of COVID-19 within some migrant families may result in more equal gender relations that may in turn benefit partner's relationship to infants, and also provide health benefits to women. The clinicians in our study were of the view there was some evidence of this changing male role in the migrant populations they served.

The imperative to preserve the healthcare workforce has become paramount during the pandemic. Large groups of health workers in isolation or unwell will result in reduced or possibly even no capacity to provide care. Our research found clinicians understood that institutional and government shift to a system-level 'for greater good' focus, led to women-centred care being swept away in a confusing array of changing protocols, and policy changes. An underpinning pregnancy care philosophy and policy for many years has been to provide a holistic 'woman-centred' maternity care service, although this ideal is often not well understood or achieved.[42] Providing optimal maternity care is thought to focus on a woman's right to have choice of care, to be involved in decisions and have care that respects her emotional as well as physical needs.[43] A 'woman-centred' care framework has more recently been embedded in Midwifery National professional standards and the Australian pregnancy care strategic guidelines.[44,45] Although the precise definition and focus of 'woman-centred' care has been debated, the ideas remain central to particularly midwifery practice.[42,46,47]
Evidence from our study suggests that the pandemic and associated protocol and policy changes has undermined attempts to embed 'woman-centred' care in contemporary clinical care, protocols and practice. COVID-19 precautions, for a variety of clinical and public health reasons, have shifted focus to a central tenant of protection of staff. Our findings of the loss of individual women-centred care are supported by other research.[11] There may be no ideal solution to this issue during high COVID-19 case prevalence and high risk to staff as preservation of service is vital. However, there is evidence that healthcare workers during

COVID-19 are at greater risk of mental health challenges when exposed to practices that may be considered against a moral code,[48] as one midwife in our study said: *"This doesn't feel right"*. This information may inform appropriate mental health support to be offered to staff who are more acutely aware of morally and/or professionally dissonant practices.

We found the discordance occurred when staff felt a disconnect between reduced community restrictions due to low or zero case prevalence and onerous hospital restriction policies. Beneficence is an overarching principle in healthcare, a duty to act for the benefit of others.[49] Assessing risk for midwifery and medical obstetric staff is embedded in usual practice. In an environment where protocols are constantly shifting, we found staff were more likely to be utilizing this professional risk assessment skill-set during the pandemic and balancing beneficence and risk by, as clinicians put it, "doing your own thing".

Although staff said they "just dealt with it" the challenges and difficulties the pandemic has thrown up to health worker's personal lives have been significant. Providing care in a high-migrant population may also mean this migrant diversity is reflected in the workforce. Our research confirmed that COVID-19 related travel restrictions and separation from overseas family responsibilities and support structures, may also impact staff along with women in their care. This may create an added stress to clinicians in these settings.

Beneficence principles merge with altruism as many staff in our study were carers of young children and older relatives, therefore highly concerned with the risk their work posed to those in their care. Women are more likely have increased family responsibilities during the pandemic particularly increased hours on childcare, escalating the stress and complexity of their lives.[50] It should be considered that the cumulative impact of increased family responsibilities and stress associated with healthcare work put this group at particular mental illness risk during the pandemic.[14] Our study has illustrated that some clinicians dealt with this increased risk to their mental health by inventing activities and practices we coined as "rituals of keeping safe mentally", activities of self-care that maintained or enhanced their personal well-being, some related to symbolic or real practices of infection control, others related to calming or pleasurable non-COVID related activities or exercise.

The capacity for large complex institutions to be flexible and have agile proactive policies, require time and consideration that pandemic conditions often precluded. At the time of this study the primary restrictions within the maternity service was on the number of support people and appeared highly restrictive due to low to no cases of COVID-19 in the community. However, the study period restrictions and preparations has allowed for a rapid and appropriate clinical escalation of restrictions in response to the current mid-2021 surge in COVID-19 cases in the local area. Therefore, it may be considered as beneficial to the system to have prioritised restrictions in preparedness. This study adds to understanding these issues and experiences and may assist in future planning and optimising service delivery that ensure that women-centred care is optimised as soon as possible in changing conditions.

Strengths and limitations

This study explored clinicians' experience in a single centre, and this can be considered both a strength as rich contextualised detailed data was able to be collected, but it also brings a limitation to transferability. As, to the best of our knowledge, no other research has been conducted on a similar culturally diverse clinician group in Australia, it is difficult to say whether or how these findings may compare or be generalisable to other clinician groups servicing a diverse migrant population.

Some memory bias may have occurred as all interviews were conducted in a COVID-19 'lull' during loosening of community restrictions with no local lockdowns. A significant portion of clinical systems discussions were concerning the first few weeks of the COVID-19 initial outbreak that had occurred up to seven months prior. There is always the limitation in qualitative studies of missing divergent opinions of participants who are unwilling to be interviewed. As management was supportive of the study and interviews could be conducted during work time, there appeared to be a general willingness from clinicians to participate in this study. Once participants gave informed consent all continued to the interview, after a suitable time was arranged.

The inclusion of both medical and midwifery clinicians as key informants is considered a strength of this study as well as inclusion of a variety of areas of maternity care and experience for rich data and perspectives.

Conclusion

The global COVID-19 pandemic highlights the vulnerability of maternity care to migrant communities and their tenuous support networks. Providing quality maternity care for all women in a pandemic is problematic. However, in high-migrant populations heath care providers need to be aware of the significant and often long-term support role overseas relatives play for women during pregnancy, birth and early infancy. Clinicians should be aware the loss of this support during the COVID-19 pandemic is ongoing and requires culturally competent care, possible extra antenatal education and psychosocial support. To assist with maternity clinicians complying with hospital infectious control protocols during the pandemic, the health policies of relevant institutions should communicate effectively and strive to be compatible with community social distancing and other pandemic control measures.

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Cardiometabolic Impact and Pregnancy During the Pandemic: Interventions and Acceptability

Chapter 6

Women's Experience of Perinatal Support in a High Migrant Australian Population During the COVID-19 Pandemic: A Mixed Methods Study

6.1 Preface

The introduction to this thesis has detailed the impact that poor social support can have on cardiometabolic outcomes. Social support has strong cultural differences and preferences. This chapter explores the disrupted social support identified by clinicians in Chapter 5 impacting women in the peripartum period during the pandemic in a high migrant population. I felt privileged to bear witness to the resilience of women with lived experience of pregnancy and birth during the COVID-19 pandemic.

This chapter identified most women in pregnancy had significant disruption to social support, disruption continued postpartum mainly for migrant women. Participants found the use of technology helpful to maintain social connection, partners working from home and also partners stepping into traditional gendered roles of missing female relatives were highly valued. This chapter provides some understanding of the impact on patients of the sudden and unexpected changes in peripartum health care delivery during the pandemic. Future pandemic preparedness can be informed by these findings to adequately meet the needs of patients. Results from this chapter can also assist in understanding future association of cardiometabolic disease and possible drivers including reduced physical activity and increased stress.

BMC Pregnancy and Childbirth Birth is an interdisciplinary open access Q1 journal for Obstetrics and Gynaecology. This journal was chosen as the optimal journal to freely disseminate information regarding migrant experience to a diverse range of clinicians.

The published manuscript is presented as Chapter 5 structured as per the journal guidelines with minor formatting changes for thesis consistency. Published version in Appendix 6a and supplementary material (survey) Appendix 6b. Further unpublished supporting quotes Appendix 6c.

6.2 Dissemination of research

Peer reviewed and published

Melov SJ, Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Women's experience of perinatal support in a high migrant Australian population during the COVID-19 pandemic: a mixed methods study. **BMC Pregnancy Childbirth** 23, 429 9 June, 2023. doi.org/10.1186/s12884-023-05745-9

Presentation

Invited speaker: Australian College of Midwives NSW state conference Orange 17-18 June, 2022; **Melov SJ,** Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Women's experience of perinatal support in a high migrant Australian population during the COVID-19 pandemic

International Confederation of Midwives, 11 - 14 June 2023. 33rd ICM Triennial Congress, Bali, Indonesia; **Melov SJ,** Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D*, McNab J*. Women's Experience of Perinatal Support in a High Migrant Australian Population During the COVID-19 Pandemic: a Mixed Methods Study

6.3 Author attribution statement

I, Sarah Melov, was responsible for designing the study, survey tools, project administration, resources-funding, ethics submission and revision responses, consenting patients, conducting all qualitative interviews, data curation, coding the data in NVivo, collaborating in generating themes, qualitative analysis, writing initial draft manuscript, coordinating revisions, submission of manuscript as corresponding author, drafting responses to reviewer comments and co-ordinating co-investigator comments and edits to finalise and submit the manuscript. My co-supervisor Dr Justin McNab oversaw all qualitative aspects of analysis and manuscript writing.

My co-authors Galas N, Swain J, Alahakoon TI, Lee V, Cheung NW, McGee T, Pasupathy D, McNab J, all contributed significantly to aspects of the study including study design, interpretation of findings and critical review of the manuscript.

Primary supervision for this thesis chapter was by Dr Justin McNab and Prof Dharmintra Pasupathy.

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statement above is correct.

Signature:

Prof Dharmintra Pasupathy

6.4 Manuscript

6.5 Women's Experience of Perinatal Support in a High Migrant Australian Population During the COVID-19 Pandemic: A Mixed Methods Study

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6.6 Abstract

Background: As a COVID-19 risk mitigation measure, Australia closed its international borders for two years with significant socioeconomic disruption including impacting approximately 30% of the Australian population who are migrants. Migrant populations during the peripartum often rely on overseas relatives visiting for social support. High quality social support is known to lead to improved health outcomes with disruption to support a recognised health risk.

Aim: To explore women's experience of peripartum social support during the COVID-19 pandemic in a high migrant population. To quantify type and frequency of support to identify characteristics of vulnerable perinatal populations for future pandemic preparedness.

Methods: A mixed methods study with semi-structured interviews and a quantitative survey was conducted from October 2020 to April 2021. A thematic approach was used for analysis.

Results: There were 24 participants interviewed both antenatally and postnatally (22 antenatal; 18 postnatal). Fourteen women were migrants and 10 Australian born. Main themes included; 'Significant disruption and loss of peripartum support during the COVID-19 pandemic and ongoing impact for migrant women'; 'Husbands/partners filling the support gap' and 'Holding on by a virtual thread'. Half of the participants felt unsupported antenatally. For Australian born women, this dissipated postnatally, but migrants continued to feel unsupported. Migrant women discussed partners stepped into traditional roles and duties of absent mothers and mothers-in-law who were only available virtually.

Conclusion: This study identified disrupted social support for migrant women during the pandemic, providing further evidence that the pandemic has disproportionately impacted migrant populations. However, the benefits identified in this study included high use of virtual support, which could be leveraged for improving clinical care in the present and in future

pandemics. The COVID-19 pandemic impacted most women's peripartum social support with migrant families having ongoing disruption. Gains in the pandemic included greater gender equity for domestic work as husbands/partners increased their contribution to domestic work and childcare.

6.7 Introduction

The COVID-19 pandemic has had a devastating impact on the world including increased direct mortality, morbidity, poverty and significant social upheaval.[1,2] Australia experienced an initial low prevalence of COVID-19 disease compared to many other countries. The majority (89%) of COVID-19 deaths and cases in Australia during 2020 were in the state of Victoria and by mid-2021 Australia-wide there had been a total of 910 deaths.[3] Measures such as lockdowns and health facility preparedness were largely successful in containing the spread of COVID-19 until the sharp rise in cases mid-2021.[4] Other measures for containment included closing the Australian international borders to non-citizens for nearly two years from March 20, 2020 to February 21st 2022.[5]

The closed international borders during the pandemic have impacted many aspects of life including access to overseas social support networks. This was particularly relevant for the migrant community throughout Australia. Australia has a high migrant population with 7.7 million migrants in 2020, nearly 30% of the population.[6] The main countries of birth for migrant Australians are: England (3.8%), India (2.8%), China (2.5%), New Zealand (2.2%) and the Philippines (1.2%).[6] Of note for maternity care, the English migrant median age is 58 years while it is 35 years for Indian and 38 years for Chinese migrants.[6] Therefore, Indian and

Chinese migrant women are more likely to be users of maternity services than English migrants.

Research and media reports have highlighted the impact of closed international borders on social support for migrant women in the peripartum period.[7-9] High quality social support can be a buffer against stress and consequently improve health.[10] Social support may be defined as having three main elements; emotional support from people who provide understanding and empathy; instrumental or tangible support defined as having people physically available to complete tasks for you; and people who can provide advice or knowledge, referred to as informational support.[11] Culture may also play a role in the type of, and preference for, support and how this support is provided or received.[12-14]

In the Western Sydney Local Health District (WSLHD) of New South Wales (NSW) Australia, perinatal outcomes were impacted in the first year of the pandemic, including a 15% reduction in spontaneous preterm births.[15] Hospital health service changes included increased infection control measures such as mandatory mask wearing, reduced visitor access and some use of telehealth. In a low COVID-19 prevalent period, the changed obstetric outcomes are attributed largely to the indirect impact of COVID-19 through health services and societal changes. This study will assist in understanding the COVID-19 pandemic patient experience, contribute to understanding patient engagement with healthcare services and potential factors contributing to the changed perinatal outcomes during this period. Our aim was to explore the experience of peripartum support for women during the first year of the COVID-19 pandemic in a high migrant population.

6.8 Methods

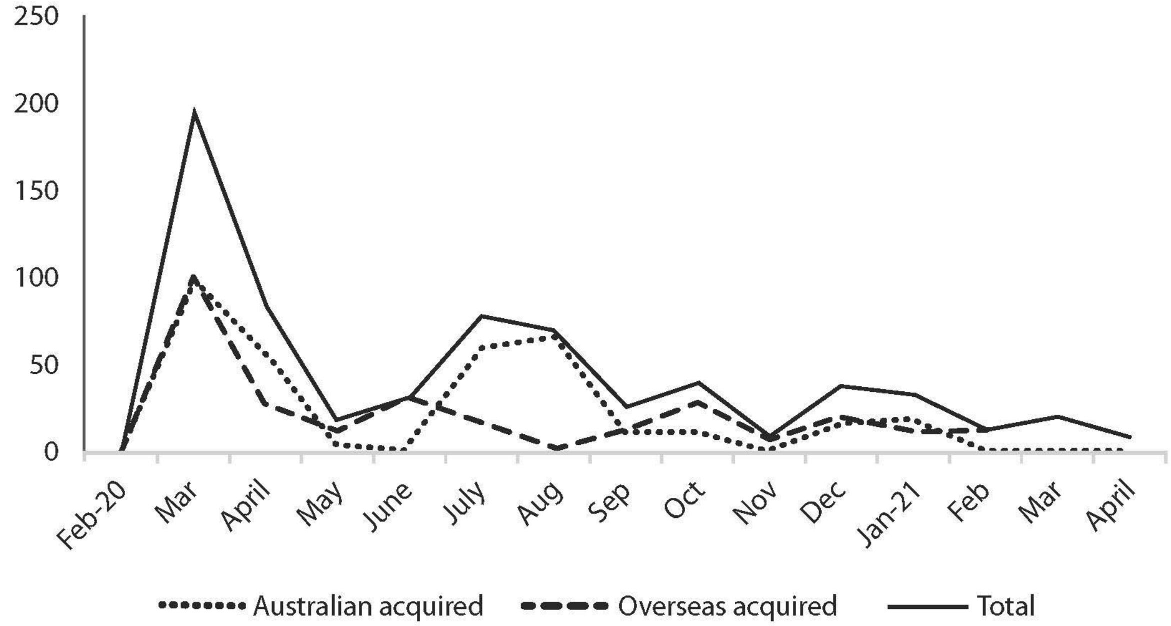
Design

A mixed methods study design was employed with semi-structured interviews used for qualitative data collection, and quantitative data extracted from hospital pregnancy records and a study specific quantitative questionnaire. The semi-structured interview schedule focussed on three-key areas: support, cultural context and maternity care. Support during the peripartum is defined as meaning family members and others who provide emotional, tangible/instrumental (practical), and informational support.[11]

Setting

Participants were recruited at a tertiary referral hospital in WSLHD, NSW, Australia. WSLHD has a high migrant population with 58% of women who use the maternity service born in non-English speaking countries.[16] The recruitment hospital has approximately 5000 births per year.[16] During the study period there was a low prevalence of COVID-19 in the community with a total of 149 cases in the health district including two women recorded to have been COVID-19 positive during pregnancy (Figure 1).[4] Community 'lockdown' orders were in place for the state of NSW for seven weeks from 30th March 2020. However, hospital COVID-19 mitigation restrictions remained for the study period including hospital entrance health screening, patient only waiting rooms, no support people in ultrasounds and only one support person permitted in the birth unit.

Figure 1. COVID-19 cases in Western Sydney Local Health District February 2020 – April 2022. Study participants interviews from 22nd October 2020 to 15th April 2021.

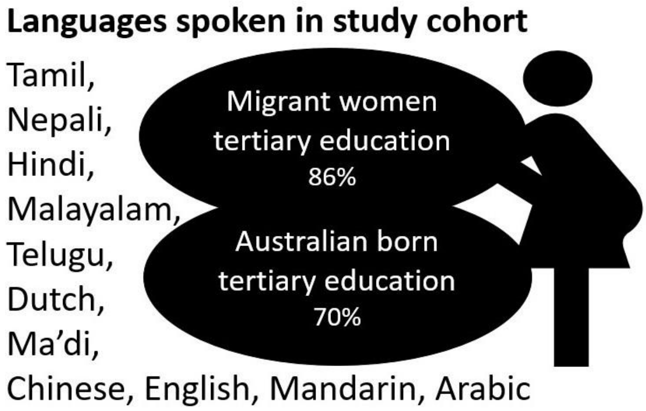


(Source https://data.nsw.gov.au/data/dataset/covid-19-cases-by-location)

Participants

There were 24 participants interviewed, with 22 interviews conducted antenatally and 18 postnatally. Antenatal inclusion criterion was gestation greater than 34 weeks and postnatal inclusion required that the baby was not a hospital inpatient. Maximum variation purposive sampling was used to ensure a culturally diverse participant voice was represented that reflected the local population (Figure 2).[17]

Figure 2. Characteristics of the 24 study participants



Data collection

Three sources were used for data collection: interviews, study specific questionnaires (Appendix 6b) and routinely collected maternity data. The survey instrument was developed by the investigators and edited after pilot testing for readability with eight culturally diverse women. Cultural groupings were based on Mothers and Babies annual report New South Wales with known local demographic considerations.[16]

Antenatal and postnatal interviews occurred over a six-month period from October 2020 to April 2021. All participants were offered an option of face to face (when COVID-19 restrictions allowed), telephone or video interview at times convenient for them. Of the twenty-two antenatal interviews eleven were face to face, six were video interviews and five interviews were completed by telephone. Eighteen postnatal interviews were conducted with participants, 17 by telephone and one by video. Recruitment ceased when sufficient rich data was collected from a diverse range of participants to provide insight into the research question. The interview times ranged from 30 to 75 minutes antenatally and 15 to 70 minutes postnatally interviews. All interviews were transcribed by a professional transcription service. Interviews were conducted by the research midwife first author (SJM) with progress and oversight provided by an expert qualitative researcher (JM).

Data analysis

Quantitative data was collated from surveys and presented as descriptive statistics. Data from transcribed interviews were coded and analysed thematically using an inductive approach. Analysis was conducted in six non-sequential phases as described by Braun and Clarke.[19] Deep familiarisation with the data by the first author was the initial phase that included reading and rereading all interview transcripts, discussing interviews with the senior author (JM), reviewing field notes, reviewing transcription with audio to correct transcription errors. Iterative phases for data analysis were: generating codes; exploring initial categories and themes; reviewing initial themes; finalising and naming themes, and producing the report.[18] Two authors (SJM, JM) agreed upon and defined codes (derived from both explicit and implicit meanings), categories and themes. Themes were reviewed and consensus reached by a third author (NG) acting as a content expert as the maternity cultural liaison officer in the study hospital (MLO). NVivo (release 1.5.1) was used for data management and assistance with analysis.

Personal, research and clinical experience of investigators was taken into reflexive consideration and trustworthiness during all phases of the research process. All investigators had disruption to their professional and personal lives through the lived experience of the pandemic and this was also reflected upon by investigators throughout the project design, data collection, analysis and interpretation phases.

6.9 Results

The study covers a low COVID-19 prevalence period in the local health district (Figure1). Antenatal interviews were conducted with women between 34 - 39.4 weeks gestation and postnatal interviews 5-12 weeks after birth (Table 1). There were 14 overseas born participants and 10 Australian born. One of the overseas born participants stated she was a refugee. Five out of the 10 Australian born women stated they had partners who were migrants. Most participants were tertiary educated (19 out of 24, 79%, Figure 2). Most Australian born (7 out of 10) and migrant (8 out of 14) women were employed fulltime, part-time/casual or were on maternity leave.

Table 1. Antenatal and postnatal interview and participants characteristics during the low prevalence first year of the COVID-19 pandemic in Western Sydney, Australia

Participant	Country of birth	Self-identified cultural group	Primiparous	Years lived in Australia	Weeks of gestation antenatal interview	Weeks postpartum at interview
P1_OS	India	SA	Yes	4	.	8
P2_OS	Nepal	SA	Yes	2	37.1	9
P3_OS	Nepal	SA	Yes	3	39.1	10
P4_OS	India	SA	Yes	2	38.5	12
P5_OS	India	SA	Yes	4	36.5	9
P6_OS	India	SA	Yes	3	.	10
P7_OS	India	SA	Yes	2	38	9
P8_OS	Nigeria	African	No	5	34	.
P9_OS	Netherlands	Dutch/Irish	No	6	36.6	7
P10_OS	Philippines	SEA	No	10	39	10
P11_OS	South Sudan	African	No	10	35.1	8
P12_OS	China	NEA	No	5	36.6	7
P13_OS	India	SA	Yes	10 months	39.1	.
P14_OS	China	NEA	No	8	35.4	12
P15_AustB	Australia	ES	No	.	36.6	
P16_AustB	Australia	ES	No	.	37	10
P17_AustB	Australia	ES	No	.	36.2	.
P18_AustB	Australia	ES	No	.	34.3	6
P19_AustB	Australia	ME/ES	Yes	.	34.6	9
P20_AustB	Australia	ES	No	.	34.3	7
P21_AustB	Australia	ES	Yes	.	39	.
P22_AustB	Australia	ES	Yes	.	39.4	6
P23_AustB	Australia	ES	Yes	.	36.6	5
P24_AustB	Australia	ES	No	.	38.6	.

OS = Overseas born AustB = Australian born SA = South Asian SEA = Southeast Asian NEA = Northeast Asian ES = English Speaking: Australia, United Kingdom. New Zealand or America ME/ES = Middle Eastern/English Speaking

Themes

Among this well-educated cohort, we identified four major themes when exploring support for women in a high migrant population during the first year of the COVID-19 pandemic. These themes were: significant disruption and loss of peripartum support during the COVID-19 pandemic that had ongoing impact for migrant women; holding on by a virtual thread; supportive employers making a difference, and impact on mental health of both participants and partners. Other themes identified were: husbands/partners filling the support gap; building family bonds; a lucky few with neighbourhood support close and plentiful; COVID-19 fear and baby safety.

Significant disruption and loss of peripartum support during the COVID-19 pandemic that had ongoing impact for migrant women

No migrant women in the study had access to their mother's physical tangible support due to COVID-19 related travel restrictions. Half the migrant women in the study described feeling unsupported or having less support than they would have wanted. This was the case in the antenatal interviews and remained so for the postnatal interviews when COVID-19 restrictions had largely been removed in the community; "…life has somehow stopped, and I really want my mum to visit me as soon as possible" (P4 India Postpartum). Half the Australian born women also described a lack of support during pregnancy when hospital, local and interstate COVID-19 related travel restrictions were present. However, satisfaction with support improved for Australian born women postnatally when these restrictions were eased.

> *So now that all the COVID restrictions, especially with the amount of people in your households and everything like that, have been completely reduced, we've had more support than we can handle*. (P24 Australian born (Aust) Postpartum)

Issues with access to support continued for most migrant women into the postnatal period with no difference between multiparous or first-time mothers. Missing out on overseas family support appeared to be similar for women who were new migrants and for those who had migrated more than five years previously. The survey identified most (64%) migrant participants had planned on receiving supportive visits from overseas relatives. The duration of planned visits was to have been from three to six months.

> *But this time, due to COVID, no one is able to [come]. [Last baby]…we have four parents here and then this year no one is able to come...Yeah, most worry is I don't have any family support, they restrict me from getting supports from my family.*
> (P14 China Antenatal)

First time migrant mothers stated they missed instructional support and multiparous women expressed missing emotional support and child-care support for older children. Two migrant women stated they paid for in-home help to fill the gap left by absent relatives. One had assistance for a few hours a day, the other had live-in help for six weeks. The participant with in-home help felt she had not missed her mother as much as anticipated in the antenatal period as the carer had provided valued professional guidance for newborn care. However, she also said paying for this help had been a significant economic burden on the family.

Almost all migrant women when interviewed postpartum felt they missed their mother but by using various strategies were able to cope better than they had thought they would during the antenatal period.

> *So, yeah, it turned out really good. Day by day started falling in place, we got sort of prepared that, no, our in-laws couldn't come, no one from the family is going to come, so we have to be by ourselves, borders are not going to open. We were very well prepared, we were by ourselves, we have to do things on our own, and by God's grace we have really good friends around who stepped forward for our support.*
> (P6 India Postpartum)

Husbands/partners filling the support gap; "*He did a fantastic job. I'm so blessed. I'm totally blessed"*

Most (13 out of 14) migrant participants stated their partners were integral to them feeling supported during their pregnancy and when caring for their newborn; "I really don't have much support, ... only my husband he is there for me" (P11 South Sudan Antenatal). In contrast only a minority (3 out of 10) of Australian born women discussed partner support. Migrant women described that their partners had stepped in to provide support to compensate for the loss of traditional support mothers and other relatives would have provided.

> *…it was my husband who stepped into my mother's role, or a true companion role, I could say, that he started cooking, he started learning how to cook and take care of me. He did a fantastic job. I'm so blessed. I'm totally blessed.* (P6 India Postnatal)

There were other factors during the pandemic that facilitated partner support such as opportunities created from husbands/partners working at home. More than half the participants described the supportive benefits of their partners' capacity to work from home.

> *Just my husband is home. [Laughs] So easy. He's always available. If it was not COVID, then my mom would have been here. So that would have been a different story. But my husband is home, working from home, so he's available 24/7. So, if I find any difficulty or trouble, anything really, to my mood swing or whatever, I can go to him.* (P4 India Antenatal)

Building family bonds - the benefit of missing support; "*…it made us more self-dependent"*

Gender equity and opportunity

Women described that their partners had benefited from the extra family time that may not have occurred without COVID-19. There were increased opportunities for husbands to not only understand the needs of their partners during the peripartum period and provide support for them, but also engage in care for their newborn and older children. One study participant described that the pandemic had provided a unique opportunity for them to understand gender roles and for her husband to be a greater part of the pregnancy journey.

> *[My husband]...started to understand more like, OK, what exactly a woman is, what exactly a man is. Those things are something I believe it's really hard… And he actually know what an importance a woman is, what a pregnancy is, what a baby delivery is. So, I think that makes your relationship and your bonding more stronger.*
> (P6 Postnatal India)

A participant explained during the postpartum interview she had found some benefits to relatives being unable to visit including not having to deal with the stress of negotiating inter-family harmony; "I don't have to worry about the relationship between in-laws or my parents and me because sometimes we have different opinions [on baby care] [laughs]" (P14 China). She further explained the support from her husband with caring for her first-born child had strengthened their relationship and their family unit. Another participant explained COVID-19 travel restrictions benefits included staying with her husband rather than separating for the birth.

> *I would go to India for the delivery, and come back after some time, my in-laws or my parents would have been here, and he would have gone to work at the time…Yeah, he would have missed everything, yeah.* (P1 India Postpartum)

Illustrating the support from her husband to care for both her needs and the newborns', one participant described the extent of organised leave he had taken to provide the practical support that would have otherwise been given by relatives; "…my husband has taken off two months, and after two months definitely I have to look after me, like for myself and as well as for the kid" (P3 India Antenatal). The practical skills gained of infant care for both parents that would have been relegated to others were also appreciated by some participants. In antenatal interviews, the forced parenting independence and infant care skill acquisition was the cause of some anxiety, that participants' parents would not be present to be 'taking charge', but this was ultimately valued postnatally.

…it's a positive, but then you're learning the hard way…when someone is there taking charge, they are thinking, it's not you who are thinking, you're just following the lead. So you are not thinking and you're not, you know, trying to understand what's happening, but now you have to think and you have to get things done.
(P5 India Postpartum)

Families that had previous experience of live-in help from relatives were aware of missing that support but also understood the opportunities of a different experience with partners, for example having the time and space to be more engaged with infant care.

And he's very excited as well because the last one obviously we had all the family and he didn't necessarily have to step up …there was times where he felt like he – my mum would take over or something like that. Well, he's quite excited about the fact that he will have to do night feeds and he will have to change all the nappies.
(P9 Netherland Antenatal)

Holding on by a virtual thread; "*…thank God for technology"*

Almost all participants described a high level of virtual contact with families, particularly their mother. For both Australian born and migrant women, contact with their extended family was daily for approximately two thirds of women in the study (16 out of 24), with three women describing virtual contact as being several times a day. More migrant women had daily contact than Australian born women. All other participants stated contact with family was at least weekly. Virtual contact was through the use of audio only telephone, text or video (Table 2). Participants' definition of 'frequent' speaking or contact varied from 'multiple times a day' to weekly and the length of contact ranged from five minutes to several hours.

…she was pretty excited to come here and help me through, but unfortunately it could not happen. But I speak to her every day. I do a video call and then we speak for hours.
(P4 India Antenatal)

One Australian born participant described the routine daily video contact with her mother who lives interstate: "She likes to have breakfast with us… She'll have her coffee ready and then she watches my son eat his breakfast and make a mess" (P20 Aust Antenatal).

Distance did not appear to be associated with the frequency of virtual family contact for both Australian born or migrant women. One Australian born woman who had her mother, relatives and friends in close proximity, had virtual contact by telephone with her mother 2-3 times per day, her sister multiple times per day and her brother, who lived interstate, weekly. A study participant described daily contact with various family members who had migrated to other countries: “All family in different four countries, every day someone is checking” (P6 India Postpartum). Three participants spoke of frequent video calls that fostered a virtual relationship with grandchildren and assisted with virtual childminding.

> *…they want to see her and talk to her. So, we make a video call, and we fix in a stand, and make them to speak with her. So she babbles again to them. So they feel little relieved, and they feel little happy… I’ll do my cooking things, and I’ll do all the housework things. And so that they could interact with her, and they make her distracted…* (P1 India Postpartum)

Table 2. Quantitative survey data participant peripartum support details during the low prevalence first year of the COVID-19 pandemic in Western Sydney, Australia

Participant	Planned length of stay for live in help (months)	Frequency	Contacts overseas relatives
P1_OS	6	Daily	Facetime
P2_OS	6	Every few days	Viber
P3_OS	.	Every few days	Viber
P4_OS	3	Daily	N/A
P5_OS	6	Daily	WhatsApp
P6_OS	.	Daily	WhatsApp
P7_OS	3	Daily	WhatsApp
P8_OS	.	Every few days	Voice phone
P9_OS	1	Every few days	WhatsApp
P10_OS	.	Occasionally	Facebook Messenger
P11_OS	12	Every few days	Voice phone
P12_OS	.	Every few days	N/A
P13_OS	.	Daily	N/A
P14_OS	6	Every few days	WeChat
P15_AustB	.	.	.
P16_AustB	.	.	.
P17_AustB	.	Weekly	Facetime
P18_AustB	.	.	.
P19_AustB	.	Daily	WhatsApp
P20_AustB	3	Every few days	Voice phone
P21_AustB	1 week	.	.
P22_AustB	.	.	.
P23_AustB	.	.	.
P24_AustB	.	.	.

OS = Overseas born AustB = Australian born N/A = not available

Participants stated frequent inexpensive virtual contact with their support networks was also beneficial to their mental health, particularly during COVID-19 lockdown periods with reduced opportunities to socialise: “I was in (virtual) contact with friends and family frequently, I didn’t feel much loneliness or any sort of things during COVID (lockdown)” (P13 India Antenatal).

However, some women expressed the frequent virtual contact did not replace the desire for physical presence. One participant discussed the loss of child-minding support; “they can just only tell us what to do but they cannot help…” (P14 China Postpartum). Most women from overseas also sought virtual guidance to maintain cultural connection and adherence to traditions.

The content of conversations with relatives for the majority of Australian born women differed from overseas born women. Australian born participants stated the content was primarily connection and emotional support rather than cultural connection and adherence to traditions; “…sometimes we’ll just sit there and share recipes of what we’re making for the week, just to kind of have that communication” (P23 Aust Antenatal).

Not all migrant women had access to reliable frequent virtual support due to both financial constraints and overseas relatives having limited or no access to technology, which reduced capacity for frequent virtual support and contact. The difficulty for some migrant women to connect to family members in low-income countries was discussed. One study participant from South Sudan described it was easy and free to use phone apps to contact her sister but connecting to her mother was problematic; “My mum is in a village, and I have to put a credit and call and sometimes I do not have credit”.

Two-way virtual support

The desire for, and disruption of, frequent support was two-way. Both Australian born and migrant participants stated that as well as receiving support, they were also having to provide support virtually that they would have provided in-person without COVID-19 restrictions. For example, one Australian born woman spoke of providing virtual support for her mother:

> *Mum has leukaemia, so I can’t see her during COVID… I think it’s just one of those two-way things where we just feel so horrible about the whole situation, and that we can’t – we aren’t doing enough for each other.* (P23 Aust Antenatal)

Virtual contact was the only option due to travel restrictions and the vulnerability of her unwell mother. However, she was able to facetime daily from ten minutes to two hours; “I mean half the time we just lay there, and I wait for the baby to move so she can see it” (P23 Aust Antenatal). One migrant woman described her father’s illness and then his death. She was unable to be present to support her mother in the Philippines but could at least provide some support virtually.

> *…you know, thank God for technology. We can still talk to them and call them, and Mum gave us updates when Dad was in hospital, in the ICU, and all those things. So we were still there but we were not there, if that makes sense.*
> (P10 Philippines Antenatal)

Supportive employers making a difference; “*…the work that he’s with now has been amazing”*

There were eleven women who specifically discussed support they or their partner received from employers. All participants who discussed paid employment stated during the COVID-19 pandemic they felt supported in their pregnancy by their workplace; “Even my manager told me like, ‘If you need to take more breaks, take it.’” (P5 India Antenatal). No participant reported that their management or their husband’s workplace had been obstructive with requests concerning pregnancy care or leave.

Working from home for most participants was valued and viewed positively. Women discussed feeling more relaxed as they no longer had to spend time on crowded public transport with the associated COVID-19 risk. Women stated they benefited financially from reduced expenditure on transport and clothing.

The neighbourhood village: a lucky few with support close and plentiful; “…*we’ve had more support than we can handle.”*

Almost all Australian born women who had relatives living nearby felt well supported. Migrant families drew support from local friends, siblings or their own or partners’ families but still did not feel as supported as Australian born women. One participant had both her family and her husband’s family living close and felt COVID-19 had not changed anything for her. At both the antenatal and postnatal interview she felt well supported by her close family; “Yeah, it's been great [support]. I've got a great family; got a very large family, and my partner's family is great as well… I just live right around the corner from my parents, so we were over there quite a lot” (P16 Aust Antenatal).

Impact on mental health for both parents; “…*It was very lonely”*

Both migrant and Australian born women discussed the impact the pandemic and restrictions had on support and their mental health. Loss of joy around the pregnancy experience was discussed: “It’s been very different. Otherwise I would have really enjoyed it” (P4 India Antenatal). The emotional burden of living in the pandemic was difficult for many women;

"…it was all just kind of one thing after another after another, where it'd been this extreme emotional rollercoaster for myself and my husband" (P23 Aust Antenatal). The direct impact of hospital restrictions on partners attending some appointments and ultrasound impacted the mental health of the family and created uncertainty for women's access to support; "Like he ended up in tears when we couldn't see the first ultrasound [together], and he wasn't allowed in" (P23 Aust Antenatal).

Three women had a history of anxiety or depression which was noted on routinely collected data at hospital booking. Two of these women stated they felt well supported postnatally and antenatally on interview. No women in the study cohort scored >10 on the Edinburgh Depression Score (EPDS) at booking-in visit with the midwife. Two participants on interview disclosed they had professional help for mental health concerns, neither disclosed a history of mental health issues at routine booking visit or scored >4 on the EPDS. One of these participants was diagnosed with depression for the first time during the antenatal period and stated the loss of her husband's presence and support during appointments contributed to her depression and feelings of isolation.

> *Just with the COVID restrictions the experience wasn't great. Just mentally, I think, more than anything, COVID impacted it. I had a really healthy pregnancy, I didn't really have any issues, but mentally it was a bit of a challenge… just a huge mental drain.* (P23 Aust Antenatal)

During the study period, only patients were allowed in the antenatal waiting room. One participant explained these hospital restrictions had left her partner feeling like a criminal; "He always uses that phrase: 'I feel treated like a criminal' " (P10 Philippines Antenatal). The threat and uncertainty around the potential loss of partner support was a source of concern and stress for women; “I was worried that he wouldn’t be able to be there or that I would have to go through labour on my own” (P9 Netherlands Postpartum).

COVID-19 fear and baby safety above all else: “…*so worried, that if I get COVID, it would kill the baby”*

Overall, the majority of study participants (18 out of 24) stated in antenatal interviews that their main concern regarding COVID-19 was the safety of their baby while pregnant or as a newborn: “…what if I get it, it's going to pass onto my baby. And I'm not scared for myself” (P6 India Antenatal). This concern for their unborn baby restricted most participants’ movements outside the house beyond the lockdown and lasted throughout their pregnancy. This was the case for most migrant and Australian born women; “I am very scared to go out and risk meeting other people…We rarely went out’ (P10 Philippines Antenatal); ‘I was so, so worried, that if I get COVID, it would kill the baby” (P23 Aust Antenatal).

The strong public health messaging in the community around the importance of hand sanitising and wearing face masks left four women feeling unsupported with lack of information on how to keep their baby and children safe from COVID-19.

> *We cannot wear mask or sanitise the hands of the baby. We can do it but we cannot do it for the baby… What are we going to do with the baby, like how are we going to ensure the safety of the baby is a question and concern.* (P13 India Antenatal)

Many participants spoke in the antenatal interviews of ways to mitigate infection risk. Three women discussed the fear of the effect COVID-19 infection may have on their unborn child which resulted in themselves or their husband changing or stopping work which could have a significant financial impact:

When I have my pregnancy last time I was working, but this time when I found I was pregnant I quit my job because of the COVID-19 just to keep safe… I would like to work because I can earn money for the family, but yeah, I have to balance the safety.
(P12 China Antenatal)

Most migrant women postpartum discussed their primary concern with COVID-19 had shifted away from the risk of COVID-19 infection to the shut borders and missing support: "…the major thing is my family. I'm, like, I'm worried my baby can't see my family" (P2 Nepal Postpartum).

6.10 Discussion

This study identified differences between migrant and non-migrant women in their experience of peripartum social support during the COVID-19 pandemic. We found that migrant women were significantly impacted during the pandemic both antenatally and postnatally, primarily due to the loss of support from disrupted international travel. Migrant populations have been disproportionately impacted by the COVID-19 pandemic with studies providing evidence of increased burden of COVID-19 disease, mental health and socio-economic consequences in both high and low-income countries.[1,19-23] It is essential to understand women's experience during the pandemic to assist in providing optimal support, planning future pandemic risk mitigation and identifying potential factors that affect obstetric and other health outcomes.

Supportive social networks are important as a buffer for stressful life events and have been shown to improve cardiometabolic health outcomes.[10,24-26] Optimal social supports are mitigators for the known impact that stress, disasters and pandemics can have on long term cardiometabolic health as well as a wide range of immediate benefits, including mental health and child development.[27-34] Disrupted support during the pandemic may also influence perinatal outcomes.[35] Healthcare systems understanding, facilitating, and supporting these buffers for long term health, may prove increasingly important.

This study identified a disrupted support network for participants but also identified how technology played an integral part assisting women to remain connected to family. Virtual support has been identified as a mediator to improved perinatal mental health and social support both before and during the pandemic.[33,36,37] We found virtual support acted as a significant buffer to stress providing emotional and informational support, as well as improving mental health. Clinicians should continue to find avenues to encourage and facilitate the use of virtual social support during the peripartum.

The cultural expectation of many migrant women is their mothers or relatives will provide extensive support postpartum to facilitate resting and care of the newborn. For some cultural groups this may involve 30 days of no cooking or domestic cleaning duties for new mothers, with the expectation of complete physical rest and a focus on caring for the new baby.[14,38] This study identified migrant fathers were facilitating new mothers' rest and this assisted with maintaining valued cultural practices and connection to countries of birth.

Our research has highlighted the impact of missing relatives within culturally driven gendered domestic roles, now filled with 'husbands/partners stepping up'. This study has illustrated that opportunities to work from home facilitated filling of a domestic labour void by partners. Women described that COVID-19 delivered unexpected gains of opportunities for men to participate meaningfully in partnering more equally in parenting and domestic life, with research suggesting health benefits for both.[39]

We have identified most women during the peripartum period had contact with their mother or close relatives frequently and are highly reliant on them for social support. We found a generation that has access to and utilised instant communication facilitating support. The shift to communicating virtually during the pandemic was embraced by our families. However, other research has shown the pandemic drove maternity care away from patient centred care and focused on preservation and safety of staff without providing meaningful alternative options to support and connect clinicians with women and partners during the pregnancy journey.[9,40-41] Understanding and leveraging existing virtual patient communication preferences in clinical care may strengthen care provided. Virtual emotional and informational support has been identified in this study to improve mental health and be highly valued by all women, but particularly women in our migrant population. Potentially utilising and leveraging this connection for family group counselling intervention programs and education may improve health outcomes as well as engagement with maternity services. Exploring new ways to support women using eHealth mental health programs may also offer some feasible and affordable ways to improve the health impact of isolation and depression during the peripartum period, particularly for migrant women.[42,43]

We found the adverse impact on mental health for migrant women was largely driven by the loss of valued overseas tangible support. Other research has identified that during the pandemic higher levels of social support were protective for adverse perinatal mental health.[44,45] Migrant women are potentially more at risk due to barriers to mental health diagnosis and treatment.[46, 47] Antenatal screening has been recommended to identify women who have low levels of social support and are more vulnerable to mental health disorders, but this has been problematic both in the development of care pathways and an appropriate universal screening tool.[48,49] We identified women with a significant mental health concern requiring treatment in our cohort who were not identified at early pregnancy screening. Clinicians need to reassess patients' mental health status throughout the perinatal period and offer appropriate clinical support. Pandemic preparedness should include development and use of social support screening and care pathways particularly for vulnerable and migrant women.

Similar to other studies, we identified that hospital restrictions on support people and women fearing the impact of COVID-19 on their unborn babies also negatively influenced women.[9,50] Some women chose loneliness to protect their baby from potential COVID-19 infection. The increased isolation during pregnancy beyond lockdown periods identified in this study may provide some evidence for potential drivers for the reduction in spontaneous preterm births found in our district.[15] It has been hypothesised COVID-19 isolation may reduce exposure to pathogens associated with preterm birth.[15,51]

Strengths and limitations

A strength of this study is utilising an interview process including both antenatal and postnatal interviews with the same participant to clarify and compare pre- and postnatal experience. Limitations include the cohort was highly educated potentially with greater capacity for partners to be working from home and have the financial means for access to virtual support. Another limitation is the follow-up interviews were only up to 12 weeks postpartum. Migrant women's experience of partner support may well be different at one year postpartum when partners are no longer on parental leave or unable to work from home.

Conclusion

During the pandemic there has been a growing body of research highlighting the disparities in health outcomes for migrant populations and this study provides further evidence of the vulnerabilities of migrant women. Half the migrant women in this study felt unsupported or reported less support than they would have wanted due to pandemic restrictions. We found no difference between migrant women who felt unsupported postpartum if they were multiparous, primiparous, new migrants or had migrated greater than five years ago. In contrast to migrant women, perceptions of support improved postpartum for Australian born women. These findings demonstrate the wide-spread devastating impact the pandemic has had on our migrant families and highlights the need for perinatal support assessment in pandemic preparedness. However there have been some benefits including gains in gender equity and therefore the need for care providers to be mindful of gender role assumptions in migrant families. Assessing ongoing disruption to support experienced by migrant women will assist with clinical care, as well as planning for future pandemics and the potential impact on current and long-term health associated with impaired support.

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Cardiometabolic Impact and Pregnancy During the Pandemic: Interventions and Acceptability

Chapter 7

Investigating Service Delivery and Perinatal Outcomes During the Low Prevalence First Year of COVID-19 in a Multiethnic Australian Population: A Cohort Study

7.1 Preface

Qualitative investigations in Thesis Chapters 5 and 6 informed my understanding of the experiences of both clinicians and patients during a unique time in the pandemic with unprecedented societal and health service disruption but very little COVID-19 disease. In this chapter I present quantitative findings that will further inform understanding for potential cardiometabolic risk.

