Trends and Socio-economic Inequalities of Overweight, Obese and Underweight Women of Reproductive Age in South Asian Countries: Bangladesh, India, Maldives, Nepal and Pakistan

Miranda Hendry

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Statement of Originality

This is to certify that the content of this thesis is my own work. This thesis has not been submitted for any other degree or for any other purpose.

I certify that the intellectual content of this thesis is the product of my own work, and that all assistance received in preparing this thesis and all sources have been acknowledged.

Miranda Hendry

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Author Attribution Statement

Chapter 2 of this thesis has also been presented as a poster presentation titled “Trends and social determinants of obesity among women in South Asia” at the *World Public Health Nutrition Congress* 10-13th July 2024 at the University of Westminster, London, United Kingdom. I designed and presented the poster.

In addition to the authorship attribution statements above, permission to include the submitted manuscript was granted by the corresponding author.

Student: Miranda Hendry

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

Lead supervisor: Tanvir Huda

Artificial Intelligence Attribution Statement

During the preparation of the thesis, the author used Apple Writing Tools and ChatGPT 5.2 for minor text enhancement as the student was needing some assistance with sentence structure. The author confirms that where the text was modified by generative AI, the content was reviewed for possible errors, inaccuracies and bias. The author takes full responsibility for the submitted thesis and ensures that the work is their own and has used generative AI within the parameters of use (refer to the University of Sydney generative AI guide for researchers).

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List of Abbreviations

AARC	Average annual rate of change
AD	Absolute difference
BMI	Body mass index
DALY	Disability adjusted life years
DBM	Double burden of malnutrition
DHS	Demographic health surveys
ICF	Inner City Fund
LMIC	Low-to-middle income country
NCD	non-communicable disease
SDG	Sustainable Development Goals
SUN	Scaling Up Nutrition
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization

Abstract

This thesis assesses the trends and prevalence of associations between overweight, obesity and thinness among women and social determinants in low-and-middle-income countries (LMICs) in South Asia. We investigated the differences in wealth, education, and residence. We used data from the Demographic and Health Surveys (DHS) of 3,132,203 women aged 15-49 across Bangladesh, India, Nepal, Maldives, and Pakistan between 2000 and 2022. Overweight and obesity rose significantly in all countries except the Maldives, ranging from 5% to 37%. It was more pronounced among urban (13% to 46% in Bangladesh), less educated (7.3% in India to 70% in the Maldives), and wealthier women (23% in Nepal to 73% in Pakistan). Thinness showed smaller but consistent shifts, apart from the Maldives where prevalence declined. The risk of thinness declined among women living in rural areas (49% in Bangladesh to 10% in the Maldives) with less education (52% to 3% in the Maldives), then among poorer women too (51% in Bangladesh to 8% in Nepal). Overall, the findings indicate progress in alleviating the burden of undernutrition, yet a shifting towards the risk of increasing overweight and obesity rates.

Keywords: overweight, obesity, thinness, socioeconomic inequalities, women of reproductive-age, South Asia

Chapter 1: General Introduction

Nutrition in Women During the Life Course

Malnutrition among women is a multifaceted issue influenced by biological, social, and cultural factors that overlap to magnify their vulnerability throughout their life course. Women of reproductive age (15 to 49 years) are particularly more susceptible to malnutrition because menstruation, pregnancy, and lactation place physiological demands on their bodies. Reproductive age is therefore a nutritionally critical period, as women require increased energy (The ESHRE Capri Workshop Group, 2006) and key nutritional requirements, such as iron, folate, calcium, and other micronutrients (Institute of Medicine, 2006) to support these biological processes. Adolescent girls are similarly vulnerable to malnutrition, facing both the pressures of