Chapters 3 and 4 of this thesis identified that breastfeeding intensity was an important factor to reduce cardiometabolic risk. In this Chapter, I have identified that during the first year of the pandemic, there was a reduction in full breastfeeding. This will have long term cardiometabolic health implications for both mother and infant. Furthermore, I identified an increase in caesarean section births. This may also contribute to an increase in population cardiometabolic risk for mothers and obesity risk in infants. This chapter also presents findings of reduced iatrogenic preterm birth. Understanding factors that may have contributed to a reduction will be important for future consideration and may be informed by the qualitative results of this thesis.

This manuscript was submitted to BMJ Open as it is a multidisciplinary Medicine Q1 journal with open access. Improving visibility for this important topic was a consideration. The published manuscript has received over 2700 full article download as of October 2023.

The published manuscript is presented as Chapter 7 structured as per the journal guidelines with minor changes for thesis clarity and consistency. Published version in Appendix 7.

7.2 Dissemination of research

Peer reviewed and published

Melov SJ, Elhindi J, McGee T, Lee V W, Cheung NW, Chua SC, McNab J, Alahakoon TI, Pasupathy D. (2022). Investigating service delivery and perinatal outcomes during the low prevalence first year of COVID-19 in a multiethnic Australian population: a cohort study. **BMJ Open**, 2022 Jul 12;12(7):e062409. PMID: 35820747; PMCID: PMC9277027. https://doi.org/10.1136/bmjopen-2022-062409

Published abstract
Melov SJ, Elhindi J, McGee T, Lee V, Cheung NW, McNab J, Alahakoon TI, Pasupathy D. Investigating Perinatal Outcomes During the Low Prevalence First Year of COVID-19 in a Multiethnic Australian Population. **Journal of Paediatrics and Child Health**, May 2022; 58(S2). https://doi.org/10.1111/jpc.15945

Presentation
PSANZ: Perinatal Society of Australia and New Zealand, 2022 Adelaide May 16-18; **Melov SJ**, Elhindi J, McGee T, Lee V, Cheung NW, McNab J, Alahakoon TI, Pasupathy D. Investigating Perinatal Outcomes During the Low Prevalence First Year of COVID-19 in a Multiethnic Australian Population.

7.3 Author attribution statement

I, Sarah Melov, was responsible for designing the study, project administration, ethics submission, revision responses, electronic data extraction, data curation, directing analysis, interpreting the data, writing initial draft manuscript, coordinating revisions with co-authors, submission of manuscript as corresponding author, drafting responses to reviewer comments and co-ordinating co-investigator comments and edits to finalise manuscript and submission.

My co-authors**,** Elhindi J, McGee T, Lee V W, Cheung NW, Chua SC, McNab J, Alahakoon TI, Pasupathy D, all contributed significantly to aspects of the study including study design, analysis, interpretation of findings and critical review of the manuscript.

Primary supervision for this thesis chapter was by Prof Dharmintra Pasupathy.

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statement above is correct.

Signature:

Prof Dharmintra

7.4 Manuscript

7.5 Investigating Service Delivery and Perinatal Outcomes During the Low Prevalence First Year of COVID-19 in a Multiethnic Australian Population: A Cohort Study

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7.6 Abstract

Objective Investigate the impact of the COVID-19 pandemic on perinatal outcomes in an Australian high migrant and low COVID-19 prevalent population to identify if COVID-19 driven health service changes and societal influences impact obstetric and perinatal outcomes.

Design Retrospective cohort study with pre COVID-19 period 1st January 2018-31st January 2020, and first year of global COVID-19 period 1st February 2020–31st January 2021. Multivariate logistic regression analysis was conducted adjusting for confounders including age, area-level socioeconomic status, gestation, parity, ethnicity and BMI.

Setting Obstetric population attending three public hospitals including a major tertiary referral centre in Western Sydney, Australia.

Participants Women who delivered with singleton pregnancies over 20 weeks gestation. Ethnically diverse women, 66% overseas born. There were 34 103 births in the district that met inclusion criteria: before COVID-19 n=23 722, during COVID-19 n=10 381.

Main outcome measures Induction of labour, caesarean section delivery, iatrogenic and spontaneous preterm birth, small for gestational age (SGA), composite neonatal adverse outcome, and full breastfeeding at hospital discharge.

Results During the first year of COVID-19 there was no change for induction of labour (aOR 0.97; 95% CI 0.92-1.02, $p=0.26$) and a 25% increased odds in caesarean section births (aOR 1.25; 95% CI 1.19-1.32, $p<0.001$). During the COVID-19 period we found no change in iatrogenic preterm births (aOR 0.94; 95% CI 0.80-1.09) but a 15% reduction in spontaneous preterm birth (aOR 0.85; 95% CI 0.75-0.97, $p=0.02$) and a 10% reduction in SGA infants at birth (aOR 0.90; 95% CI 0.82-0.99, $p=0.02$). Composite adverse neonatal outcomes were marginally higher (aOR 1.08; 95% CI 1.00-1.15, $p=0.04$) and full breastfeeding rates at hospital discharge reduced by 15% (aOR 0.85; 95% CI 0.80-0.90, $p<0.001$).

Conclusion Despite a low prevalence of COVID-19, both positive and adverse obstetric outcomes were observed that may be related to changes in service delivery and interaction with health care providers. Further research is suggested to understand the drivers for these changes.

Strengths and limitations of this study

- The analysis provides the opportunity to evaluate the indirect effects of COVID-19 against a background of low COVID-19 prevalence in the local health district with a total of six women with COVID-19 during pregnancy for the study period.
- The cohort comprised of a large ethnically diverse population with similar exposure of restriction experience and service delivery changes.
- Analysis for both iatrogenic and spontaneous preterm birth.
- Missing some COVID-19 related confounders is a limitation such as physical activity levels, prevalence of pregnancy population working from home, or missing planned overseas social support due to international border restrictions.
- A limitation of the study is multiple outcomes were compared however, our results are consistent with several other studies in different populations increasing the veracity of our findings.

7.7 Introduction

In the beginning of 2020, non-pharmaceutical interventions to reduce the spread of COVID-19 led to great changes in society such as lockdowns, enforced movement and travel restrictions.[1,2] There were also many changes to medical and maternity care around the world that are well documented, impacting direct care and social support.[3-6] Initial concerns of the impact of COVID-19 infection on pregnant women focused research on pregnancy outcomes for women who were infected and results varied, findings included increased COVID-19 infection risk in ethnic minorities, and a rise in both preterm and caesarean births.[7-10] More recently perinatal research has assessed the indirect impact of the pandemic,[11] particularly the impact of lockdowns.[12-14] Indirect impact will vary significantly between countries and within country due to diverse drivers such as lockdown experiences, social distancing measures, COVID-19 prevalence, societal compliance, economic and healthcare access.[4,6,15]

Studies of the indirect effects of COVID-19 on pregnancy outcome have shown inconsistent results. A reduction in preterm birth in the general population during the pandemic has been reported by some authors but not others.[12,16-18] Differences in study design and other factors have led some authors to conclude that there is insufficient evidence to determine if preterm birth has been reduced during COVID-19.[19]

Maternity care in Australia during the first year of the pandemic in 2020 experienced a disparate range of changes from very little to significant alterations in service delivery, dependent on population and perceived risk in the community.[3,20] Little evidence exists for the impact of societal and service changes on a culturally diverse obstetric population who initially experienced minimal COVID-19 community transmission, a short lockdown period but experienced significant obstetric service and societal changes due to the pandemic.

In our study population, we hypothesise obstetric outcomes may have been impacted by the rapid changes in hospital service delivery as they shifted focus during the pandemic from patient centred care to preservation of service and staff.[21] Western Sydney with its multicultural population is an ideal environment to examine the indirect effects of the response to the pandemic on perinatal outcomes given the setting of low COVID-19 case numbers. There was a total of 632 cases recorded of COVID-19 in the local health district for the study period. However, considerable preventative measures were implemented in the region including access to telehealth, ability to work from home, restrictions in healthcare settings such as mask wearing and health-screening questions on entry to all hospitals.[22]

We aim to identify indirect and direct pandemic-related morbidity in our large multi-ethnic Australian population and uncover potential drivers for both improved and adverse maternity care outcomes.

7.8 Methods

We conducted a retrospective cohort study using routinely collected obstetric, medical and administrative data for women seeking antenatal care in the Western Sydney Local Health District. We compared birth outcomes greater than or equal to 20 weeks of gestation in the two years prior to the COVID-19 pandemic to the first year of the COVID-19 pandemic. The study period is defined as pre COVID-19 1st January 2018 – 31st January 2020 to the first twelve months of the COVID-19 pandemic 1st February 2020 – 31st January 2021.

The state of New South Wales (NSW) has a population of approximately 8.2 million.[23] The three study hospitals serve a health district population of approximately one million people. For the study period a total of 39 pregnant women had a confirmed COVID-19 diagnosis in NSW, six of these were in the study health district and none of these were admitted to hospital for COVID-19 complications. There were fewer than 60 COVID-19 related deaths recorded for the total population in NSW in the first year.[24] The prevalence of COVID-19 in the local community was also low (total 632 cases Supp Figure 1).[25]

The study period was determined by the time when public awareness grew in NSW of the impending pandemic with official government announcements and a sharp rise and dominance of media coverage concerning COVID-19 from early February 2020.[26] The study period was after the 30th January 2020 WHO announcement declaring 2019-nCoV virus (COVID-19) as a public health emergency of international concern.[27] Public health order restrictions commenced 16th March 2020 with restrictions on gathering of over 500 people in NSW to reduce the spread of COVID-19. The restrictions escalated on the 30th March 2020, to 'hard lockdown' issuing of public health orders "that a person must not, without reasonable excuse, leave the person's place of residence'.[27] The restrictions were present for approximately 7 weeks easing 15th May, 2020.

The short hard lockdown in NSW, was primarily enforced in greater Sydney, accompanied by increased restrictions and COVID-safe practices including all health facilities women and their families accessed. The restrictions for local maternity services included hospital entrance screening of all patients, staff and visitors including temperature checks, asking about recent travel and symptoms of COVID-19. Within the antenatal service, there was also an introduction of telehealth for the Diabetes in Pregnancy clinics, restrictions on visitors such as allowing only patients in waiting rooms, no support person during ultrasound and only one support person with no changing-over in the birth unit. The potential changes in background stress for women during the peripartum due to these restrictions, reduced social support and service delivery changes may potentially impact perinatal outcomes.[28] During this time there were frequent changes to service delivery and some confusion regarding rules for patients reported by staff at the tertiary referral study Hospital.[21]

Women in the public health sector in NSW are triaged to their nearest public hospital for pregnancy care according to their home address and pregnancy complications. Therefore, during the pandemic period there would be limited changes in referrals pathways for the district obstetric population.

Community activities returned to near normal by July 2020 in NSW, however international and state borders continued to be disrupted with ongoing outbreaks emerging. Restrictions to visitors and other COVID-19 risk mitigation policies remained present for the maternity services throughout the study period. COVID-19 vaccinations were not available in Australia during the study period.

Western Sydney Local Health District human research ethics committee provided ethical approval for this study using deidentified routinely collected administrative data (WSLHD HREC QA2101-15).

Definitions

Routinely collected maternity data for singleton pregnancies greater than 20 weeks gestation was retrieved from the electronic maternal database. Terminations of pregnancy were not included in the database. Gestational age was determined and calculated in the electronic maternity system utilising the rules: use of last menstrual period (LMP) if regular, date was amended after available early ultrasound 6 week - 13+6 weeks gestation. If ultrasound dating varies from LMP by more than 5 days, if irregular or uncertain LMP then ultrasound expected date of delivery (EDD) was used.

Area-level socioeconomic status (SES) in our study was derived from the postcode address of participants during pregnancy as determined for that area by the last Australian census information (2016), informing the Index of Relative Socioeconomic Disadvantage (IRSD). The index is based on households in that area using information on variables that include income, English fluency, education and employment status. A lower index score represents greater disadvantage.[29]

Outcomes of interest

Outcomes of interest were selected based on literature review, state obstetric benchmarking outcomes and outcomes that plausibly may be impacted by service delivery changes. Literature has reported criteria changes in some healthcare setting for induction of labour and overall induction rates changing, therefore we included any induction via any method at all gestations in our outcomes of interest. We defined all vaginal births as one outcome inclusive of breech vaginal births. All preterm births were defined as less than 37 weeks gestation. Spontaneous preterm was defined as vaginal preterm births without an induction or caesarean section preterm births with a history of preterm labour. Iatrogenic preterm births were those initiated by care providers, defined as either a planned caesarean section with no preterm labour or an induction prior to 37 weeks gestation. Small for gestational age (SGA) is birth weight less than 10th centile assessed by the Fenton growth chart.[30] Combined adverse neonatal outcome included any of the following; stillbirth, admission to special care/neonatal intensive care (NICU), Apgar score under 7 at 5 minutes, or newborn resuscitation with intubation.

Data analysis and statistical methods

Demographic and obstetric characteristics of women were compared before and during the first year of COVID-19 using the chi-squared, Fisher's exact, or t-test where appropriate. Univariate logistic regression was applied to each characteristic to estimate unadjusted odds ratios. Then, three adjusted models were devised and implemented using multivariate logistic regression. Model 1 was for maternal characteristics and adjusted for maternal age, area-level socioeconomic status, gestational age (except for the preterm birth outcome), parity, ethnicity, BMI, smoking status and mental health status. Model 2 adjusted for model of pregnancy care and the variables from Model 1. Model 3 adjusted for additional covariates that are clinically relevant for specific outcomes. For the caesarean section birth outcome, birthweight and induction of labour were added to the covariates from Models 1 and 2. For the preterm birth outcome, a composite gestational diabetes/hypertension variable was added to the covariates from Models 1 and 2. For the breastfeeding outcome, mode of delivery, length of stay <24 hours, and preterm birth were added to the covariates form Models 1 and 2. For each model, an adjusted odds ratio with a 95% confidence interval was reported. P values less than 0.05 were considered statistically significant. The cohort was restricted to records with complete data on outcomes of interest. Missing indicator variables were utilised for covariates in the multivariate analyses. All statistical analyses were completed using Stata Special Edition Version 14.2 (StataCorp).

Patient public involvement statement

This retrospective cohort study had no patient public involve in the design or analysis or dissemination of results.

7.9 Results

Baseline characteristics

The pre COVID-19 period had a total of 23 722 singleton births and during the first year of COVID-19 (period 1st February 2020–31st January 2021) there were 10 381 singleton births. The principle tertiary referral centre had the greatest number of births in the cohort (n=17 005; 49.9%), with the large secondary hospital comprising of 36.6% (n=12 467) of the cohort.

Women who birthed in the first year of COVID-19 were more likely to be Australian born (35.1% vs 32.9%), overweight or obese (45.8% vs 44.5%), under 35 years old (59.7% vs 50.6%), have a history of a mental illness (15% vs 13%), to present for their first comprehensive antenatal visit at <10 weeks gestation (80.8% vs 64.4%) and less likely to be privately insured (5.9% vs 6.9%) compared to the preceding two years (Table 1). Women were admitted antenatally less often (10.1% vs 12.1%) and women who elected to have an early discharge postpartum at <24 hours, were higher from 15.5% during the pre-COVID period to 19.1% in the first year of COVID-19. Other demographic and pregnancy characteristics are documented in Table 1.

Table 1. Maternal demographic characteristics and pregnancy outcomes first year of COVID-19 compared to pre-COVID in a NSW metropolitan health district

Pre-COVID-19 = 1st January 2018 – 31st January 2020 COVID-19 = 1st February 2020 – Jan 31st 2021

Characteristics	**Pre-COVID-19 n = 23,722 N (%)**	**COVID-19 n = 10,381 N (%)**	**P value**
Clinical & demographic characteristics			
Maternal age group years			
<20	38 (0.2)	46 (0.4)	<0.001
20-24	614 (2.6)	452 (3.1)	
25-34	11 335(47.8)	5 835 (56.2)	
35-39	8 939 (37.7)	3 335 (32.1)	
>39	2 796 (11.8)	713 (6.9)	
Ethnicity			
South Asian	6047 (25.5)	2 950 (28.4)	<0.001
Caucasian/European	3 307 (13.9)	1 886 (18.1)	
South-East Asian	3249 (13.7)	1 357 (13.1)	
Middle Eastern	8116 (34.2)	3827 (36.9)	
Aboriginal Torres Strait Islander	338 (1.4)	188 (1.8)	
Unknown/missing§	2665 (11.2)	173 (1.7)	
Australian born	7 809 (32.9)	3 648 (35.1)	<0.001
SES disadvantage			
Quintile 1 (most disadvantaged)	5 367 (22.7)	2 361 (22.8)	0.04
Quintile 2	5 721 (24.1)	2 568 (24.8)	
Quintile 3	3 508 (14.8)	1 494 (14.4)	
Quintile 4	3 291 (13.9)	1 528 (14.7)	
Quintile 5 (least disadvantaged)	5 809 (24.6)	2 416 (23.3)	
BMI (kg/m2) at booking			
<18.50	1 116 (4.7)	417 (4.5)	0.02
18.5–24.9	11 981 (50.5)	5 207 (50.2)	
25.0–29.9	6 317 (26.3)	2 875 (27.3)	
≥30.0	4 308 (18.2)	1 922 (18.5)	
Nulliparous	10 331 (43.6)	4 475 (43.1)	0.45
Assisted conception	1 050 (4.4)	471 (4.5)	0.65
Current smoking at booking	1 380 (5.8)	619 (6.0)	0.60
Disclosed domestic violence	340 (1.5)	141 (1.5)	0.69
Diagnosed mental illness	3 083 (13.0)	1 552 (15.0)	<0.001
History of hypertension	844 (3.6)	327 (3.2)	0.06
History of diabetes (T1DM T2DM)	265 (1.3)	114 (1.3)	0.93
History of gestational diabetes	1,555 (6.6)	738 (7.1)	0.06
Health service characteristics			
< 10 weeks gestation first comprehensive assessment	15,221 (64.4)	8,360 (80.8)	<0.001
Model of care			
Low risk hospital	15,210 (64.1)	6,768 (65.2)	<0.01
Hospital complex medical	6 775 (28.6)	3,096 (29.4)	
Private maternity	1 635 (6.9)	611 (5.9)	
No antenatal care	102 (0.4)	38 (0.4)	
Antenatal admission to hospital	2 863 (12.1)	1 044 (10.1)	<0.001
Postnatal maternal length of stay < one day	3 674 (15.5)	2 000 (19.1)	<0.001
Postnatal maternal length of stay (days, median IQR)	2.02 (1.51)	2.00 (1.68)	<0.001

SES = Socio Economic Status (Index of Relative Socio-economic Disadvantage)

Low risk hospital: Midwifery care and shared antenatal care (General Practitioner/family doctor); Hospital complex medical care: Hospital based medical and high-risk clinic; Private maternity care: Obstetrician & privately practicing midwife, § missing due to ethnicity as routine collection introduced mid-2018

Pregnancy complications and outcomes

There were no differences in overall median gestation age at birth between the two time periods (Table 2). We did observe that the rate of preterm birth was lower during COVID-19 compared to the preceding period (7.2% vs 8.1%). We also observed a higher proportion of births at or after 41 weeks gestation during the first year of COVID-19 (10.0% vs 9.0%). We identified a reduction in all vaginal births (66.6% vs 69.6%) including reduced vaginal breech births (0.7% vs 0.9%). This corresponded with the caesarean section rate increasing during the first year of the COVID-19 pandemic (33.4% vs 30.5%) (Table 2). There was an overall higher rate of induction of labour (35.3% vs 29.9%) and a lower rate of SGA births (6.9% vs 7.8%). We found no change for adverse birth outcomes including for stillbirth (0.9% vs 1.0%) or admissions to special care/neonatal intensive care (16.8% vs 16.2%) (Table 2).

In adjusted analysis no difference was identified for labour inductions during the COVID-19 period compared to the pre-COVID period (aOR 0.97; 95% CI 0.92-1.02). There was a 25% increase in caesarean section births during the pandemic first year in our health district (aOR 1.25; 95% CI 1.19-1.32) (Table 3). The rate of spontaneous preterm births was reduced by 15% (aOR 0.85; 95% CI 0.78-0.95) and no change was found for iatrogenic preterm births (aOR 0.94; 95% CI 0.80-1.09) (Table 3). Adjusted models also uncovered a 10% reduction for SGA infants at birth during the COVID-19 period (aOR 0.90; 95% CI 0.82-0.99). We found a marginal increase for a combined adverse neonatal outcome during the COVID-19 period (aOR 1.08; 95% CI 1.00-1.15) (Table 3).

Table 2. **Pregnancy outcomes in a low-prevalence COVID-19 high-migrant Australian urban population**

Pre-COVID = 1st January 2018 – 31st January 2020 COVID-19 =1st February 2020 – Jan 31st 2021

Pregnancy complications	Pre-COVID-19 N=23 722	COVID-19 n = 10 381	P value
Timing of birth	**N (%)**	**N (%)**	
Gestational age (weeks) median (IQR)	39.2 (1.8)	39.2 (1.8)	0.25
<28 weeks	301 (1.3)	128 (1.2)	<0.001
28-32 weeks	232 (1.0)	84 (0.8)	
<37 weeks	1 439 (6.1)	539 (5.2)	
37+ weeks	21 748 (91.7)	9 630 (92.8)	
Mode of delivery			
Vaginal birth	13 931 (58.8)	5 819 (56.1)	<0.001
Instrumental	2 340 (9.9)	1 016 (9.8)	
Vaginal breech	204 (0.9)	76 (0.7)	
Caesarean section	7 224 (30.5)	3 465 (33.4)	
Onset of labour			
Induction	7 095 (29.9)	3 666 (35.3)	<0.001
Birth weight			
Appropriate for gestational age	20 071 (85.1)	28 884 (85.5)	0.39
Large for gestational age	1 676 (7.1)	784 (7.6)	0.11
Small for gestational age	1 832 (7.8)	713 (6.9)	0.01
Adverse birth outcomes			
Stillbirth	227 (1.0)	95 (0.9)	0.71
Apgar <7 at 5mins	662 (2.8)	257 (2.5)	0.10
Intubation resuscitation at birth	262 (1.1)	100 (1.0)	0.24
Admission to NICU	3 851 (16.2)	1 743 (16.8)	0.23
Composite adverse neonatal			
	4 261 (18.2)	1 907 (18.3)	0.41
Neonatal feeding			
Skin to skin at birth	16 454 (69.4)	7 961 (76.7)	0.02
Feeding within 1 hour	14 353 (60.5)	6 424 (61.9)	0.02
Fully breastfeeding at discharge	15 620 (65.8)	6 410 (62.1)	<0.001

Composite adverse neonatal includes any: stillbirth, admission to NICU, Apgar score under 7 at 5 minutes, or newborn resuscitation with intubation.

In our study population, the first year of the pandemic impacted breastfeeding when compared to the previous two years. When adjusted for several confounders including birthweight, mode of delivery, and prematurity, we found a 15% reduction for women fully breastfeeding their infant at discharge (aOR 0.85; 95% CI 0.80-0.90) (Table 3). There was no difference in effect size between model 1 and the fully adjusted model that included birthweight, mode of delivery, length of stay <24 hours and gestational age/preterm variable. Notably, there was a higher rate during the COVID-19 period in both breastfeeding within one hour (61.9% vs 60.5%, p=0.02) after birth and maternal/infant skin to skin contact at birth (76.7% vs 69.4%, p=0.02) (Table 2).

Table 3. Odds ratio for maternal and neonatal pregnancy outcomes during the first year of COVID-19 compared to the previous two years in an Australian metropolitan health district

COVID = 1st February 2020 – Jan 31st 2021 (n=10 381) Pre-COVID = 1st January 2018 – 31st January 2020 (n=23 722)

Outcome	Sample Size	Unadj. OR	P	Model 1 OR	P	Model 2 OR	P	Model 3 OR	P
Induction of labour	34,082	0.90 (0.86,0.94)	<0.001	0.97 (0.92,1.02)	0.30	0.97 (0.92,1.02)	0.26	-	-
Caesarean birth	34,063	1.14 (1.09,1.20)	<0.001	1.24 (1.17,1.30)	<0.001	1.23 (1.17,1.30)	<0.001	1.25 (1.19,1.32)	<0.001
Preterm birth	34,080	0.86 (0.79,0.94)	0.00	0.91 (0.83,0.99)	0.05	0.91 (0.83,0.99)	0.03	0.88 (0.80,0.97)	0.01
Spontaneous preterm birth	34,080	0.76 (0.67,0.85)	<0.001	0.88 (0.77,0.99)	0.04	0.88 (0.77,0.99)	0.04	0.85 (0.75,0.97)	0.02
Small for gestational age at birth	33,880	0.88 (0.81,0.96)	0.01	0.90 (0.82,0.99)	0.03	0.90 (0.82,0.99)	0.02	-	-
Composite adverse neonatal outcome	33,632	1.03 (0.97,1.09)	0.38	1.08 (1.00,1.15)	0.03	1.08 (1.00,1.15)	0.04	-	-
Full breastfeeding at hospital discharge	31,113	0.86 (0.81,0.90)	<0.001	0.85 (0.80,0.90)	<0.001	0.85 (0.81,0.90)	<0.001	0.85 (0.80,0.90)	<0.001

Composite adverse neonatal includes any: stillbirth, admission to NICU, Apgar score under 7 at 5 minutes, or newborn resuscitation with intubation.

Variables adjusted for in each model:

Model 1 Maternal characteristics: Includes maternal age, area-level socioeconomic status SEIFA disadvantage quintile, gestational age, parity, ethnicity, BMI (numeric), smoking status, and mental health status.

Model 2 Model of care: Model 1 variables and model of pregnancy care variable.

For preterm birth outcome the models are not adjusted for gestational age.

Model 3 Outcome of interest: Includes Model 1 and 2 covariates and additional covariates as listed below.

Caesarean section birth: birthweight and induction of labour.

Preterm birth: composite maternal complications variable (gestational diabetes or hypertensive disorders of pregnancy).

Breastfeeding: birthweight, mode of delivery, length of stay <24 hours and gestational age/preterm.

7.10 Discussion

In a health district with low COVID-19 prevalence but affected by public health measures and process changes to service delivery, we found no differences in the rate of induction of labour, a reduction in spontaneous preterm and SGA births with no change in iatrogenic preterm births during the first year of COVID-19. There was also a significant increase in caesarean section births and a reduction in women fully breastfeeding at hospital discharge during this period compared to the previous two years. We identified a marginal increase in the rate of severe adverse neonatal composite outcome. In the study population only six women were recorded to have experienced COVID-19 infection during pregnancy therefore the outcome changes identified in this study are likely related to the indirect effects of COVID-19.

A strength of the study is the population experienced similar exposure to COVID-19 restrictions and maternity care service delivery changes. The multiethnic population with an even distribution between national SES quintiles strengthens the generalisability of our findings to other high-income populations with universal health coverage such as the United Kingdom. A more homogenous population may provide a possible explanation of changes to be specific cultural drivers however the diversity of the study population supports the explanation to likely be societal and service delivery related.

A limitation of this study is the difficulty of identifying all changing population drivers however adjustment was made for known factors. There were differences in baseline characteristics between the two period that were most likely directly related to pandemic societal changes. This included an increase in Australian born women during the first year of the pandemic that may have been due to the closed international borders and potential financial insecurity of some migrant groups who may have delayed their pregnancy decision. The increase in BMI in the pandemic year may well have been due to reduced activity as a result of anxiety of leaving home related COVID and the lock down periods. There was an increase in mental health concerns during the pandemic period compared to the pre-COVID period. Although mental illness was adjusted for in the analysis, routine data may not be truly reflective of the level of anxiety experienced by women and their families during the pandemic first year when no vaccines were available and significant uncertainty existed. This is a limitation of the analysis and may have contributed to the increase in caesarean section births in the pandemic first year.

There may have been other confounders we were not able to capture that may impact on obstetric outcomes such as level of physical activity. Potentially some women may have benefited from more time to exercise with associated reduced infection risk through exercise-mediated protective immune response[31], while other women who felt unwell may have had the opportunity to rest at home. There may potentially be a uniquely cumulative improved immune environment for pregnant women during the COVID-19 period. Underlying factors such as consistent diet stabilising the microbiome and less maternal inflammatory triggers or burden from exposure to environmental and infectious factors may be the reason for improved spontaneous preterm birth rate and SGA outcomes.

It is difficult to capture individual responses to the threat of COVID-19 despite low prevalence in the community for this cohort. However, recent qualitative research at one study hospital found clinicians felt some groups of women benefited from the COVID-19 restrictions with less stress and protected family time. However, migrant women were seen to have experienced isolation and anxiety due to loss of significant practical and social support from overseas relatives unable to visit due to COVID-19 related international border closures.[21,32] The impact of the loss of expected support from relatives due to COVID-19 travel restrictions was not measured in our study and is a limitation.

Similar to other studies, we document a reduction in preterm birth.[12,17,18,33] The lack of delineation between iatrogenic and spontaneous preterm birth in some research has been an issue when comparing results and attempts to identify potential drivers.[19] A strength of our study is we were able to present the data and identified that only spontaneous preterm birth was reduced for the study period. However recent updated preterm birth meta-analysis by Yang et al found in unadjusted analysis preterm birth was reduced for both spontaneous and iatrogenic only in single centre studies, but not in national studies.[6] Local district level data and population characteristics may have less variation in obstetric service delivery confounders and other factors that increase the uniformity of experience for women and may account for the difference between large national level data and some single centre research. Local, more granular data for obstetric outcomes during the COVID-19 pandemic may assist in understanding drivers for improved and adverse obstetric outcomes. The stable iatrogenic preterm birth rate is a positive finding and reflects no change in clinical management for this important obstetric outcome. This may partly be associated with the ongoing understanding of the adverse outcomes associated with late preterm births and recent national initiatives such as ‘every week counts’ that has occurred over the study period.[34]

Shah et al in a Canadian population study, found no reduction in preterm births however, they did demonstrate preterm birth variation over time and between districts.[35] Our study covers the complete first year of the pandemic, reducing the possibility of a result based on a chance normal short-term variation.

It has been postulated that the causative mechanism for a reduction in preterm births during the COVID-19 period is reduced infection and maternal physical activity throughout lockdown.[36] In our population, these potential causative factors for a reduction in spontaneous preterm birth, may have existed in our health district during the short lockdown and likely persisted beyond the lockdown period. Some infection mitigation behaviours may have been driven by our high migrant population who received advice from overseas relatives in areas experiencing high rates of COVID-19. Encouraging suitable exercise[31] and simple hygiene measures such as appropriate hand washing, are public health measures that may reduce infection. Hand hygiene historically has been poorly done and with increased awareness and compliance, may assist with decreasing preterm births.[37,38]

We found women were presenting earlier to their family doctors for a first pregnancy visit and referral to tertiary hospital care. This may have been due to anxiety about the pregnancy and the unknown risk of COVID-19 infection to a fetus. The benefits of this early health provider contact may be correct dietary advice, provide opportunity for early aspirin prescription and other pregnancy care that may contribute to some of the improved pregnancy outcomes including preterm birth and SGA for this cohort. It is possible that the drivers for the reduction of spontaneous preterm birth and SGA are similar and multifactorial. They may include the opportunity for partners and pregnant women to work from home with the associated reduction in stress.

The increase in caesarean section births in this study is a concerning finding that may indicate changes in clinical decision making during the COVID-19 period of a lower threshold trigger for immediate delivery. However other factors may also be involved such as less surveillance during pregnancy with maternal reluctance to present or be in hospitals as demonstrated by the increase in early discharge. Another human factor that may be involved in the rise in caesarean section birth is the difficulty of midwives in birth unit to develop a rapport with the women in their care to adequately assess their non-verbal cues, recent studies have identified midwives report a loss of 'women-centred care' during the COVID-19 pandemic.[20,21] Clinician may rely more on electronic 'socially distant' continuous cardiotocography (CTG) monitoring for fetal assessment. Evidence suggests increased CTG monitoring leads to higher caesarean section rates.[39,40] The increase in caesarean section births also have known immediate and long-term associated morbidity for women and their infants, therefore measures to counter the rise in caesarean births are recommended.[41]

There was a marginal increase in the composite adverse neonatal outcome largely driven by the increase in neonatal admissions. Although it is beyond the scope of this study to determine the causes for the increased admission, there was no alteration in admission criteria for the neonatal or special care nursery during the study period. However, the increase in caesarean birth may have contributed through the associated known increased risk of NICU admission with a caesarean section birth.[41,42]

Similar to our study, a prospective Italian study found a 28% reduction in full breastfeeding at discharge in a region with high COVID-19 prevalence.[43] We identified that during the COVID-19 period there was an improvement in practices that support breastfeeding immediately after birth; maternal-infant skin to skin contact and breastfeeding within the first hour. Birth unit protocols changed during the COVID-19 period, with only one support person allowed at the birth. The improvement in skin to skin and breastfeeding in the first hour may potentially be due to midwives identifying that woman were feeling more isolated and provided more one-to one support in the birth room improving these important breastfeeding outcomes. There may be several factors that contribute to less exclusive breastfeeding at discharge in our study. Intuitively the reduction in breastfeeding should be linked with the increase in early discharge however the 25% reduction in full breastfeeding was present for both model 2 and the final model that adjusted for variables including early discharge. Other factors are therefore more likely influencing this outcome. Due to reduced visitors, women may have felt they needed to bring formula into the hospital in case they had difficulty with breastfeeding, therefore it was available and more likely to be used. There may also have been reduced opportunities for staff to provide postnatal breastfeeding support due to concerns of COVID-19 infection risk by both staff and patients, staffing shortages and increased staff workload during the COVID-19 period. It is well acknowledged the introduction of formula and bottle feeding in the early postnatal period has significant consequences for infant long-term health and reduces total length of breastfeeding.[44-46] Providing adequate lactation support antenatally, at birth and postnatally with staff shortages during the pandemic is problematic but important for both short-term and long-term metabolic maternal and infant health.[44,47,48]

Although recent literature has focused on the impact of COVID-19 disease and pregnancy, the indirect impact of the world-wide pandemic may not be fully realised for many years. There is increasing evidence of the impact of exposure to disasters including pandemics, on long term health consequences. A recent systematic review concluded fetal and maternal exposure to natural disasters including pandemics resulted in increased cardiometabolic risk in both.[49] Understanding a pandemic population with a low prevalence of COVID-19 but subject to changes in maternity care and societal stress, may assist in future investigations of drivers for cardiometabolic health.

Conclusions

In a low COVID-19 prevalent population this study found no change in inductions of labour or iatrogenic preterm births. However, an increase in caesarean section births, a reduction in SGA and spontaneous preterm births was identified. The benefit to women, their families and the community of reduced SGA and preterm birth is long lasting, including improved cardiometabolic lifetime risk for both women and their infants.[42] The drivers for these changes in perinatal outcomes during the COVID-19 first year may be difficult to identify but may be a reduction in maternal inflammatory triggers. However, the results from this study in a cohort primarily exposed only to COVID-19 related service and societal changes, provides unique opportunity to generate evidence of these changes on pregnancy complications. The significant reduction in breastfeeding at discharge may be more easily addressed now identified. Funding appropriate intervention strategies is imperative both in the antenatal and postnatal periods to improve breastfeeding outcomes. Revealing all drivers for obstetric changes during the pandemic may be difficult to ascertain, further research in this high migrant cohort with higher prevalence of COVID-19 cases may reveal evidence for more specific drivers.

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Chapter 8

Understanding Barriers, Enablers, and Acceptability of an ehealth Intervention for Cardiometabolic Risk Reduction

8.1 Preface

The following chapter is the complete version of methodology and results edited and included in a submitted manuscript for the *Smart Mums with Smart Phones 2* (SMs2) randomised control trial. My contribution to the SMs2 clinical trial included co-leading the text message content for parenting, breastfeeding and infant health. An adapted Sydney BLISS tool was also used for the breastfeeding assessment and scoring for analysis. The qualitative exit evaluation of SMs2 forms part of this thesis (Chapter 8). The randomized clinical trial outcomes are not part of this thesis. However, acknowledgment is made of my contribution beyond the qualitative evaluation of SMs2. I was an active member of the SMs2 trial team, with contributions to protocol development, content for intervention, ongoing attendance at trial meetings, analysis and manuscript drafting. I would like to acknowledge the valuable learning experience of involvement with an expert trial team throughout the trial process.

8.2 Author attribution statement

I, Sarah Melov, was responsible for designing the Smart mums with smart phone 2 (SMs2) exit qualitative study, project administration, resources-funding, conducting all qualitative interviews, data curation, coding the data in NVivo, collaborating in generating themes and qualitative analysis. My co-supervisor Dr Justin McNab oversaw all qualitative aspects of analysis and report writing.

Further to the SMs2 contribution I coordinated the COVID-19 HealthyMums@Westmead ethics submission, editing and dissemination of text-message support and feedback for participant responses.

My co-authors provided critical review of the chapter.

Primary supervision for this thesis chapter was by Dr Justin McNab and Prof N Wah Cheung.

As the primary supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statement above is correct.

Signature:

Prof Dharmintra Pasupathy

8.3 Introduction

This thesis has presented evidence of the increasing prevalence and significant global health burden of diabetes, together with the associated increased risk of long term cardiometabolic disease.[1] A pregnancy affected by gestational diabetes (GDM) places a woman at increased risk of type 2 diabetes (T2DM) and other long term cardiometabolic disease.[2,3] Postpartum is therefore an opportune time for patient education and engagement in evidenced based health interventions to reduce cardiometabolic risk. Finding the evidence for an effective cost-efficient intervention has been problematic, and intervention programs primarily have not incorporated breastfeeding support as a driver to reduce cardiometabolic risk.[4-7]

Some intervention programs to reduce cardiometabolic risk postpartum have been effective but require a significant time-commitment from health professionals. A postpartum weight loss and exercise intervention with an intensive thirteen telephone support session program, proved modestly effective in the large Gestational Diabetes' Effect on Moms (GEM) study[8] However, labour intensive programs such as these can be difficult to sustain and can be expensive to deliver. Staffing health interventions may be more difficult in the post pandemic era because of endemic staff shortages and staff burnout.[9,10] Midwives are often the facilitators for maternity digital health interventions providing diet, lifestyle, pregnancy and parenting interventions. However, there is a recognised global workforce shortage of more than 900,000 midwives as well as other health professionals.[10,11] Therefore, postpartum risk reduction interventions need to take into consideration workforce, be cost-effective and be scalable. Use of smartphone technology with text messaging has been found to meet these requirements, improving cardiometabolic health outcomes and risk in diverse populations.[12-15]

This chapter presents a qualitative evaluation of barriers and enablers to a postpartum eHealth intervention program in a multicultural community aimed to improve cardiometabolic risk after a GDM affected pregnancy. Smart Mums with Smart Phones 2 (SMs2) is a registered (ACTRN12620000615987) randomised control trial aimed to provide a scalable cost-efficient postpartum health program based on a promising pilot study.[16] The primary outcome was a 'Healthy Lifestyle Outcome' composite of weight, diet and physical activity (PA), evaluation included surveys at at 4, 12 and 26 weeks postpartum. The SMs2 study recruited women with GDM at three tertiary maternity care hospitals in New South Wales, Australia. Participant eligibly criteria included ownership of a smartphone, a singleton pregnancy, physically capable of walking regularly and no diagnosis of pre-existing diabetes or an OGTT results reflective of a diagnosis of diabetes in pregnancy. All women were recruited in pregnancy but randomised postpartum to ensure appropriate consideration of a potential adverse birth outcome. Participants were randomised to either usual care postpartum or to a six-month lifestyle diabetes prevention program, facilitated through smart phone text messages and a wrist activity monitor with adaptive step-count goals.[17] The text messages were sent with some personalised content such as use of the participants name, individualised step count, infant feeding preferences (formula or breastfeeding) and vegetarian appropriate messages.

8.4 Smart Mums2 intervention

Four messages from week 1-2 postpartum were sent per week to participants in the intervention arm of the study. Messages were grouped in three categories: parenting support, healthy eating, physical activity advise and there were also text messages related to feedback from the activity monitor. The latter was step count encouragement provided to participants for them to reach progressively higher step counts per day, with the aim of 5 days of >10,000 steps and 30 minutes of moderate intensity activity. Texts about parenting, infant health and breastfeeding were also sent. Breastfeeding messages were developed in consultation with two lactation consultants. Messages-were appropriately matched to number of postpartum weeks, including reminders when infant vaccinations were due and links to videos on infant settling techniques. Many messages about parenting had links to government or reputable health websites where more information could be obtained (Appendix 8a).

8.4.1 Background to COVID-19 disruption of the Smart Mums2 clinical trial

In 2020 the COVID-19 pandemic interrupted the SMs2 trial activities prior to commencement of recruitment of participants. All research in the Health District was directed by the governing body to be suspended due to the emerging pandemic. The 'HealthyMums@Westmead' (Appendix 8) program was a clinical care response I initiated to provide postnatal support utilising the bank of text messages that were developed for the trial but not used due to the suspension of all research. From October to December 2020, women at our hospital who were discharged with term babies were sent a text invitation to register for the HealthyMums@Westmead program. This thesis and other research have documented that during the first year of the COVID-19 pandemic there was a disruption to both antenatal and postnatal service delivery. The messages were altered to remove diabetic specific questions and step counting as no step counting feedback was involved. Text-message support was provided to women who had reduced access to antenatal classes and postnatal care due to COVID-19 restrictions (Figure 1). Ethics approval was gained to send all women an exit survey at the completion of HealthyMums@Westmead program (WSLHD HREC 2020/ETH01649). The use of the SMs2 text support was well received (Figure 2). Of the thirty-eight women providing feedback 95% agreed that the text support was useful. Feedback responses are presented in Figure 2. When asked to indicate the most useful websites that were sent to participants the most useful websites were: https://www.breastfeeding.asn.au and https://raisingchildren.net.au. Of interest, 21% of participants also found the COPE organisation website for postnatal depression useful.

Figure 1. HealthyMums@Westmead sample texts

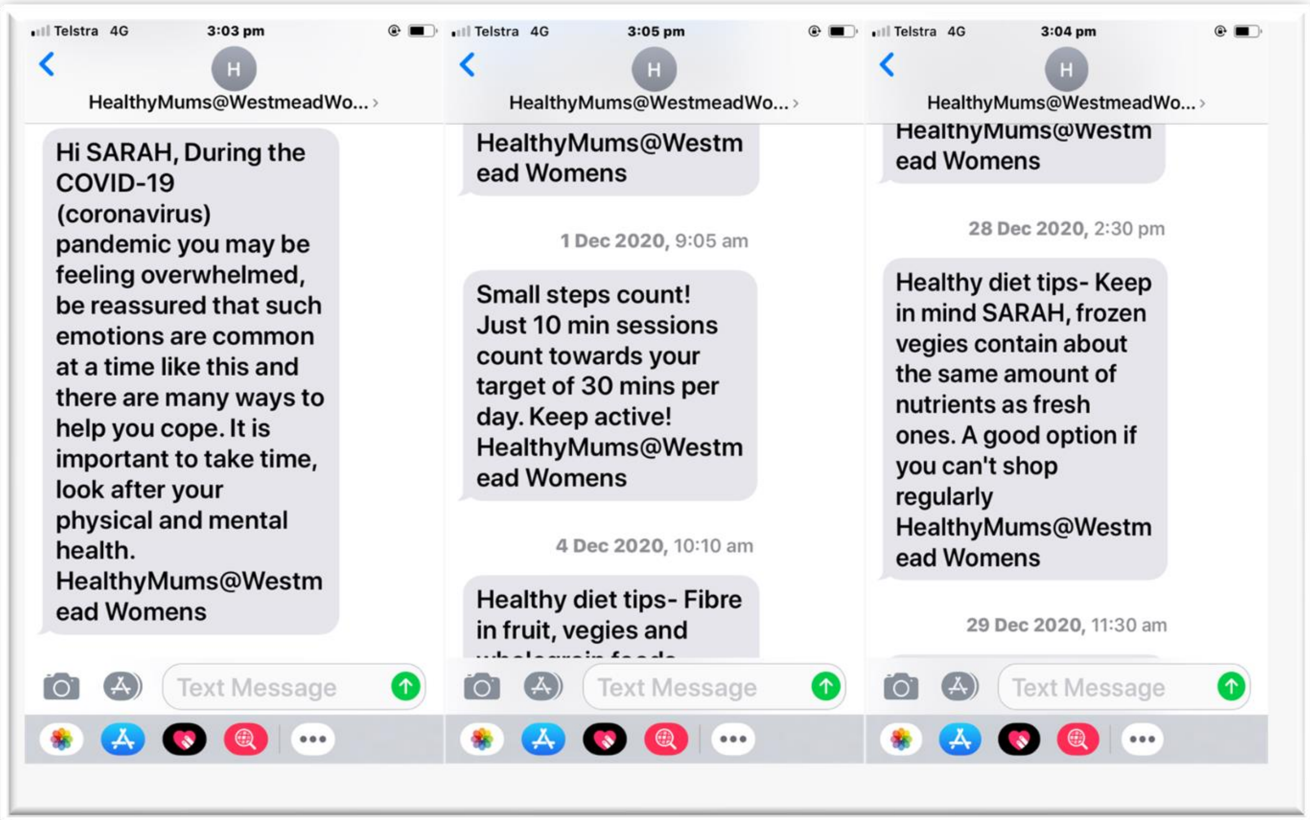
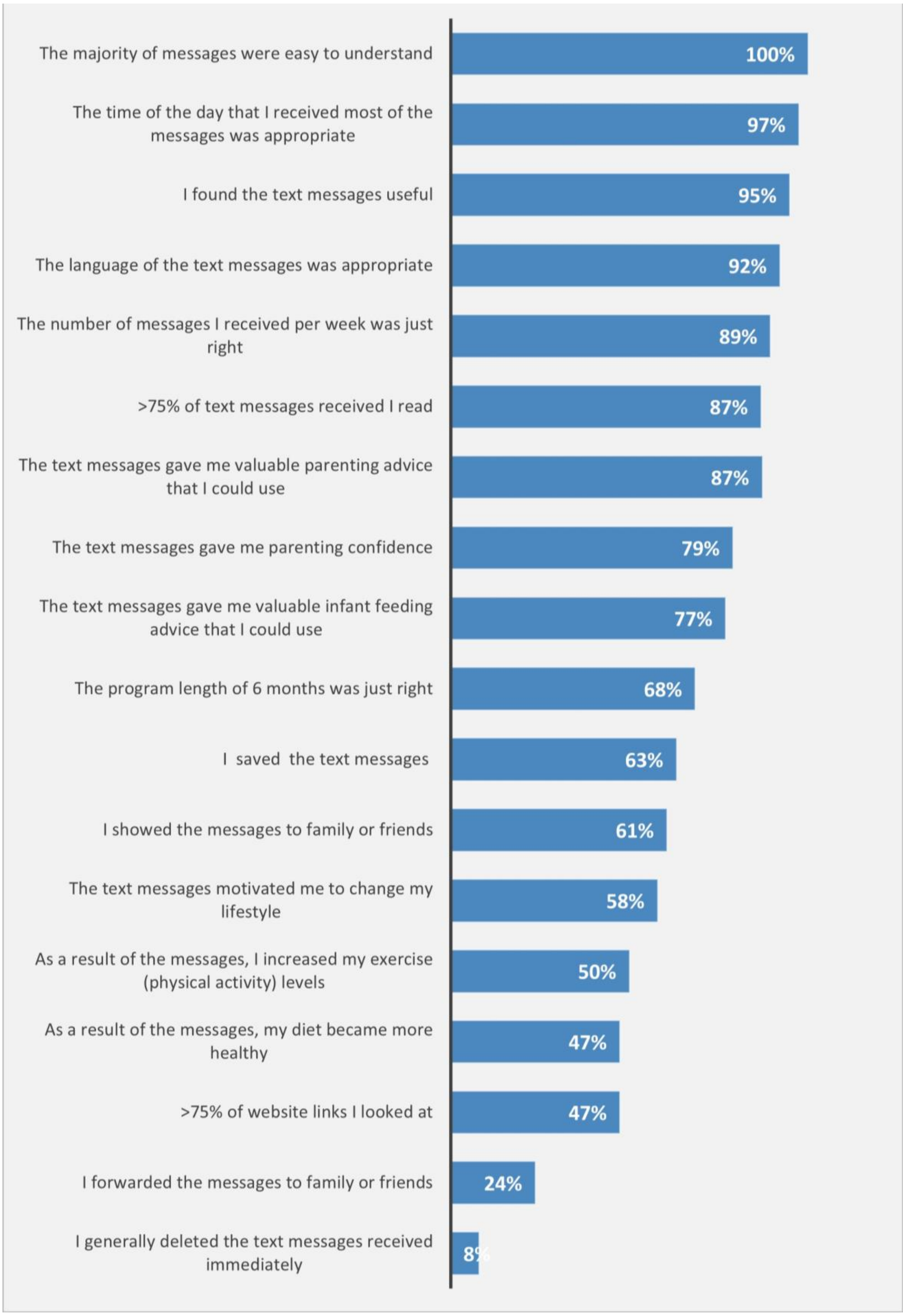


Figure 2. HealthyMums@Westmead participant survey feedback



This adapted program was presented at the Perinatal Society of Australia and New Zealand (PSANZ) conference in 2022 (Appendix 8).[18] After commencement of the SMs2 trial, COVID-19 restrictions continued to disrupt trial participants lives including all participants experiencing lockdowns and closed international Australian borders.

8.5 Qualitative evaluation of Smart Mums2 clinical trial

The primary aim of the qualitative exit evaluation of SMs2 was to investigate barriers and enablers to engaging with the intervention program.

8.6 Methods

Semi-structured qualitative exit interviews were conducted with intervention participants at SMs2 program completion to provide the opportunity for participants' feedback and to understand barriers and enablers to participation in the program. Opportunity was also given to participants to comment on areas of the program that could be improved. Interviews were by telephone and commenced in July 2022. An invitation was first given to the intervention participants who had most recently completed the program. Interviews commenced after reaffirming consent and with the initial question "Can you tell me about your experience on the Smart Mums program?". All following questions and prompts regarding aspects of the program and detailed in Appendix 8b. I conducted all qualitative interviews. Interviews were audio recorded with transcription completed by a professional transcription service. A reflexive thematic approach with six non-sequential phases as described by Braun and Clarke was used for analysis (Figure 3).[19] Familiarisation with data, coding and theme development was conducted by two authors (SJM and JM). Analysis and data management was assisted by NVivo (release 1.5.1).

Figure 3. Six phases of reflexive thematic analysis

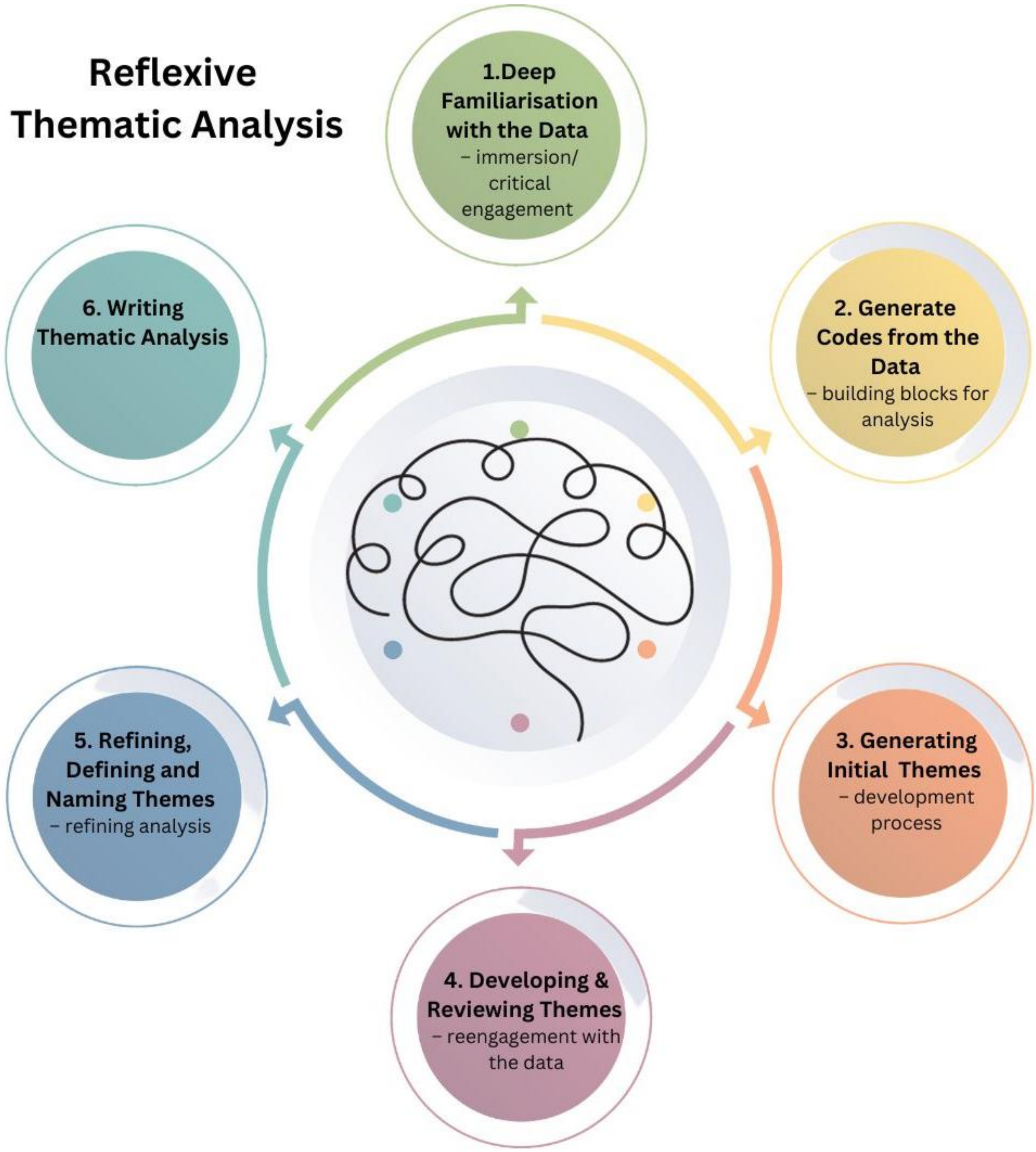


Figure by SJ Melov 2023 based on Braun and Clarke, 2022

8.7 Findings

There were 177 participants randomised postpartum for the SMs2 study of whom 88 were intervention participants. There were 57 intervention participants who had outcome data available, twenty-two (29%) of these were invited by text and phone message to participate in the qualitative interviews at completion of the SMs2 trial. Fourteen women agreed to be interviewed. The non-participation was mainly due to women who did not reply to text message invitation, and some stated they were busy. Interviewing ceased at saturation when sufficient information was obtained of diverse opinions to assist with contextualising study findings. [19] Interviews ranged from 20 minutes to 1 hour in length.

The median age of the participants was 32 years (±5.8), similar to the total intervention group age (32 years ±4.5). In the SMs2 total study intervention arm 46% of women were of South Asian ethnicity. Half the participants in the qualitative study were migrants, most of these were South Asian (5 of 8 participants). Six of the fourteen qualitative study participants interviewed were primiparous at recruitment to the Smart Mums program (Table 1).

Table 1. Participant characteristics SMs2 qualitative cohort

	Age	Region born	Primiparous
Participant 1	35-39	Australian	No
Participant 2	25-29	South Asian	No
Participant 3	30-34	Australian	No
Participant 4	30-34	Australian	No
Participant 5	35-39	Australian	No
Participant 6	40-44	America's	Yes
Participant 7	35-39	New Zealand	Yes
Participant 8	30-34	Australian	Yes
Participant 9	30-34	Australian	No
Participant 10	30-34	Middle eastern	No
Participant 11	35-39	South Asian	No
Participant 12	30-34	South Asian	Yes
Participant 13	25-29	South Asian	Yes
Participant 14	30-34	South Asian	Yes

8.7.1 Enablers

SMs2 motivated women to make healthier choices: *giving me some sort of discipline*

All participants identified that some aspect of the SMs2 program was motivational for healthy choices and beneficial to their wellbeing postpartum.

> *...it's kind of giving me some sort of discipline. And then the regular messages, I basically read and then it's top on my mind. So what should I eat and what should I not? Yeah, it is beneficial.* (Participant 13)

> *I'm a bit sad that it's over. Yeah, I think it's a great experience. I find it really valuable, and I do hope that it does continue because just creating that awareness and that consciousness, I think it's really, really important.* (Participant 7)

First time mothers were most likely to identify all three supportive text message areas (diet, exercise, parenting) as beneficial. All participants stated they would recommend the program to a friend; "…definitely for me it is very helpful, so I will recommend for others also" (Participant 11). The step counting activity device and exercise texts were viewed favourably as a good motivator to reach exercise goals.

> *…knowing your step count – because you have a goal. And then when you know that you're close to it, you just push yourself that little bit more.* (Participant 2)

> *…it helped because it was continuously on me and I was looking how many steps I did and how many I'd have to do more and all that.* (Participant 14)

The healthy diet text message support was viewed as helpful to most women (11 of 14). The main positive message from participants was that the texts kept them on track, with reminders and small helpful suggestions.

> *…the reminders are really, really good, otherwise I wouldn't have any other sort of positive support really when I was sitting at home with the baby. That would be my only reminder...So for example, when I got a text message – instead of having a packet of chips that was sitting [in] the pantry, I would probably go and reach for an apple.* (Participant 6)

8.7.2 Barriers

1. Lack of practical social support: *I guess I kind of put myself last*

The main theme underpinning barriers to health goals was '*Lack of practical social support: putting myself last'* (Figure 4). It was evident that a major issue for women to achieve health goals was an absence of practical social support to assist participants with child-minding, home-schooling and household tasks. Practical social support can provide women with the opportunity to put themselves first; "except for my husband, there was no one [for support]" (Participant 12). Guilt around prioritising participants own needs was also explicitly stated "I felt guilty putting myself first" (Participant 7). The constant demands placed on new mothers by infant care was discussed by participants as a significant barrier to achieving health goals, but this was clearly underpinned by a lack of assistance with childcare responsibilities and led to feelings of being overwhelmed; "you are constantly with the baby, and you don't have any time to think about yourself" (Participant 13).

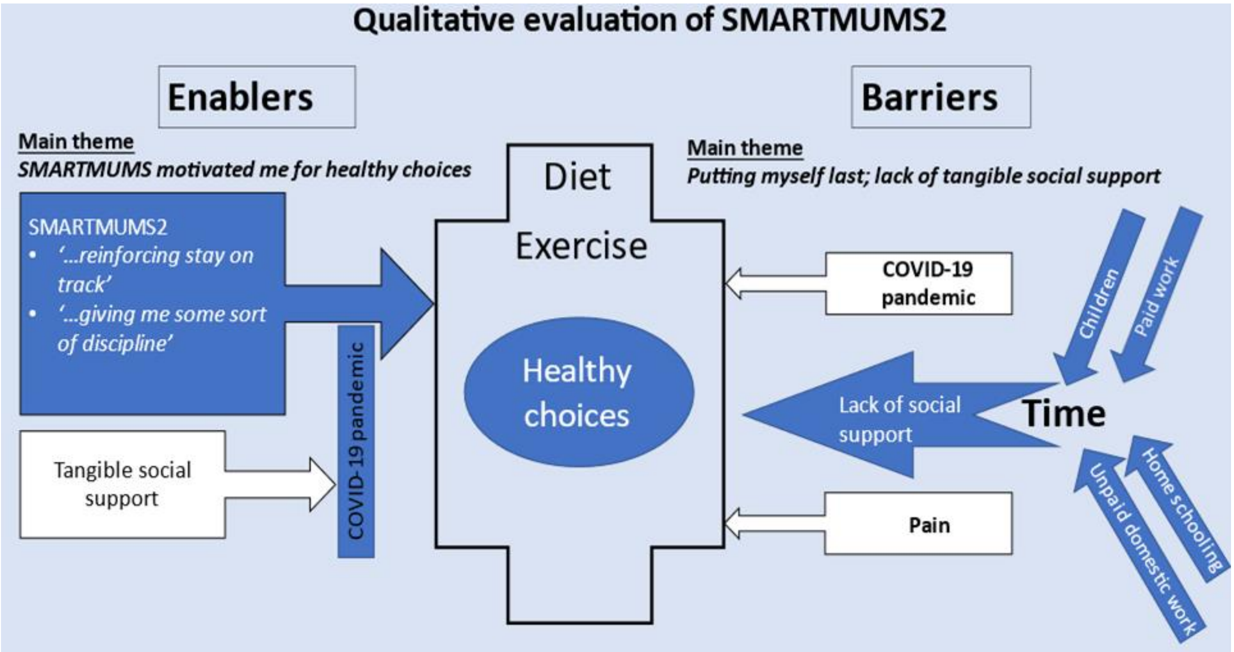
> *I'm just struggling with life…I guess I kind of put myself last.* (Participant 8)
> *It is tough finding that little space to do something for yourself.* (Participant 7)
> *No time to look after myself...just baby, baby, baby all day.* (Participant 14)

The lack of protected time to exercise was particularly difficult for participants when returning to paid work. However, this is also a reflection of lack of practical support.

> Returned to fulltime paid work at three months postpartum:
> *I had way less time. So our routine in the morning was get up straight away, get yourself [laughs] to day care, get yourself to work, do your eight hours, nine hours then come [home]– like you've got to pick bub [up] from day care, drive back home the 45 minutes, then it's straight into dinner, it's straight into routine and bath and all that. By the time I've done all those general daily things that I needed to do chores, and that sort of thing, to get myself prepared for the next day, it's like nine, ten o'clock at night and I'm not exercising then.* (Participant 8)
>
> *So mostly I do nightshifts, so it was really hard for me to get up in the morning, do some exercises, and eat my veggies and the proteins… it was good reminder with the text message. It's really good.* (Participant 3)

Returned to paid early shift work 7 am – 3.30pm:
I'm still trying to find that space or that time for me because I don't get any alone time except grocery shopping. (Participant 7)

Figure 4. Enablers and barriers to participation in SMs2 program



Qualitative slide used in the SMs2 presentation: International Association of the diabetes in Pregnancy Study Groups conference hosted by ADIPS Sydney, Australia, November 2022

2. COVID-19 barriers: *I'm scared …didn't go out*

The majority (11 out of 14) of participants identified that the COVID-19 lock-down periods had negatively impacted their healthy eating, such as increasing their takeaway food consumption and their capacity to exercise to meet SMs2 goals.

I'm scared because my son is small and I'm also vulnerable during that time because I'm very weak. I mean after delivery, physically, yeah, we don't have that much energy and that like immunity also, right?... Like for my child and for my safety, didn't go out. (Participant 11)

…everybody was at home including the kids. So it was hard to keep up with my steps. And it makes me – it made me a bit more lazy when I'm home…So I was out of routine in that and I was eating a lot of junk… because I was home. (Participant 3)

Home schooling demands during school closures due to COVID-19 restrictions was also discussed as a barrier to exercise for SMs2 participants who had school age children. There was nearly five months of home schooling reported during the SMs2 study period.

> *…the exercise, well that was sort of hit and miss with COVID and home schooling. And I think that sort of made it harder than anything else…It was a struggle. When she was born I had a year one and a year eight* [school grades]. (Participant 4)

COVID-19 driven international border closures disrupted available practical support and impacted participants. However, the parenting texts were of greater benefit to some participants due to the missing parental support and engaged both the participant and their partner in the program providing valued information.

> Multiparous woman – first baby was born overseas:
> *…because of COVID when our parents couldn't come here. So me and my husband only have to take care. So it is a bit harsh sometimes. We forget also if he – if the baby's also not well, it is stressful to us, we'll forget how to handle it. Because our brain won't work properly sometimes. So during that time, if we read those messages and all we'll get some information. It is helpful definitely, like how to handle the baby and all.* (Participant 11)

3. Pain as a barrier; *I've really struggled a lot with trying to heal properly*

Nearly half of the participants (6 of 14) revealed that pain was a barrier to meeting exercise goals. Most of these women stated it was related to their caesarean birth.

> *I had a caesarean …for quite a few months, like even into this year, I still had some pain from the stitches.* (Participant 4)

> *I was just scared of doing too much too soon. I think that was my biggest fear because it was a little bit drilled in "Don't do too much because then you're going to be in a world of pain later*". (Participant 6)

Pain was a barrier for not only women who had a caesarean birth, but also women who described ongoing pain from traumatic vaginal births and pregnancy related injuries that prevented their engagement in exercise and meeting goals of SMs2 program.

Well for me I tore pretty bad... So for me, exercise straight out was not a thing… like maybe two and a half, three [months]… I probably wouldn't have done anything prior…I also have a hernia from giving birth to her as well. So I am not comfortable… (Participant 8)

Concern about safety and wound healing was described with a desire for more information regarding when it was safe to exercise without the risk of compromising wound healing.

…mum she keep telling me to lie down because of the stitches. And there was a family friend, they had opened their stitches …So my mum keep telling me to lie down. (Participant 10)

8.7.3 Participant feedback

The main aim of the qualitive exit interviews were to ascertain barriers and enables to participation in the SMs2 healthy lifestyle behaviour program. However, participants also discussed the content of messages for breastfeeding support and offered suggestions to improve the program.

- **Lack of access to quality breastfeeding support and antenatal education: *I didn't know what to do***

All first-time mothers found the breastfeeding text support of benefit except one who had a history of breast surgery and couldn't breastfeed. Five of the seven multiparous women who could breastfeed stated they found the text messages on breastfeeding supportive.

I was just referring for the videos, like how to hold the baby, how to get her next to the breast or using a pillow or something like that. So all these little, little things which I didn't know about it, I was reading it and then utilising it. (Participant 14)

Because obviously first baby I didn't know what to do and what not to and how he was sucking. So the links that were sent, I opened and studied. That helped me. (Participant 12)

Regarding breastfeeding texts and links to education videos, multiparous women found they liked them because every child is different, and they had simply forgotten some parenting skills.

It was useful, a lot useful…I was constantly checking whatever you guys sent me. …I was holding him the wrong way because I forgot it from the first baby [laughs]. But when I check that, it helped to put him properly on the breast to suck. (Participant 10)

Providing breastfeeding information inclusive of benefits to cardiometabolic health was motivational for some women to continue to breastfeed**.**

Yeah, and those are helpful actually, if we give them breastfeeding and all, I have read like in future there is less chances of getting diabetes... I had gone through the messages and I read them, and the information is very helpful for me.
(Participant 11)

Keep sending the messages is very good, you know the breastfeeding for your health as well. So I did read. .. it was very tiring because baby started sucking and another five minutes, I feed, spend another ten minutes he want to suck again, but still because of those benefits, because of those videos, I continue breastfeeding.
(Participant 13)

One woman, who had considerable difficulties, stated her main motivation to continue to breastfeed was health benefits due to her recent GDM.

I was committed to that [breastfeeding] because I knew I had gestational diabetes. That was everything for me… you guys encouraged me that with gestational diabetes to try and take it to a year which I have. I'm still breastfeeding. (Participant 7)

- **Problems with the activity device**

When asked if there were any problems with the activity monitor some participants reported the main issue was just forgetting to wear it (4 out of 14). Also, some activities where the wrist was more stationary were not captured accurately and this was perceived as a problem; "I was annoyed because it didn't pick it up [step count]" (Participant 7). Participants reported that pushing the pram, using a stationary bike or pushing a shopping trolley didn't capture steps accurately (5 out of 14).

I was running around the house mopping like crazy and I'm like, "I know I've done kilometres running through this house," but it didn't pick up. … But it did pick up shaking baby bottles... So if I mopped I'd have to shake the baby bottle to make up for it [laugh]. (Participant 9)

Although most women stated when they were not wearing the activity device it was simply because they forgot to put it on, one primiparous woman stated she didn't wear it intentionally in the early postpartum period. She felt that with a newborn baby she was concerned the activity device may injure her baby when she was holding her.

> *I was still so wary of how tiny and delicate she was, I didn't wear it. Because it was every time I tried to change position with her, or hold her or breastfeed, it kind of got in the way and it was rubbing against her neck and her head… I wore no jewellery. I wore nothing, no watches, no bracelets or anything, I was just very, very wary of her obviously.* (Participant 8)

- **Timing of first text messages**

Nearly all participants (10 out of 14), when asked what they thought the ideal time was to start exercise text reminders, thought that they should start after 6 weeks postpartum. However, they also said parenting and healthy eating texts were acceptable to them from early discharge. An option for customisation of texts for type of birth was also suggested.

> *I think it was too early because I had the c-section, I wasn't able to get active anyway. …When you have that first appointment, maybe that reminder to talk to your GP about when you can start exercising?* (Participant 7)

> *I think probably six to eight weeks would probably be a good point. Because I know before that point I was just in survival mode.* (Participant 9)

- **Weight loss goal**

Nearly all participants (13 out of 14) thought a goal for weight loss that was individualised would be of benefit and motivating. One participant thought the focus should be on improved activity rather than a goal for weight loss. The suggested way to set the goals and the timing of set goals varied between participants. Women primarily identified that weight loss goals should be individualised and timing of set goals to be anywhere from weekly to one weight loss goal at six months.

…maybe a couple of weeks or a month after giving birth, if we had someone to go through it and just go, "Hey, what's your goals? This is what we can try to achieve this month or in six months," that would be actually really good to write it down and have like that physical kind of goal in front me. Yeah. ....But a month [goal] I think would be holding someone more accountable. (Participant 8)

I think to have a goal in your mind, it definitely helps. Otherwise you'll keep growing. ...I think month-by-month could be better. Because in a month if you lose a kilo, then maybe in 12 months you can lose, say, 12 kilo. (Participant 14)

➢ **Completion of study surveys**

Women were asked about how they found completing the surveys during the main trial. At protocol development there were concerns that the number of surveys would be onerous for busy new mothers. When asked, no women found the surveys too long or difficult to complete; "They were pretty quick and easy" (Participant 4); "And they were simple English, so that was really easy to understand" (Participant 3). Nearly half the participants stated that they felt that the surveys positively impacted their health.

So it was just a reminder that I can do it, I have done it and I can get back to it ...it would just highlight the fact that I need to make better choices no matter what I had around me. (Participant 6)

…once I saw … the survey, I was like - I was expected to do, maybe it's safe to do it, then I started after survey to do more like walking and even running a little bit. (Participant 10)

…it made me accountable because when I had to fill in my weight and all that. Yeah, I was like oh dear, sorry guys [laughs]. Every time I like "sorry guys." …It just kept reminding me to stay on course…they were pretty short, they were quick. They were easy. They were done really quick. (Participant 7)

➢ **Satisfaction and suggestions**

Most participants offered some ideas to improve the program. These suggestions included sending links for health podcasts, more human interaction in the program, or for the program text messages to be also sent to a support person to encourage the participant to achieve their goals (Appendix 8c). However, overall, the acceptability and satisfaction with the SMs2 program was high among the qualitative study participants.

> *…I don't think there is anything that you need to improve. You guys were fantastic, regular message, regular targets, regular diet plan, all that a person wants so I think you all are doing a fantastic job. ...Yeah, the program is good as is.* (Participant 14)

8.8 Discussion

The qualitative evaluation for the SMs2 program has highlighted what other research and this thesis have also highlighted, that during the pandemic women were bearing much of the extra burden of unpaid work such as child-rearing, home schooling and domestic labour.[20,21] This burden being further heightened by pandemic-related disrupted social support.[22-25] The lack of practical support was the main barrier impacting women's ability to reach the health goals of SMs2. Incorporating a significant 'other' as part of the program may provide additional practical support for women to achieve their health goals. However, this thesis and other research have identified the high acceptability of virtual support offered by such programs.[25] The positive response to the use of the text-message bank for HealthyMums@Westmead provides further evidence of the acceptability of the SMs2 text message program.

It is of particular importance when introducing an intervention intended to improve health in a culturally diverse population, to understand the lived experience of women receiving the intervention. Qualitative exit interviews in clinical trials can assist in informing the development and operational aspects of trials, assist in interpreting trial results, and improving interventions to better meet the needs of target populations. The SMs2 qualitative evaluation has identified the intervention program as well-accepted by participants, who perceived the intervention as beneficial to motivate postpartum healthy lifestyle changes.

In the development of the SMs2 text message intervention, careful consideration was given by investigators to the language regarding weight loss, and the potential risk to stigmatise obesity. Therefore, the focus of messages was more on health, activity and diet without setting individual goals for weight loss.[26] However, optimising BMI is beneficial and potentially well accepted.[27,28] This qualitative study provides some evidence that women may desire more concrete goal setting for healthy weight loss. However, participants stated this needs to be individualised. A qualitative systematic review by Spreckley et al[28] also identified that clear personalised goal setting was desired by participants for weight loss programs.

Lifestyle adjustment to a new baby is significant. Embedding healthy activity habits around the postpartum period while developing a new routine for parenting may be essential for ongoing health. Forming healthy habits take repetition, and appropriate and timely cues. Pain was identified in this research as a significant barrier to forming and embed healthy exercise habits postpartum.[29,30] There is little research regarding how pain impacts physical exercise postpartum despite chronic caesarean wound pain identified as an issue for 11% of women at 12 months postpartum.[31] Understanding the barriers and enablers for women postpartum will assist in planning appropriate feasible exercise interventions to reduce cardiometabolic risk.

Although SMs2 was not powered to detect a difference in breastfeeding outcomes, the qualitative data provides some understanding of the lack of professional support postpartum currently available for both parenting and breastfeeding support. Given the myriad of mobile applications, the evidence from this study is that there is a need for curated information from a trusted source to optimise outcomes for women in the fourth trimester. Providing text messages with embedded videos was acceptable for women in this study and filled a need for postpartum breastfeeding and parenting support. Other research has also found the desire and acceptability for postpartum virtual breastfeeding and parenting support.[32,33] It was of interest that multiparous women in this study also found parenting and breastfeeding advice beneficial, suggesting the importance of not making assumptions about need based on number of children or apparent expertise.

Metanalysis by Li et al[34] identified that lifestyle interventions were effective to reduce the risk of diabetes postpartum, but commencement time of an intervention was identified as an important factor in success. This study provides further evidence that there are strong opinions by women as to when they would like to engage in exercise intervention programs. Women in this study recommended exercise texts should commence after six weeks and should be accompanied by information about safety of the exercise with birth recovery. These considerations may assist with participant engagement.

It was of interest that participants identified completion of the surveys as an intervention within itself, as they were a reminder to make healthy choices. It is therefore feasible that survey completion may result in behaviour change in the control arm, improving their healthy choices. How often surveys are delivered, and the impact they have on both the intervention and control participants may need careful consideration and further evaluation.

Research has identified that pandemics and natural disasters impact negatively on long-term cardiometabolic health.[35] This study provides some evidence of the difficulty women encounter to achieve healthy goals and may illuminate some drivers to poor cardiometabolic outcomes for postpartum women both generally and during a pandemic. The insights this study has gained into the impact of COVID-19 related restrictions on a health intervention program, has highlighted the importance of qualitative evaluation. Evaluation of a digital health intervention is acknowledged to be a complex process and often a pragmatic approach based on feasibility is advisable.[36] The quantitative surveys of SMs2 included assessing time spent wearing the activity device and number of text messages read. However, the numbers do not provide context of the individual experience. It is through in-depth interviews that reasons are uncovered for not exercising such as fear of COVID-19. Also, less common reasons for non-engagement such as for not wearing the device due to concern regarding injuring a delicate newborn's skin may be identified. These factors can be taken into consideration to improve study designs and so improve participant engagement with the interventions in future trials.

A limitation of this research is recall bias. A pretrial, in-trial and post-trial interview schedule, as proposed by the FDA[37], may reduce this bias. However, this may also lead to potential behavior change. In-depth qualitative interviews with only some trial participants may influence behaviour as participants reflected more closely on barriers to achieving their health goals and overcome them in trial. Interference with trial results was a primary concern for timing of exit interviews. Qualitative trial-team investigators may gain potential insights into barriers for participants prior to completion of the trial. At protocol development it was decided all participants needed to have completed participation in the study. Therefore, the length of time from last health text message and interview varied. Immediate exit interviews should be considered for future trials with results blinded to trial investigators until trial completion.

The participant's 'voice' is becoming increasingly valued both in trial design and interpretation of results with regulatory bodies, facility accreditation and journal expectation of consumer input.[37,38] This thesis has incorporated participants' voices to both investigate the impact of COVID-19 and importantly evaluate an intervention during the pandemic aimed to improve cardiometabolic outcomes. Findings from this study aligns with results discussed in chapters five and six that identified the difficulty new mothers have with accessing practical support, particularly during the pandemic.[24,39] Data generated in this study can provide guidance for trial modifications for future healthy lifestyle intervention research.

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Chapter 9
Discussion

9.1 Thesis overview

Cardiometabolic conditions such as diabetes and heart disease do not exist as siloed entities but are embedded within complex biosocial interactions both promoting and preventing disease.[1] The global burden of non-communicable disease (NCD) and increase in cardiometabolic conditions has led to calls for reframing our approach to understanding both drivers and interventions within a syndemic framework.[2-4] A syndemic framework refers to bidirectional factors such as depression and diabetes that intersect impacting health, that is inclusive of social and or economic inequities.[3] This thesis has taken a holistic approach to understanding cardiometabolic disease risk for women postpartum that fits within a multisectoral syndemic framework. The focus of the thesis is on the contribution of breastfeeding, gestational diabetes, and the COVID-19 pandemic disease-social interaction within a defined high-migrant population (Figure 1).

9.2 Summary of principal findings

Biosocial interaction is an underlying theme throughout this thesis. The social isolation and lack of practical social support for women postpartum has significant implications for lifelong health.[5,6] The results of this thesis, for the first time, have identified that breastfeeding intensity may be crucial for optimal glucose tolerance in the next pregnancy (Chapters 3 and 4). These findings may help explain one of the mechanisms of the known association of suboptimal intensity and duration of breastfeeding and increased long term cardiometabolic risk.[7,8]

Reduced practical social support was identified in chapters 5, 6 and 8. Investigating loneliness, stress and other factors associated with reduced social support is essential given the detrimental cardiometabolic ramifications over the life course of these social determinants of health, as well as their intergenerational impact.[5,9-12] This thesis has recognised that the COVID-19 pandemic has mediated gender-specific cardiometabolic risk through pathways that include but are not limited to reduced breastfeeding intensity, increased stress, reduced physical activity and reduced social support.

Figure 1. Thesis overview
Peripartum cardiometabolic syndemic: selected bidirectional factors impacting health

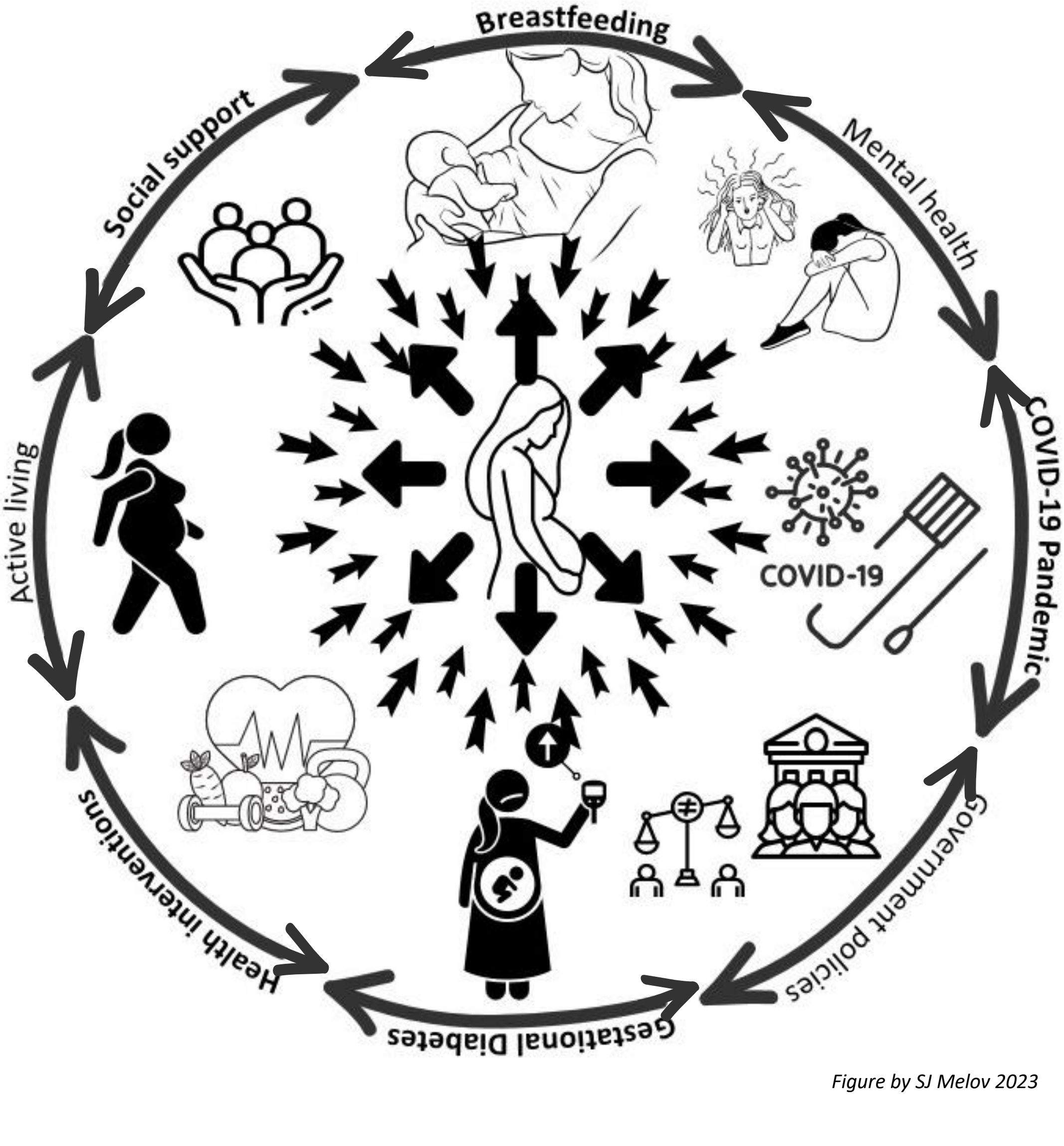


Figure by SJ Melov 2023

- **9.2.1 Cardiometabolic risk and breastfeeding: Chapters 3 and 4**

Chapters 3 and 4 focused on the cardiometabolic disease of gestational diabetes (GDM), and breastfeeding. Women after a GDM affected pregnancy are likely to be affected again in their next pregnancy,[13,14] with the unfortunate greater likelihood of progression to type 2 diabetes mellitus (T2DM).[14] Previous research has established the association that breastfeeding mitigates some risk of cardiometabolic disease including T2DM.[7,8] However, there is a gap in knowledge regarding breastfeeding and subsequent pregnancy GDM risk. I addressed an evidence gap in Chapter 3 by investigating the metabolic influence of breastfeeding patterns and subsequent pregnancy GDM risk. This was firstly with a proof-of-concept pilot study, the BLIiNG study. This study investigated the association of breastfeeding patterns and next pregnancy oral glucose tolerance test (OGTT) and gestational diabetes diagnosis. The study cohort was high-risk for GDM.

The findings of the pilot study (Chapter 3) reveal that breastfeeding patterns may modify glucose tolerance in a subsequent pregnancy. Interestingly, we identified that there was an association of duration and intensity of breastfeeding and OGTT results in partially adjusted multivariate models and in fully adjusted models for breastfeeding duration. Breastfeeding for greater than six months was associated with improved 1-hour OGTT results and high intensity breastfeeding (HIBF) was associated with improved 2-hour OGTT results. These promising findings in a small select cohort of 210 women indicate that further research is required in a larger unselected population to further investigate these associations.

➢ 9.2.2 Sydney BLISS Check

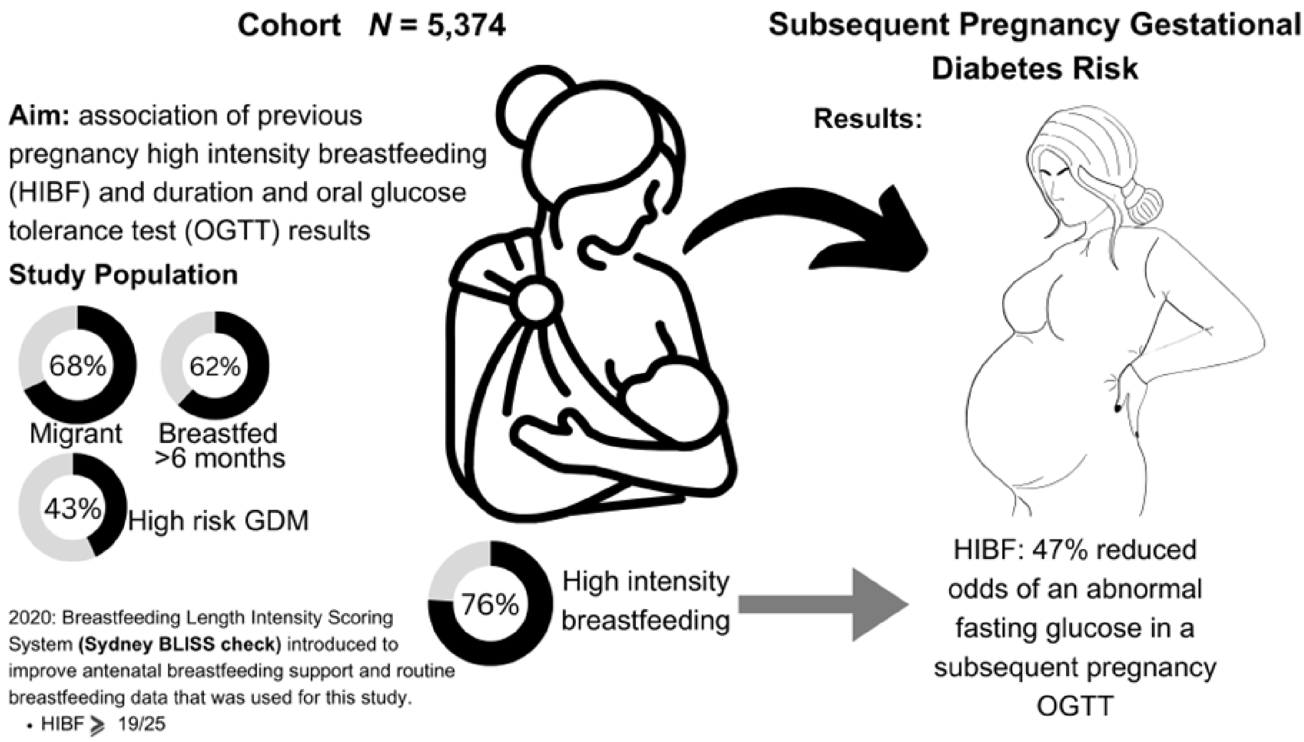
Together with duration of breastfeeding, HIBF is an important lactation indicator that has no uniform measurement tool and is not routinely assessed or recorded. However, intensity of breastfeeding is known to be associated with increased duration of breastfeeding, among other benefits.[7,15] To objectively measure HIBF I developed an antenatal survey tool with an expert lactation team and consumer feedback – the Sydney BLISS check – to assess the first three months of breastfeeding patterns in a woman's previous pregnancy by maternal recall.

In the BLIiNG study we validated our Sydney BLISS cutoff score groupings, by identifying that a high BLISS score cut off of ≥19 (HIBF) was associated with increased duration of breastfeeding (Chapter 3). In this pilot cohort study, 83% of HIBF women breastfed for greater than 6 months. [16] Further validation of the BLISS score groupings was achieved in Chapter 4 in the large cohort study. The median duration for breastfeeding was 12 months for women who were grouped as HIBF (IQR 6–18 months, n = 4,074, 76%) with the lower intensity group breastfeeding mean duration 3 months (IQR 1–7 months, n = 1,300, 24%; P < 0.01). This was a reassuring finding - that the clinically driven cut off value designations determined a priori by the lactation team was confirmed both in the pilot study and the larger cohort study.

The pilot BLIiNG study data assisted with the implementation of the Sydney BLISS check into routine clinical care in our health district, embedded into the electronic booking data in March 2020. I was able to use the routine data to complete the follow up study for a large, unselected cohort of over 5,000 participants (Chapter 4). I was able to confirm there was an association between breastfeeding patterns and OGTT results in a subsequent pregnancy for both women at high and low risk for GDM (Figure 2). High intensity breastfeeding reduced the risk of an abnormal fasting glucose level in the OGTT (aOR 0.53; 95%CI 0.38–0.75; $P < 0.01$). Duration of breastfeeding in this cohort was not associated with changes in glucose levels. In Chapter 4, I was also able to investigate factors associated with suboptimal breastfeeding. This will provide data to inform targeted intervention strategies for clinical care in groups identified most at risk of sub-optimal breastfeeding such as antenatal referral to the lactation clinic and free breastfeeding classes.

This thesis identifies that HIBF may be crucial for a metabolic reset from an insulin resistant state in pregnancy to improve cardiometabolic postpartum health.

Figure 2. Graphical abstract Chapter 4



Graphical abstract SJ Melov 2023

- **9.2.3 Cardiometabolic impact and pregnancy during the pandemic: interventions and acceptability: Chapters 5–8**

Research conducted during the COVID-19 pandemic is presented in Chapters 5, 6, 7 and 8. I felt privileged to have the opportunity to investigate and play some part in documenting this global and devastating pandemic. I investigated the experience of women in the peripartum period and clinicians, both working clinically as well as their personal experience. The sixty-eight interviews I completed, often discussing traumatic experiences during the pandemic, were at times distressing to hear and difficult to reflect on. However, understanding the pandemic will assist in pandemic preparedness and optimise intervention programs to improve cardiometabolic risk.

During the first year of the pandemic in 2020 our local health district experienced a very low prevalence of COVID-19 disease but significant infection risk mitigation changes, including a seven-week lockdown commencing in March 2020. There were also numerous hospital restrictions enacted. These included having no support people in waiting rooms and only one support person allowed in birth units. Unprecedented measures were enforced by the Federal government to reduce COVID-19 infection risk. Government response included shutting the Australian borders to international travellers for nearly two years from March 20, 2020.[17,18] In early 2020 there was a barrage of media coverage of health systems overwhelmed by the pandemic, including images from New York of empty streets, mass graves and mobile morgues.[19] At this time there were constant reminders of the impending disaster advancing towards our island continent at a time when no COVID-19 vaccines were available.[20]

Contemporaneous investigation of the impact of stress, and lack of social support at this time, can inform an understanding of potential long term cardiometabolic risk. A key theme among the maternity care clinicians interviewed was their perception that migrant women were feeling fearful and had lost valued family support, they were *'sad, depressed and lonely'.* Clinicians were of the view that Australian born women had a different experience to migrants. It was said that some Australian born women 'really liked being isolated and living in their family bubble'. However, most clinicians felt there was an increase in mental health issues for women in the peripartum period during the pandemic, and a loss of 'joy' around pregnancy and birth.

There was a shift from patient centred care in the hospital to a concern to preserve the healthcare workforce. This change in approach caused distress for clinicians, particularly when there was a disconnect between strict hospital rules and lax infection disease approaches in the community. Clinicians identified inequities in enforcement of hospital infectious control orders. These factors together with a desire for a 'women centred' approach, led clinicians to 'bend rules' to optimise clinical care such as increased time spent with patients.

More nuanced results were from women themselves regarding their experience of social support during the pandemic (Chapter 6). I conducted 54 interviews with 24 participants antenatally and postnatally. Migrant and Australian born women both identified significant psychological hardship during the first year of the pandemic, but migrant women continued to experience less practical support postpartum. However, benefits were also commented on including migrant women identifying greater gender equity for domestic duties. Migrant and Australian born women were fearful during pregnancy of contracting COVID-19 despite very low prevalence in the community; The fear of infection restricted participants' movements beyond the lockdown period also reducing their physical activity.

To further understand the perinatal impact of the indirect factors regarding the pandemic I conducted a quantitative study in our health district (Chapter 7). I compared birth outcomes of 23,722 pre-COVID-19 births to 10,381 births in the first year of the pandemic. Reassuringly I identified the proportion of patients who were unbooked (no formal care) at birth was unchanged and there was no alteration in inductions or iatrogenic preterm births. Interestingly, I found there was a 10% reduced odds of spontaneous preterm birth (aOR 0.90; 95% CI 0.82-0.99). During the study period the odds of caesarean section birth unfortunately increased by 25% (aOR 1.25; 95% CI 1.19-1.32). Also, it was disappointing that full breastfeeding at discharge was less likely in the first year of the pandemic (aOR 0.85; 95% CI 0.80-0.90) than in the previous two years. This was somewhat surprising, as there had been an increase in factors that support full breastfeeding such as skin to skin and breastfeeding within the first hour after birth.

- **9.2.4 Smart mums with smart phones exit interviews: Chapter 8**

In my thesis I was very interested to investigate, not only pregnancy related cardiometabolic risk, but also solutions to reduce risk. It was also important to understand the consumer perspective of how risk reduction interventions were accepted in our high migrant population. I conducted the exit interviews and qualitative analysis that forms part of this thesis (Chapter 8) for the Smart Mums with Smart phones2 (SMs2) randomised control clinical trial. The trial aimed to reduce cardiometabolic and more specifically diabetes risk after a GDM affected pregnancy with a text message healthy lifestyle program. The trial was conceived pre-pandemic and the pandemic emerged shortly after commencement of the trial. I was fortunate to be part of the investigator team for this trial. I was able to provide input for the parenting and infant feeding messages, as well as provide a modified Sydney BLISS check for collection of prospective breastfeeding data during the trial. The trial participants interviewed were of a culturally diverse background, reflective of the main trial participants.

The key theme identified for barriers to engaging in the SMs2 program was a lack of practical support postpartum. This theme underpinned barriers to healthy lifestyle raised by participants such as lack of time, childcare demands, paid work, domestic duties and home schooling. For nearly half the participants ongoing pregnancy associated pain such as cesarean wound pain, was an unexpected finding as a significant barrier to physical activity and contributed to participants' inability to meet step count goals. Understandably, COVID-19 related reasons were also a significant barrier for optimal participation for healthy eating and exercise. These reasons were primarily regarding lockdown periods and ongoing fear of infection if women left their homes. Consistent with other qualitative thesis findings, practical support for women in the postnatal period was poor. I have identified that practical support was reduced during the pandemic, particularly for migrant women. Disrupted social support is a known biosocial risk for cardiometabolic disease. It was reassuring for future trial planning that the SMs2 program was very well accepted. All qualitative participants found some aspect of the program beneficial to them in the postpartum period and all would recommend the program to a friend.

9.3 Thesis in context

9.3.1 Lactation

The global burden of NCD inclusive of cardiometabolic conditions is immense and well documented.[21-23] Addressing the disease burden is at the forefront of both local government and the World Health Organisation healthcare priorities. These priorities include the important sustainable development goal (SDG) 3.4 to reduce by one third premature deaths from NCD.[24] Chapters 3 and 4 have provided evidence to resolve the thesis aim to understand the association between previous breastfeeding duration and intensity and next pregnancy OGTT results. The BLIiNG study presented in chapter 3 builds on research that has investigated the association of breastfeeding and improved metabolic outcomes including OGTT results outside of pregnancy.[7,25,26]

The BLIiNG study is the first study I am aware of to investigate previous breastfeeding patterns and OGTT results during pregnancy. This pilot study provided the first glimpse that there may be in-pregnancy metabolic improvement associated with previous breastfeeding. Our results are consistent with a recent systematic review of 15 studies in non-pregnant women with a history of GDM. The review found an association between breastfeeding intensity and fasting glucose levels but no association with 2 hour blood glucose results on the OGTT.[27] These findings are consistent with Chapter 4 results. The systematic review also confirmed that breastfeeding was associated with reduced risk of T2DM for women with a history of GDM.[27] This provides further evidence that breastfeeding is associated with reduced cardiometabolic risk.

In the SWIFT study Gunderson et al conducted the first detailed prospective study to review postpartum OGTT results in the first 6-9 weeks postpartum.[7] The investigators identified a dose response to breastfeeding intensity of a greater ratio of breastfeeding to formula, was associated with improved fasting blood glucose, no association was identified with 2 hour glucose results.[7] This provides evidence that the association of HIBF and improved fasting glucose on the OGTT is present outside of pregnancy, therefore plausibly continues in pregnancy.[28] In a study population of over 1000 women with a history of GDM Shen et al[28] also identified a dose response and progression to T2DM with high intensity and duration of breastfeeding, both associated with lower T2DM risk.

- **9.3.2 Sex-specific cardiometabolic risk**

We provided evidence for the first time that HIBF is associated with improved fasting pregnancy OGTT results irrespective of time elapsed since the birth of a woman's last child, in an unselected population. This thesis assists with understanding gender specific cardiometabolic risk and provides important evidence for an intervention that can improve fasting glucose – HIBF. The Framingham heart study of over 4,000 participants (2,163 women)[29] was one of the first studies to identify that women with impaired fasting glucose were at increased cardiovascular disease (CVD) risk. This finding was not the case for men in the study.[29] The Framingham Offspring cohort was followed up at four years with participants grouped by impaired fasting glucose cut off values. Impaired fasting glucose predicted coronary heart disease in women only.[29] More recently Kohansal et al[30] identified abnormal fasting glucose increased all-cause mortality in a large population study of over 8,000 women. Impaired fasting glucose conferred increased risk of all-cause mortality, even when participants had not progressed to T2DM. This association was not identified for men, their risk for all-cause mortality only increased if they progressed to T2DM.[30]

With acknowledgement that CVD in general is more common in males, once women develop diabetes, they are at approximately 30% greater risk for a fatal coronary event than men with diabetes.[31,32] The greater the dysglycemia (higher HbA1Cc) for both men and women the higher the CVD risk.[33] Prevention of diabetes and optimising modifiable factors are therefore key. Results in chapters 3 and 4 of this thesis identify breastfeeding as a biosocial mechanism to potentially improve glucose levels and thereby cardiometabolic disease. This thesis supports calls for primary preventions to address the growing global prevalence of T2DM.[34] Specifically, calls for greater research and guidelines that identify sex specific modifying factors for cardiometabolic disease such as promotion of breastfeeding.[9,35-37]

Chapter 4 provides evidence that specific groups of women are at risk for suboptimal breastfeeding. These women may therefore be at increased risk for cardiometabolic disease. My findings are consistent with previous research regarding factors that reduce both exclusivity and duration of breastfeeding including caesarean birth, Aboriginal and Torres Strait Islander ethnicity, smoking, preterm birth and obesity.[38-40]

- **9.3.3 Mental health**

Interestingly, a history of any mental health issue increased vulnerability to suboptimal breastfeeding. This is consistent with previous research.[40-42] Mental illness is identified as a bidirectional factor with breastfeeding. However, there is inconclusive evidence regarding associations and directionality with additional confounders and complex biosocial factors involved, including sleep quality.[43-45] The potential for mental health symptoms to improve for breastfeeding women is biologically plausible, with breastfeeding reducing stress through oxytocin release as one mechanism that may improve mood.[46-48] Importantly, mental illness has been identified as bidirectional with cardiometabolic disease.[49-52] Of significance for this thesis, research has identified adults with mental illness have increased risk of co-occurring diabetes – an important group, therefore, to be adequately supported when breastfeeding to help reduce cardiometabolic disease.[53,54] The uncertain association between anxiety and diabetes warrants further investigation in our perinatal population.[52] This is of particular concern given the global rise in anxiety and depression during the pandemic.[55]

This thesis has provided evidence that supporting exclusive breastfeeding, or close to it, will improve glucose levels in the next pregnancy for women in general, irrespective of their risk for GDM. I have also provided evidence for the knowledge gap and thesis aim, regarding the association between previous breastfeeding duration and intensity and next pregnancy oral glucose tolerance test results.

- **9.3.4 Social determinants of health**

This thesis recognises the imperative to reduce NCD. This is consistent with the call to include social determinants of health in both understanding disease and planning interventions.[56,57] The vulnerability of a high-migrant population during the COVID-19 pandemic has been highlighted in this thesis in Chapters 5, 6 and 7 and supported by research that has found migrants were disproportionately impacted by the pandemic.[58-60] Trentin et al postulate that the iniquitous impact of the COVID-19 pandemic on ethnic minorities in high income countries is intertwined with structural racism.[59,61] This thesis has highlighted the increased social burden among our migrant populations that will have ongoing cardiometabolic health effects. Health system barriers such as access to interpreters and clear communication for migrants, particularly during the pandemic, can be viewed as structural racism.[62-65] Closing Australian international borders for biosecurity had significant economic impact on many Australians. However, the social disruption on our migrant community was devastating.[66] This thesis provides some understanding and may guide future pandemic interventions to reduce distress for migrant families, such as early implementation of, and leveraging technology to improve support and early ongoing assessment of social isolation. Early assessments and interventions may potentially reduce ongoing cardiometabolic risk that is associated with disasters and pandemics.[11,67-69]

This thesis can inform the intersectionality and cumulative effect of mental illness, gender, ethnicity-related socioeconomic factors overlapping with disadvantage and risk trajectory that may occur during a pandemic and beyond.[70] This thesis provides context to assist with understanding factors that may be additive for cardiometabolic risk, particularly in our migrant community.

- **9.3.5 Disasters and pandemics**

Our findings are consistent with earlier research that identifies the association between pandemics and disasters with cardiometabolic risk.[11,67-69] Through a mixed methods approach, I have identified factors in chapter 5-8 that may assist in understanding drivers for cardiometabolic disease risk. These include, but are not limited to, increased social isolation, anxiety, stress, reduced physical activity and reduced breastfeeding at discharge.[5,48,55,71-73]

9.3.6 Social support

Our research showed that women lacked practical and social support postpartum, and this was the greatest barrier to engaging in a healthy lifestyle program, and that migrant women were most likely to experience reduced practical and social support. This finding is disappointingly consistent with research conducted nearly 20 years ago in our health district. In a postpartum post-GDM cohort that was primarily Arabic and Cantonese speaking (70%), Razee et al identified a lack of social support as the main barrier to engaging in healthy lifestyle activities.[74] We have identified lack of support is still a significant issue for women postpartum. Our findings highlight the COVID-19 pandemic has exacerbated this issue, particularly for migrant women.

9.3.7 Gender equity

Addressing gender equity, unbalanced childcare responsibilities and structural racism are part of the syndemic framework that clearly needs greater attention. Improving opportunities for women with young families to feel supported, promote mental health and engage in the paid workforce if desired, has been shown to improve cardiometabolic outcomes.[75-77] Gender equity is a recognised determinant of health, as reflected in the fifth Sustainable Development Goal, and other government initiatives to monitor gender equality.[76-79] Addressing gender and restrictive gendered roles as an issue is imperative for improving women's health outcomes.[76] However, it has been estimated that it will take 131 years for gender equity to be achieved at the current speed of progress.[79] This thesis has identified reduced practical and social support as a significant gendered barrier to improved cardiometabolic health.

In Australia mothers spend nearly 20 hours per week more than fathers doing unpaid domestic work.[80] The greater domestic burden exists both when women are working full time or part time.[80] It is not surprising women interviewed for this thesis identified lack of time as a significant barrier to engaging in healthy lifestyle. Health facilities can provide more gender equity opportunities for antenatal parenting classes that includes discussion for both parents regarding infant care workload and domestic labour aimed at partnership participation.

- **9.3.8 Pain as a barrier to physical activity**

An unusual finding of this thesis was that pain was a significant barrier for some women in SMs2 to participate in physical activity. A systematic review identified persistent chronic caesarean wound pain for 11% of women at 12 months and beyond.[81] In the qualitative research undertaken women stated a variety of reasons for pregnancy related postpartum pain. Persistent chronic vaginal pain has been documented to be present for between 2-6% of women at 6 months after a vaginal birth.[82] Further investigation in our population is required regarding how pain may impact meeting exercise guidelines and what strategies can improve outcomes for women.

- **9.3.9 Virtual support**

Various postpartum programmes of virtual support aimed to improve cardiometabolic outcomes are successful and desired.[5,83-85] Personalising content with some human interaction was important to women in our exit interviews in SMs2. Personalized content should include specific weight goals and be inclusive of considerations of potential morbidity such as ongoing pain to optimise engagement in postpartum cardiometabolic risk reduction programs. Further investigation of cost-efficient scalable programs needs to be considered.

9.4. Significance and implication

This thesis has addressed areas of global significance around the bidirectional factors of breastfeeding, gestational diabetes, the COVID-19 pandemic and the implications for long-term cardiometabolic risk. The importance of understanding cardiometabolic disease intersectionality is increasingly recognised with biosocial factors including perinatal outcomes, breastfeeding, BMI, social support, and mental illness being implicated.[4,57,86,87] This thesis has contributed valuable understanding to gaps in knowledge around this intersectionality.

- **9.4.1 Lactation**

Improving global breastfeeding rates is a WHO goal.[88,89] The global rise in diabetes requires urgent coordinated multisectoral efforts. The contribution of breastfeeding will promote health of infants, mothers and potentially reduce diabetes prevalence. GDM confers a 13-fold increased risk of GDM in a second pregnancy and an additive risk for T2DM.[13,14] I have contributed important novel understanding around the value of breastfeeding intensity to reduce cardiometabolic risk in a subsequent pregnancy, and valuable information to cardiometabolic and lactation research. Recognizing groups to target for intervention will be critical for clinical care to promote, protect and support breastfeeding and meet World Health Organization (WHO) targets of 70% exclusive breastfeeding in the first six months.[90] This includes providing additional lactation support for infants admitted to a neonatal intensive care unit with the known negative impact this has on exclusive breastfeeding.[91] Interestingly, there is evidence of bidirectional benefits that exist for maternal exercise, with improved breastmilk composition identified in exercising women as well as favourable metabolic effects on infant heath.[92] Therefore, exercise promotion for breastfeeding women may have added benefits for breastfed infants.

- **9.4.2 Sydney BLISS check**

Development of the Sydney BLISS check has been a significant achievement presented in this thesis with direct clinical care impact. This survey tool fills the gap in capacity to easily evaluate antenatal breastfeeding history of both intensity and duration, and reasons for stopping breastfeeding. The Trademarked Sydney BLISS check (Figure 3) is also continuing to build a unique database to assist research and clinical care. National and international interest in the use of the Sydney BLISS check is evidence of the ongoing potential for this survey tool. Since its introduction to clinical care in March 2020 to October 2023 approximately 20,000 multiparous women in WSLHD have been screened for previous breastfeeding problems and offered lactation support as needed – a direct result of the research undertaken in this thesis. Early discussions are in progress for international collaboration and introduction of the Sydney BLISS check with Imperial College, London and Brigham Health, Harvard Medical School Boston. I have collaborated with the Brigham Health group in Boston on further validation of the BLISS check as a contemporaneous tool with the abstract submitted for presentation at the Pediatric Academic Societies Annual meeting, Toronto, 2024.

Figure 3. Trademark Sydney BLISS check logo

➢ 9.4.3 COVID-19 pandemic cardiometabolic risk

There was a narrow window of opportunity I had to gain unique insights into the lives of clinicians and women during the peripartum period in the first year of the COVID-19 pandemic. This was during the period in the local health district and state of NSW of high social upheaval including closed international borders but low disease prevalence and no available vaccine. Chapters 5-8 provided contemporaneous data that will assist in understanding future cardiometabolic risk and ongoing pandemic preparedness. Themes in the qualitative research included clinicians did not follow directives and modified rules, using their own risk evaluation to optimise patient care. Clearly these findings need to be taken into consideration in future pandemics management. My qualitative work also highlighted that social support is not adequately measured or addressed during the peripartum. Improved understanding of the social determinants of health will assist in providing targeted intervention for vulnerable groups.

➢ 9.4.4 Breastfeeding and economic benefits

Identification of reduced full breastfeeding at discharge may impact long term cardiometabolic health of both infant and mother. This thesis adds to the dialogue of the importance of breastfeeding to the economy, including potential reduction in healthcare costs associated with diabetes. There have been estimates made that the global cost of not breastfeeding to be about 1,500 lives and one billion dollars each day.[93] However, there is ongoing undervaluing of 'free' maternal time, with lack of practical support postpartum reflected in this thesis. The invisible labour and economic benefits of breastfeeding and childcare needs more recognition.[94]

➢ 9.4.5 Migrant women

Vulnerabilities of migrant women and the disproportionate impact on them during the pandemic have been identified in this thesis and other research.[60,95,96] Issues identified include increased mental health issues, structural racism, gender inequity, loneliness and cultural barriers.[59,60,95,96] This thesis provides further evidence that there was increased mental health impact on migrant women during the pandemic. There is a need to understand the ongoing implications of this psychological burden as well as the cardiometabolic ramifications.

➢ 9.4.6 Gender equity and practical social support

Value signalling for gender equity around pregnancy language, such as partners of pregnant women declaring "we're pregnant", needs to be accompanied by greater actual practical contribution to 'their' pregnancy and infant care inclusive of domestic labour by fathers.[97] This thesis identified partners stepping up to fulfil the female gendered role of missing female relatives. However, little is known if this move towards gender equity continued after the first three months postpartum. Only women can do the unpaid infant feeding work of breastfeeding. Yet this time-consuming activity is not counted as part of unpaid domestic labour. This is despite the benefit of breastfeeding to the woman's and child's cardiometabolic health as well as economic benefits to society.[89,94] Promotion of breastfeeding is also hindered by formula companies' social media campaigns and other aggressive advertising practices supported by $3 billion of advertising globally.[98-101] If breastfeeding had a similar budget, possibly the WHO exclusive breastfeeding goals would be met. Other factors that can promote breastfeeding include breastfeeding accredited workplaces, paid parental leave, improved access to childcare, and flexible work hours among other measures to support equity in parental care.[102,103] This thesis adds to ongoing evidence for more government incentives for business and government bodies to support breastfeeding.[104]

- **9.4.7 Peripartum cardiometabolic syndemic**

Evidence from this thesis threads together biosocial factors to understand and investigate drivers to future cardiometabolic disease for women after pregnancy. I have identified that complex pregnancies are not the only risk to future cardiometabolic disease. Exposure to the pandemic, lack of practical and social support and reduced breastfeeding may all contribute to disease (Figure 1).

9.5 Strengths and limitations

Strengths and limitations of each study are detailed within results chapters. However further to these, some limitations and strengths should be noted. I acknowledge the inability to replicate the COVID-19 pandemic research is a limitation. Qualitative research undertaken beyond the window of opportunity of the first year of the pandemic with low disease prevalence may result in recall bias. Increased prevalence of disease and availability of vaccines presents a very changed social milieu. Conducting the SMs2 intervention study during the pandemic has been both a negative and positive. A unique insight was gained for acceptability and feasibility of a text message lifestyle intervention during extreme social upheaval. The intervention may well have been received differently in a non-pandemic period. Further limitations are that all research was conducted in a culturally diverse population and may therefore be applicable only to similarly diverse populations. In addition, all data were collected from public hospitals only, therefore the results may not be generalisable to some higher socioeconomic populations. The methodological limitation of using retrospective routine data is that causal relationships are unable to be made however, this does provide important information for ongoing prospective research.

Implementing research findings is notoriously difficult and long lag times are often encountered with reports of an average of 17 years to implement research findings.[105] A strength of this thesis work is that I am an embedded clinician within the health district. I have longstanding professional relationships therefore I had the opportunity to present unpublished BLIiNG study pilot data with the novel BLISS check to key midwifery leadership stakeholders. I was able to advocate and gain support for implementation. Therefore, the Sydney BLISS check implementation and clinical pathway was expeditious. However, a limitation of the BLISS data is that it has not accurately captured women who choose not to breastfeed at all. It is also less accurate than a contemporaneous collection of infant feeding through mechanisms such as daily diary or validated tools such as the Infant Feeding Practices Survey. However, a recall tool such as the Sydney BLISS has advantages including increased feasibility and opportunity for whole population estimates of infant feeding practices.

A further limitation is the methodological barriers to breastfeeding more broadly. There is a lack of consensus among breastfeeding researchers regarding breastfeeding term definitions and appropriate measurement tools.[106] Another limitation that may impact assessment of next pregnancy GDM risk is the BLISS check did not estimate length of exclusive breastfeeding. Further evaluation of the BLISS tool will be undertaken inclusive of additional question regarding duration of exclusive breastfeeding. Ongoing modification of the BLISS check will also aim to more accurately capture this group and enable important investigation of the cohort of women who choose not to commence breastfeeding. The Sydney BLISS check will require further validation in other populations both nationally and internationally. Additional support will be gained through my participation in the leadership team in the advanced research translation centre of Sydney Health Partners Clinical Academic Group–Reproductive, Maternal and Newborn Health.

It is well acknowledged education is vital as a determinate of health and integral to pregnancy outcomes and cardiometabolic risk.[107-109] Maternal education level impacts on perinatal outcomes and significantly for this thesis, evidence also confirms higher paternal education level improves breastfeeding outcomes.[110] It is a limitation of the data for this thesis that education is not available for either maternal or paternal participants. Importantly, the migrant population in Australia are principally accepted through the skilled migrant scheme. Understanding the impact of education level, particularly among our migrant population would have enhanced the methodology of this thesis.

A further limitation of this thesis is the lack of follow up data presented regarding infant outcomes for women with HIBF and or improved fasting OGTT. The HAPO study has identified the relationship of maternal pregnancy OGTT glucose levels and adverse neonatal outcomes is on a continuum.[111] I have identified an association with HIBF and subsequent pregnancy improved fasting glucose but not explored potential neonatal or longer term infant health outcomes.

A particular strength of this thesis is the multidisciplinary supervisory team who provided a wholistic approach to peripartum cardiometabolic risk investigation. Understanding cardiometabolic risk through a singular disciplinary lens would have been a limitation to the broad scope that has been supported by multidisciplinary expertise. A further positive aspect of this thesis is the use of mixed methodology. The consumer voice is increasingly recognised as a vital part of research. During the pandemic, particularly investigating complex biosocial behaviours such as physical activity and breastfeeding, may only be fully gained from in-depth interviews with participants.

9.6 Recommendations for public health and policy

Findings from this thesis can be used to inform clinical care pathways and public health policies. This thesis highlights the complexity and intersectionality of biosocial constructs that can inform policies that aim to improve cardiometabolic health outcomes for women and their families inclusive of strengthening social support. This thesis has identified areas in cardiometabolic health that require consideration including the impact of mental illness and social support during pregnancy or the postpartum period and has highlighted the importance of the 'fourth trimester'. Economic considerations are known to be a barrier to accessing health care. Government funding that provides free health care to women and their infants during the fourth trimester may assist with identification of high risk women for long term cardiometabolic disease and provide appropriate follow up. Funded policies that support the 'fourth trimester' may have significant economic benefits reaped through reduced morbidity and mortality in the community.

Global support for breastfeeding is underpinned by initiatives such as United Nations Sustainable Development Goals and World Health Organisation infant nutrition targets to increase exclusion breastfeeding rates.[112] Equity of access must be an essential part of breastfeeding support provided through government policies that straddle a range of policy portfolios that impact vulnerable populations. Wholistically addressing employment, education and structural social barriers to promote and protect breastfeeding is essential to population health. Evidence from chapters 5, 6 and 7 highlight the variation in outcomes and factors impacting our migrant population. Policies that address equity of access, health literacy and pathways to address poor social support and strengthen e-connections may reduce disparities in outcomes.

The Breastfeeding Trends initiative (WBFi) is a global collaborative agency initiative that includes the World Health Organization and UNICEF and part of the Australian National Breastfeeding Strategy.[113] The WBFi provides an opportunity for countries to benchmark policies on infant feeding practices and programs including the provision of breastfeeding counselling, number of hospitals in a country who are Breastfeeding Friendly Initiative (BFHI) accredited and that breastfeeding is monitored at a national level through appropriate data collection. Australia has underperformed and made little progress as assessed by WBFi, gaining a score of only 33/100 in 2023. Upscaling of the Sydney BLISS check would support data collection. Research such as presented in this thesis, can assist Government policy driving targeted intervention programs to improve our national WBFi score and benefit the long term health of the community.

9.7 Recommendation for future clinical care and research

This thesis has a clinical focus and has highlighted the importance of the fourth trimester (12 weeks postpartum) in cardiometabolic risk reduction. I have several recommendations for improved clinical care and further research based on findings from this thesis (Table 1). Increasing attention has been paid to address the service gap from tertiary hospital discharge to primary care in the fourth trimester to improve the outcomes for women.[114,115] This is particularly important for women at high risk for cardiometabolic disease and requires systematic healthcare surveillance and intervention.[116,117]

This thesis has highlighted a gap in professional and social support in the postpartum fourth trimester in our public health service. Tertiary care, child and family health services and primary care General Practitioner services need greater coordination in the postpartum period with relevant data capture also necessary. The economic value of providing a consistent, expected postpartum schedule of health care contacts with lactation support needs to be evaluated. In Australia all antenatal visits in a public hospital are at no cost to patients. Similarly, free routine follow-up needs to be investigated to optimise health outcomes for women. Leveraging text messages and smart phone interaction may well be an option for incorporation into a coordinated postpartum program and will need ongoing evaluation. Improved breastfeeding intensity may be a vital key to reducing cardiometabolic risk and therefore all avenues should be explored to support women with their infant feeding choice.

Contemporaneous and local breastfeeding data has been made available through this thesis by the successful local implementation of the Sydney BLISS check. This data can now be used to drive appropriate intervention and breastfeeding support programs. The check provides improved clinical care through standardised antenatal breastfeeding assessment and triage pathway to telehealth lactation consultation. Ongoing assessment and backend programming are underway for the Sydney BLISS check, including additional questions for primiparous women. This clinical service tool will need further validation and trial in different populations.

The tool potentially will be clinically useful in rural or remote populations, with the capacity to provide telehealth lactation clinics once patients are identified through the BLISS check. Future directions for the Sydney BLISS check will be aimed at implementation throughout the state. This thesis has highlighted that duration of breastfeeding is not the only important lactation metric. Documenting and benchmarking duration of any breastfeeding does not reflect intensity. I recommend that breastfeeding intensity should be a benchmarked variable between institutions and countries.

The vulnerable groups for suboptimal breastfeeding identified through the Sydney BLISS check will need targeted co-designed intervention strategies. This should include women with mental health issues. This valuable data should be available in all health districts, strengthening the evidence for state-wide implementation to address equity of access to lactation support. Antenatal education should include the provision of consistent information regarding the risk of not breastfeeding for both maternal and infant health to ensure informed decision making regarding infant feeding choices. That breastfeeding can reduce the risk of T2DM was valued by women interviewed in this thesis, and a direct motivator for some women to breastfeed for more than 6 months.

In contrast to breastfeeding intensity, in this thesis I found that duration of breastfeeding was not associated with changes in maternal glucose levels on an OGTT in a subsequent pregnancy. Further investigation is indicated to understand if duration of breastfeeding is beneficial for subgroups of women and reflected in glycemic changes in a subsequent pregnancy, as has been identified outside of pregnancy.[7,25,26,28] Investigation of other biomarker benefits for cardiometabolic profile should also be investigated in pregnancy associated with previous pregnancy breastfeeding.

Social support and its association with cardiometabolic disease has been investigated as an important factor in this thesis. Migrant women were likely to experience low levels of practical and social support and have recognised barriers to access health care.[64,96] Further investigation is warranted to understand length of residency in the host country and impact on perinatal outcomes, including breastfeeding. Implementation of routine antenatal assessment of social support may also assist in identification of at-risk women. The utility of routine social support will be investigated in our ongoing PROMOTE cohort study in our district. The PROMOTE cohort study aims to collect a range of cardiometabolic indicators and pregnancy outcomes in a culturally diverse cohort that can further improve individualised care and cardiometabolic risk management.

Table 1. Future directions and recommendations

Selected findings	Recommendation: research and clinical care
Breastfeeding intensity is associated with improved odds of a normal fasting glucose level on OGTT in pregnancy.	• Investigate other cardiometabolic biomarkers in pregnancy that may be associated with greater intensity and duration of breastfeeding in a previous pregnancy.
Successful implementation of the Sydney BLISS check in Western Sydney Local Health District.	• Recommend breastfeeding intensity should be a benchmarked variable between institutions and countries. • Recommend the scaling of the Sydney BLISS check to other health districts inclusive of a trial in rural and remote areas to address equity of access to breastfeeding support.
Duration of breastfeeding was not associated with changes in OGTT results in a subsequent pregnancy.	• Further investigation is indicated to understand if there are subgroups of women where duration does influence glycemic changes as indicated in research findings outside of pregnancy.
The Sydney BLISS check identified vulnerable groups for suboptimal intensity and duration of breastfeeding.	• Recommend surveys and qualitative research to understand barriers to identified vulnerable groups. • Use co-design principles to provide acceptable targeted education to promote optimal breastfeeding.
Increase in known risk factors for cardiometabolic disease were identified during the pandemic including reduced social support and diagnosed mental illness.	• Implement education of staff regarding cardiometabolic risk and poor social support as well as mental illness. • Undertake a trial of standardised inclusion in antenatal classes of benefits and strategies for shared parenting workload. • Trial utility of routine antenatal scoring of social support with a validated tool in the PROMOTE cohort study. ✓ • Identification of women with a history of mental illness for improved antenatal breastfeeding education and support. • Consider additional risk factor list for groups at risk of suboptimal breastfeeding added to the Sydney BLISS check and auto prompt to booking midwife to offer breastfeeding classes.
Increase in known risk factors for cardiometabolic disease included: Reduced social support noted for migrant women.	• Investigate perinatal outcomes for migrant women and length of residency. ✓
The information that breastfeeding reduced the risk of T2DM was valued and a direct motivator for some women postpartum in SMs2 to breastfeed for more than 6 months.	• Co-leading a breastfeeding and GDM education video that is in production to be sent routinely to all women with a GDM diagnoses in our health district. ✓ • Make the link to the GDM and breastfeeding video freely available and promoted on diabetes education websites.
Pain was a significant barrier for some women to meet exercise guidelines as well as the concern that exercise would damage wound healing.	• Recommend further investigation in a larger cohort of prevalence of chronic postnatal pain in our population and the impact on physical activity. • Use co-design principles with a culturally diverse population to design education material regarding safety of exercise postpartum.
SMs2 text message program for parenting and healthy lifestyle support was well accepted and a desired program postpartum.	• Investigate acceptability and feasibility of benchmarked set schedule of fourth trimester healthcare contacts similar to antenatal visit benchmarking. • Trial next iteration of Smart Mums program with co-designed patient reported outcomes. Include achievement of individualised weight loss / health goals.
	√= recommendation in progress

9.8 Conclusion

In this thesis I have investigated peripartum drivers and interventions for cardiometabolic disease. There have been increasing calls for greater understanding of sex-specific risk for cardiometabolic disease.[33,118-121] The peripartum is an opportune period to gain greater insight into cardiometabolic risk. This thesis has provided new understanding for sex-specific cardiometabolic risk in the peripartum period to be considered more broadly as a public health issue, not siloed within maternity care. The wide scope of investigation of this thesis has highlighted the peripartum intersectionality and bidirectional factors impacting cardiometabolic risk and flags to future disease. These factors should be taken into consideration in both clinical care and research direction.

In this thesis, I have addressed a research gap demonstrating that breastfeeding intensity is associated with improved fasting glucose levels on an OGTT in pregnancy. This may have important implications for cardiometabolic health. Disappointingly I found no association with duration of breastfeeding and glycemic improvement in the large cohort study. This was unexpected as the association has been identified outside of pregnancy. This thesis has clinical significance including the introduction of an antenatal breastfeeding assessment tool for improved clinical care and the generation of data to inform future research.

The global impact of the COVID-19 pandemic will continue to be far reaching and disproportionately impacting vulnerable groups such as migrants. During the pandemic I have identified there is a need for improved postpartum support and the text-message intervention SMs2 may assist to optimise postpartum support and health. This thesis has established the interconnecting biosocial factors that inform sex-specific cardiometabolic risk. These factors were identified to be worse in the pandemic including reduced full breastfeeding at discharge, increased mental health conditions, loss of practical and social support and increased risk of caesarean birth. These revealed drivers may underlie some of the known increase in cardiometabolic disease that has been recognised to be associated with disasters and pandemics.[122-125] In this thesis I have identified that women who birthed in the first year of the pandemic may be at increased risk for gestational diabetes in the next pregnancy and thereafter at increased risk of cardiometabolic disease. Bidirectional and complex drivers require a syndemic intervention approach that incorporate social support and the fourth trimester.

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Thesis

Appendices

Methods

1 The Sydney BLISS check

2 Chapter 3 BLIiNG survey and scoring published Supplementary 1

3 Chapter 6 Survey

Breastfeeding and gestational diabetes

4 Chapter 3 Published paper

Cardiometabolic impact and pregnancy during the pandemic:
Interventions and acceptability

5 Chapter 5 Published paper

5a Chapter 5 Further unpublished supporting quotes

6 Chapter 6 Published paper

6a Chapter 6 Further unpublished supporting quotes

7 Chapter 7 Published paper

8 Chapter 8 HealthyMums@Westmead poster

8a Chapter 8 Smart Mums2 breastfeeding text messages

8b Chapter 8 Qualitative guide

8c Chapter 8 Suggestions for improvements to Smart Mums2

Appendix 1

Breastfeeding Length Intensity Scoring System

These questions are to help us find the right breastfeeding support for you.

1. How many babies have you breastfed? (*circle*) 0 1 2 3 4 5 6 other_______

2. How many months did you breastfeed each of your children?

1st child _____months 2nd child _____months 3rd child _____months

4th child _____months other children ____

➢ **All questions below are about how you fed your last baby**

3. During your last baby's first <u>week of life</u>, how did you feed him/her?

❒ a) breastfeeding only ❒ b) both breastfeeding and formula ❒ c) formula feeding only

If you ticked b), did you give:
- ❒ only 1-4 formula feeds in first week?
- ❒ most days, 1-3 formula feeds?
- ❒ most days, 4 or more formula feeds?

4. During your last baby's first <u>month of life</u>, how did you feed him/her? (*<u>after the first week</u>*)

❒ a) breastfeeding only ❒ b) both breastfeeding and formula ❒ c) formula feeding only

If you ticked b), did you give:
- ❒ only 1-4 formula feeds in the first month?
- ❒ most weeks, only 1-4 formula feeds?
- ❒ most days, 1-3 formula feeds?
- ❒ most days, 4 or more formula feeds?

5. <u>After the first month</u>, how did you feed your last baby?

❒ a) breastfeeding only ❒ b) both breastfeeding and formula ❒ c) formula feeding only

If you ticked b), did you give:
- ❒ most weeks, only 1-4 formula feeds?
- ❒ most days, 1-3 formula feeds?
- ❒ most days, 4 or more formula feeds?

6. <u>At three months</u> of age, how did you feed your last baby?

❒ a) breastfeeding only ❒ b) both breastfeeding and formula ❒ c) formula feeding only

If you ticked b), did you give:
- ❒ most weeks, only 1-4 formula feeds?
- ❒ most days, 1-3 formula feeds?
- ❒ most days, 4 or more formula feeds?

7. Are you currently breastfeeding? (circle) No Yes - Age of infant______

8. Why did you stop breastfeeding your last baby? (you may tick more than one reason)

❒ attachment / feeding problems	❒ baby weight gain problems	❒ took medication-can't breastfeed
❒ baby's age	❒ problems with expressing	❒ pregnant / planning pregnancy
❒ baby lost interest	❒ low breast milk supply	❒ returned to work / study
❒ baby unsettled	❒ mastitis	❒ other______________________

Appendix 2

Supplementary 1

BLIiNG DM: Breastfeeding Length Intensity in Gestational DM
DATA collection form: SURVEY
Survey for women who had GDM in first pregnancy

Country of birth _______________ Need an Interpreter- Yes □ No □

If not born in Australia how long have you lived in Australia________

What ethnic group do you identify with?
Aboriginal □
Torres Strait Islander □
Caucasian / White □
Indian subcontinent □ (India, Sri Lanka, Pakistan, Nepal, Bangladesh)
Chinese □
Islander □ (Fiji, Samoa, Tonga)
Other: _______________________

Same partner for both pregnancies: Yes □ No □

Family History of Diabetes: No □ Yes □ If yes what relation:

Mother or Father □ Brother or Sister □ other relation: _______
Type of diabetic if you know: _____________________ _________________

You may remember all or only some of the below questions about your first pregnancy. Please fill out what you can.
***Please tick or answer the most appropriate response to the questions below*.**

Mothers Information:

1. Was gestational diabetes present in the first pregnancy and controlled by:
Diet □ tablets (Metformin) □ Insulin □ highest daily dose______
Other diabetic treatment □ detail: ________________________________

2. Did you have any tests for diabetes after the last pregnancy? No □
Yes □result was: Normal □ Diabetes □ Prediabetes □ Unsure □
How long after your baby's birth was your diabetes test done- ____

3. Did you take vitamin D in first pregnancy: Yes □ No □

4. Did you rest at home for a set period of time after the birth of your baby for cultural reasons? Yes □ for_____days No □ rest for cultural reasons

First Baby information:

1. Date of birth first baby: ________Baby Weight: _________grams
How many weeks pregnant were you when baby was born:________weeks
Birth: Caesarean Section □ or Vaginal Birth □

2. Baby spent time in the neonatal Intensive Care/Special Care Yes □ No □
If Yes: how many days: _____Reason for admission: Premature □
Monitor baby's sugar level □ other: _________________________

3. Did you ever breast feed your first baby?
Yes □ please **continue next page**.
No □ please comment why you did not breastfeed: ___________________

If you never breastfed your first baby there are no more questions, thank you for participating in this research.

4. How old was your baby when you stopped breastfeeding?

___years___months____days

5. During the **first week of life** how did you feed your first baby**?**

a. breastfeeding only □
b. formula feeding only □
c. breastfeeding and formula □
if you ticked c. did you give:
Most days 1-3 formula feeds □
Most days 4 or more formula feeds □
Only 1-4 formula feeds in first week □

6. During the **first month of life** how did you feed your first baby?

a. breastfeeding only □
b. formula feeding only □
c. breastfeeding and formula □
if you ticked c. did you give:
Most days 1-3 formula feeds □
Most days 4 or more formula feeds □
Only 1-4 formula feeds in first month □

7. **After the first month** how did you feed your first baby until you stopped breastfeeding?

a. breastfeeding only □
b. formula feeding only □
c. breastfeeding and formula □
if you ticked c. did you give:
Most days 1-3 formula feeds □
Most days 4 or more formula feeds □

8. **At three months** how were you feeding your first baby?

a. breastfeeding only □
b. formula feeding only □
c. breastfeeding and formula □
if you ticked c. did you give:
Most days 1-3 formula feeds □
Most days 4 or more formula feeds □

Comment: ____
____

9. Why did you stop breastfeeding?

I thought my baby was old enough □ Didn't think I had enough milk □
Baby had trouble latching or feeding □ Baby lost interest □
My nipples were too sore □ My breasts were infected □
Breastfeeding was too painful □ Had to go back to work □
Pumping milk no longer seemed worth it □
Other reason: ____

10. How old was your baby when you introduced solid/family food:
______months old

11. Did you feel supported by your partner / husband to breastfeed?
Very Much□ Somewhat□ Neutral□ Not Much□ Not at All□
Comment____

12. Did you receive any breastfeeding information during your first pregnancy?
Yes □ No □
It was from Hospital □ other: ______________________________

13. Did you think the hospital gave you enough information on breastfeeding?
Yes □ No □
Comment: ____

14. Did you have any trouble with breastfeeding? Yes □ No □

If yes did you know where to get help from Yes □ No □

15. Rate how you found breastfeeding in the first few days while in hospital:

Very difficult □ Difficult □ Neutral □ Easy □ Very easy □

16. Rate the help/support you received for breastfeeding in the first few days while you were in hospital
Very poor□ Not good□ All right□ Good□ Excellent□

17. Did you receive any breastfeeding assistance from:
(Tick as many as you like)
Hospital Midwives □ Home Visiting Midwives □
Hospital Lactation Consultant □ Early childhood Nurse □
Australian Breastfeeding Association □ Chemist nurse □
Private Lactation Consultant □ Friend □
Mother □ Mother-in-law □
Other: _______________

Any other comments on feeding your first baby -

____

____

Thank you for your assistance with this research

Research Scoring Sheet Used in the BLIiNG Study

BLISS® SCORING

To Score:
Add Type of Feeding (A) to Amount (B) at each time period B.1, B.2, B.3, B.4

A. Type of Feeding		**BLISS Score**
Formula only (no B score)		0
Breastfeeding only		6
Breastfeeding and formula		1
B. Amount of Formula		
B.1 First Week		
1-4/week formula		4
1-3/day formula feeds		2
≥4/day formula feeds		1
First Week Total	**A + B.1 =**	**/ 6**
B.2 First Month		
Breastfeeding only bonus		1
1-3/day formula feeds		2
≥4/day formula feeds		0
First Month Total	**A + B.2 =**	**/ 7**
B.3 After First Month		
1-3/day formula feeds		2
≥4/day formula feeds		0
After First Month Total	**A + B.3 =**	**/ 6**
B.4 At Three Months		
1-3/day formula feeds		2
≥4/day formula feeds		0
At Three Months Total	**A + B.4 =**	**/ 6**
Total BLISS Score =		**/ 25**

Breastfeeding Length and Intensity Scoring System (BLISS®)

Example Score:
Participant A was breastfeeding in the first week but her baby received two formula feeds when he was in the nursery, however participant A continued to breastfeed for 6 months and no other formula was given to her baby.
Her BLISS score is 24.

A. Type of Feeding		**BLISS Score**
Formula only		0
Breastfeeding only		6
Breastfeeding and formula		1
B. Amount of Formula		
B.1 First Week		
1-4/week formula		4
1-3/day formula feeds		2
≥4/day formula feeds		1
First Week Total	**1 + 4 =**	**5/ 6**
B.2 First Month		
Breastfeeding only bonus		1
1-3/day formula feeds		2
≥4/day formula feeds		0
First Month Total	**6 + 1 =**	**7/ 7**
B.3 After First Month		
1-3/day formula feeds		2
≥4/day formula feeds		0
After First Month Total	**6 + 0 =**	**6/ 6**
B.4 At Three Months		
1-3/day formula feeds		2
≥4/day formula feeds		0
At Three Months Total	**6 + 0 =**	**6/ 6**
Total BLISS Score =		**24 / 25**

Appendix 3

The Perinatal 3C project : Patient survey version 1 27.7.20

Exploring Perinatal Care and Cultural perspectives during the COVID-19 pandemic

Please complete the below questions (tick boxes)

Country of Birth :__________________ Language spoken at home :__________________ Years lived in Australia :__________________	**Cultural group** □ **English Speaking** Australia, UK, New Zealand, America □ **Other** Please list cultural group: ________________________	□ **South Asian** India, Sri Lanka, Pakistan, Afghanistan, Bangladesh, Bhutan, Maldives, Nepal	□ **North East Asian** China, Japan, Taiwan, Mongolia, North Korea and South Korea
Highest level of education □ No formal education	□ High school or lower □ Trade certificate/ Certificate Ill	□ Diploma or degree (Bachelor's, Honours) □ Other_______	□ Postgraduate (Master's, PhD)
Paid Employment □ Fulltime	□ Part-time	□ Casual	□ Looking for employment
Number of hours in paid employment per week ___ Hrs	□ Temporarily stood down due to COVID-19	□ Stood down due to COVID-19	□ On maternity leave
Has your income been affected by COVID 19?	□ Yes □ No	Comment:	
If you have a husband/ partner are they employed?	□ Fulltime □ Temporarily stood down due to COVID-19	□ Part-time □ Stood down due to COVID-19	□ Casual
Has your partner/husband's income been affected by COVID 19?	□ Yes □ No	Comment:	
Are you or have you been a refugee?	□ Yes □ No	Comment:	

Patient survey form v 1 27.7.20

Present relationship?	□ Living with father of baby □ Separated/Divorced not living with father of baby		
What other people do you live with?	□ Mother □ Friend □ Relative □ Mother-in-law □ Other_____________		
Did you plan to have someone other than your husband live with you to help you with the baby?	□ Yes □ No	***If answered Yes*** This person was to be:	□ Mother □ Mother-in-law □ Friend □ Relative
		How many months did they plan to stay?	_______ months
		Did they plan to come from another country to stay with you?	□ Yes □ No
		Did COVID 19 stop them coming?	□ Yes □ No
Do you access the internet from home?	□ Yes □ No	Include internet access using desktop/laptop computers, mobile or smart phones, tablets, music or video players, gaming consoles, smart TVs etc	
Do you speak to relatives overseas?	□ Yes □ No	Please circle how you speak to them: voice phone, Skype, Zoom, face-time, Wechat, Other________	
	If yes	How often?	□ Daily □ Every few days □ Occasionally □ Almost never
For pregnancy care appointments during COVID pandemic would you like to have the option of:	□ Telephone appointments □ Video (webcam) appointments	□ I only like face to face appointments	

Thank you for completing this survey prior to your interview with the researcher

Midwifery 107 (2022) 103262

Contents lists available at ScienceDirect

Midwifery

journal homepage: www.elsevier.com/locate/midw

The BLIiNG study - Breastfeeding length and intensity in gestational diabetes and metabolic effects in a subsequent pregnancy: A cohort study

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A R T I C L E I N F O

Article history:
Received 7 June 2021
Revised 18 January 2022
Accepted 19 January 2022

Keywords:
Breastfeeding
Cardiovascular disease
Diabetes
Gestational diabetes mellitus
Lactation
Pregnancy
Type 2 diabetes mellitus

A B S T R A C T

Background: Gestational diabetes mellitus is associated with higher risk for developing type 2 diabetes. Breastfeeding is protective against the development of type 2 diabetes after gestational diabetes. There are no data regarding the effect of breastfeeding on the development of recurrent gestational diabetes.
Objective: Investigate the relationship of previous breastfeeding duration and intensity with the recurrence of gestational diabetes, and second pregnancy glucose tolerance test results.
Methods: We conducted a questionnaire-based pilot cohort study, enrolling 210 women during a subsequent second pregnancy, after a gestational diabetes-affected first pregnancy. Models for length and intensity of breastfeeding as predictors of the oral glucose tolerance test and for diagnosis of gestational diabetes in second pregnancy were fitted and then adjusted for possible confounders.
Results: Recurrent gestational diabetes rate in the study cohort was 70% ($n = 146$). In a fully adjusted model high intensity breastfeeding was associated with a lower 2-hour glucose level on the oral glucose tolerance test (by 0.66 mmol/L, 95% CI [0.15–1.17]; $p = 0.01$) and breastfeeding greater than six months with a lower 1-hour glucose on the oral glucose tolerance test (by 0.67 mmol/L, 95% CI [0.16–1.19]; $p = 0.01$), compared to women who breastfed less intensively or for a shorter duration respectively. There was an 18% reduction in the risk of gestational diabetes if a woman breastfed for more than six months (RR 0.82, 95% CI [0.69–0.98]; $p = 0.03$). The association was attenuated in the fully adjusted model (RR 0.89, 95% CI [0.78–1.02]; $p = 0.09$).
Conclusions and implications for practice: We found the risk of recurrent gestational diabetes was reduced by both increased duration and intensity of breastfeeding. Antenatal lactation education should be embedded into care pathways for women diagnosed with gestational diabetes.

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https://doi.org/10.1016/j.midw.2022.103262
0266-6138/

Introduction

There is a global rise in the incidence of gestational diabetes mellitus (GDM), with current rates documented to be between 5 and 36% of pregnant women, dependent on the population, screening and diagnostic criteria (Duran et al., 2014; Eades et al., 2017; Lee et al., 2018). GDM is associated with a significant burden for women and their families including adverse perinatal outcomes, psychological impact and long-term cardiometabolic health consequences (Craig et al., 2020; Kramer et al., 2019). It is important to identify modifying factors that can reduce GDM and improve pregnancy outcomes for women and infants through targeted use of health resources.

Women who have GDM in their first pregnancy have up to a 13-fold increased risk of GDM in their second pregnancy (Foster-Powell and Cheung, 1998; Getahun et al., 2010). Every subsequent pregnancy after a GDM-affected pregnancy has a compounding risk of GDM and progression to type 2 diabetes (Getahun et al., 2010). Strategies to reduce recurrent GDM and type 2 diabetes are important public health measures for the community.

The benefits of breastfeeding to infants are well documented (Victora et al., 2016) and have resulted in ongoing programs worldwide to improve breastfeeding rates. Less attention has been given to the maternal benefits. Increasing evidence indicates that breastfeeding intensity and the total length of time a woman breastfeeds during her life can positively influence her health and result in an improved cardiometabolic risk profile (Gunderson et al., 2015; Ley et al., 2020; Ram et al., 2008; Schwarz et al., 2009; Shen et al., 2019).

There is a growing body of evidence demonstrating the association between breastfeeding and a reduction in type 2 diabetes (Ley et al., 2020; Stuebe et al., 2005; Tarrant et al., 2020). Stuebe (2015b) hypothesized that early, high intensity lactation may be crucial in the “resetting” of an endocrine balance from an insulin-resistant state in pregnancy, and, without the lactation-mediated reset, there may be long-term cardiometabolic health consequences. Researchers have demonstrated that with a greater lifetime-years of maternal breastfeeding there is a corresponding risk reduction for type 2 diabetes (Gunderson et al., 2015; Villegas et al., 2008). Research using data from the Nurses’ Health Study found that for every extra lifetime-year of breastfeeding, there was a 15% reduction in the risk of type 2 diabetes for women who had a pregnancy in the last 15 years (Stuebe et al., 2005). However, there are as yet no data regarding any potential protective effect of breastfeeding reducing the development of recurrent GDM.

The primary aim of this study of women who had GDM during their first pregnancy, was to determine the association between previous breastfeeding duration and intensity on recurrence of gestational diabetes. We also sought to determine the effect of breastfeeding duration and intensity on the parameters of the glucose tolerance test results in the second pregnancy.

Methods

This was a multisite pilot cohort study in Western Sydney, Australia with retrospective and prospective data collection. The study was approved by the Western Sydney Local Health District (WSLHD) Human Research and Ethics Committee (LNR/16/WMEAD/404), all participants provided informed consent.

Sample

Women who were over 20 week’s gestation in a second pregnancy after a first pregnancy that had been affected by GDM were our target population for this pilot study. Recruitment occurred from 2017 to 2019. Inclusion criteria were GDM in a first pregnancy, greater than 20 week’s gestation, over 18 years of age and able to give informed consent. Exclusion criteria were pre-existing diabetes, pre-term first pregnancy (< 37 weeks), multiple birth first pregnancy, a history of more than three miscarriages, fetal anomaly or stillbirth. Women who had care in their first pregnancy in a country other than Australia were also excluded from the study to improve homogeneity of GDM screening, diagnosis and treatment.

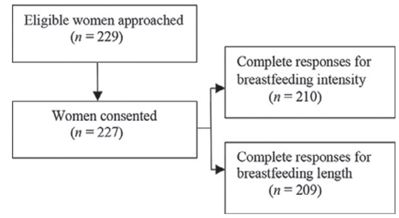

Fig. 1. Flow diagram.

Eligible women for this study were identified through the electronic maternity database from information provided at their booking visit. All participants were recruited prior to the results of the oral glucose tolerance test (OGTT) being accessed by the researchers. A total of 229 eligible women were approached with a final sample for analysis of 210 women for breastfeeding intensity and 209 available for length of breastfeeding (Fig. 1).

There is no previous study on which to base sample size calculations and one purpose of this pilot study was to obtain estimates for length and intensity of breastfeeding and outcomes to inform future studies which could then be appropriately powered.

Measurement

For all participants, details of their current (second) pregnancy and the results of their pregnancy OGTT and booking BMI were collected from their medical record.

First Pregnancy and Demographic Information

Participants provided details about their first pregnancy and demographic information by completing the study-specific BLIiNG (Breastfeeding Length Intensity iN Gestational diabetes) questionnaire (Supplemental S1 online). As an existing appropriate and validated antenatal GDM risk and breastfeeding recall instrument was not identified by the researchers, the customised BLIiNG questionnaire was developed. An expert panel, including International Board Certified Lactation Consultants (IBCLC), endocrinologists and a maternal fetal medicine specialist, developed the BLIiNG breastfeeding questionnaire instrument which incorporates the BLISS® (Breastfeeding Length and Intensity Scoring System, Supplemental S2 online). Testing of the questionnaire among our target population was undertaken, and revisions were made based on feedback. The result was a final simple questionnaire design appropriate for our multi-ethnic population. After revision, 92% (11/12) of participants agreed or strongly agreed that the questions were easy to understand and **“**accurately records how I fed my baby**”**.

Terminology of infant feeding research can be separated to receiver/infant or provider/lactation focused (Yourkavitch and Chetwynd, 2019). This study’s focus was on **“**provider**”** benefit of breastfeeding, therefore researcher’s defined exclusive breastfeeding from maternal research participant (provider) perspective. This was explained to study participants by the research interviewer as an infant receiving only the infant's mother's milk by direct breastfeeding or participants expressed milk from a device.

Breastfeeding intensity is a determination of the amount of maternal breastfeeding inclusive of expressing, relative to formula feeding. The highest intensity is mostly or exclusively breastfeeding, and the lowest intensity is mostly formula feeding. The BLISS score gives levels of intensity and these were validated by two IBCLC**s** based on typical optimal feeding patterns. The maximum BLISS score was 25. Assessment of infant feeding by BLISS occurred via maternal recall for the time periods as follows; the first week post-partum (score/6), during the first month (score/7), one to three months (score/6) and at three months (score/6). Breastfeeding only at any time point was given full marks, formula only feeding scored 0, and scores were incrementally reduced for 1–4 formula feeds a week, 1–3 per day, with four or more formula feeds per day scoring similar or equal to full formula feeding. A woman who exclusively breastfed her infant from birth would score 25. High intensity breastfeeding was classified as a score between 19 and 25, moderate intensity 7–18, and a low-intensity score was defined as between 0 and 6.

At the participating hospitals, GDM was diagnosed on the basis of a 75 g OGTT using the 1998 Australasian Diabetes in Pregnancy Society criteria (Hoffman et al., 1998**)**. GDM was diagnosed if the fasting blood glucose level was ≥5.5 mmol/L and/or the 2-hour glucose was ≥8.0 mmol/L. The glucose level at 1 hour was also routinely collected but not used for diagnostic purposes. All pregnant women were tested for GDM at 24–28 weeks' gestation, and earlier if clinically indicated.

Standard treatment for GDM included blood glucose monitoring, dietician review, and insulin treatment if glucose targets were not met. One hospital also used metformin. All women were advised to maintain a similar healthy diet after the birth of their baby and have follow-up with their family doctor.

Data collection

Eligible women were approached in the antenatal clinic or in hospital during the first two days postpartum, after completion of their second pregnancy. Participants who had been identified as eligible were approached and provided with written and verbal information about the study prior to signing a consent form and then completing the study self-administered questionnaire.

Data analysis

Demographic and clinical variables were summarized and compared between GDM groups, with percentages for categorical variables and median and interquartile range (IQR) for continuous variables, as not all were normally distributed. The relationships between length of breastfeeding and the BLISS score with the development of GDM in the current pregnancy, and each glucose time point of the OGTT, were analysed using a linear regression model. The risk of the development of GDM did not increase linearly with either increasing length of breastfeeding or BLISS score so these predictors were dichotomised for these models. Both the models for OGTT and for diagnosis of GDM were fitted unadjusted and then adjusted for medical treatment of GDM in the first pregnancy, BMI as ≥30 kg/m^2 or <30 kg/m^2, age at current pregnancy ≥30 or <30 years old, and ethnicity as self-identified Caucasian, South Asian or other. Family history of any diabetes was assessed but did not contribute to any model so was excluded. There was no imputation of missing data and no adjustment for multiple comparisons. All analyses were done with SAS 9.4 SAS Institute Inc., Cary, NC, USA.

Results

Recurrent GDM was diagnosed in 146 (70%) of the 210 women in the study cohort. For the total cohort the majority of women were born overseas with 39 (19%) born in Australia and most of self-identified ethnicity was stated as South Asian (52%), with Caucasian the next most frequently identified group (16%). Demographics were similar between women diagnosed with GDM and those in the non-GDM group (Table 1). The mean (SD) age for participants in the GDM group at second pregnancy was 34 (3.6), higher than the age of the participants in the non-GDM group which was 33 (4.4). There was no difference between the two groups in years between first and second pregnancy (both means = 3 (2)). There was also no difference between the two groups in BMI at second pregnancy booking, with median BMI 26 (IQR = 22–27) for women in the GDM group and 25 (IQR = 23–30) in the non-GDM group. However, there was a significant difference for obesity (BMI ≥30), greater in women with recurrent GDM (Table 1).

There was no difference in median first pregnancy breastfeeding duration between women diagnosed with GDM and those in the non-GDM group (non-GDM median = 11 months, IQR = 3–17; GDM median = 7 months, IQR = 3–15; p = 0.16). All women commenced breastfeeding after their first pregnancy. Of the 209 women who provided length of breastfeeding data, 43 (21%) breastfed for less than three months, between 3 – 6 months 49 (23%) women stopped breastfeeding and 117 (56%) of the cohort breastfed longer than six months. In the total cohort, 49 (23%) had a low intensity BLISS score and 36 (73%) of these women breastfed for less than three months (Table 2).

The most common reason women gave for stopping breastfeeding was "I didn't think I had enough milk" (34%).

The relationship between previous breastfeeding duration and intensity and recurrent gestational diabetes

Women who breastfed ≤6 months were more likely to have GDM (71/92, 77%), compared to women who breastfed >6 months (74/117, 63%). This equates to an 18% risk reduction associated with breastfeeding >6 months (RR 0.82, 95% CI [0.69–0.98]; p = 0.03) (Table 3).

Duration of breastfeeding greater than six months remained a significant predictor for reduced GDM diagnosis when adjusted for age (RR 0.79, 95% CI [0.67–0.94]; p = 0.01) or BMI (RR 0.84, 95% CI [0.70–1.00]; p = 0.05). After adjusting for both age and BMI there remained a 19% reduction in the risk of GDM if a woman breastfed for more than six months (RR 0.81, 95% CI [0.68–0.96]; p = 0.01). The association was attenuated in the fully adjusted model with the following confounders, medical treatment of GDM in the first pregnancy, BMI, maternal age and ethnicity (RR 0.89, 95% CI [0.78–1.02]; p = 0.09) (Table 3).

Women who breastfed in the high intensity range (≥19 BLISS; 63%) had a 17% reduction in the risk of being diagnosed with GDM compared to lower intensity breastfeeding groups, (<19 BLISS, 71/112 (63%) vs. 75/98 (77%), p = 0.04) (Table 3). In the adjusted model that included age and BMI, there was a 22% reduction in GDM (RR 0.78, 95% CI [0.63–0.96]; p = 0.02). However, in the fully adjusted model, the association between BLISS score groups and GDM diagnosis was attenuated (RR 0.90, 95% CI [0.77–1.05]; p = 0.17) (Table 3).

The relationship between previous breastfeeding duration and intensity with the glucose tolerance test result

After adjusting for confounders (medical treatment of GDM in first pregnancy, BMI, maternal age at second pregnancy, ethnic-

Table 1
Characteristics of women who were diagnosed with recurrent gestational diabetes in their second pregnancy ($N = 210$).

Outcome		GDM 2nd Pregnancy GDM Not Diagnosed $n = 64$ (30%) *n (%)*	GDM Diagnosed $n = 146$ (70%) *n (%)*	*p-value*
Australian Born				
	Yes	16 (41%)	23 (59%)	0.11
	No	48 (28%)	123 (72%)	
Self-identified ethnicity*				
	Caucasian	14 (42%)	19 (58%)	0.08
	South Asian	28 (26%)	81 (74%)	
	Chinese	5 (19%)	21 (81%)	
	Middle Eastern	7 (54%)	6 (46%)	
	Other	9 (33%)	18 (67%)	
First degree family history of diabetes*				
	Yes	31 (28%)	80 (72%)	0.47
	No	30 (33%)	62 (67%)	
GDM first pregnancy details				.
GDM-medicated 1st pregnancy[a]		24/64 (38%)	69/146 (47%)	0.19
Practiced cultural rest[b] 1st pregnancy*		25/63 (40%)	72/142 (51%)	0.14
Caesarean section birth 1st pregnancy*		39/62 (63%)	93/143 (65%)	0.77
Baby admitted Special Care/NICU*		15/63 (24%)	46/145 (32%)	0.25
BMI at second pregnancy booking				
≥30		8 (17%)	38 (83%)	0.03
<30		56 (34%)	108 (66%)	

GDM = Gestational Diabetes Mellitus
[a]Insulin or metformin: Insulin ($n = 82$), metformin ($n = 10$), both ($n = 1$)
[b]Cultural tradition of resting postpartum for a set number of days.
*Missing values on: Self-identified ethnicity ($n = 2$), First degree family history of diabetes ($n = 7$),.
Practiced cultural rest, 1st pregnancy ($n = 5$), Caesarean section birth 1st pregnancy ($n = 5$), Baby.
admitted to Special Care/NICU ($n = 2$).

Table 2
Relationship between total length of any breastfeeding and breastfeeding intensity Score (BLISS) ($N = 209$).

Length of time breastfeeding	Low	Moderate	High
	BLISS 0–6 $n = 49$ *n* (%)	BLISS 7–18 $n = 49$ *n* (%)	BLISS 19–25 $n = 111$ *n* (%)
⩽1 month	26 (53)	2 (4)	0 (0)
<3 months	10 (20)	4 (8)	1 (1)
3–6 months	9 (18)	22 (45)	18 (16)
>6–12 months	2 (4)	11 (22)	30 (27)
>12 months	2 (4)	10 (20)	62 (56)

BLISS = Breastfeeding Length and Intensity Scoring System.

ity), breastfeeding greater than six months was associated with a lower mean 1-hour glucose result on the OGTT (by 0.67 mmol/L, 95% CI [0.16–1.19] $p = 0.01$) and women in the high intensity breastfeeding group had a lower 2-hour glucose result of 0.66 mmol/L (95% CI [0.15–1.17]; $p = 0.01$) (Table 4). There were no significant associations between any of the other glucose results and duration or intensity of breastfeeding.

Discussion

We found that both increased duration and intensity of breastfeeding following a GDM-affected pregnancy were associated with a reduction in the risk of developing GDM in a subsequent pregnancy. Furthermore, breastfeeding duration and intensity influenced the glucose levels of the OGTT performed during the subsequent pregnancy.

These novel findings give added significance to the benefits of breastfeeding. Breastfeeding is known to improve long-term outcomes for the mother and child, but our data suggests that it may potentially also improve outcomes for future offspring. By protecting against GDM in subsequent pregnancies, the fetal environment will be more favourable and adverse fetal programming effects will be minimised.

Age and obesity are significant known risk factors for the development of GDM (Eades et al., 2017; Lee et al., 2018). After ad-

Table 3
Association between gestational diabetes and length/intensity of breastfeeding ($N = 210$).

	≤6 months	>6 months	RR (95% CI)	*p*-value
Unadjusted [a]	71/92 (77%)	74/117 (63%)	0.82 (0.69, 0.98)	0.03
Adjusted [a,b]			0.89 (0.78, 1.02)	0.09
Intensity of Breastfeeding by BLISS score ($N = 210$)				
	<19 (low–medium)	**≥19 (high)**	**<19 vs. ≥19 (95% CI)**	***p*-value**
Unadjusted	75/98 (77%)	71/112 (63%)	0.83 (0.69, 0.99)	0.04
Adjusted [b]			0.90 (0.77, 1.05)	0.17

Length of breastfeeding and percent of GDM ($N = 209$).
GDM = Gestational Diabetes Mellitus BLISS = Breastfeeding Length and Intensity Scoring System.
The full model was adjusted for medical treatment of GDM in first pregnancy, BMI ≥30, maternal age at second pregnancy, ethnicity.
Missing values: [a] length of breastfeeding 1.
[b] ethnicity 2.

Table 4
Relationship between first pregnancy length/intensity of breastfeeding and subsequent Second pregnancy oral glucose tolerance test blood glucose result ($N = 210$).

Adjusted	Length of breastfeeding [a,b] ≤ 6mths *M (SD)*	> 6mths *M (SD)*	Mean difference (95% CI)	*p*-value
Fasting	4.9 (0.8)	4.8 (0.6)	0.05 (−0.13, 0.24)	0.56
1 h	10.5 (2.2)	9.8 (1.9)	0.67 (0.16, 1.19)	0.01
2 h	8.6 (1.9)	8.1 (1.9)	0.51 (−0.01, 1.02)	0.05
	Intensity of breastfeeding [b] BLISS <19 *M (SD)*	BLISS ≥19 *M (SD)*		
Fasting	4.9 (0.8)	4.8 (0.6)	0.05 (−0.13, 0.23)	0.61
1 h	10.4 (2.3)	9.8 (1.8)	0.40 (−0.12, 0.93)	0.13
2 h	8.7 (2.0)	8.0 (1.8)	0.66 (0.15, 1.17)	0.01

Note. Oral glucose tolerance test results were measured in mmol/L CI = Confidence Interval.
BLISS = Breastfeeding Length Intensity Scoring System BLISS ≥19: high intensity breastfeeding.
Adjusted: Maternal age 2nd pregnancy, ethnicity, BMI, treatment of GDM in first pregnancy.
[a] 1 length of breastfeeding missing: total 209.
[b] Missing values: GTT 1 hour 8, 2 h 1, ethnicity 2.

justing for these factors we still found breastfeeding greater than six months led to a 19% reduction in GDM. The attenuation of the association in the fully adjusted model which included GDM treatment medication use in the first pregnancy, may be a reflection of the modest size of the cohort. This may also indicate for women with poorly controlled GDM who require insulin, the impact of breastfeeding may not be as significant. There is evidence that there may be a significant interaction between obesity and the effect of breastfeeding on the improvement of insulin sensitivity. One study found women who breastfed at high intensity had a lower homeostasis model assessment (HOMA-IR; Homeostatic Model Assessment of Insulin Resistance) at 6–10 weeks' postpartum, and only evident in obese women (Yasuhi et al., 2019). Although research has found all women may benefit with improved long-term cardiometobolic health from breastfeeding (Schwarz et al., 2009), further research is required to identify if specific groups of women with GDM receive greater benefit from breastfeeding for protection against recurrent GDM.

Studies to date have largely focused on the association between breastfeeding and non-pregnancy glycaemic outcomes (Tarrant et al., 2020). The SWIFT study was the first prospective investigation of breastfeeding intensity and hyperglycemia (Gunderson et al., 2012). The investigators found an association between higher intensity breastfeeding and improved postpartum OGTT levels. As early as 6–9 weeks postpartum, a greater intensity of breastfeeding in women with GDM resulted in a lower fasting plasma glucose level as measured at their postpartum OGTT and a dose response to improved HOMA-IR. The SWIFT study investigators also demonstrated that there was a dose-protective response of intensity and length of breastfeeding for type 2 diabetes risk two years after the GDM pregnancy (Gunderson et al., 2012).

Although there are benefits of breastfeeding for women who have had GDM, evidence suggests that these women have greater difficulty breastfeeding than unaffected women (Matias et al., 2014; Stuebe, 2015a). Women with GDM have more issues establishing breastfeeding, experience delayed lactogenesis, breastfeed for a shorter duration than other women and experienced practices in the hospital that are known to negatively impact on long-term breastfeeding (Nguyen et al., 2019; Oza-Frank and Gunderson, 2017). The importance of breastfeeding for women with GDM therefore requires greater understanding for effective, targeted lactation support. Careful consideration should be given to protocols whereby babies of women with gestational diabetes are routinely admitted to special care nurseries as this may negatively impact breastfeeding success (Oza-Frank and Gunderson, 2017).

All women in our study commenced breastfeeding but 21% stopped before three months, nearly all these women had a low BLISS score. This may indicate that lactation issues existed but were not adequately addressed, with low milk supply the most common reason given for stopping breastfeeding. The majority of women in the study were born in another country, cultural barriers and low health literacy may also be factors that contribute to women not accessing appropriate lactation support and should be investigated to improve service delivery**.**

Breastfeeding intensity and duration can be improved through appropriate education and consistent advice that ideally includes both antenatal and postnatal care (Bonuck et al., 2014). Novel engagement with the use of text-based support has been investigated, with one group of investigators (Martinez-Brockman et al., 2018) suggesting the best predictor for exclusive breastfeeding was strong engagement in the first two weeks postpartum using two-way lactation consultant texting support. Stuebe et al. (2016) found that woman with GDM were less likely to stop breastfeeding or introduce formula at six weeks when provided with a pre- and postnatal lifestyle intervention program that included breastfeeding text-based support (Stuebe et al., 2016).

Provision of comprehensive lifestyle and breastfeeding support for women with GDM requires investment in additional staff time and resources. However, our study and others have demonstrated that optimal breastfeeding for women with a history of a GDM pregnancy reduces the risk of the mother developing type 2 diabetes and other cardiometabolic disorders. A reduction in hyperglycemia in a subsequent pregnancy also negates some of the maternal and fetal risks associated with GDM. The savings from this are likely to offset the investment in the provision of breastfeeding support. There is a growing awareness of the rising worldwide economic implications for health service delivery associated with GDM (Dall et al., 2014). It is a financially judicious use of health resources to support early prevention for cardiometabolic disease and a unique opportunity to engage women in health intervention programs that include breastfeeding support during pregnancy and the postpartum period.

We are not aware of any published methods for the routine assessment of previous breastfeeding intensity. This is important as duration of breastfeeding by itself does not necessarily reflect early breastfeeding issues. Low intensity breastfeeding may occur early postpartum; however a small percentage of mothers will persist despite extreme difficulties (Table 2). Women who breastfeed more successfully with greater intensity tend to breastfeed longer (Piper and Parks, 2001). The BLISS check is therefore a novel means of assessing breastfeeding intensity through a maternal recall questionnaire. Evaluation of previous breastfeeding is an important component of the pregnancy and postpartum evaluation, and this can easily be established as a routine tool for use by clinicians. The findings of our study suggest that the BLISS® may be a useful clinical tool with routine clinical use under evaluation in our health district (Supplemental S2 online). Further research on the utility of the BLISS check for antenatal triaging to appropriate lactation support and its use in research is warranted. Certainly capturing both length and intensity routinely can lead to improved personalised targeted breastfeeding support and may elucidate the impact high intensity breastfeeding may have as a metabolic reset on long-term maternal cardiometobolic health.

The high participation rate of women gave our study strength and reduced potential recruitment bias. This suggests that women are interested in breastfeeding and are keen to discuss their breastfeeding history and associated problems. This also suggests the need for more antenatal breastfeeding support that provides an appropriate clinical avenue for breastfeeding counselling and information. Ethnic diversity is an additional strength of our study and informs the capacity to extrapolate the results to other populations.

We have demonstrated that a greater intensity of breastfeeding could potentially reduce glycemia and recurrent GDM in pregnant women who have had a previous GDM-affected pregnancy. Although a randomized controlled trial of breastfeeding will not be possible, prospective studies would be informative and this pilot will inform our larger population study. Breastfeeding may also reduce future type 2 diabetes and cardiovascular disease risk for the mother and is known to provide benefits to the health of the infant. Further routine support for the promotion and facilitation of breastfeeding should be implemented inclusive of early parenting education and antenatal assessment of previous breastfeeding experience (Linde et al., 2020).

The limitations of our study include potential recall bias. In the literature, however, maternal recall of breastfeeding history has been validated as a reliable method to determine infant feeding history (Li et al., 2005; Natland Fagerhaug et al., 2013). In a Norwegian study, recall of duration of breastfeeding was found to be accurate after 20 years with a median over-estimation of only two weeks (Natland Fagerhaug et al., 2013). The recall bias in our BLIiNG study would be less, as all participants had only one previous pregnancy and feeding details to remember. The same recall limitation would exist for both GDM and non-GDM groups and the mean time between births was three years for both groups. Another limitation of this study is the lack of some data that may be potentially important, such as first pregnancy morbidity, current/previous pregnancy diet, BMI and between pregnancy weight gain.

Conclusion

There is concern about the high incidence of GDM and its recurrence. Much of the focus among women who have had GDM is to reduce obesity and improve lifestyle in between pregnancies. However, programs aimed at these risk factors are challenging, resource intensive, and have in general met with little success (Koivusalo et al., 2016; Simmons et al., 2015). On the other hand, breastfeeding is already encouraged, and for the majority of women, is acceptable, and can be undertaken successfully. Yet this has largely been neglected in the GDM and diabetes prevention literature.

Credit author statement

Statement: The research idea was conceived by SJM and LW. The study was designed by SJM, LW, MS, IA, SP and WC. AK performed the statistical analysis, SJM interpreted the data and wrote the initial drafts with supervision from WC and DP. Invaluable support was given by IA, WC, DP, LW, MS, SP, VS and AK for final interpretation of findings, and critical revision of the article.

Ethical approval

Granted by Western Sydney Local Health District Human Research Ethics Committee.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

None declared.

Acknowledgments

The authors would like to thank the women who participated in the study. We also wish to thank Monica Hook for her assistance with data retrieval.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.midw.2022.103262.

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Women and Birth 35 (2022) 493–502

Contents lists available at ScienceDirect

Women and Birth

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Exploring the COVID-19 pandemic experience of maternity clinicians in a high migrant population and low COVID-19 prevalence country: A qualitative study

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ARTICLE INFO

Keywords:
COVID-19
Midwives
Pandemics
Maternity care
Migrants
Social support

ABSTRACT

Background: Australia experienced a low prevalence of COVID-19 in 2020 compared to many other countries. However, maternity care has been impacted with hospital policy driven changes in practice. Little qualitative research has investigated maternity clinicians' perception of the impact of COVID-19 in a high-migrant population.
Aim: To investigate maternity clinicians' perceptions of patient experience, service delivery and personal experience in a high-migrant population.
Methods: We conducted semi-structured in-depth interviews with 14 maternity care clinicians in Sydney, New South Wales, Australia. Interviews were conducted from November to December 2020. A reflexive thematic approach was used for data analysis.
Findings: A key theme in the data was 'COVID-19 related travel restrictions result in loss of valued family support for migrant families'. However, partners were often 'stepping-up' into the role of missing overseas relatives. The main theme in clinical care was a shift in healthcare delivery away from optimising patient care to a focus on preservation and safety of health staff.
Discussion: Clinicians were of the view migrant women were deeply affected by the loss of traditional support. However, the benefit may be the potential for greater gender equity and bonding opportunities for partners.
Conflict with professional beneficence principles and values may result in bending rules when a disconnect exists between relaxed community health orders and restrictive hospital protocols during different phases of a pandemic.
Conclusion: This research adds to the literature that migrant women require individualised culturally safe care because of the ongoing impact of loss of support during the COVID-19 pandemic.

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https://doi.org/10.1016/j.wombi.2021.10.011
Received 4 September 2021; Received in revised form 21 October 2021; Accepted 29 October 2021
Available online 5 November 2021
1871-5192/

Statement of significance

Problem or issue

Limited qualitative research exists on the impact of the COVID-19 pandemic on the experience of clinicians providing maternity care to high-migrant populations.

What is already known

Health outcomes in migrant populations can be improved. Research indicates barriers to high-quality maternity care can be a result of rapid changes during the pandemic.

What this paper adds

Clinicians in maternity care are impacted by migrant populations ongoing loss of support. Culturally competent care should facilitate support and promote equitable heath care access.

Maternity care has shifted focus from women-centred to clinician safety. COVID-safe policies should be dynamic and reflect community risk to optimize staff pandemic policy compliance.

Introduction

'It takes a village to raise a child'… but what happens when the village is locked out [1]. The magnitude and speed of the spread of the COVID-19 pandemic and its impact since the beginning of 2020 has been devastating, including sudden country border closures with Australian international borders closing on March 20, 2020 [2]. The impact of COVID-19 is largely due to direct associated morbidity and mortality as well as indirect economic, social and health care delivery disruptions [3, 4]. Australia has been fortunate with the early containment of COVID-19 at the start of the pandemic in 2020. Significant loss of life has been avoided through a variety of public health measures including closing international borders, quarantining of overseas travellers, comprehensive contact tracing, and a population that was largely compliant to intermittent movement restrictions and 'lockdown' isolation measures when required [5–7].

The early containment and management gains of COVID-19 in Australia was tempered with a slow uptake and access to COVID-19 vaccination compared to other OECD (Organisation for Economic Co-operation and Development) countries in 2021, with media documenting the slow progress [8,9]. The Australian community has therefore experienced ongoing vulnerability to COVID-19 outbreaks. This vulnerability has been highlighted by sudden varied population lockdown orders due to state and nation-wide outbreaks of the highly contagious COVID-19 Delta strain in mid-2021. Rolling movement-restriction health orders occurred in 2021 primarily in the metropolitan areas of Sydney and Melbourne, with Sydney experiencing nearly four months of lockdown orders with easing of restrictions from mid-Oct 2021. During this time in 2021, COVID-19 cases occurred among women in Western Sydney who were pregnant and admitted to hospital. The prevalence of COVID-19 in New South Wales (NSW) was greatest in the high migrant population in Western Sydney [10].

The response to COVID-19 in maternity care across Australia has varied since the commencement of the pandemic. A survey of 620 Australian midwives conducted in May–June 2020 reported a varying response by hospitals in implementing restrictions of visitor and support persons due to COVID-19 [11]. These restrictions differed from no visitors or support persons permitted to no restrictions at all implemented. This is possibly a reflection of the varied assessment of risk in the different states and regions of Australia due to the different dynamics and risk profiles of particular outbreaks at various times throughout the pandemic. In the Bradfield et al. study, 16 midwives from across Australia were also interviewed about their experience of providing care during the pandemic. Among key findings, clinicians reported experiencing many challenges to providing women-centred care [11]. One of the main themes also identified in this study was 'coping with rapid and radical change', reflecting the situation that, despite a low prevalence of COVID-19 cases, providing maternity care has been problematic due to rapid, and sometimes contradictory, changes in policies.

A Spanish qualitative study of 14 midwives who had cared for COVID-19 positive women during pregnancy and childbirth, explored 'challenges and differences when working in a pandemic' [12]. They found staff were stressed and overwhelmed with constant changes in guidelines. These findings were consistent with the Australian experience of midwives reported by Bradfield et al., that midwives found it challenging to provide consistent supportive practice and that this was a barrier to women-centred care [13].

Although Australia has not experienced the death rate from COVID-19 that some countries have, significant stress, ongoing risk and impact exist for the community and clinicians. A study of health care workers (nurses, doctors, allied health and non-clinical) in Melbourne in mid-2020, found rates of psychological distress comparable to countries that experienced high prevalence of COVID-19 with 30% of health workers in Melbourne, Australia during the study screening positive for work-place burnout [14].

The health order restrictions on movement and border closures during the COVID-19 crisis has changed access to family and friends for many women potentially impacting their childbirth experience [15,16]. Women who utilise the maternity services in Western Sydney Local Health District (WSLHD) are predominantly born in a non-English speaking country (58%) [17], with relatives living in countries that are significantly impacted by COVID-19. A previous study at Westmead Hospital found 85% of South Asian or Chinese women planned to have relatives visit from overseas to provide support during pregnancy and the postnatal period [18]. In person support from overseas relatives is no longer available due to government mandated international flight restrictions in Australia. How clinicians have perceived the effect of COVID-19 on social support networks for overseas born and Australian born women and the impact on care in the peripartum period to our knowledge has not been investigated.

Improved understanding of clinicians' experience and difficulties caring for women and their families during the COVID-19 pandemic can assist with enhanced maternity care for families and professional support. This understanding may improve future pandemic planning to deliver care in diverse multiethnic communities. The aim of this study was to explore the experience of maternity clinicians serving a high migrant population during the COVID-19 pandemic, including investigating perceptions of patient experience, service delivery and personal experience of living in the pandemic.

Methods

Design

A qualitative study design with data generated from semi-structured individual interviews was employed for this study. Reflexive thematic approach was used as described by Braun and Clarke [19]. This approach was chosen as it provided the flexibility of inquiry required to examine the novel lived experiences of clinicians serving a culturally diverse patient population in an evolving pandemic where no previous data was available.

Setting

Midwives and medical staff were recruited at a major tertiary referral hospital in Western Sydney Local Health District (WSLHD), NSW, Sydney, Australia. Sydney is the largest city in Australia with a population of 5.4 million. WSLHD has the highest overseas migration gain for the state of NSW [20]. The study hospital is the tertiary referral hospital for the

Local Health District population of more than 946,000 residents [21]. This hospital has an average of 5500 births per year. The study hospital is within a health district that has 58% of the mothers born in a non-English speaking country and the highest South Asian maternal population (25%) in the state of NSW [17].

Recruitment and interviews occurred during a period of no locally acquired COVID-19 cases in the state of NSW, after the first high prevalence COVID-19 case period in March-April 2020 (Fig.1). During this first surge there had been no COVID-19 positive pregnant women admitted at the study hospital. Approval for COVID-19 vaccines did not occur in Australia until 2021 and were not available to health staff or the community during the study period.

Participants

Inclusion criteria for the study required participants to be a registered midwife or medical practitioner who had been employed at the study hospital for greater than 12 months in the Department of Women's and Newborn Health. This inclusion criteria was to ensure participants could discuss their experience since the beginning of the pandemic. Participants were recruited through information posters in maternity care staff areas and routine work maternity staff email pathways. Purposive sampling was utilised to enrich data collection for varied clinical experience of participants from all maternity care areas [22]. Recruitment and interviews occurred over a four-week period from 18th November 2020 to 16th December 2020.

Thirteen clinicians were interviewed face to face and one by a secure video link. All but one of the participants were women and most of the clinicians were midwives, with two participants medical doctors. Approximately 40% of the clinicians in the study were migrants themselves reflecting the local migrant population. Eight of the participants stated they were parents, all with children living at home except one who had adult children not living at home. Further demographic information is presented in Table 1.

Data collection

A semi-structured interview schedule was used to collect data consisting of three categories for exploration of the participants understanding of: (1) clinicians' perceptions of patient experience (including support required), (2) service delivery and (3) personal experience of living in the pandemic. The leading question for each category investigated were: 'Can you tell me what your perceptions of changes in women's family support has been like during COVID pandemic?' In exploring service delivery: 'Can you tell me about your experience caring for pregnant women during the COVID pandemic?' And for the final category of personal experience the lead question was: 'How have you felt in yourself during the COVID pandemic?' Questions regarding family support are defined in this study to mean a person's partner, relatives, and people around who can be called on to provide emotional, tangible (instrumental), and informational support.

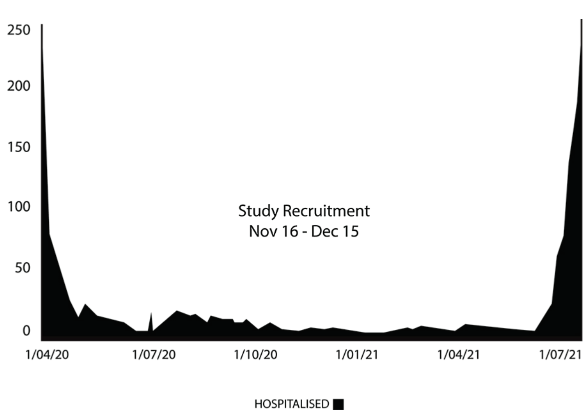

Fig. 1. COVID-19 hospitalisation in New South Wales, Australia April 2020–July 2021.
Recruitment period for COVID-19 maternity clinician qualitative study: November–December 2020.
(Graphic T Melov based on Source https://www.abc.net.au/news/2020-03-17/coronavirus-cases-data-reveals-how-covid-19-spreads-in-australia/12060704#hospitalisation).

Table 1
Characteristics grouped by years of experience of 14 maternity clinician participants during the COVID-19 pandemic in a tertiary referral hospital Sydney, Australia.

Years of experience	Age group represented	Primary maternity clinical area (n)
1–5	<30	Continuity of Care (1) Antenatal Clinic (1) Mixed Areas (2)
6–9	30–40	Continuity of Care (1) Postnatal Ward (1)
10–20	>40 30–40	Birth Unit (1) Mixed Areas (2) Antenatal Clinic (3)
>20	>40	Postnatal Home Care (1) Continuity of Care (1)

Interviews conducted over four weeks: November-December 2020.
Registered midwives: 11, Student midwife: 1, Trainee obstetrician: 1, Obstetrician: 1.

All interviews were conducted by a single investigator who is an experienced midwife and researcher (SM). The interview progress, transcript coding and analysis were overseen by an expert qualitative researcher (JM). The interviews ranged from 28 to 65 min, with eight interviews over 50 min, and one interrupted at 15 min and unable to be continued. Recruitment ceased at saturation when sufficient rich data from a diverse range of participants was collected to generate insights and meaning for the research question. This was in the context of the recruitment period occurring in a COVID-19 'lull' with loosened restrictions and a stable government COVID-19 response. A total of 665 min of interviews with clinicians were recorded and subsequently transcribed.

A professional transcription service provided verbatim text of audio recording. SM reviewed transcriptions against audio for accuracy. To ensure confidentiality of participants all transcriptions were de-identified.

Data analysis

Reflexive thematic data analysis was used within a framework of the three primary areas of clinician perceptions of patient experience, service delivery and personal experience of living in the pandemic.

Analysis was based on the six phases as set out by Braun and Clarke [23]; these were not sequential but commenced with deep familiarisation with the data. This first step of familiarisation was enhanced by the first author completing all interviews, therefore aware of greater context below surface transcription detail. Field notes were also used to assist with the familiarisation process. The other five phases for analysis were generating codes, exploring initial themes, reviewing initial themes, finalising and naming themes and then producing the report [19].

After familiarisation with data, codes were defined by the two primary authors JM and SJM utilizing both sematic and latent meaning to provide richer understanding and categorisation of participant data by JM and SM. Assumptions and context of code generation were checked through non-discipline social scientist 'outside' voice of senior author (JM) in the analysis process.

Generating final themes were based on central connecting concepts. The five phases of analysis were conducted by authors SM and JM with all authors reviewing and reaching consensus on final themes.

Consensus was reached iteratively for final themes and final report. NVivo was used for data management and analysis (QRS International Pty Ltd 2020).

Investigators addressed reflexivity particularly in consideration of the primary researcher's own position as embedded within both the subject matter and shared participant professional experience as a clinical midwife. A further reflexive consideration was that all investigators were experiencing the pandemic and it is acknowledged this shared experience enhanced insight into the areas under investigation in this study.

The collection, analysis and presentation of in-depth, detailed and contextualised data, paying critical attention to matters of reflexivity from the perspectives of authors SM and JM – in the interview process but also in the rationale and implementation of all phases of the study – enhanced rigour, trustworthiness and quality. Quality of data coding and analysis was further strengthened by author JM evaluating, cross checking, and, where necessary, reassessing both coding frames and coded text in iterative dialogue with author SM.

Ethical considerations

The interviewer is employed in the same institution however has no managerial role and no working relationship with any participant. All participants were provided with written information and signed a consent form that is stored by the interviewing researcher in a locked research room. Audio data was securely deleted after transcription verification. All transcriptions and data were de-identified for analysis and investigator discussions to ensure anonymity of the participants from researchers who may be colleagues. All research data is securely stored with password protection and access only by named investigators. The final manuscript was reviewed for identifiers by an independent study-site midwifery researcher. Approval was granted by Western Sydney Local Health District Human Ethics Committee (2020/ETH02074) 23 September 2020.

Findings

The three main themes within the areas explored were: COVID-19 related travel restrictions result in loss of valued family support for migrant families; For the greater good, loss of efficient women-centred care; Challenges and difficulties in difficult times- you just dealt with it. The main themes and subthemes are provided in Table 2.

Clinicians' perceptions of patient experience

COVID-19 related travel restrictions result in loss of valued family support for migrant families

In this culturally diverse migrant population, the main theme woven through all aspects of this area of inquiry 'Perception of patient experience' were related to the impact travel restrictions had on family support, which in turn impacted both patients and clinical care. All clinicians described the lack of family support from overseas as one of the biggest challenges they perceived for women during the COVID-19 pandemic at the study hospital. A typical response was:

> *…the most important thing is the inability to have extended family, potentially, travel to be with them to give support around the time of the delivery, and with the newborn baby… that choice has been taken away from them.* (Clinician 11 Obstetrician).

Birth and cultural differences: "…they're just by themselves, as opposed to an Aussie couple…"

Four clinicians identified that there was a difference that separation from traditional family support had on overseas born women when compared to Australian born women. One clinician observed that women from India were highly reliant on relatives, and they had a strong family connection. This midwife explained she found the connection to family was different to Australian born women who often wanted to experience the pregnancy journey with just their partner.

> *…the women seem to be very sad and depressed and lonely because their mother and their mother-in-law can't come from India to support them… I think they feel as though they're being abandoned because of the virus, that they're just by themselves, as opposed to an Aussie couple that feel as though they want to cope by themselves.* (Clinician 1 Antenatal Clinic Midwife)

This midwife, with over 20 years' experience, went on to explain how she found that there was not a reliance or even usually a mention of relatives for Australian born women: *"They talk about the couple and themselves, whereas [Indian women] tend to incorporate the whole family into this childbearing support mechanism."* Other clinicians also mentioned the individualistic nature of pregnancy for some Australian born

Table 2
Main themes and sub-themes. Exploring the COVID-19 pandemic experience of maternity clinicians in a high migrant population and low COVID-19 prevalence country: a qualitative study.

1.	Clinicians' perceptions of patient experience
	Main theme *COVID-19 related travel restrictions result in loss of valued family support for migrant families* **Sub-themes** *Birth and cultural differences: "…they're just by themselves, as opposed to an Aussie couple…"* *The cultural practice of postpartum extended in-house support from overseas* *Loss of support and impact on clinical care* *Changing support from partners: "…the fathers themselves actually did step up"* *Mental health impact of loss of support: "Big time struggling because she's sort of just very isolated"* *Missing out on important life events in the pregnancy journey "…husbands are missing the births of their babies"* *The hospital is not a safe place to be "… we're a big tertiary hospital, and we're the COVID central"*
2.	Maternity care service delivery during COVID-19
	Main theme *For the greater good, loss of efficient women-centred care: "it was just a matter of plugging the holes when you could identify them"* **Sub-theme** *Doing your own thing: "This doesn't feel right …"*
3.	Clinicians' personal experience during COVID-19
	Main theme *Challenges and difficulties in difficult times- "you just dealt with it";"… and we came straight off the bushfires"* **Sub-themes** *Guilt- "can I keep everyone safe?"; "…that was the fear. Taking it home and then … them not surviving it."* *Self-care: new activities and work facilitating connection with people*

families. A young trainee obstetrician observed; "*Caucasian families seem to just really want their partner and no one else*" (Clinician 10). Two midwives stated that some of the Australian born nuclear family units found COVID lockdown beneficial to isolate themselves from the available but uninvited extended family and visitors, COVID-19 restrictions provided protected time.

> *…for some [Australian born women], they didn't mind it, actually, because that meant less family coming over. And so they could enjoy that time just with their partner and with their baby, … They were like, "Yeah, I prefer it. I can just stay at home, and now I can use COVID as an excuse for them not to come.* (Clinician 8 Continuity of Care Midwife)
> *They really liked being isolated and living in their bubble. And I found that for couples, in particular, the dad and the mum and the baby were just this tiny little world …No, the Australian, particularly the Australians have loved it.* (Clinician 4 Postnatal Home Care)

Some clinicians stated this contrasted with the deeply felt sense of loss of support from extended family that overseas born women frequently discussed.

The cultural practice of postpartum extended in-house support from overseas

The loss of support for many overseas born women is within the context of a cultural norm. Most clinicians described the importance and common practice among South Asian and Chinese migrant women of in-home family support coming from overseas during pregnancy and for many months postpartum.

> *…it's nearly always the mum, or the mother-in-law, are always there, especially for the first three months, to help out, to cook, to help to clean. And that's just their normal way of life. And if they were back home in their country that's how it would be. They would have even more family, and that's just their way of life. So to be here in a foreign country, and to not have that community that you usually have that's normal to their culture, would definitely … really depress them.* (Clinician 8 Continuity of Care Midwife)

Clinicians described the very practical and tangible nature of support during the postpartum that some cultural groups of women knew they were missing. One clinician stated that relatives:

> *…do everything for these mums; they will cook, clean, they take care of their baby, they do the night shift if mum needs a sleep. Mum really doesn't need to do anything except have the baby handed to her to breastfeed basically.* (Clinician 4 Postnatal Midwife)

The support traditionally provided and now absent from overseas relatives, can be extended and substantial;

> *"they stay for about six months, sometimes longer and then they swop over depending on each side of the family. So, there's a good year or a couple of years that they have support in the home where they're not having that now"*. (Clinician 10 Trainee Obstetrician)

Loss of support and impact on clinical care

More than half the clinicians described the impact on clinical care from loss of support from overseas relations as increased time commitment for two primary reasons: providing greater parenting education and increased time required in the clinical encounter to address psychosocial needs. Clinicians stated both new mothers and multiparous women may require extensive help as some multiparous women had previously had live-in assistance from relatives with all baby care needs and therefore required more education support. This lack of support was exacerbated as clinicians felt many women did not attend antenatal classes or were unable to attend due to COVID-19 antenatal education class disruption. As one midwife described it:

> *The primips [primiparous women] in particular with their mother crafting and breastfeeding, they needed more intensive support. Multips [multiparous women] who weren't used to it also needed reminding. Do you remember what it was like before? And they had to stop and think how much their mum did for them, or their mother-in-law.* (Clinician 4 Postnatal Midwife)

The increased time required for patient care by clinicians was also due to greater demand for emotional support for women. Another midwife described a woman from Europe who had a history of postpartum depression and had organised for her relatives to fly-in to provide support, which, because of international flight restrictions, did not happen.

> *… she couldn't get her sister or her mum, or anybody from overseas, really made things worse… you have to take on that added responsibility of being that friend and that family and the clinician at the same time. And that woman was very draining.* (Clinician 8 Continuity of Care Midwife)

Changing support from partners: "…the fathers themselves actually did step up"

Nearly all clinicians discussed the changing role of husbands to provide support that would have been provided by overseas relatives. Research has found that during the pandemic partners have felt they were missing out on aspects of the pregnancy journey [24]. However, in our findings clinicians stated some cultural groups may have benefited from more opportunities to be with their partner in protected time to provide support that may have been provided by female relatives traditionally. As one clinician explained:

> *And a lot of the women said that's the expectation in Australia that the husband and the wife or both parents are involved in looking after the baby. Not just the mum and the grandmother or the dad getting a few cuddles at the end of the day. And the husbands were actually pretty happy to be allowed to do that because I think culturally, they are pushed out. They're pushed out by the older women… I think a lot of them actually felt really great that the older women weren't around bossing them around and the couple could actually work it out for themselves.* (Clinician 5 Continuity of Care)

More than half the clinicians discussed in some way how the COVID-19 experience had impacted and challenged traditional male provider role, particularly regarding gender roles and equity, this was perceived as more apparent within migrant couple's experience. The role of male partners engaged with parenting, inclusive of division of household tasks were highlighted as external support network was absent due to restrictions placed by COVID-19 on overseas relatives: "*the fathers are doing a lot of it now, and I'll tell you what, they're doing a great job*" (Clinician 4 Postnatal Home Care).

Mental health impact of loss of support: "Big time struggling because she's sort of just very isolated"

Almost all clinicians stated they felt COVID-19 had increased migrant women's feeling of isolation. Ten clinicians discussed that the pandemic had increased mental health concerns for all women. Most of the clinician who discussed mental health, specified that they felt that there was an increase in anxiety among women both antenatally and postnatally. This was often attributed to loss of support from relatives unable to travel to stay with migrant women. Some clinician reported cases they recalled of women not coping:

> *…she has no friends, her family are all in the UK, they were going to come support her for the birth, but now they're not. So she's really massively struggling. She's having anxiety attacks. Big time struggling because she's sort of just very isolated.* (Clinician 7 Birth Unit Midwife)

Clinician 8 who works within the continuity of care model stated loss of support: *"It's definitely increased levels of anxiety"*. This clinician also reported that the fear of COVID-19 also impacted mental health *"there* *was a lot of questions about how it could affect my baby, how it could affect me, and that increased levels of anxiety for all women".* Another experienced midwife (Clinician 5), who was able to observe women and their families at home throughout their pregnancy journey with continuity of care said: *"…some of the women felt sad that their babies were born at this time. They felt that they weren't able to be joyous and weren't able to really celebrate the birth of their children with their family."*

Missing out on important life events in the pregnancy journey "…husbands are missing the births of their babies"

Almost all clinicians identified that partners and other important support people for women were missing significant life experiences in the pregnancy journey. Clinicians stated this was felt differently by some cultural groups in the birth unit. As one trainee obstetrician observed; *"Pacific Islander patients, they often have a lot of family members in birth – like, all the women. So not having that might have been hard for them"* (Clinician 10 Trainee Obstetrician).

The rules to provide a COVID-19 safe environment within the hospital appeared to some staff to not be consistent with the flexibility of social distancing rules that NSW state public health orders were allowing for the general population at the time of the study.

> *It's pretty brutal, really. I think even now they're still only allowed one [support person]. But you can have a whole football stadium full of people, but you can only have one person. So a lot of them are choosing not to have their partners at the birth.* (Clinician 7 Birth Unit)

This clinician continued that they felt the support person rules were not equitably applied within the hospital: "…*if you contacted the [hospital] and gave a reason of some kind, then basically you were approved for two … and it's only the ones that kick up a song and dance that have been allowed to have more than one [support person]."* This raises the issue of equity of access for non-English speaking women who find it more difficult to negotiate the healthcare system and actors within it [25–27].

The hospital is not a safe place to be "… we're a big tertiary hospital, and we're the COVID central"

Seven of the clinicians discussed that woman felt that the hospital environment may be unsafe, a risk for COVID-19 exposure… *"I think they just didn't want to risk coming in; either would not ring up or would cancel"* (Clinician 3 Antenatal Clinic). Substantial evidence exists that there are barriers for migrant populations to access health care, COVID-19 places another barrier for women during this period [26,27]. Particularly in the first wave of the pandemic when there was more uncertainty, a Continuity Care Midwife (Clinician 5) said; *"I think they were just really scared, really, really scared, and just didn't really want to come [to hospital]".*

Maternity care service delivery during COVID-19

For the greater good, loss of efficient women-centred care: "it was just a matter of plugging the holes when you could identify them"

All clinicians discussed issues that were essentially rooted in the aim of a health care system attempting to rapidly reorganise to protect the greatest number of staff and patients from the looming threat of COVID-19 infection; 'For the greater good'. Providing optimal care was balanced with providing COVID-19 safe care. Some staff expressed concern that their safety was not prioritised and others that too much concern was given to staff safety and consequently patient care was reduced. Nine clinicians identified unclear and constant changes in practice guidelines as impeding care and creating uncertainty for both clinicians and the families in their care. As one clinician put it:

> *…the rules about one person in the birth unit only, no swapping. And then at one point it became OK, you could swap, but only once. I think now you can swap more than that. I'm not really sure, really... "Maybe ring birth unit when you're closer to term, and I'll ask them." Which, you know, then when you're in birth unit and the phone never stops ringing, you sort of think, "Oh, maybe I shouldn't have said that".* (Clinician 10 Trainee Obstetrician)

Some clinicians thought mixed messages to staff resulted as hospital administration assessed changing COVID-19 risks, based on evolving overseas experiences and also the process of interrogating existing clinical practices. "*Well, we had five different rules in five days [laughter]. So, it was just a very drastic change, just a different rule every day that was being brought in with all the emails and things'* (Clinician 9 Antenatal Clinic). However, other clinicians expressed how well they thought the service had responded:

> *I think there was a lot of people really making an effort to work out the best thing to do. I think it was excellent how quickly they shut down the hospital. I think that made a massive difference to our service capability. I think if we'd left the hospital open for six weeks it would have been pandemonium.* (Clinician 5 Continuity of Care)

Doing your own thing: "This doesn't feel right ..."

Most clinicians in our study have found the shift in clinical care from the centrality of a 'woman-centred' approach to the 'greater good' of safety for both patients and a new higher focus on staff safety, to be problematic. Maternity staff in this study stated they were often making their own judgment about risk and clinical care. A sub-text of 'doing your own thing' expresses the underlying concept of comments by most clinicians to provide optimal care that adjusted to the new rules but also conformed to their individual ethical maternity care standards. This was particularly in the context of low or zero COVID-19 local community prevalence.

> *…they encouraged phone consults. And I tried one. I did do one, but it just didn't feel right. And then also with the women as well. They'll be like "Oh, so you're not going to see me?" And that just – yeah, it was … It was like a wounded soul. They're so hurt by it. They understand but they're hurt, and I'm like – and then I was like, nah, just … This doesn't feel right.* (Clinician 8 Continuity of Care)

Clinicians expressed frustration at following recommendations to reduce exposure risk to COVID-19 to themselves at the expense of providing optimal care. This was discussed by most clinicians regarding the time limitation rule for consultations with women and the perceived impact this had on clinical care. Clinicians found following the short visit rule, of staying with a patient for only 15 min to reduce COVID-19 contact risk and maintain social distancing, unsatisfactory. As one clinician said: *"you'd find that they had other questions, so we were constantly going over time… it was really difficult, and I could never sort of say to them, uh, 15 minutes is up, I'm leaving"* (Clinician 5 Continuity of Care). Another clinician elaborated:

> *You know, say you're talking to a diabetic mother about expressing, and wanting to give her the syringes and the info sheet. If you really stuck to the 15, well, you just wouldn't be able to do that. You'd just get through her diabetic care, check her scan, and send her on her way. But that was really suboptimal.* (Clinician 10 Trainee Obstetrician)

Clinicians' personal experience of living through the pandemic

Challenges and difficulties in difficult times- "you just dealt with it";"… and we came straight off the bushfires"

When clinicians discussed their personal experiences of living with the pandemic a central theme was; 'Challenges and difficulties in difficult times- *you just dealt with it'*. All clinicians expressed that they had experienced adversity personally during the COVID pandemic. Some adversity was psychological with increased stress and anxiety. *"I was on hyperalert, but I didn't recognise it at the time … you just dealt with it"* (Clinician 4 Postnatal Home Care). Three clinicians who had partners that were either healthcare workers or essential workers stated this situation increased the complexity of issues to deal with, including concerns with risk and safety. This is also within the context of the state of NSW experiencing the worst bushfire season on record with 4.9 million hectares of the state burned over the summer period [28].

It's been tough because my husband's …on the front line as well and we came straight off the bushfires. So he was off attending to those and not at home all the time with that and then we went straight into COVID. … challenging for our kids in that with both their parents being on the frontline. (Clinician 14 Postnatal Ward)

One in nine adults in Australia are informal carers and these are most likely to be women and often disproportionately take on extra duties of unpaid care [29]. Of the predominantly female group of fourteen clinicians interviewed, five clinicians described COVID-19 as a barrier to providing support to elderly parents. Some of these difficulties are shared by the general public, however, clinicians felt they were more at risk of infecting vulnerable or elderly relatives with COVID-19 *"Am I transmitting the virus because I've interacted with so many people during the day?*" (Clinician 1 Antenatal Clinic). One clinician who worked in the busy birth unit discussed this in relation to their particularly vulnerable parent: "*My dad was unwell with cancer and having treatment, so we couldn't go and see him*" (Clinician 7 Birth Unit).

Clinicians from migrant backgrounds had similar stressful experiences to the migrant patient population with forced separation from extended family and restricted international flights. A Continuity of Care Midwife (Clinician 12) experienced the death of their mother during the pandemic who lived overseas: "*…in February, when my mum passed away, I was able to go back to my home country to sort out things"*. She discussed the difficultly as an only child of managing remotely the complexity of caring for their elderly father, with significant health issues, who was left alone after the death of his wife.

…so I hire a 24-hour nanny as well. …he has to have 24-hour care. So I just worried about COVID-19, when it's going to stop, because I have to go overseas next year to kind of sort things. So, I'm not sure at this stage. … the relatives visit him quite regularly. … no way to go, so yeah…I have like a webcam, like a kind of camera. I can just talk to them. (Clinician 12 Continuity of Care)

The difficulties of negotiating international travel and organising ongoing remote care of the clinician's father highlights the complexities that a migrant workforce live with, maintaining connection to family in their country of origin. In our patient population these issues are focused on family and birth. However, in our workforce the issues also include illness and death, as the clinician continued "*That's the thing. I haven't buried my mum's ashes yet, so I am hoping next year I can go"* (Clinician 12).

Guilt- "can I keep everyone safe?"; "…that was the fear. Taking it home and then … them not surviving it."

'Guilt' was another theme for clinicians living in the pandemic. Feelings of guilt were explicitly expressed by five clinicians. Some of the guilt was based in the personal ethical dilemma of balancing professional beneficence and personal risk to family. Anxiety surrounding the fear of COVID-19 transmission to vulnerable pregnant women or to clinicians' families was expressed by nearly all clinicians. They also talked about stress around potentially not working if a long quarantine was required or when waiting for COVID-19 swab results. As one clinician put it, "*You feel like why do I feel guilty. You think- I could be working, I'm really actually OK. But you can't come in"* (Clinician 7 Continuity of Care). Some of the guilt was driven by knowing that there could be extra stress and workload for colleagues in this situation "*… there's always that burden that you're … because in nursing you're never replaced, so when you don't come to work everybody else has to carry your load. So, you're already feeling guilty"* (Clinician 4 Postnatal Home Care). This altruistic concern to keep yourself safe for preservation of the maternity service was expressed by both midwives and medical staff as an obstetrician explained "*anxiety around, especially, the vulnerability of yourself. So, if I was to get coronavirus or have to have a test, then it would mean me needing to be absent from work and unavailable for a period of time"* (Clinician 11 Obstetrician). Another clinician elaborated the fear and anxiety associated with coming into contact with a potentially COVID-19 positive patient:

…the anxiety that I felt was sickening because I thought, uh, my goodness what have I done yesterday. So that was the Tuesday, and she rang me on the Tuesday night, so I was already home. So, I'd seen her. I'd seen other women. I'd seen my team members. I'd been at the hospital. I'd been home. I'd been with both of my children, who worked, and my husband who's working from home, and I was panic stricken with the number of potential contacts that I could have hit. (Clinician 5 Continuity of Care)

There were five participants who had school age children, most discussed the importance of keeping their children safe. When discussing the greatest personal concern during the pandemic one clinician described the fear for the survival of her vulnerable children.

I think my kids getting it. Because they were high risk and maybe they wouldn't survive it. I'm pretty healthy. I think if I – hopefully I would survive it. But maybe my kids wouldn't. So I guess that was the fear. Taking it home and then … Them not surviving it... everyone else is at home and isolating, and you have to come to work and potentially look after these women. And then take that home to your kids. That was scary. (Clinician 7 Birth Unit)

For most clinicians attempting to 'keep everyone safe' to reduce risk manifested in what could be described as 'coming home rituals'. As a clinician explained:

…we allocated this toilet, and my kids put [a sign] there, 'the Corona room' [laughs], 'don't enter' They didn't go in that. We told them, we said OK, because we are both parents working in the hospital. OK, now with during this pandemic, we just need to try to protect you, what we can do. So that's why. So we say OK, mummy and daddy were just changing our uniform in that room, and we will shower, everything in that room. (Clinician 6 Mixed Areas)

Clinicians discussed keeping safe mentally as part of what could be termed COVID safe rituals: As one clinician put it, *"I feel OK, because I have enough toilet paper."*

Self-care: new activities and work facilitating connection with people

Clinicians also described self-care as part of the rituals of keeping safe mentally. New activities that clinicians said they purposefully engaged in for mental health included cooking, online shopping, doing puzzles, sketching and investigating the family tree. Exercise was also described as important. One clinician said she had started jogging and another two had bought bicycles during the pandemic.

Clinicians also described the importance and meaning for them to continue to work for their mental health during the pandemic. As one clinician said: *"…being able to still birth with women and have that contact with them was a saving grace"* (Clinician 5 Continuity of Care). Most clinicians felt a sense of purpose providing care for women in difficult times. Work was viewed both as anchoring a sense of self and helpful for self-care.

[At the beginning of the pandemic] I felt as though we were like crusaders coming to work. We were kind of like on the battlefields, that we deserved bravery medals to come because of this unknown. … were we all going to die? … when you come to work you think what's going to happen kind of thing. So I felt a sense of purpose and – I don't know what the word is, but you felt like a soldier in the battle kind of thing. For the greater good, here we are. We're all going to die but it doesn't matter; here we are. (Clinician 1 Antenatal Clinic)

Discussion

It is estimated worldwide there is over 272 million migrants and in Australia approximately 50% of its population is either a migrant or a child of a migrant [30,31]. Migrant families have unique and more complex needs during pregnancy and birth than non-migrants, these include higher rates of stillbirth, preeclampsia and depression [32,33]. It is important particularly in Australia, to understand in depth the impact that the COVID-19 pandemic has had in this population to optimise care and understand service provision. Our qualitative study aimed to explore the effect of the current pandemic among clinicians providing maternity care in a high migrant population. We identified three main themes in the data collected from maternity clinicians: 'COVID-19 related travel restrictions result in loss of valued family support for migrant families', 'For the greater good, loss of efficient women-centred care' and personal 'Challenges and difficulties in difficult times- you just dealt with it'. This study adds to the limited maternity literature of the impact COVID-19 has had in high-migrant populations.

To our knowledge this is the first in-depth qualitative investigation that has specifically explored maternity clinicians' perceptions of changes to family support including overseas relatives. We have identified loss of the overseas family support as a major and ongoing concern for migrant women during the pandemic which in turn can impact service delivery. It is of interest to note there is supporting evidence for this finding in the Bradfield et al. study as midwife participants mentioned the difficulty in providing women-centred care in a culturally safe way. This was to both women from culturally and linguistically diverse backgrounds and to Aboriginal women due to unmet cultural expectations [11].

High quality and supportive social relationships have been increasingly linked to resilience, well-being, and reduced morbidity and mortality [34–37]. High quality social support can be defined to include optimally a combination of structural factors such as strong social networks and living arrangements or functional self-reported measures of support including an internal perception of high-availability of support [36]. Robust social support can be drawn on in times of adversity and can act as an emotional buffer. Access to strong networks of social support have been found to not only impact an individual's health but also influence emotional connection and warmth of a mother and child relationship, with some research finding increased social support lays a foundation for improved parent child connection [38]. Understanding the disruption to this important aspect during pregnancy, birth and early childhood can be viewed as understanding an aspect of healthcare that has immediate impact and implications for both mental and physical health outcomes long-term. Our study has provided clear evidence of the impact of lack of support from overseas relatives has had for pregnant migrant women on the resulting effects for the provision of healthcare by a culturally diverse workforce providing maternity care to this population.

The COVID-19 pandemic is an acutely stressful event that has significant and detrimental impacts across the entire Australian population, particularly due to the uncertainly and swiftly changing capacity for individuals to connect with their usual support networks. In the specific context of perinatal care, networks that would usually provide a buffer against acute stress around significant events such as childbirth were largely absent. In particular, our participants stated that the impact on clinical care of the loss of the expected support network for migrant women included increased time required with women to provide adequate education and increased need for psychosocial support.

However, adding nuance to this finding, clinicians in our study also felt that Australian born women discussed the loss of relative support less or indeed stated they benefited from a family unit 'bubble' without having to interact with intrusive relatives during lockdown periods. These varied perspectives highlight the need for clinicians to refrain from assumptions about patient preferences and the need to individualise care and utilise cultural competency skills to provide optimal care.

The negative impact of mandated restrictions on support people during antenatal care and birth during COVID-19 pandemic is described in our study: as missing out on important life events in the pregnancy journey. This issue has been documented in social media and other supporting research [13,24,39].

Australian research has identified that partners felt psychological distress primarily concerning COVID-19 hospital restrictions [24]. However, clinicians in our study also described the adaptation and positive aspects for partners to the loss of support from overseas relatives. Clinicians felt husbands and partners were 'stepping-up' and filling the support-gap left by overseas relatives. The perceived benefit was that partners were more involved with newborn care, whereas previously they may have not had as much opportunity due to the cultural traditions of mothers and mother-laws inhabiting this space. Concepts about gender equity, or the lack of it, in the country of origin and within the migrant population is important to understand for service provision and the subsequent impact on women's health. The risk of negative physical and mental health outcomes is associated with gender inequality, often because of reduced decision making within an intimate partner relationship [40,41]. The changing male role due to the impacts of COVID-19 within some migrant families may result in more equal gender relations that may in turn benefit partner's relationship to infants, and also provide health benefits to women. The clinicians in our study were of the view there was some evidence of this changing male role in the migrant populations they served.

The imperative to preserve the healthcare workforce has become paramount during the pandemic. Large groups of health workers in isolation or unwell will result in reduced or possibly even no capacity to provide care. Our research found clinicians understood that institutional and government shift to a system-level 'for greater good' focus, led to women-centred care being swept away in a confusing array of changing protocols, and policy changes. An underpinning pregnancy care philosophy and policy for many years has been to provide a holistic 'woman-centred' maternity care service, although this ideal is often not well understood or achieved [42]. Providing optimal maternity care is thought to focus on a woman's right to have choice of care, to be involved in decisions and have care that respects her emotional as well as physical needs [43]. A 'woman-centred' care framework has more recently been embedded in Midwifery National professional standards and the Australian pregnancy care strategic guidelines [44,45]. Although the precise definition and focus of 'woman-centred' care has been debated, the ideas remain central to particularly midwifery practice [42,46,47].

Evidence from our study suggests that the pandemic and associated protocol and policy changes has undermined attempts to embed 'woman-centred' care in contemporary clinical care, protocols and practice. COVID-19 precautions, for a variety of clinical and public health reasons, have shifted focus to a central tenant of protection of staff. Our findings of the loss of individual women-centred care are supported by other research [11]. There may be no ideal solution to this issue during high COVID-19 case prevalence and high risk to staff as preservation of service is vital. However, there is evidence that healthcare workers during COVID-19 are at greater risk of mental health challenges when exposed to practices that may be considered against a moral code [48], as one midwife in our study said: *"This doesn't feel right"*. This information may inform appropriate mental health support to be offered to staff who are more acutely aware of morally and/or professionally dissonant practices.

We found the discordance occurred when staff felt a disconnect between reduced community restrictions due to low or zero case prevalence and onerous hospital restriction policies. Beneficence is an overarching principle in healthcare, a duty to act for the benefit of others [49]. Assessing risk for midwifery and medical obstetric staff is embedded in usual practice. In an environment where protocols are constantly shifting, we found staff were more likely to be utilizing this professional risk assessment skill-set during the pandemic and balancing beneficence and risk by, as clinicians put it, “doing your own thing”.

Although staff said they “just dealt with it” the challenges and difficulties the pandemic has thrown up to health worker’s personal lives have been significant. Providing care in a high-migrant population may also mean this migrant diversity is reflected in the workforce. Our research confirmed that COVID-19 related travel restrictions and separation from overseas family responsibilities and support structures, may also impact staff along with women in their care. This may create an added stress to clinicians in these settings.

Beneficence principles merge with altruism as many staff in our study were carers of young children and older relatives, therefore highly concerned with the risk their work posed to those in their care. Women are more likely have increased family responsibilities during the pandemic particularly increased hours on childcare, escalating the stress and complexity of their lives [50]. It should be considered that the cumulative impact of increased family responsibilities and stress associated with healthcare work put this group at particular mental illness risk during the pandemic [14]. Our study has illustrated that some clinicians dealt with this increased risk to their mental health by inventing activities and practices we coined as “rituals of keeping safe mentally”, activities of self-care that maintained or enhanced their personal well-being, some related to symbolic or real practices of infection control, others related to calming or pleasurable non-COVID related activities or exercise.

The capacity for large complex institutions to be flexible and have agile proactive policies, require time and consideration that pandemic conditions often precluded. At the time of this study the primary restrictions within the maternity service was on the number of support people and appeared highly restrictive due to low to no cases of COVID-19 in the community. However, the study period restrictions and preparations has allowed for a rapid and appropriate clinical escalation of restrictions in response to the current mid-2021 surge in COVID-19 cases in the local area. Therefore, it may be considered as beneficial to the system to have prioritised restrictions in preparedness. This study adds to understanding these issues and experiences and may assist in future planning and optimising service delivery that ensure that women-centred care is optimised as soon as possible in changing conditions.

Strengths and limitations

This study explored clinicians’ experience in a single centre, and this can be considered both a strength as rich contextualised detailed data was able to be collected, but it also brings a limitation to transferability. As, to the best of our knowledge, no other research has been conducted on a similar culturally diverse clinician group in Australia, it is difficult to say whether or how these findings may compare or be generalisable to other clinician groups servicing a diverse migrant population.

Some memory bias may have occurred as all interviews were conducted in a COVID-19 ‘lull’ during loosening of community restrictions with no local lockdowns. A significant portion of clinical systems discussions were concerning the first few weeks of the COVID-19 initial outbreak that had occurred up to seven months prior. There is always the limitation in qualitative studies of missing divergent opinions of participants who are unwilling to be interviewed. As management was supportive of the study and interviews could be conducted during work time, there appeared to be a general willingness from clinicians to participate in this study. Once participants gave informed consent all continued to the interview, after a suitable time was arranged.

The inclusion of both medical and midwifery clinicians as key informants is considered a strength of this study as well as inclusion of a variety of areas of maternity care and experience for rich data and perspectives.

Conclusion

The global COVID-19 pandemic highlights the vulnerability of maternity care to migrant communities and their tenuous support networks. Providing quality maternity care for all women in a pandemic is problematic. However, in high-migrant populations heath care providers need to be aware of the significant and often long-term support role overseas relatives play for women during pregnancy, birth and early infancy. Clinicians should be aware the loss of this support during the COVID-19 pandemic is ongoing and requires culturally competent care, possible extra antenatal education and psychosocial support.

To assist with maternity clinicians complying with hospital infectious control protocols during the pandemic, the health policies of relevant institutions should communicate effectively and strive to be compatible with community social distancing and other pandemic control measures.

Author agreement

The authors listed on this research agree: This manuscript is original work and has not received prior publication or under consideration by any other journal. All authors have seen and approved the manuscript and this submission. All authors abide by the copyright terms and conditions of Elsevier and the Australian College of Midwives

Ethical statement

Western Sydney Local Health District Human Research and Ethics Committee approval was granted for this research on (2020/ETH02074) 23 September 2020.

Funding

A two-year grant was awarded to SJ Melov by the Westmead Hospital Charitable Trust. Some funds from this grant were used to support this research: professional transcription and back-fill of substantive CMC role. The funding body had no role in study design, analysis or manuscript development.

Conflict of interest

All authors declare they have no conflicts of interest for the research presented in this manuscript.

CRediT authorship contribution statement

Sarah J. Melov: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Writing - original draft, Writing - review & editing. **Nelma Galas:** Conceptualization, Writing - review & editing. **Julie Swain:** Conceptualization, Writing - review & editing. **Thushari I. Alahakoon:** Conceptualization, Writing - review & editing. **Vincent Lee:** Conceptualization, Writing - review & editing. **N Wah Cheung:** Conceptualization, Writing - review & editing. **Terry McGee:** Conceptualization, Writing - review & editing. **Dharmintra Pasupathy:** Supervision, Conceptualization, Methodology, Resources, Writing - review & editing, . **Justin McNab:** Supervision, Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing - original draft, Writing - review & editing.

Acknowledgments

We would like to thank all clinicians who gave their precious and valuable time to be interviewed for this study. We acknowledge and appreciate the support from the funding body. Appreciate the assistance Tony Melov gave with designing the figure graphic.

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Appendix 5a

Chapter 5 Supplementary supporting quotes (not published)

1. Clinicians' perceptions of patient experience a. COVID-19 related travel restrictions result in loss of valued family support for migrant families
'I miss my mum', was a common one. A lot of the time they couldn't speak, they would just tear up. And they would nod and agree that it was just too hard with COVID. ***(Clinician 4)*** *…the subcontinental groups … a big part of their culture, when you have a newborn baby, all your family comes and helps out, and you don't do any housework, and, you know, just focus on bonding and feeding and all of that. So having to do all the stuff around the house which she wasn't planning on having to do, you know, even though in other cultural groups it's expected that you just do all of that, for them, it was a big adjustment. From when they decided to get pregnant, that's what they thought would happen, and it didn't.* ***(Clinician 10)*** *…some parents are more anxious, because the parents are not coming, ... So, I need to spend more time for the antenatal education, and sometimes they even ask me what sort of baby clothes I need to buy 'Is that a good thing to buy?' So, for me antenatal check take[s] one hour at least, to do everything, and answer all the questions they want to ask.* ***(Clinician 12)*** *Covid's there, which has caused the reason for the family members not being able to come, but it's also the reason why the husband's been able to work from home, and is more available…[women] have said 'It's been really good because my husband's working from home, so he can help out a lot more'.* ***(Clinician 11)*** *I feel that with Australian born culture it's very much like a partnership when it comes to having a baby or having a family. It's the husband relying on the wife, the wife relying on the husband, and so they're used to doing things together. But … So, yeah, so I feel like a lot don't like to have their parents or other family members involved as much.* ***(Clinician 8)*** *…one of the very first things that I would start to talk about is their family support and I'd say in about 40 percent of cases there were tears because they were just grieving, literally grieving the way they had planned everything to go, and it didn't work out that way.* ***(Clinician 4)***
2. Maternity care service delivery during COVID-19 For the greater good, loss of efficient women-centred care: *"it was just a matter of plugging the holes when you could identify them"*
…in the beginning with the toilet paper escapade, people didn't come. They just didn't come. When you rang them and said, "You had an appointment today. Are you all right?" They go, "Oh yeah". They were frightened of the virus because the hospital was full of virus. And one lady even said to me, "When I have the baby will I be put near a patient who has the virus?" ***(Clinician 1)*** *…you can't provide really good care in a short period of time. I mean I know what we're doing is you're trying to review it all, have a quick review on the computer and chase up results before you get the woman in the room so that you can minimise it. But I think it takes away from patient care. Education would definitely have been reduced.* ***(Clinician 3)*** *I think that the amount of emails we were getting, and the amount of information coming through, I mean, we were getting like three emails a day about COVID. And it became really overwhelming to understand what, like what we were meant to do and not meant to do… You just never felt in control of anything. You didn't know what you were doing from one day to the next. And then if something changed you kind of thought, uh, I did the wrong thing yesterday because we're not doing that now or we're doing this now.* ***(Clinician 3)***

3. Clinicians' personal experience of living through the pandemic Challenges and difficulties in difficult times
…bringing it home to my family was one thing; and then do I risk seeing my elderly parents or not? That was another thing, and I think we all went through that. And … or were they to have caught it from me and die, how do I feel about that? There were a whole lot of things that … I didn't see my parents for a while. ***(Clinician 4)*** *It makes you realise how little you have for yourself. It's just – we're so used to just work being the centre of our universe, and really not doing much for ourselves. So …Yeah, so it made me realise that I really don't have anything else for myself other than work, which is pretty sad. I don't have any major hobbies.* ***(Clinician 8)*** *Look, to be honest with you I was happy to be able to work out of home because everybody was home, and I would come home and my whole family were just there. My husband was there. My kids were there. They were all there, everyone was on their laptops…I think, yeah, being busy and being connected with people was really good. You know, everybody that was working from home disconnected really, whereas I was still able to have that physical contact with people. Like in labour it's very intimate … I felt that they [patients] needed to have that closeness as much as what I did. So, I found being able to still birth with women and have that contact with them was a saving grace.* ***(Clinician 5)***

Keeping safe *– coming home rituals for clinicians during the COVID-19 pandemic*
…you would come home and shower and put your uniform in the wash straight away. And make sure you don't touch or kiss anybody before you interact with anyone at home. ***(Clinician 1)*** *I would always shower [laughs]. I mean as it was, with my mother, she was isolating herself in a retirement village. So that was difficult because you can't just pop in like you normally would. But yeah, I definitely would shower and change before I saw anybody because I just didn't want to risk sharing any germs. And, yeah, my husband was pretty concerned about too, I think… he would know that I'm seeing so many people in a day, but he was obviously happy that I was showering [laughs].* ***(Clinician 3)*** *What we did at home was we change our linen very, very frequently. So sometimes even a couple of times a week. We didn't even know. We used to change the hand towel in the bathroom daily. Everybody that walked in the house had to strip off, shower and change. We had hand sanitiser everywhere. We washed our hands as soon as we came in.* ***(Clinician 5)*** *We even allocated our toilet, our downstairs toilet, just for the two of us to change our uniform everything. So we do change, like it's a bit changed our life. So we do, like even after nightshift come home, and even no matter how I am tired, I say I have to really change everything, shower, everything, before I jump into the bed [chuckles].* ***(Clinician 6)*** *I'm a lot more careful getting my uniform on and off.* ***(Clinician 9)*** *…at the beginning of COVID, I will use the Glen. You know the Glen, the spray? Yeah, so I just spray all over my body, like my clothes, my shoes, before I enter into the house, and the first thing I do is like wash hands, you know, and maybe take a shower, something like that.* ***(Clinician 12)*** *…so soon as I get home, I get changed and have a shower. So, the girls know not to touch mummy yet until I've had a shower and got changed.* ***(Clinician 14)***

Melov et al. BMC Pregnancy and Childbirth (2023) 23:429
https://doi.org/10.1186/s12884-023-05745-9

BMC Pregnancy and Childbirth

RESEARCH **Open Access**

Women's experience of perinatal support in a high migrant Australian population during the COVID-19 pandemic: a mixed methods study

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Abstract

Background As a COVID-19 risk mitigation measure, Australia closed its international borders for two years with significant socioeconomic disruption including impacting approximately 30% of the Australian population who are migrants. Migrant populations during the peripartum often rely on overseas relatives visiting for social support. High quality social support is known to lead to improved health outcomes with disruption to support a recognised health risk.

Aim To explore women's experience of peripartum social support during the COVID-19 pandemic in a high migrant population. To quantify type and frequency of support to identify characteristics of vulnerable perinatal populations for future pandemic preparedness.

Methods A mixed methods study with semi-structured interviews and a quantitative survey was conducted from October 2020 to April 2021. A thematic approach was used for analysis.

Results There were 24 participants interviewed both antenatally and postnatally (22 antenatal; 18 postnatal). Fourteen women were migrants and 10 Australian born. Main themes included; 'Significant disruption and loss of peripartum support during the COVID-19 pandemic and ongoing impact for migrant women'; 'Husbands/partners filling the support gap' and 'Holding on by a virtual thread'. Half of the participants felt unsupported antenatally. For Australian born women, this dissipated postnatally, but migrants continued to feel unsupported. Migrant women discussed partners stepped into traditional roles and duties of absent mothers and mothers-in-law who were only available virtually.

Conclusion This study identified disrupted social support for migrant women during the pandemic, providing further evidence that the pandemic has disproportionately impacted migrant populations. However, the benefits identified in this study included high use of virtual support, which could be leveraged for improving clinical care in the present and in future pandemics. The COVID-19 pandemic impacted most women's peripartum social support

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with migrant families having ongoing disruption. Gains in the pandemic included greater gender equity for domestic work as husbands/partners increased their contribution to domestic work and childcare.

Keywords COVID-19, Pandemics, Maternity care, Migrants, Social Support, Antenatal Care, Gender equity, Postpartum

Introduction

The COVID-19 pandemic has had a devastating impact on the world including increased direct mortality, morbidity, poverty and significant social upheaval [1, 2]. Australia experienced an initial low prevalence of COVID-19 disease compared to many other countries. The majority (89%) of COVID-19 deaths and cases in Australia during 2020 were in the state of Victoria and by mid-2021 Australia-wide there had been a total of 910 deaths [3]. Measures such as lockdowns and health facility preparedness were largely successful in containing the spread of COVID-19 until the sharp rise in cases mid-2021 [4]. Other measures for containment included closing the Australian international borders to non-citizens for nearly two years from March 20, 2020 to February 21st 2022 [5].

The closed international borders during the pandemic have impacted many aspects of life including access to overseas social support networks. This was particularly relevant for the migrant community throughout Australia. Australia has a high migrant population with 7.7 million migrants in 2020, nearly 30% of the population [6]. The main countries of birth for migrant Australians are: England (3.8%), India (2.8%), China (2.5%), New Zealand (2.2%) and the Philippines (1.2%) [6]. Of note for maternity care, the English migrant median age is 58 years while it is 35 years for Indian and 38 years for Chinese migrants [6]. Therefore, Indian and Chinese migrant women are more likely to be users of maternity services than English migrants.

Research and media reports have highlighted the impact of closed international borders on social support for migrant women in the peripartum period [7–9]. High quality social support can be a buffer against stress and consequently improve health [10]. Social support may be defined as having three main elements; emotional support from people who provide understanding and empathy; instrumental or tangible support defined as having people physically available to complete tasks for you; and people who can provide advice or knowledge, referred to as informational support [11]. Culture may also play a role in the type of, and preference for, support and how this support is provided or received [12–14].

In the Western Sydney Local Health District (WSLHD) of New South Wales (NSW) Australia, perinatal outcomes were impacted in the first year of the pandemic, including a 15% reduction in spontaneous preterm births [15]. Hospital health service changes included increased infection control measures such as mandatory mask wearing, reduced visitor access and some use of telehealth. In a low COVID-19 prevalent period, the changed obstetric outcomes are attributed largely to the indirect impact of COVID-19 through health services and societal changes. This study will assist in understanding the COVID-19 pandemic patient experience, contribute to understanding patient engagement with healthcare services and potential factors contributing to the changed perinatal outcomes during this period. Our aim was to explore the experience of peripartum support for women during the first year of the COVID-19 pandemic in a high migrant population.

Methods

Design

A mixed methods study design was employed with semi-structured interviews used for qualitative data collection, and quantitative data extracted from hospital pregnancy records and a study specific quantitative questionnaire. The semi-structured interview schedule focussed on three-key areas: support, cultural context and maternity care. Support during the peripartum is defined as meaning family members and others who provide emotional, tangible/instrumental (practical), and informational support [11].

Setting

Participants were recruited at a tertiary referral hospital in WSLHD, NSW, Australia. WSLHD has a high migrant population with 58% of women who use the maternity service born in non-English speaking countries [16]. The recruitment hospital has approximately 5000 births per year [16]. During the study period there was a low prevalence of COVID-19 in the community with a total of 149 cases in the health district including two women recorded to have been COVID-19 positive during pregnancy (Fig. 1) [4]. Community 'lockdown' orders were in place for the state of NSW for seven weeks from 30th March 2020. However, hospital COVID-19 mitigation restrictions remained for the study period including hospital entrance health screening, patient only waiting rooms, no support people in ultrasounds and only one support person permitted in the birth unit.

Participants

There were 24 participants interviewed, with 22 interviews conducted antenatally and 18 postnatally. Antenatal inclusion criterion was gestation greater than 34

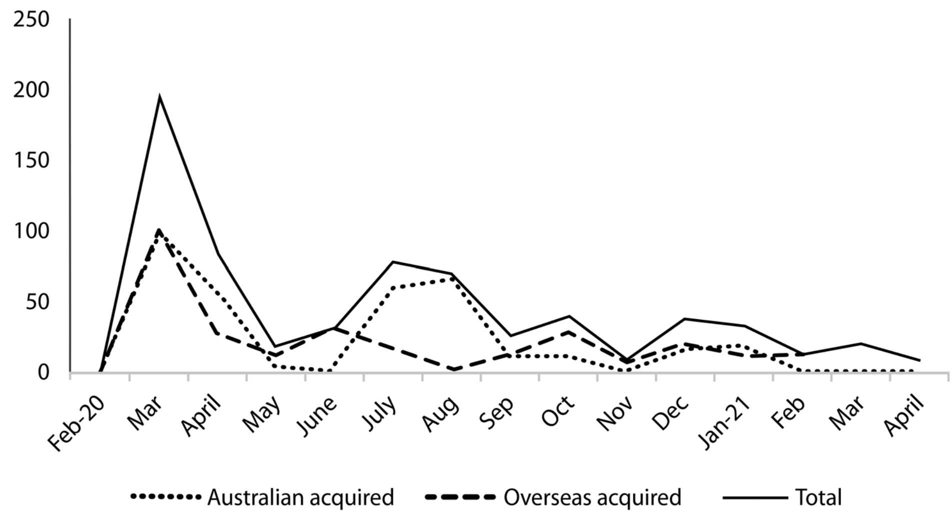

Fig. 1 COVID-19 cases in Western Sydney Local Health District February 2020 – April 2021. Study participants interviews from 22nd October 2020 to 15th April 2021. (Source https://data.nsw.gov.au/data/dataset/covid-19-cases-by-location)

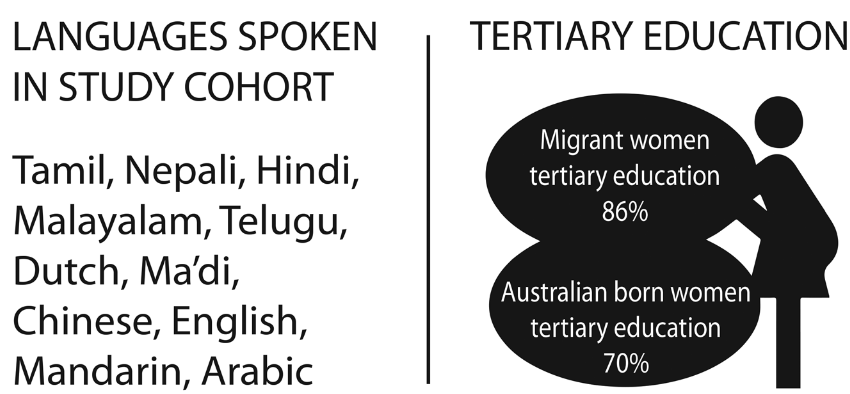

Fig. 2 Characteristics of the 24 study participants

weeks and postnatal inclusion required that the baby was not a hospital inpatient. Maximum variation purposive sampling was used to ensure a culturally diverse participant voice was represented that reflected the local population (Fig. 2) [17].

Data collection

Three sources were used for data collection: interviews, study specific questionnaires (Additional file 1) and routinely collected maternity data. The survey instrument was developed by the investigators and edited after pilot testing for readability with eight culturally diverse women. Cultural groupings were based on Mothers and Babies annual report New South Wales with known local demographic considerations [16].

Antenatal and postnatal interviews occurred over a six-month period from October 2020 to April 2021. All participants were offered an option of face to face (when COVID-19 restrictions allowed), telephone or video interview at times convenient for them. Of the twenty-two antenatal interviews eleven were face to face, six were video interviews and five interviews were completed by telephone. Eighteen postnatal interviews were conducted with participants, 17 by telephone and one by video. Recruitment ceased when sufficient rich data was collected from a diverse range of participants to provide insight into the research question. The interview times ranged from 30 to 75 min antenatally and 15 to 70 min postnatally interviews. All interviews were transcribed by a professional transcription service. Interviews were conducted by the research midwife first author (SJM) with progress and oversight provided by an expert qualitative researcher (JM).

Data analysis

Quantitative data was collated from surveys and presented as descriptive statistics. Data from transcribed interviews were coded and analysed thematically using an inductive approach. Analysis was conducted in six non-sequential phases as described by Braun and Clarke

[18]. Deep familiarisation with the data by the first author was the initial phase that included reading and rereading all interview transcripts, discussing interviews with the senior author (JM), reviewing field notes, reviewing transcription with audio to correct transcription errors. Iterative phases for data analysis were: generating codes; exploring initial categories and themes; reviewing initial themes; finalising and naming themes, and producing the report [19]. Two authors (SJM, JM) agreed upon and defined codes (derived from both explicit and implicit meanings), categories and themes. Themes were reviewed and consensus reached by a third author (NG) acting as a content expert as the maternity cultural liaison officer in the study hospital (MLO). NVivo (release 1.5.1) was used for data management and assistance with analysis.

Personal, research and clinical experience of investigators was taken into reflexive consideration and trustworthiness during all phases of the research process. All investigators had disruption to their professional and personal lives through the lived experience of the pandemic and this was also reflected upon by investigators throughout the project design, data collection, analysis and interpretation phases.

Results

The study covers a low COVID-19 prevalence period in the local health district (Fig. 1). Antenatal interviews were conducted with women between 34 and 39.4 weeks gestation and postnatal interviews 5–12 weeks after birth (Table 1). There were 14 overseas born participants and 10 Australian born. One of the overseas born participants stated she was a refugee. Five out of the 10 Australian born women stated they had partners who were migrants. Most participants were tertiary educated (19 out of 24, 79%, Fig. 2). Most Australian born (7 out of 10) and migrant (8 out of 14) women were employed full-time, part-time/casual or were on maternity leave.

OS = Overseas born AustB = Australian born SA = South Asian SEA = Southeast Asian NEA = Northeast Asian.

ES = English Speaking: Australia, United Kingdom. New Zealand or America.

ME/ES = Middle Eastern/English Speaking.

Themes

Among this well-educated cohort, we identified four major themes when exploring support for women in a high migrant population during the first year of the COVID-19 pandemic. These themes were: significant

Table 1 Antenatal and postnatal interview and participants characteristics during the low prevalence first year of the COVID-19 pandemic in Western Sydney, Australia

Participant	Country of birth	Self-identified cultural group	Primiparous	Years lived in Australia	Weeks of gestation antenatal interview	Weeks postpartum at interview
P1_OS	India	SA	Yes	4	.	8
P2_OS	Nepal	SA	Yes	2	37.1	9
P3_OS	Nepal	SA	Yes	3	39.1	10
P4_OS	India	SA	Yes	2	38.5	12
P5_OS	India	SA	Yes	4	36.5	9
P6_OS	India	SA	Yes	3	.	10
P7_OS	India	SA	Yes	2	38	9
P8_OS	Nigeria	African	No	5	34	.
P9_OS	Netherlands	Dutch/Irish	No	6	36.6	7
P10_OS	Philippines	SEA	No	10	39	10
P11_OS	South Sudan	African	No	10	35.1	8
P12_OS	China	NEA	No	5	36.6	7
P13_OS	India	SA	Yes	10 months	39.1	.
P14_OS	China	NEA	No	8	35.4	12
P15_AustB	Australia	ES	No	.	36.6	
P16_AustB	Australia	ES	No	.	37	10
P17_AustB	Australia	ES	No	.	36.2	.
P18_AustB	Australia	ES	No	.	34.3	6
P19_AustB	Australia	ME/ES	Yes	.	34.6	9
P20_AustB	Australia	ES	No	.	34.3	7
P21_AustB	Australia	ES	Yes	.	39	.
P22_AustB	Australia	ES	Yes	.	39.4	6
P23_AustB	Australia	ES	Yes	.	36.6	5
P24_AustB	Australia	ES	No	.	38.6	.

disruption and loss of peripartum support during the COVID-19 pandemic that had ongoing impact for migrant women; holding on by a virtual thread; supportive employers making a difference, and impact on mental health of both participants and partners. Other themes identified were: husbands/partners filling the support gap; building family bonds; a lucky few with neighbourhood support close and plentiful; COVID-19 fear and baby safety.

Significant disruption and loss of peripartum support during the COVID-19 pandemic that had ongoing impact for migrant women

No migrant women in the study had access to their mother's physical tangible support due to COVID-19 related travel restrictions. Half the migrant women in the study described feeling unsupported or having less support than they would have wanted. This was the case in the antenatal interviews and remained so for the postnatal interviews when COVID-19 restrictions had largely been removed in the community; "…life has somehow stopped, and I really want my mum to visit me as soon as possible" (P4 India Postpartum). Half the Australian born women also described a lack of support during pregnancy when hospital, local and interstate COVID-19 related travel restrictions were present. However, satisfaction with support improved for Australian born women postnatally when these restrictions were eased.

> *So now that all the COVID restrictions, especially with the amount of people in your households and everything like that, have been completely reduced, we've had more support than we can handle. (P24 Australian born (Aust) Postpartum)*

Issues with access to support continued for most migrant women into the postnatal period with no difference between multiparous or first-time mothers. Missing out on overseas family support appeared to be similar for women who were new migrants and for those who had migrated more than five years previously. The survey identified most (64%) migrant participants had planned on receiving supportive visits from overseas relatives. The duration of planned visits was to have been from three to six months.

> *But this time, due to COVID, no one is able to [come]. [Last baby]…we have four parents here and then this year no one is able to come...Yeah, most worry is I don't have any family support, they restrict me from getting supports from my family. (P14 China Antenatal)*

First time migrant mothers stated they missed instructional support and multiparous women expressed missing emotional support and child-care support for older children. Two migrant women stated they paid for in-home help to fill the gap left by absent relatives. One had assistance for a few hours a day, the other had live-in help for six weeks. The participant with in-home help felt she had not missed her mother as much as anticipated in the antenatal period as the carer had provided valued professional guidance for newborn care. However, she also said paying for this help had been a significant economic burden on the family.

Almost all migrant women when interviewed postpartum felt they missed their mother but by using various strategies were able to cope better than they had thought they would during the antenatal period.

> *So, yeah, it turned out really good. Day by day started falling in place, we got sort of prepared that, no, our in-laws couldn't come, no one from the family is going to come, so we have to be by ourselves, borders are not going to open. We were very well prepared, we were by ourselves, we have to do things on our own, and by God's grace we have really good friends around who stepped forward for our support. (P6 India Postpartum)*

Husbands/partners filling the support gap; "He did a fantastic job. I'm so blessed. I'm totally blessed"

Most (13 out of 14) migrant participants stated their partners were integral to them feeling supported during their pregnancy and when caring for their newborn; "I really don't have much support, … only my husband he is there for me" (P11 South Sudan Antenatal). In contrast only a minority (3 out of 10) of Australian born women discussed partner support. Migrant women described that their partners had stepped in to provide support to compensate for the loss of traditional support mothers and other relatives would have provided.

> *…it was my husband who stepped into my mother's role, or a true companion role, I could say, that he started cooking, he started learning how to cook and take care of me. He did a fantastic job. I'm so blessed. I'm totally blessed. (P6 India Postnatal)*

There were other factors during the pandemic that facilitated partner support such as opportunities created from husbands/partners working at home. More than half the participants described the supportive benefits of their partners' capacity to work from home.

> *Just my husband is home. [Laughs] So easy. He's*

always available. If it was not COVID, then my mom would have been here. So that would have been a different story. But my husband is home, working from home, so he's available 24/7. So, if I find any difficulty or trouble, anything really, to my mood swing or whatever, I can go to him. (P4 India Antenatal)

Building family bonds - the benefit of missing support; "…*it made us more self-dependent"*

Gender equity and opportunity

Women described that their partners had benefited from the extra family time that may not have occurred without COVID-19. There were increased opportunities for husbands to not only understand the needs of their partners during the peripartum period and provide support for them, but also engage in care for their newborn and older children. One study participant described that the pandemic had provided a unique opportunity for them to understand gender roles and for her husband to be a greater part of the pregnancy journey.

[My husband]...started to understand more like, OK, what exactly a woman is, what exactly a man is. Those things are something I believe it's really hard… And he actually know what an importance a woman is, what a pregnancy is, what a baby delivery is. So, I think that makes your relationship and your bonding more stronger. (P6 Postnatal India)

A participant explained during the postpartum interview she had found some benefits to relatives being unable to visit including not having to deal with the stress of negotiating inter-family harmony; "I don't have to worry about the relationship between in-laws or my parents and me because sometimes we have different opinions [on baby care] [laughs]" (P14 China). She further explained the support from her husband with caring for her first-born child had strengthened their relationship and their family unit. Another participant explained COVID-19 travel restrictions benefits included staying with her husband rather than separating for the birth.

I would go to India for the delivery, and come back after some time, my in-laws or my parents would have been here, and he would have gone to work at the time…Yeah, he would have missed everything, yeah. (P1 India Postpartum)

Illustrating the support from her husband to care for both her needs and the newborns', one participant described the extent of organised leave he had taken to provide the practical support that would have otherwise been given by relatives; "…my husband has taken off two months, and after two months definitely I have to look after me, like for myself and as well as for the kid" (P3 India Antenatal). The practical skills gained of infant care for both parents that would have been relegated to others were also appreciated by some participants. In antenatal interviews, the forced parenting independence and infant care skill acquisition was the cause of some anxiety, that participants' parents would not be present to be 'taking charge', but this was ultimately valued postnatally.

…it's a positive, but then you're learning the hard way…when someone is there taking charge, they are thinking, it's not you who are thinking, you're just following the lead. So you are not thinking and you're not, you know, trying to understand what's happening, but now you have to think and you have to get things done. (P5 India Postpartum)

Families that had previous experience of live-in help from relatives were aware of missing that support but also understood the opportunities of a different experience with partners, for example having the time and space to be more engaged with infant care.

And he's very excited as well because the last one obviously we had all the family and he didn't necessarily have to step up …there was times where he felt like he – my mum would take over or something like that. Well, he's quite excited about the fact that he will have to do night feeds and he will have to change all the nappies. (P9 Netherland Antenatal)

Holding on by a virtual thread; "…*thank God for technology"*

Almost all participants described a high level of virtual contact with families, particularly their mother. For both Australian born and migrant women, contact with their extended family was daily for approximately two thirds of women in the study (16 out of 24), with three women describing virtual contact as being several times a day. More migrant women had daily contact than Australian born women. All other participants stated contact with family was at least weekly. Virtual contact was through the use of audio only telephone, text or video (Table 2). Participants' definition of 'frequent' speaking or contact varied from 'multiple times a day' to weekly and the length of contact ranged from five minutes to several hours.

…she was pretty excited to come here and help me through, but unfortunately it could not happen. But I speak to her every day. I do a video call and then

Table 2 Quantitative Survey data participant peripartum support details during the low prevalence first year of the COVID-19 pandemic in Western Sydney, Australia

Participant	Planned length of stay for live in help (months)	Frequency	Contacts overseas relatives
P1_OS	6	Daily	Facetime
P2_OS	6	Every few days	Viber
P3_OS	.	Every few days	Viber
P4_OS	3	Daily	N/A
P5_OS	6	Daily	WhatsApp
P6_OS	.	Daily	WhatsApp
P7_OS	3	Daily	WhatsApp
P8_OS	.	Every few days	Voice phone
P9_OS	1	Every few days	WhatsApp
P10_OS	.	Occasionally	Facebook Messenger
P11_OS	12	Every few days	Voice phone
P12_OS	.	Every few days	N/A
P13_OS	.	Daily	N/A
P14_OS	6	Every few days	WeChat
P15_AustB	.	.	.
P16_AustB	.	.	.
P17_AustB	.	Weekly	Facetime
P18_AustB	.	.	.
P19_AustB	.	Daily	WhatsApp
P20_AustB	3	Every few days	Voice phone
P21_AustB	1 week	.	.
P22_AustB	.	.	.
P23_AustB	.	.	.
P24_AustB	.	.	.

OS = Overseas born AustB = Australian born N/A = not available

> *we speak for hours. (P4 India Antenatal)*

One Australian born participant described the routine daily video contact with her mother who lives interstate: "She likes to have breakfast with us… She'll have her coffee ready and then she watches my son eat his breakfast and make a mess" (P20 Aust Antenatal).

Distance did not appear to be associated with the frequency of virtual family contact for both Australian born or migrant women. One Australian born woman who had her mother, relatives and friends in close proximity, had virtual contact by telephone with her mother 2–3 times per day, her sister multiple times per day and her brother, who lived interstate, weekly. A study participant described daily contact with various family members who had migrated to other countries: "All family in different four countries, every day someone is checking" (P6 India Postpartum). Three participants spoke of frequent video calls that fostered a virtual relationship with grandchildren and assisted with virtual childminding.

> *…they want to see her and talk to her. So, we make a video call, and we fix in a stand, and make them to speak with her. So she babbles again to them. So they feel little relieved, and they feel little happy… I'll do my cooking things, and I'll do all the housework things. And so that they could interact with her, and they make her distracted… (P1 India Postpartum)*

Participants stated frequent inexpensive virtual contact with their support networks was also beneficial to their mental health, particularly during COVID-19 lockdown periods with reduced opportunities to socialise: "I was in (virtual) contact with friends and family frequently, I didn't feel much loneliness or any sort of things during COVID (lockdown)" (P13 India Antenatal).

However, some women expressed the frequent virtual contact did not replace the desire for physical presence. One participant discussed the loss of child-minding support; "they can just only tell us what to do but they cannot help…" (P14 China Postpartum). Most women from overseas also sought virtual guidance to maintain cultural connection and adherence to traditions.

The content of conversations with relatives for the majority of Australian born women differed from overseas born women. Australian born participants stated the content was primarily connection and emotional support rather than cultural connection and adherence to traditions; "…sometimes we'll just sit there and share recipes of what we're making for the week, just to kind of have that communication" (P23 Aust Antenatal).

Not all migrant women had access to reliable frequent virtual support due to both financial constraints and overseas relatives having limited or no access to technology, which reduced capacity for frequent virtual support and contact. The difficulty for some migrant women to connect to family members in low-income countries was discussed. One study participant from South Sudan described it was easy and free to use phone apps to contact her sister but connecting to her mother was problematic; "My mum is in a village, and I have to put a credit and call and sometimes I do not have credit".

Two-way virtual support

The desire for, and disruption of, frequent support was two-way. Both Australian born and migrant participants stated that as well as receiving support, they were also having to provide support virtually that they would have provided in-person without COVID-19 restrictions. For example, one Australian born woman spoke of providing virtual support for her mother:

> *Mum has leukaemia, so I can't see her during COVID… I think it's just one of those two-way things where we just feel so horrible about the whole situation, and that we can't – we aren't doing enough for each other. (P23 Aust Antenatal)*

Virtual contact was the only option due to travel restrictions and the vulnerability of her unwell mother. However, she was able to facetime daily from ten minutes to two hours; "I mean half the time we just lay there, and I wait for the baby to move so she can see it" (P23 Aust Antenatal). One migrant woman described her father's illness and then his death. She was unable to be present to support her mother in the Philippines but could at least provide some support virtually.

> *…you know, thank God for technology. We can still talk to them and call them, and Mum gave us updates when Dad was in hospital, in the ICU, and all those things. So we were still there but we were not there, if that makes sense. (P10 Philippines Antenatal)*

Supportive employers making a difference; *"…the work that he's with now has been amazing"*

There were eleven women who specifically discussed support they or their partner received from employers. All participants who discussed paid employment stated during the COVID-19 pandemic they felt supported in their pregnancy by their workplace; "Even my manager told me like, 'If you need to take more breaks, take it.'" (P5 India Antenatal). No participant reported that their management or their husband's workplace had been obstructive with requests concerning pregnancy care or leave.

Working from home for most participants was valued and viewed positively. Women discussed feeling more relaxed as they no longer had to spend time on crowded public transport with the associated COVID-19 risk. Women stated they benefited financially from reduced expenditure on transport and clothing.

The neighbourhood village: a lucky few with support close and plentiful; *"…we've had more support than we can handle."*

Almost all Australian born women who had relatives living nearby felt well supported. Migrant families drew support from local friends, siblings or their own or partners' families but still did not feel as supported as Australian born women. One participant had both her family and her husband's family living close and felt COVID-19 had not changed anything for her. At both the antenatal and postnatal interview she felt well supported by her close family; "Yeah, it's been great [support]. I've got a great family; got a very large family, and my partner's family is great as well… I just live right around the corner from my parents, so we were over there quite a lot" (P16 Aust Antenatal).

Impact on mental health for both parents; *"…It was very lonely"*

Both migrant and Australian born women discussed the impact the pandemic and restrictions had on support and their mental health. Loss of joy around the pregnancy experience was discussed: "It's been very different. Otherwise I would have really enjoyed it" (P4 India Antenatal). The emotional burden of living in the pandemic was difficult for many women; "…it was all just kind of one thing after another after another, where it'd been this extreme emotional rollercoaster for myself and my husband" (P23 Aust Antenatal). The direct impact of hospital restrictions on partners attending some appointments and ultrasound impacted the mental health of the family and created uncertainty for women's access to support; "Like he ended up in tears when we couldn't see the first ultrasound [together], and he wasn't allowed in" (P23 Aust Antenatal).

Three women had a history of anxiety or depression which was noted on routinely collected data at hospital booking. Two of these women stated they felt well supported postnatally and antenatally on interview. No women in the study cohort scored >10 on the Edinburgh Depression Score (EPDS) at booking-in visit with the midwife. Two participants on interview disclosed they had professional help for mental health concerns, neither disclosed a history of mental health issues at routine booking visit or scored > 4 on the EPDS. One of these participants was diagnosed with depression for the first time during the antenatal period and stated the loss of her husband's presence and support during appointments contributed to her depression and feelings of isolation.

> *Just with the COVID restrictions the experience wasn't great. Just mentally, I think, more than anything, COVID impacted it. I had a really healthy pregnancy, I didn't really have any issues, but mentally it was a bit of a challenge… just a huge mental drain. (P23 Aust Antenatal)*

During the study period, only patients were allowed in the antenatal waiting room. One participant explained these hospital restrictions had left her partner feeling like a criminal; "He always uses that phrase: 'I feel treated like a criminal' " (P10 Philippines Antenatal). The threat and uncertainty around the potential loss of partner support was a source of concern and stress for women; "I was worried that he wouldn't be able to be there or that I would have to go through labour on my own" (P9 Netherlands Postpartum).

COVID-19 fear and baby safety above all else: "…so worried, that if I get COVID, it would kill the baby"

Overall, the majority of study participants (18 out of 24) stated in antenatal interviews that their main concern regarding COVID-19 was the safety of their baby while pregnant or as a newborn: "…what if I get it, it's going to pass onto my baby. And I'm not scared for myself" (P6 India Antenatal). This concern for their unborn baby restricted most participants' movements outside the house beyond the lockdown and lasted throughout their pregnancy. This was the case for most migrant and Australian born women; "I am very scared to go out and risk meeting other people…We rarely went out' (P10 Philippines Antenatal); 'I was so, so worried, that if I get COVID, it would kill the baby" (P23 Aust Antenatal).

The strong public health messaging in the community around the importance of hand sanitising and wearing face masks left four women feeling unsupported with lack of information on how to keep their baby and children safe from COVID-19.

> *We cannot wear mask or sanitise the hands of the baby. We can do it but we cannot do it for the baby… What are we going to do with the baby, like how are we going to ensure the safety of the baby is a question and concern. (P13 India Antenatal)*

Many participants spoke in the antenatal interviews of ways to mitigate infection risk. Three women discussed the fear of the effect COVID-19 infection may have on their unborn child which resulted in themselves or their husband changing or stopping work which could have a significant financial impact:

> *When I have my pregnancy last time I was working, but this time when I found I was pregnant I quit my job because of the COVID-19 just to keep safe… I would like to work because I can earn money for the family, but yeah, I have to balance the safety. (P12 China Antenatal)*

Most migrant women postpartum discussed their primary concern with COVID-19 had shifted away from the risk of COVID-19 infection to the shut borders and missing support: "…the major thing is my family. I'm, like, I'm worried my baby can't see my family" (P2 Nepal Postpartum).

Discussion

This study identified differences between migrant and non-migrant women in their experience of peripartum social support during the COVID-19 pandemic. We found that migrant women were significantly impacted during the pandemic both antenatally and postnatally, primarily due to the loss of support from disrupted international travel. Migrant populations have been disproportionately impacted by the COVID-19 pandemic with studies providing evidence of increased burden of COVID-19 disease, mental health and socio-economic consequences in both high and low-income countries [1, 19–23]. It is essential to understand women's experience during the pandemic to assist in providing optimal support, planning future pandemic risk mitigation and identifying potential factors that affect obstetric and other health outcomes.

Supportive social networks are important as a buffer for stressful life events and have been shown to improve cardiometabolic health outcomes [10, 24–26]. Optimal social supports are mitigators for the known impact that stress, disasters and pandemics can have on long term cardiometabolic health as well as a wide range of immediate benefits, including mental health and child development [27–34]. Disrupted support during the pandemic may also influence perinatal outcomes [35]. Healthcare systems understanding, facilitating, and supporting these buffers for long term health, may prove increasingly important.

This study identified a disrupted support network for participants but also identified how technology played an integral part assisting women to remain connected to family. Virtual support has been identified as a mediator to improved perinatal mental health and social support both before and during the pandemic [33, 36, 37]. We found virtual support acted as a significant buffer to stress providing emotional and informational support, as well as improving mental health. Clinicians should continue to find avenues to encourage and facilitate the use of virtual social support during the peripartum.

The cultural expectation of many migrant women is their mothers or relatives will provide extensive support postpartum to facilitate resting and care of the newborn. For some cultural groups this may involve 30 days of no cooking or domestic cleaning duties for new mothers, with the expectation of complete physical rest and a focus on caring for the new baby [14, 38]. This study identified migrant fathers were facilitating new mothers' rest and this assisted with maintaining valued cultural practices and connection to countries of birth.

Our research has highlighted the impact of missing relatives within culturally driven gendered domestic roles, now filled with 'husbands/partners stepping up'. This study has illustrated that opportunities to work from home facilitated filling of a domestic labour void by partners. Women described that COVID-19 delivered unexpected gains of opportunities for men to participate meaningfully in partnering more equally in parenting and domestic life, with research suggesting health benefits for both [39].

We have identified most women during the peripartum period had contact with their mother or close relatives frequently and are highly reliant on them for social support. We found a generation that has access to and utilised instant communication facilitating support. The shift to communicating virtually during the pandemic was embraced by our families. However, other research has shown the pandemic drove maternity care away from patient centred care and focused on preservation and safety of staff without providing meaningful alternative options to support and connect clinicians with women and partners during the pregnancy journey [9, 40, 41]. Understanding and leveraging existing virtual patient communication preferences in clinical care may strengthen care provided. Virtual emotional and informational support has been identified in this study to improve mental health and be highly valued by all women, but particularly women in our migrant population. Potentially utilising and leveraging this connection for family group counselling intervention programs and education may improve health outcomes as well as engagement with maternity services. Exploring new ways to support women using eHealth mental health programs may also offer some feasible and affordable ways to improve the health impact of isolation and depression during the peripartum period, particularly for migrant women [42, 43].

We found the adverse impact on mental health for migrant women was largely driven by the loss of valued overseas tangible support. Other research has identified that during the pandemic higher levels of social support were protective for adverse perinatal mental health [44, 45]. Migrant women are potentially more at risk due to barriers to mental health diagnosis and treatment [46, 47]. Antenatal screening has been recommended to identify women who have low levels of social support and are more vulnerable to mental health disorders, but this has been problematic both in the development of care pathways and an appropriate universal screening tool [48, 49]. We identified women with a significant mental health concern requiring treatment in our cohort who were not identified at early pregnancy screening. Clinicians need to reassess patients' mental health status throughout the perinatal period and offer appropriate clinical support. Pandemic preparedness should include development and use of social support screening and care pathways particularly for vulnerable and migrant women.

Similar to other studies, we identified that hospital restrictions on support people and women fearing the impact of COVID-19 on their unborn babies also negatively influenced women [9, 50]. Some women chose loneliness to protect their baby from potential COVID-19 infection. The increased isolation during pregnancy beyond lockdown periods identified in this study may provide some evidence for potential drivers for the reduction in spontaneous preterm births found in our district [15]. It has been hypothesised COVID-19 isolation may reduce exposure to pathogens associated with preterm birth [15, 51].

Strengths and limitations

A strength of this study is utilising an interview process including both antenatal and postnatal interviews with the same participant to clarify and compare pre- and postnatal experience. Limitations include the cohort was highly educated potentially with greater capacity for partners to be working from home and have the financial means for access to virtual support. Another limitation is the follow-up interviews were only up to 12 weeks postpartum. Migrant women's experience of partner support may well be different at one year postpartum when partners are no longer on parental leave or unable to work from home.

Conclusion

During the pandemic there has been a growing body of research highlighting the disparities in health outcomes for migrant populations and this study provides further evidence of the vulnerabilities of migrant women. Half the migrant women in this study felt unsupported or reported less support than they would have wanted due to pandemic restrictions. We found no difference between migrant women who felt unsupported postpartum if they were multiparous, primiparous, new migrants or had migrated greater than five years ago. In contrast to migrant women, perceptions of support improved postpartum for Australian born women. These findings demonstrate the wide-spread devastating impact the pandemic has had on our migrant families and highlights the need for perinatal support assessment in pandemic preparedness. However there have been some benefits including gains in gender equity and therefore the need for care providers to be mindful of gender role assumptions in migrant families. Assessing ongoing disruption to support experienced by migrant women will assist with clinical care, as well as planning for future pandemics and the potential impact on current and long-term health associated with impaired support.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-023-05745-9.

Additional file 1

Acknowledgements

We thank the women who participated in this study for their valuable time.

Authors' contributions

SJM: Conceptualisation, data curation, methodology, interview data acquisition, analysis, project administration, resources-funding, Writing- original draft, Writing- reviewing and editing. JM: Supervision, conceptualisation, data curation, methodology, analysis, Writing- original draft, Writing- reviewing and editing. DP: Conceptualisation, methodology, resources-funding, writing- reviewing and editing. NG: Conceptualisation, methodology, recruitment, analysis, Writing- reviewing and editing. TIA, VL, NWC, TM, JS: Conceptualisation, Writing- reviewing and editing. All authors read and approved the final manuscript.

Funding

A Westmead Hospital Charitable Trust grant was awarded to SJM. Some funds from this grant were used for this research: professional transcription and back-fill of substantive CMC role. The funding body had no role in study design, analysis or manuscript development.

Data Availability

Due to privacy issues of participants individual dataset is not publicly available. Summary data is available on reasonable request from the corresponding author if compliant with local ethical guidelines.

Declarations

Ethical approval and consent to participate

The interviewer (SJM) had no clinical relationship with the participants. Informed written consent was gained from all participants prior to participation in the study. Approval was granted by Western Sydney Local Health District Human Ethics Committee (2020/ETH02074) 23 September 2020. All research methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 10 October 2022 / Accepted: 29 May 2023
Published online: 09 June 2023

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Publisher's Note

Appendix 6a

Chapter 6 Supplementary table supporting quotes (not published)

Main Theme: Significant disruption and loss of peripartum support during the COVID-19 pandemic but ongoing impact for migrant women: ***I don't have anybody else here***
I don't have anybody else here…this is our first baby right now. So, you know, things are extremely difficult. ***(P1 Postpartum India)*** *So for me, the thing I miss the most is my mother is not here. If she could have been here, I know everything would have been different, that's something I talk to my husband every day.* ***(P2 Antenatal Nepal)*** *I feel like if my mum was there, like, she would have known whether this is normal or not. So there are situations where we kind of start panicking when we are not supposed to panic. So, yeah, I think, yeah, it would have been a lot, lot better if she could have been there, but I think we are managing.* ***(P2 Postpartum Nepal)*** *I get regular support from them (friends) like in terms of giving me the food or coming here over for support, moral support and physical support. Like if I need something to be done in the house, they come over and they help me a lot. So of course, I don't have the family here, but I have good friends here who are helping me a lot of this phase...I would have loved to have my mother here, but unfortunately, I couldn't.* ***(P4 India Antenatal)*** *My concern is that life has somehow stopped, and I really want my mum to visit me as soon as possible. So if at all it happens to get better and the flights open, then my mum will be here.* ***(P4 India Postpartum)*** *Yeah, we do have friends, we don't have relatives here. But yeah, we do have friends. But yeah, everyone are busy in their lives. Everybody has their world. So they can't support us.* ***(P7 India Antenatal)*** *She (mother) is devastated that she can't come out. She just, yeah, wants to be here and meet the baby and look after me.* ***(P9 Netherlands Antenatal)*** *...they changed the restrictions so they were able to come down, no problem...nearly three weeks and they pretty much looked after my other two children while I just tended to the baby really [laughs], so really lots of help, which is good.* ***(P18 Aust Postpartum)*** *So, she (Aunt) really wanted to be here when the baby arrived because my mum passed away from breast cancer 10 years ago; so that's her sister and she just really wanted to be there for the baby. And she's really exciting, and she, I guess, wanted to step in and fill that role and just provide extra support when the baby was born. But that's not possible now…A green zone to red zone, or something.* ***(P21 Aust Antenatal)*** *I guess because we knew that this was coming. So are trying to, like, cope with it, like it's not that it's the end of the world. But I'm sure, like, if my mum could have been here, it would have been better.* ***(P2 Nepal Postpartum)***
Holding on by a virtual thread…*thank God for technology.*
And when I talk to them, like, I mean, I don't feel, you know, sometimes like they are there, with us if not near to us, with a video chat I will say it's fine sometimes... Sort of connected… Yeah, thanks to the technology we can video chat. [Laughs]. Otherwise, I would've been in a depression. ***(P3 postpartum Nepal)*** *… it was sad when they can't see my baby, but at least, you know, if the video call is there at least they can, you know, I can show them.* ***(P5 India Postpartum)*** *My son will be smiling to them. And then show off what he can do to them. Like, he can play the little piano to them. It's his show-off time to the grandparents.* ***(P14 China Antenatal)***

His little girls are four and his boy's two, so it's hard not seeing them, because they're so little. They forget who you are. So I think that's why Skype is good to actually be able to see them and watch them for the whole year. ***(P16 Aust Postpartum)***

So that's been probably the biggest struggle, because of just not having that face-to-face communication, or like being able to see her physically… having to do everything remotely. Even though we grew up in the generation where everything's up on the TVs, and computers, and everything else, it was still a bit of a shell-shock experience. ***(P23 Aust Antenatal)***

I am worried about COVID in Sudan because like there in Sudan everything like technology and health everything is not in place is very very poor. So, if anyone gets COVID there only God knows what they goes through… Yeah they need support from me and I need support from them too because the situation there like financially they are poor some of them lose their job there is no job keeper …sometimes they need financial support to get soap to wash your clothes or even cooking oil things you cannot get from the farm you have to buy, so it is a bit hard. ***(P11 South Sudan Antenatal)***

But I don't speak the same language. So he'll speak Arabic. So I just say hello. They just tell me that they miss me, they love me, tell me that my belly is getting big and it all like charades. And then my husband talks to them for hours... minimum five times a week... a big family, he has to get through them all.
(P20 Aust Antenatal)

Husbands/partners filling the support gap… ***He did a fantastic job. I'm so blessed. I'm totally blessed.***

At least my husband can be right now with me[working from home], so that's like really the only positive news for me. Because my family couldn't be here, at least he could help me at that time so I'm little, what to say, like I'm little fearless… he is very supportive of me, and he's helping me with chores, and taking care of the baby whenever… we are like sharing a lot of the workload. ***(P1 postpartum India)***

…he was taking care of everything. So that was something I think which mattered more than anything else, so … I was pretty happy. Like if I just think back, it was just a very peaceful pregnancy… he's there always, so … So, I did not feel that bad.. He was a big support throughout my nine months of my pregnancy.
(P5 India Antenatal)

And it's my first baby, I don't know what to do, what to eat, how am I going to take care of myself, and especially my husband never entered kitchen…He has never been in the kitchen he started going to the kitchen started to cook. He was a big support throughout my nine months of my pregnancy, I don't miss my family, my mum dad, his mum dad or anyone else .. he did the best… He really took good care of me and my baby, it is difficult without family emotionally, we needed them I think for me personally he was always there, he tried to do his best. ***(P6 India Postpartum)***

…we don't have any support, only me and my husband are doing everything from the beginning, and now also it's the same. Because of the COVID, everything is so different. ***(P7 India Postpartum)***

Building family bonds - the benefit of missing support; ***… it made us more self-dependent.***

- ***Gender equity and opportunity***

It was always a good relationship …but after this I think that it actually …it became more stronger and stronger... a lot of people have been complaining that COVID did this, we are facing this, we are facing that, but I personally feel that it has made us more mature, more responsible. Otherwise, we have been dependent on our family throughout, they are coming, they'll do things. But it made us more self-dependent.
(P6 India Postpartum)

I think if they were there[parents] maybe he would not, like, involve in most of the things because they will take care. But, yeah, as they are not there, then he is taking care of so many things. Maybe it is also good, for some reason. [Laughs]…It's like the bonding between the baby, me, and then it's more than – if they are there then they will be doing more work, so a little bonding will be missing. ***(P7 India Postpartum)***

… you really want your mum to be your – like you know, to be there with you on your side, or your sister or, you know, someone from your family to be there. But I think, you know, my husband did not give me a chance

[laughs] to think about that, like you know. Every time I'll be thinking about something, he would sort of overrule that…Like if I want to eat something, I don't know. He would somehow like try to make that or, you know, he would bring – buy it from somewhere or get that to me or if I want to talk, he's there always, so … So, I did not feel that bad and since I've been away from home for like, you know, almost seven years now, I do not feel that bad. ***(P5 India Antenatal)*** *… it was just a good way to learn more about each other and how we would react to different situations. So when there was all of the panic buying, navigating running out of toilet paper during that.* ***(P21 Aust Antenatal)***
Lucky few with the neighbourhood village with support close and plentiful…'*we've had more support than we can handle.'*
…my friend, they used to come like every day, and for the first two weeks, and then she was helping me with the cooking and massaging baby and even the in-laws, they used to come every day for two to three weeks… they usually come in the morning, and in the afternoon, and they will just stay for like, five, six hours and then they will leave. ***(P3 Nepal Postpartum)*** *So other than my direct family being up the coast and in Brisbane, we have my husband's mum and dad five minutes around the corner, his brother and sister-in-law ten minutes down the road, and then 20 minutes down the road is his sister. And then all our friends are within five minutes. So they pop over after work, they come over on their days off… they come over, they'll either cook for us or they'll bring meals, or they'll do some of our washing.* ***(P23 Aust Postpartum)*** *When I gave birth to my first daughter, she [sister] came over and prepared food that is hot to the body, like a lot of ginger, so we believe that we have to eat hot food after a major operation. So, yeah, she's a good support**...**we were lucky to have my partner's dad come over and stay at home actually. So he stayed here for three nights – the whole duration I was in hospital and the night before…That was a very good support system that we had…****(P10 Philippines Postpartum)*** *We send our kids to my husband's brother's home for two days. And then, after that we took care of them ourselves…Yeah, no choice [laughs]. They have to help.* ***(P12 China Postpartum)*** *So that did take a lot of the pressure off me. And it's very good support to have that …I was really thankful that I was with extended family, because I think if I wasn't, it might have been even more difficult if it was just, say, me and the kids.* ***(P15 Aust Antenatal)*** *Oh, amazing. We have … We see people all the – people are always wanting to come over, and even if it's just to give us a break or give us a chance to sleep for an hour, or … I had a friend come over the other day who literally just wanted to do some washing for me and wash up.* ***(P23 Aust Postpartum)*** *My in-laws are retired, so they're quite available, I guess, to help with babysitting and, whenever we sort of need them.* ***(P24 Aust Antenatal)***
Supportive employers making a difference
So because it's COVID, I'm mostly working from home, so it's kind of been a relaxed pregnancy for me, because I haven't had to travel a lot for my work. ***(P1 India Antenatal)*** *…everybody in his office knows that he's having his first baby, and there is no-one to help. And they were little lenient because if the baby cries, they allow him to go and take care of the baby.* ***(P1 India Postpartum)*** *...because of COVID my husband has been working from home, so it's more like, it's been very helpful because he has been around all the time, so it's OK. I somehow managed it.* ***(P4 India Postpartum)*** *I have had good support from my team and my employer, like people checking on me like, you know, at times. Like how I was doing and then you know, they were asking me, like my chief operating officer … she used to check in on me, she sends me books to read, like you know … Even my manager told me like, "If you need to take more breaks, take it. I'm not stressing you off. Like do the work whenever you're comfortable."... You might*

not expect that from the employer, because you know, you are – like I did not see any other pregnant women walking around in the office, so I don't know how things were going to be. ***(P5 India Antenatal)***

Ever since the lockdown started in March, I have stayed home and do my work. And my partner, looks after our 2 year old whilst I'm working. So, yeah, it's pretty much well supported during COVID.
(P10 Philippines Antenatal)

…the work that he's with now has been amazing. They put him on basically Metro for the remain – for the next six months, I think it is, until he says he's ready to go back to do it. ***(P23 Aust Antenatal)***

…one positive is that I've been able to work from home and keep safer, in a safer environment just because, you know, the COVID's unknown and, you know, how it would affect a pregnancy. ***(P24 Aust Antenatal)***

Impact on mental health of both parents- It was very lonely

Fear, anxiety and depression driving behaviour changes

Because of the infection. I was really scared of stepping out and for a very long time, I think for months I could not go. So that was depressing. …because of Covid I could not enjoy my pregnancy to the extent I wanted to. And I was mostly irritated, because I could not do things and I was always scared. Always. ***(P4 India Antenatal)***

I guess primarily it's the mental health thing. It's really driving me crazy because I'm stuck at home with my husband and toddler and newborn, and together we can't go out because of COVID.
(P10 Philippines Postpartum)

… yes…loneliness yes, it is, but I just try because of safety. I feel lonely. ***(P11 South Sudan Antenatal)***

On entry to Australia pregnant alone for 14 days of hotel quarantine without husband*: I think on the 7th day I started crying [laughs]. …I'm an 'out and about' person so being stuck on that bed and I'd move from the bed to the chair, and then the chair to the bed. And obviously I'm not working; I couldn't do anything, work online. I don't know; you just feel trapped, lonely… I was worried about when I go to the bathroom, oh, my God, what happens if I slipped. Like those stupid thoughts.* ***(P19 Aust Antenatal)***

And especially being the male, I mean they don't get to feel what we feel inside, they don't get to feel her rolling around, or waking up in the middle of the night because she's kicking, ..and it's all kind of all the fun stuff. So I think taking away (attend appointments) that element where he could be a part of a bit more just kind of killed him… I mean the ultrasound part is what killed him. ***(P23 Aust Antenatal)***

…The other week I had my last growth scan, and I came home, and I got to tell him that I got to see her face, and that you could kind of work out what she would look like, and everything like that. And he just turned around, and he said, I know it's not the same, but I feel like I've missed her first dance concert, that she's been practising for, and everything like that. Like we've done this whole thing for eight months now, and that was the last time before she's going to be born, and I wasn't able to see her. So – but he's – I mean my husband's the best person in the whole entire world, there's no doubt about it. He's so supportive, but he just – you can see that it breaks him when he doesn't get to do that stuff. ***(P23 Aust Antenatal)***

I got very nervous and anxious around the time that she was born because of the outbreak at the Northern Beaches at the time, and I was really scared that my partner wouldn't be allowed into the hospital or whatever. So that definitely added stress and anxiousness to the thing, and I was like just get this baby out as soon as possible because at that moment there was no – the restriction. ***(P9 Netherlands Postpartum)***

I think it was just the idea of the more information that I had, the more I'd be OK, rather than if I don't know, then it doesn't exist. But you would – I mean you couldn't escape it. We'd be driving on the way to work, and it'd be on the radio. Or you'd be having – when we finally could go back out to clubs or to restaurants and things like that, the people next to you at the next table, you don't hear their conversation, and it's just be about COVID. You catch up with friends or family, it'll just be about COVID, and their experiences, and their workplace situations, and if they've known someone who's gotten it. So it wasn't really something that you could even switch off, even if you did turn the TV off. ***(P23 Aust Antenatal)***

COVID-19 fear and baby safety above all else: ***so worried, that if I get COVID, it would kill the baby***
*He was worried about me getting infected, because he doesn't want to be the carrier of anything and then giving it to me. So, he was home (*stopped working*), take care of me. Cooking for me, [laughs] cleaning and doing stuff, but yeah, then later he found a job… This is our first kid…So, he didn't want to take that risk. Yeah.* ***(P5 India Antenatal)*** *I worried about the baby. I don't really feel much for myself but only for that I'm carrying baby so I feel worried about the baby.* ***(P3 Nepal Antenatal)*** *I'm not worrying about myself but I'm worried about the baby. Like, I can't take her because she might be at risk because she's small and it might attack her, you know, with immune system is low.* ***(P3 Nepal Postpartum)*** *Yeah, that's it. That's the only reason, because I'm afraid to take her out. Like, I'm afraid for her all the time.* ***(P4 India Postpartum)*** *Yeah, I was scared, I was scared to go out. I was really scared and I found that I was pregnant when I got here, so more reason to be more scared. Yeah.* ***(P8 Nigeria Antenatal)*** *…the event itself was very fearful, people were dying. And it was just like you couldn't – all these restrictions came into place about what you need to do for this virus until we know a little bit more about it. So I'm not saying that it didn't play on my mind a little bit, but I didn't want to buy into the whole fear of things.* ***(P15 Aust Antenatal)*** *Well, we just didn't know what was going to happen to the baby because there's no information. If I got sick or if my son got sick, or what could happen to the baby – and I just didn't leave the house at all.* ***(P20 Aust Antenatal)*** *I'd still take her to the shops and stuff. I was just mindful of have her in the carrier instead of the pram so there's less people trying to – you hear stories about people are like, "A cute baby. Let me touch," or whatever. By being in the carrier she's more protected I guess.* ***(P22 Aust Postpartum)*** *…baby can't wear masks, you know… in the pram they're low, that other people, they will breathe in other people's, yeah, maybe, no fresh air. And then when people is sick, they will get sick easily. That's my concern.* ***(P12 China Postpartum)*** *If I had have known there was a pandemic coming I wouldn't have got pregnant…as long as there's a pandemic around I wouldn't fall pregnant again.* ***(P23 Aust Postpartum)*** *…we make sure that we've got our pram completely covered, and we stay away from any busy periods.* ***(P23 Aust Postpartum).*** *So, and then we, you know, we always used to follow the sanitising our house doors, and sanitising the stuff, we're getting the disinfectant advice, we used to follow all those things. We'd wash our clothes immediately we come out from somewhere, so that's, we used to follow. Straight away for washing, take shower, done.* ***(P6 Postpartum)***

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BMJ Open

Investigating service delivery and perinatal outcomes during the low prevalence first year of COVID-19 in a multiethnic Australian population: a cohort study

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To cite: Melov SJ, Elhindi J, McGee TM, *et al.* Investigating service delivery and perinatal outcomes during the low prevalence first year of COVID-19 in a multiethnic Australian population: a cohort study. *BMJ Open* 2022;**12**:e062409. doi:10.1136/bmjopen-2022-062409

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-062409).

Received 28 February 2022
Accepted 26 June 2022

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ABSTRACT

Objective Investigate the impact of the COVID-19 pandemic on perinatal outcomes in an Australian high migrant and low COVID-19 prevalent population to identify if COVID-19 driven health service changes and societal influences impact obstetric and perinatal outcomes.

Design Retrospective cohort study with pre COVID-19 period 1 January 2018–31 January 2020, and first year of global COVID-19 period 1 February 2020–31 January 2021. Multivariate logistic regression analysis was conducted adjusting for confounders including age, area-level socioeconomic status, gestation, parity, ethnicity and body mass index.

Setting Obstetric population attending three public hospitals including a major tertiary referral centre in Western Sydney, Australia.

Participants Women who delivered with singleton pregnancies over 20 weeks gestation. Ethnically diverse women, 66% overseas born. There were 34 103 births in the district that met inclusion criteria: before COVID-19 n=23 722, during COVID-19 n=10 381.

Main outcome measures Induction of labour, caesarean section delivery, iatrogenic and spontaneous preterm birth, small for gestational age (SGA), composite neonatal adverse outcome and full breastfeeding at hospital discharge.

Results During the first year of COVID-19, there was no change for induction of labour (adjusted OR, aOR 0.97; 95% CI 0.92 to 1.02, p=0.26) and a 25% increase in caesarean section births (aOR 1.25; 95% CI 1.19 to 1.32, p<0.001). During the COVID-19 period, we found no change in iatrogenic preterm births (aOR 0.94; 95% CI 0.80 to 1.09) but a 15% reduction in spontaneous preterm birth (aOR 0.85; 95% CI 0.75 to 0.97, p=0.02) and a 10% reduction in SGA infants at birth (aOR 0.90; 95% CI 0.82 to 0.99, p=0.02). Composite adverse neonatal outcomes were marginally higher (aOR 1.08; 95% CI 1.00 to 1.15, p=0.04) and full breastfeeding rates at hospital discharge reduced by 15% (aOR 0.85; 95% CI 0.80 to 0.90, p<0.001).

Conclusion Despite a low prevalence of COVID-19, both positive and adverse obstetric outcomes were observed that may be related to changes in service delivery and interaction with healthcare providers. Further research is suggested to understand the drivers for these changes.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The analysis provides the opportunity to evaluate the indirect effects of COVID-19 against a background of low COVID-19 prevalence in the local health district with a total of six women with COVID-19 during pregnancy for the study period.
⇒ The cohort comprised a large ethnically diverse population with similar exposure of restriction experience and service delivery changes.
⇒ Analysis for both iatrogenic and spontaneous preterm birth.
⇒ Missing some COVID-19-related confounders is a limitation such as physical activity levels, prevalence of pregnancy population working from home or missing planned overseas social support due to international border restrictions.
⇒ A limitation of the study is multiple outcomes were compared, however, our results are consistent with several other studies in different populations increasing the veracity of our findings.

INTRODUCTION

In the beginning of 2020, non-pharmaceutical interventions to reduce the spread of COVID-19 led to great changes in society such as lockdowns, enforced movement and travel restrictions.[1 2] There were also many changes to medical and maternity care around the world that are well documented, impacting direct care and social support.[3–6] Initial concerns of the impact of COVID-19 infection on pregnant women focused research on pregnancy outcomes for women who were infected and results varied, findings included increased COVID-19 infection risk in ethnic minorities, and a rise in both preterm and caesarean births.[7–10] More recently perinatal research has assessed the indirect impact of the pandemic,[11] particularly the impact of lockdowns.[12–14] Indirect impact will vary significantly between countries and within country due to diverse drivers such as lockdown experiences, social distancing measures, COVID-19 prevalence, societal compliance, economic and healthcare access.[4 6 15]

Studies of the indirect effects of COVID-19 on pregnancy outcome have shown inconsistent results. A reduction in preterm birth in the general population during the pandemic has been reported by some authors but not others.[12 16–18] Differences in study design and other factors have led some authors to conclude that there is insufficient evidence to determine if preterm birth has been reduced during COVID-19.[19]

Maternity care in Australia during the first year of the pandemic in 2020 experienced a disparate range of changes from very little to significant alterations in service delivery, dependent on population and perceived risk in the community.[3 20] Little evidence exists for the impact of societal and service changes on a culturally diverse obstetric population who initially experienced minimal COVID-19 community transmission, a short lockdown period but experienced significant obstetric service and societal changes due to the pandemic.

In our study population, we hypothesise obstetric outcomes may have been impacted by the rapid changes in hospital service delivery as they shifted focus during the pandemic from patient-centred care to preservation of service and staff.[21] Western Sydney with its multicultural population is an ideal environment to examine the indirect effects of the response to the pandemic on perinatal outcomes given the setting of low COVID-19 case numbers. There was a total of 632 cases recorded of COVID-19 in the local health district for the study period. However, considerable preventative measures were implemented in the region including access to telehealth, ability to work from home, restrictions in healthcare settings such as mask wearing and health-screening questions on entry to all hospitals.[22]

We aim to identify indirect and pandemic-related morbidity in our large multiethnic Australian population and uncover potential drivers for both improved and adverse maternity care outcomes.

METHODS

We conducted a retrospective cohort study using routinely collected obstetric, medical and administrative data for women seeking antenatal care in the Western Sydney Local Health District. We compared birth outcomes greater than or equal to 20 weeks of gestation in the 2 years prior to the COVID-19 pandemic to the first year of the COVID-19 pandemic. The study period is defined as pre-COVID-19 1 January 2018–31 January 2020 to the first twelve months of the COVID-19 pandemic 1 February 2020–31st January 2021.

The state of New South Wales (NSW) has a population of approximately 8.2 million.[23] The three study hospitals serve a health district population of approximately one million people. For the study period, a total of 39 pregnant women had a confirmed COVID-19 diagnosis in NSW, six of these were in the study health district and none of these were admitted to hospital for COVID-19 complications. There were fewer than 60 COVID-19 related deaths recorded for the total population in NSW in the first year.[24] The prevalence of COVID-19 in the local community was also low (total 632 cases online supplemental figure 1).[25]

The study period was determined by the time when public awareness grew in NSW of the impending pandemic with official government announcements and a sharp rise and dominance of media coverage concerning COVID-19 from early February 2020.[26] The study period was after 30 January 2020 WHO announcement declaring COVID-19 as a public health emergency of international concern.[27] Public health order restrictions commenced on 16 March 2020 with restrictions on gathering of over 500 people in NSW to reduce the spread of COVID-19. The restrictions escalated on 30 March 2020, to 'hard lockdown' issuing of public health orders 'that a person must not, without reasonable excuse, leave the person's place of residence'.[27] The restrictions were present for approximately 7 weeks easing on 15 May 2020.

The short hard lockdown in NSW, was primarily enforced in greater Sydney, accompanied by increased restrictions and COVID-safe practices including all health facilities women and their families accessed. The restrictions for local maternity services included hospital entrance screening of all patients, staff and visitors including temperature checks, asking about recent travel and symptoms of COVID-19. Within the antenatal service, there was also an introduction of telehealth for the diabetes in pregnancy clinics, restrictions on visitors such as allowing only patients in waiting rooms, no support person during ultrasound and only one support person with no changing-over in the birth unit. The potential changes in background stress for women during the peripartum due to these restrictions, reduced social support and service delivery changes may potentially impact perinatal outcomes.[28] During this time, there were frequent changes to service delivery and some confusion regarding rules for patients reported by staff at the tertiary referral study Hospital.[21]

Women in the public health sector in NSW are triaged to their nearest public hospital for pregnancy care according to their home address and pregnancy complications. Therefore, during the pandemic period there would be limited changes in referrals pathways for the district obstetric population.

Community activities returned to near normal by July 2020 in NSW, however international and state borders continued to be disrupted with ongoing outbreaks emerging. Restrictions to visitors and other COVID-19 risk mitigation policies remained present for the maternity services throughout the study period. COVID-19 vaccinations were not available in Australia during the study period.

Definitions

Routinely collected maternity data for singleton pregnancies greater than 20 weeks gestation was retrieved from the electronic maternal database. Terminations of pregnancy were not included in the database. Gestational age was determined and calculated in the electronic maternity system utilising the rules: use of last menstrual period (LMP) if regular, date was amended after available early ultrasound 6 weeks–13+6 weeks gestation. If ultrasound dating varies from LMP by more than 5 days, if irregular or uncertain LMP then ultrasound expected date of delivery was used.

Area-level socioeconomic status (SES) in our study was derived from the postcode address of participants during pregnancy as determined for that area by the last Australian census information (2016), informing the Index of Relative Socioeconomic Disadvantage. The index is based on households in that area using information on variables that include income, English fluency, education and employment status. A lower index score represents greater disadvantage.[29]

Outcomes of interest

Outcomes of interest were selected based on literature review, state obstetric benchmarking outcomes and outcomes that plausibly may be impacted by service delivery changes. Literature has reported criteria changes in some healthcare setting for induction of labour and overall induction rates changing, therefore, we included any induction via any method at all gestations in our outcomes of interest. We defined all vaginal births as one outcome inclusive of breech vaginal births. All preterm births were defined as less than 37 weeks gestation. Spontaneous preterm was defined as vaginal preterm births without an induction or caesarean section preterm births with a history of preterm labour. Iatrogenic preterm births were those initiated by care providers, defined as either a planned caesarean section with no preterm labour or an induction prior to 37 weeks gestation. Small for gestational age (SGA) is birth weight less than 10th centile assessed by the Fenton growth chart.[30] Combined adverse neonatal outcome included any of the following; stillbirth, admission to special care/neonatal intensive care unit (NICU), Apgar score under 7 at 5 min, or newborn resuscitation with intubation.

Data analysis and statistical methods

Demographic and obstetric characteristics of women were compared before and during the first year of COVID-19 using the χ^2, Fisher's exact or t-test where appropriate. Univariate logistic regression was applied to each characteristic to estimate unadjusted ORs. Then, three adjusted models were devised and implemented using multivariate logistic regression. Model 1 was for maternal characteristics and adjusted for maternal age, area-level SES, gestational age (except for the preterm birth outcome), parity, ethnicity, body mass index, smoking status and mental health status. Model 2 adjusted for model of pregnancy care and the variables from model 1. Model 3 adjusted for additional covariates that are clinically relevant for specific outcomes. For the caesarean section birth outcome, birth weight and induction of labour were added to the covariates from Models 1 and 2. For the preterm birth outcome, a composite gestational diabetes/hypertension variable was added to the covariates from models 1 and 2. For the breastfeeding outcome, mode of delivery, length of stay <24 hours, and preterm birth were added to the covariates from models 1 and 2. For each model, an adjusted OR (aOR) with a 95% CI was reported. P values less than 0.05 were considered statistically significant. The cohort was restricted to records with complete data on outcomes of interest. Missing indicator variables were utilised for covariates in the multivariate analyses. All statistical analyses were completed using Stata Special Edition V.14.2 (StataCorp).

Patient public involvement statement

This retrospective cohort study had no patient public involve in the design or analysis or dissemination of results.

RESULTS

Baseline characteristics

The pre-COVID-19 period had a total of 23 722 singleton births and during the first year of COVID-19 (period 1 February 2020–31 January 2021) there were 10 381 singleton births. The principle tertiary referral centre had the greatest number of births in the cohort (n=17 005; 49.9%), with the large secondary hospital comprising of 36.6% (n=12 467) of the cohort.

Women who birthed in the first year of COVID-19 were more likely to be Australian born (35.1% vs 32.9%), overweight or obese (45.8% vs 44.5%), under 35 years old (59.7% vs 50.6%), have a history of a mental illness (15% vs 13%), to present for their first comprehensive antenatal visit at <10 weeks gestation (80.8% vs 64.4%) and less likely to be privately insured (5.9% vs 6.9%) compared with the preceding 2 years (table 1). Women were admitted antenatally less often (10.1% vs 12.1%) and women who elected to have an early discharge postpartum at <24 hours, were higher from 15.5% during the pre-COVID period to 19.1% in the first year of COVID-19. Other demographic and pregnancy characteristics are documented in table 1.

Pregnancy complications and outcomes

There were no differences in overall median gestation age at birth between the two time periods (table 2). We did observe that the rate of preterm birth was lower during COVID-19 compared with the preceding period (7.2% vs 8.1%). We also observed a higher proportion of

Table 1 Women with a singleton pregnancy: maternal demographic characteristics and pregnancy outcomes first year of COVID-19 compared with pre-COVID in a NSW metropolitan health district

Characteristics	Pre-COVID-19 n=23 722, N (%)	COVID-19 n=10 381, N (%)	P value
Clinical and demographic characteristics			
Maternal age group years			
<20	38 (0.2)	46 (0.4)	<0.001
20–24	614 (2.6)	452 (3.1)	
25–34	11 335 (47.8)	5 835 (56.2)	
35–39	8 939 (37.7)	3 335 (32.1)	
>39	2 796 (11.8)	713 (6.9)	
Ethnicity			
South Asian	6047 (25.5)	2 950 (28.4)	<0.001
Caucasian/European	3 307 (13.9)	1 886 (18.1)	
South-East Asian	3249 (13.7)	1 357 (13.1)	
Middle Eastern	8116 (34.2)	3827 (36.9)	
Aboriginal Torres Strait Islander	338 (1.4)	188 (1.8)	
Unknown/missing*	2665 (11.2)	173 (1.7)	
Australian born	7 809 (32.9)	3 648 (35.1)	<0.001
SES disadvantage			
Quintile 1 (most disadvantaged)	5 367 (22.7)	2 361 (22.8)	0.04
Quintile 2	5 721 (24.1)	2 568 (24.8)	
Quintile 3	3 508 (14.8)	1 494 (14.4)	
Quintile 4	3 291 (13.9)	1 528 (14.7)	
Quintile 5 (least disadvantaged)	5 809 (24.6)	2 416 (23.3)	
BMI (kg/m^2) at booking			
<18.50	1 116 (4.7)	417 (4.5)	0.02
18.5–24.9	11 981 (50.5)	5 207 (50.2)	
25.0–29.9	6 317 (26.3)	2 875 (27.3)	
≥30.0	4 308 (18.2)	1 922 (18.5)	
Nulliparous	10 331 (43.6)	4 475 (43.1)	0.45
Assisted conception	1 050 (4.4)	471 (4.5)	0.65
Current smoking at booking	1 380 (5.8)	619 (6.0)	0.60
Disclosed domestic violence	340 (1.5)	141 (1.5)	0.69
Diagnosed mental illness	3 083 (13.0)	1 552 (15.0)	<0.001
History of hypertension	844 (3.6)	327 (3.2)	0.06
History of diabetes (T1DM, T2DM)	265 (1.3)	114 (1.3)	0.93
History of gestational diabetes	1555 (6.6)	738 (7.1)	0.06
Health service characteristics			
<10 weeks gestation first comprehensive assessment	15 221 (64.4)	8360 (80.8)	<0.001
Model of care			
Low-risk hospital	15 210 (64.1)	6768 (65.2)	<0.01
Hospital complex medical	6 775 (28.6)	3096 (29.4)	
Private maternity	1 635 (6.9)	611 (5.9)	
No antenatal care	102 (0.4)	38 (0.4)	
Antenatal admission to hospital	2 863 (12.1)	1 044 (10.1)	<0.001
Postnatal maternal length of stay <one day	3 674 (15.5)	2 000 (19.1)	<0.001

Continued

Table 1 Continued

Characteristics	Pre-COVID-19 n=23 722, N (%)	COVID-19 n=10 381, N (%)	P value
Postnatal maternal length of stay (days, median IQR)	2.02 (1.51)	2.00 (1.68)	<0.001

Pre-COVID-19=1 January 2018–31 January 2020, COVID-19 = 1 February 2020–31 January 2021.
Low-risk hospital: Midwifery care and shared antenatal care (general Practitioner/family doctor); Hospital complex medical care: Hospital based medical and high-risk clinic; Private maternity care: obstetrician and privately practicing midwife.
T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus
*Missing due to ethnicity as routine collection introduced mid-2018.
BMI, body mass index; NSW, New South Wales; SES, Socio Economic Status (Index of Relative Socio-economic Disadvantage); T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus.

births at or after 41 weeks gestation during the first year of COVID-19 (10.0% vs 9.0%). We identified a reduction in all vaginal births (66.6% vs 69.6%) including reduced vaginal breech births (0.7% vs 0.9%). This corresponded with the caesarean section rate increasing during the first year of the COVID-19 pandemic (33.4% vs 30.5%)

Table 2 Pregnancy outcomes in a low-prevalence COVID-19 high-migrant Australian urban population

Pregnancy complications	Pre-COVID-19 N=23 722, N (%)	COVID-19 n=10 381, N (%)	P value
Timing of birth			
Gestational age (weeks) median (IQR)	39.2 (1.8)	39.2 (1.8)	0.25
<28 weeks	301 (1.3)	128 (1.2)	<0.001
28–32 weeks	232 (1.0)	84 (0.8)	
<37 weeks	1439 (6.1)	539 (5.2)	
37+weeks	21 748 (91.7)	9630 (92.8)	
Mode of delivery			
Vaginal birth	13 931 (58.8)	5819 (56.1)	<0.001
Instrumental	2340 (9.9)	1016 (9.8)	
Vaginal breech	204 (0.9)	76 (0.7)	
Caesarean section	7224 (30.5)	3465 (33.4)	
Onset of labour			
Induction	7095 (29.9)	3666 (35.3)	<0.001
Birth weight			
Appropriate for gestational age	20 071 (85.1)	28 884 (85.5)	0.39
Large for gestational age	1676 (7.1)	784 (7.6)	0.11
Small for gestational age	1832 (7.8)	713 (6.9)	0.01
Adverse birth outcomes			
Stillbirth	227 (1.0)	95 (0.9)	0.71
Apgar<7 at 5 min	662 (2.8)	257 (2.5)	0.10
Intubation resuscitation at birth	262 (1.1)	100 (1.0)	0.24
Admission to NICU	3851 (16.2)	1743 (16.8)	0.23
Composite adverse neonatal	4261 (18.2)	1907 (18.3)	0.41
Neonatal feeding			
Skin to skin at birth	16 454 (69.4)	7961 (76.7)	0.02
Feeding within 1 hour	14 353 (60.5)	6424 (61.9)	0.02
Fully breastfeeding at discharge	15 620 (65.8)	6410 (62.1)	<0.001

Pre-COVID=1 January 2018–31January 2020, COVID-19 =1 February 2020–31 January 2021.
Composite adverse neonatal includes any: stillbirth, admission to NICU, Apgar score under 7 at 5 min, or newborn resuscitation with intubation.
NICU, neonatal intensive care unit.

(table 2). There was an overall higher rate of induction of labour (35.3% vs 29.9%) and a lower rate of SGA births (6.9% vs 7.8%). We found no change for adverse birth outcomes including for stillbirth (0.9% vs 1.0%) or admissions to special care/NICU (16.8% vs 16.2%) (table 2).

In adjusted analysis, no difference was identified for labour inductions during the COVID-19 period compared with the pre-COVID period (aOR 0.97; 95% CI 0.92 to 1.02). There was a 25% increase in caesarean section births during the pandemic first year in our health district (aOR 1.25; 95% CI 1.19 to 1.32) (table 3). The rate of spontaneous preterm births was reduced by 15% (aOR 0.85; 95% CI 0.78 to 0.95) and no change was found for iatrogenic preterm births (aOR 0.94; 95% CI 0.80 to 1.09) (table 3). Adjusted models also uncovered a 10% reduction for SGA infants at birth during the COVID-19 period (aOR 0.90; 95% CI 0.82 to 0.99). We found a marginal increase for a combined adverse neonatal outcome during the COVID-19 period (aOR 1.08; 95% CI 1.00 to 1.15) (table 3).

In our study population, the first year of the pandemic impacted breastfeeding when compared with the previous 2 years. When adjusted for several confounders including birth weight, mode of delivery, and prematurity, we found a 15% reduction for women fully breastfeeding their infant at discharge (aOR 0.85; 95% CI 0.80 to 0.90) (table 3). There was no difference in effect size between model 1 and the fully adjusted model that included birth weight, mode of delivery, length of stay <24 hours and gestational age/preterm variable. Notably, there was a higher rate during the COVID-19 period in both breastfeeding within 1 hour (61.9% vs 60.5%, p=0.02) after birth and maternal/infant skin to skin contact at birth (76.7% vs 69.4%, p=0.02) (table 2).

DISCUSSION

In a health district with low COVID-19 prevalence but affected by public health measures and process changes to service delivery, we found no differences in the rate of induction of labour, a reduction in spontaneous preterm and SGA births with no change in iatrogenic preterm births during the first year of COVID-19. There was also a significant increase in caesarean section births and a reduction in women fully breastfeeding at hospital discharge during this period compared with the previous 2 years. We identified a marginal increase in the rate of severe adverse neonatal composite outcome. In the study population, only six women were recorded to have experienced COVID-19 infection during pregnancy, therefore, the outcome changes identified in this study are likely related to the indirect effects of COVID-19.

A strength of the study is the population experienced similar exposure to COVID-19 restrictions and maternity care service delivery changes. The multiethnic population with an even distribution between national SES quintiles strengthens the generalisability of our findings to other high-income populations with universal health coverage such as the UK. A more homogeneous population may provide a possible explanation of changes to be specific cultural drivers however the diversity of the study population supports the explanation to likely be societal and service delivery related. A limitation is the difficulty of identifying all changing population drivers, however, adjustment was made for known factors.

There may have been other confounders we were not able to capture that may impact on obstetric outcomes such as level of physical activity. Potentially some women may have benefited from more time to exercise with associated reduced infection risk through exercise-mediated protective immune response,[31] while other women who felt unwell may have had the opportunity to rest at home. There may potentially be a uniquely cumulative improved immune environment for pregnant women during the COVID-19 period. Underlying factors such as consistent diet stabilising the microbiome and less maternal inflammatory triggers or burden from exposure to environmental and infectious factors may be the reason for improved spontaneous preterm birth rate and SGA outcomes.

It is difficult to capture individual responses to the threat of COVID-19 despite low prevalence in the community for this cohort. However, recent qualitative research at one study hospital found clinicians felt some groups of women benefited from the COVID-19 restrictions with less stress and protected family time. However, migrant women were seen to have experienced isolation and anxiety due to loss of significant practical and social support from overseas relatives unable to visit due to COVID-19-related international border closures.[21 32] The impact of the loss of expected support from relatives due to COVID-19 travel restrictions was not measured in our study and is a limitation.

Similar to other studies, we document a reduction in preterm birth.[12 17 18 33] The lack of delineation between iatrogenic and spontaneous preterm birth in some research has been an issue when comparing results and attempts to identify potential drivers.[19] A strength of our study is we were able to present the data and identified that only spontaneous preterm birth was reduced for the study period. However, recent updated preterm birth meta-analysis by Yang *et al* found in unadjusted analysis preterm birth was reduced for both spontaneous and iatrogenic only in single centre studies, but not in national studies.[6] Local district level data and population characteristics may have less variation in obstetric service delivery confounders and other factors that increase the uniformity of experience for women and may account for the difference between large national level data and some single centre research. Local, more granular data for obstetric outcomes during the COVID-19 pandemic may assist in understanding drivers for improved and adverse obstetric outcomes. The stable iatrogenic preterm birth rate is a positive finding and reflects no change in clinical management for this important obstetric outcome. This may partly be associated with the ongoing understanding

Table 3 OR for maternal and neonatal pregnancy outcomes during the first year of COVID-19 compared with the previous 2 years in an Australian metropolitan health district

Outcome	Sample size	Unadj. OR	P value	Model 1 OR	P value	Model 2 OR	P value	Model 3 OR	P value
Induction of labour	34 082	0.90 (0.86,0.94)	<0.001	0.97 (0.92,1.02)	0.30	0.97 (0.92,1.02)	0.26	–	–
Caesarean birth	34 063	1.14 (1.09,1.20)	<0.001	1.24 (1.17,1.30)	<0.001	1.23 (1.17,1.30)	<0.001	1.25 (1.19,1.32)	<0.001
Preterm birth	34 080	0.86 (0.79,0.94)	0.00	0.91 (0.83,0.99)	0.05	0.91 (0.83,0.99)	0.03	0.88 (0.80,0.97)	0.01
Spontaneous preterm birth	34 080	0.76 (0.67,0.85)	<0.001	0.88 (0.77,0.99)	0.04	0.88 (0.77,0.99)	0.04	0.85 (0.75,0.97)	0.02
Small for gestational age at birth	33 880	0.88 (0.81,0.96)	0.01	0.90 (0.82,0.99)	0.03	0.90 (0.82,0.99)	0.02	–	–
Composite adverse neonatal outcome	33 632	1.03 (0.97,1.09)	0.38	1.08 (1.00,1.15)	0.03	1.08 (1.00,1.15)	0.04	–	–
Full breastfeeding at hospital discharge	31 113	0.86 (0.81,0.90)	<0.001	0.85 (0.80,0.90)	<0.001	0.85 (0.81,0.90)	<0.001	0.85 (0.80,0.90)	<0.001

COVID=1 February 2020–31 January 2021 (n=10 381), pre-COVID=1 January 2018–31 January 2020 (n=23 722) .
Composite adverse neonatal includes any: stillbirth, admission to NICU, Apgar score under 7 at 5 min or newborn resuscitation with intubation.
Variables adjusted for in each model:
Model 1: Maternal characteristics: Includes maternal age, area-level socioeconomic status (Index of Relative Socio-economic Disadvantage) quintile, gestational age, parity, ethnicity, BMI (numeric), smoking status and mental health status.
Model 2: Model of care: Model 1 variables and model of pregnancy care variable.
For preterm birth outcome the models are not adjusted for gestational age.
Model 3 outcome of interest: Includes models 1 and 2 covariates and additional covariates as listed below.
Caesarean section birth: birth weight and induction of labour.
Preterm birth: composite maternal complications variable (gestational diabetes or hypertensive disorders of pregnancy).
Breastfeeding: birthweight, mode of delivery, length of stay <24 hours and gestational age/preterm.
BMI, body mass index; NICU, neonatal intensive care unit.

of the adverse outcomes associated with late preterm births and recent national initiatives such as 'every week counts' that has occurred over the study period.[34]

Shah *et al* in a Canadian population study, found no reduction in preterm births, however, they did demonstrate preterm birth variation over time and between districts.[35] Our study covers the complete first year of the pandemic, reducing the possibility of a result based on a chance normal short-term variation.

It has been postulated that the causative mechanism for a reduction in preterm births during the COVID-19 period is reduced infection and maternal physical activity throughout lockdown.[36] In our population, these potential causative factors for a reduction in spontaneous preterm birth, may have existed in our health district during the short lockdown and likely persisted beyond the lockdown period. Some infection mitigation behaviours may have been driven by our high migrant population who received advice from overseas relatives in areas experiencing high rates of COVID-19. Encouraging suitable exercise[31] and simple hygiene measures such as appropriate hand washing, are public health measures that may reduce infection. Hand hygiene historically has been poorly done and with increased awareness and compliance, may assist with decreasing preterm births.[37 38]

We found women were presenting earlier to their family doctors for a first pregnancy visit and referral to tertiary hospital care. This may have been due to anxiety about the pregnancy and the unknown risk of COVID-19 infection to a fetus. The benefits of this early health provider contact may be correct dietary advice, provide opportunity for early aspirin prescription and other pregnancy care that may contribute to some of the improved pregnancy outcomes including preterm birth and SGA for this cohort. It is possible that the drivers for the reduction of spontaneous preterm birth and SGA are similar and multifactorial. They may include the opportunity for partners and pregnant women to work from home with the associated reduction in stress.

The increase in caesarean section births in this study is a concerning finding that may indicate changes in clinical decision making during the COVID-19 period of a lower threshold trigger for immediate delivery. However, other factors may also be involved such as less surveillance during pregnancy with maternal reluctance to present or be in hospitals as demonstrated by the increase in early discharge. Another human factor that may be involved in the rise in caesarean section birth is the difficulty of midwives in birth unit to develop a rapport with the women in their care to adequately assess their non-verbal cues, recent studies have identified midwives report a loss of 'women-centred care' during the COVID-19 pandemic.[20 21] Clinician may rely more on electronic 'socially distant' continuous cardiotocography (CTG) monitoring for fetal assessment. Evidence suggests increased CTG monitoring leads to higher caesarean section rates.[39 40] The increase in caesarean section births also have known immediate and long-term associated morbidity for women and their infants, therefore measures to counter the rise in caesarean births are recommended.[41]

There was a marginal increase in the composite adverse neonatal outcome largely driven by the increase in neonatal admissions. Although it is beyond the scope of this study to determine the causes for the increased admission, there was no alteration in admission criteria for the neonatal or special care nursery during the study period. However, the increase in caesarean birth may have contributed through the associated known increased risk of NICU admission with a caesarean section birth.[41 42]

Similar to our study, a prospective Italian study found a 28% reduction in full breastfeeding at discharge in a region with high COVID-19 prevalence.[43] We identified that during the COVID-19 period there was an improvement in practices that support breastfeeding immediately after birth; maternal-infant skin to skin contact and breastfeeding within the first hour. Birth unit protocols changed during the COVID-19 period, with only one support person allowed at the birth. The improvement in skin to skin and breastfeeding in the first hour may potentially be due to midwives identifying that woman were feeling more isolated and provided more one-to one support in the birth room improving these important breastfeeding outcomes. There may be several factors that contribute to less exclusive breastfeeding at discharge in our study. Intuitively the reduction in breastfeeding should be linked with the increase in early discharge however the 25% reduction in full breastfeeding was present for both model 2 and the final model that adjusted for variables including early discharge. Other factors are therefore more likely influencing this outcome. Due to reduced visitors, women may have felt they needed to bring formula into the hospital in case they had difficulty with breastfeeding, therefore it was available and more likely to be used. There may also have been reduced opportunities for staff to provide postnatal breastfeeding support due to concerns of COVID-19 infection risk by both staff and patients, staffing shortages and increased staff workload during the COVID-19 period. It is well acknowledged the introduction of formula and bottle feeding in the early postnatal period has significant consequences for infant long-term health and reduces total length of breastfeeding.[44–46] Providing adequate lactation support antenatally, at birth and postnatally with staff shortages during the pandemic is problematic but important for both short-term and long-term metabolic maternal and infant health.[44 47 48]

Although recent literature has focused on the impact of COVID-19 disease and pregnancy, the indirect impact of the worldwide pandemic may not be fully realised for many years. There is increasing evidence of the impact of exposure to disasters including pandemics, on long-term health consequences. A recent systematic review concluded fetal and maternal exposure to natural disasters including pandemics resulted in increased cardiometabolic risk in both.[49] Understanding a pandemic population with a low prevalence of COVID-19 but subject to changes in maternity care and societal stress, may assist in future investigations of drivers for cardiometabolic health.

CONCLUSIONS

In a low COVID-19 prevalent population, this study found no change in inductions of labour or iatrogenic preterm births. However, an increase in caesarean section births, a reduction in SGA and spontaneous preterm births was identified. The benefit to women, their families and the community of reduced SGA and preterm birth is long-lasting, including improved cardiometobolic lifetime risk for both women and their infants.[42] The drivers for these changes in perinatal outcomes during the COVID-19 first year may be difficult to identify but may be a reduction in maternal inflammatory triggers. However, the results from this study in a cohort primarily exposed only to COVID-19-related service and societal changes, provides unique opportunity to generate evidence of these changes on pregnancy complications. The significant reduction in breastfeeding at discharge may be more easily addressed now identified. Funding appropriate intervention strategies is imperative both in the antenatal and postnatal periods to improve breastfeeding outcomes. Revealing all drivers for obstetric changes during the pandemic may be difficult to ascertain, further research in this high migrant cohort with higher prevalence of COVID-19 cases may reveal evidence for more specific drivers.

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Contributors Study designed by SM, TMM, SCC, TIA and DP. JE performed the statistical analysis. SM interpreted the data and wrote the initial and final manuscript drafts with supervision from DP. Invaluable support was given by JE, TMM, VWL, NWC, SCC, JM, TIA and DP for final interpretation of findings, and critical revision of the article. SM acts as guarantor.

Funding A 2-year grant was awarded to SJ Melov by the Westmead Charitable Trust. Some funds from this grant were used to support this research: statistical analysis, publication costs.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Western Sydney Local Health District human research ethics committee: WSLHD HREC QA2101-15. Routinely collected anonymised data were used. Compliant with the Australian National Ethics statement individual patient consent was not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Institutional restrictions apply to the availability of these data, and so are not publicly available. Data are however available from the corresponding author on reasonable request and with permission of WSLHD Human Research and Ethics Committee.

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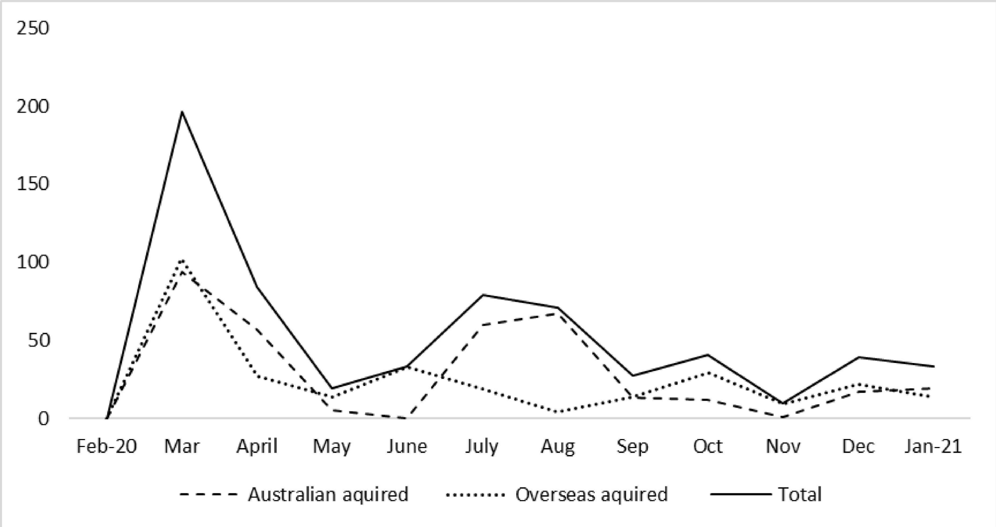
Supplementary Figure 1

Total COVID-19 cases during study period 1st Feb 2020 – Jan 31st 2021 Western Sydney Local Health District, NSW Australia; total cases 632 (open source data https://data.nsw.gov.au)



Acceptability and Utility of an Opportunistic Adaption of Digital Health Intervention Research During the COVID-19 Pandemic to Optimise Postnatal Care: SmartMums to HealthyMums@Westmead

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Background

- During the first year of COVID-19 access was disrupted to antenatal education as well as both formal and informal support for women during the peripartum period. Loss of support was ongoing for our high migrant population in Western Sydney due to closed international borders.

Aim

- To assess acceptability of a six-month postpartum Digital Health Intervention(DHI) during the COVID-19 pandemic.

Material and methods

- A postnatal support program of 3-4 text messages per week was developed for the SmartMums2 RCT to improve health outcomes for women with GDM. This study had been put on hold due to COVID-19.
- The postnatal text messages were developed by an expert multi-disciplinary team with consumer feedback. Messages included videos and websites links.
- Adapting to the COVID-19 crisis we repurposed the SmartMums2 study text message program on mental health, parenting and healthy lifestyle to support postpartum women as part of our pandemic response.
- From October to December 2020, women at our hospital discharged with term babies were sent a text invitation to register for the HealthyMums@Westmead program.
- A text-invitation to complete the evaluation survey was sent to pre-registered participants of the 'HealthyMums' program. Questions included demographics and Likert response to message content and delivery.

Sample text messages

Hi SARAH, During the COVID-19 (coronavirus) pandemic you may be feeling overwhelmed, be reassured that such emotions are common at a time like this and there are many ways to help you cope. It is important to take time, look after your physical and mental health. HealthyMums@Westmead Womens

Hi SARAH, your child and family health nurse will contact you over the next weeks to offer you an appointment and introduce their service https://www.health.nsw.gov.au/kidsfamilies/MCFhealth/child/Pages/default.aspx HealthyMums@Westmead Womens

Small steps count! Just 10 min sessions count towards your target of 30 mins per day. Keep active! HealthyMums@Westmead Womens

Worried your baby is unwell? Here are some signs that can help you recognise if your baby needs medical attention https://www.healthdirect.gov.au/symptoms-of-serious-illness-in-babies-and-children HealthyMums@Westmead Womens

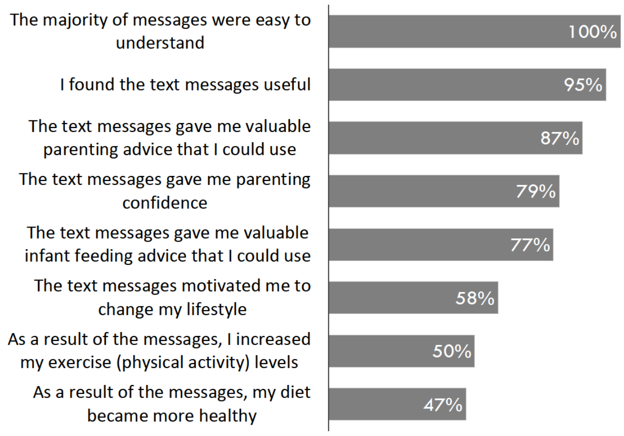
Latching baby maybe difficult-for help try https://raisingchildren.net.au/newborns/breastfeeding-bottle-feeding/how-to-breastfeed/baby-led-attachment or contact your child and family health nurse HealthyMums@Westmead Womens

Healthy diet tips- Keep in mind SARAH, frozen vegies contain about the same amount of nutrients as fresh ones. A good option if you can't shop regularly HealthyMums@Westmead Womens

Results

- There were 38 postpartum women of the 105 participants who provided feedback 6-9 months postpartum at program end.
- Most respondents were primiparous (62%) and born overseas (54%).
- For overseas born women, the median years lived in Australia was 4 years (IQR 3-20).
- Three messages per week were considered just right for 89% of participants and 97% thought the time of day appropriate.

Percentage of participants who agree or strongly agree



Free text responses

'…made me feel like someone still cared for us'

'…a major role in improving my mental health'

'…links to COPE and PANDA where very timely'

'The overall tone of messages for me was really positive, it felt like there was someone in your corner and was a little but sad when they ended.'

'Felt like a little pocket motivator. Also make you feel not so alone through the journey.'

'Regular physical activity can help you manage stress and feel positive. It inspired me and helped me in weight loss'

Percent of women who found website most useful

- 71% breastfeeding.asn.au
- 71% raisingchildren.net.au
- 50% trisillian.org.au

Conclusion

- Particularly in high migrant populations, innovative DHI can improve access and support women postpartum with trusted evidence-based advice during the COVID-19 pandemic.
- We found text-messaging DHI was an acceptable and valued support during COVID-19 when usual support and services were interrupted. Further research should review ongoing use of DHI postpartum.

Appendix 8a

Chapter 8

Sample Smart Mums texts messages unpublished

- *Did you know women who breastfeed are half as likely to develop diabetes later in life and the longer you breastfeed the better it is*? https://www.nih.gov/news-events/nih-research-matters/breastfeeding-may-help-prevent-type-2-diabetes-after-gestational-diabetes

- *Latching baby maybe difficult-for help try* https://raisingchildren.net.au/newborns/breastfeeding-bottle-feeding/how-to-breastfeed/baby-led-attachment

- *You know your baby is getting enough milk when they have 6-8 heavy wet cloth nappies or at least 5 very wet disposable nappies in 24 hours*

- *You can call the Australian Breastfeeding Association anytime day or night for breastfeeding help on 1800-686 268* https://www.breastfeeding.asn.au/

- *A crying baby can be very difficult you can try this checklist for help* https://raisingchildren.net.au/babies/videos/settle-a-crying-baby

- *Great video on baby breast attachment* https://globalhealthmedia.org/portfolio-items/attaching-your-baby-at-the-breast/?portfolioCats=191%2C94%2C13%2C23%2C65

- *You may find this video helpful on milk supply* https://globalhealthmedia.org/portfolio-items/increasing-your-milk-supply/?portfolioCats=191%2C94%2C13%2C23%2C65

- *It may seem hard to leave the house while breastfeeding. Here are some tips to help.* https://www.pregnancybirthbaby.org.au/getting-out-of-the-house-with-your-new-baby

- *Expressed breastmilk can be stored up to 3 months in the freezer and 3 days in the fridge* https://www.breastfeeding.asn.au/bf-info/breastfeeding-and-work/expressing-and-storing-breastmilk

- *It is OK for breastfeeding mums to exercise for more information* https://www.breastfeeding.asn.au/bfinfo/exercise-and-breastfeeding

- *Help for introducing family foods* https://www.tresillian.org.au/advice-tips/nutrition/6-8-months/?gclid=EAIaIQobChMI8fyQq8OS4wIVRg4rCh2jawghEAAYAyAAEgJO0_D_BwE

- *Immunisation time. Make an appointment with your GP in the coming week* https://www.health.nsw.gov.au/immunisation/app/Pages/schedule.aspx

Appendix 8b

Chapter 8 Qualitative SMs2 exit interview guide

- Can you tell me about your experience of the SmartMums program?

- Did you find the SmartMums program helpful as support for improving your health? If so, what did you find helpful (further prompt, what was most helpful)?, if not, what did you find unhelpful (further prompt, what was most unhelpful)?

- Tell me about the things that stopped you / were a barrier to achieving your health goals while on the SmartMums Program.

- Did you find that the COVID restrictions affected your ability to reach your health goals and if so did they influence whether or how well the SmartMums Program worked for you?

Did you want to breastfeed?

- Yes: What did you think about the text / and weblinks to support your breastfeeding?

- What did you think of the parenting support text messages?

- Can you tell me about your experience of using the activity monitor?

- Can you tell me about your experience of completing the study surveys?

- What do you suggest would improve this program to increase women's physical activity and healthy eating?

- Is there anything about your cultural background that you think we should be aware of to help support you achieving your health goals?

- What do you think your future risk is for developing type 2 diabetes?

- Before we finish is there anything else you would like to add about your experience on the SmartMums study that we haven't covered already, or anything else you'd like to say?

Chapter 8 Participants suggestions to improve program

Activity monitor	Well everything at the moment from my point of view, you guys are doing really good with everything from steps to nutrition, from breastfeeding links and formula links, but the only thing is that it would have been better if it **was waterproof.** (Participant 3)
Length of program	**Suggested 12 months …the year would've been good (longer program).** Because honestly I wasn't right in the head for a long time, just transitioning to new life emotionally not – shouldn't be where I was, like I really needed a lot of support and I don't think I really started enjoying it – started to enjoy being a mum until about eight, nine months. Where I then would have been more motivated in myself to better myself as well. Like after that time when I felt comfortable in my new life, is that makes sense? (Participant 8)
Text content suggestions	**Ability to opt out** once stopped breastfeeding texts. [**getting breastfeed ing texts]** It felt like a little bit of burn [laughs]. (Participant 9) …**more motivational texts**: I did get a few messages saying, "You haven't reached your goals, maybe try harder tomorrow," a few more of those would've been good. .. like, "We can see you're trying, keep going, you're doing great, that sort of thing. .. I mean the step one is like, "We noticed you haven't taken as many steps as usual," those ones I was like, "Crap, no, they're right, I haven't." [felt these were useful] (Participant 9) …**more options to replace the bad or unhealthy things**... Maybe some **vegetarian** items as well (Participant 12) I think maybe even if you have like little, **short easy home exercises**. … be cool to receive just like as a general knowledge thing, just for motivation thing. So like vacuuming for example, the amount of steps you burn. Not calories but the of steps you could – **tiny little facts like that.** … Everyday things that can easily get you moving. (Participant 7) [suggested **podcasts** while] with the kids or cook, or watch the baby or change. But they still can listen to those important information that you guys sent me. (Participant 10)
More human contact and social connection	I don't know, maybe **incorporate it with a mother's group**. So then like your sort **of more face-to-face sort of stuff**… like a local one or just an online sort of group…Like a Facebook group for people that are in the program or even like just gestational diabetes mums or something like that. (Participant 4) I would love if there was **more of like a human interaction** as well. So not just a text message, because it's so easy just to swipe away, delete, not read. **Maybe someone following it up like every month**, just go, "Hey, are you going to need any help? (Participant 8) [Involving] **someone else in my support network** to know exactly what I need to do and what I'm trying to achieve… to get a message to say, "Hey, this is what we have sent, do you want to make sure that they're OK?" Or that they're doing it to support them in this week, or this month or whatever. I would have loved that, because then I wouldn't have to go to my partner and go, "This is what I need to do or this is the message that I received today," or whatever, and have to explain it to them all over again in my terms when it could be wrong. (Participant 8)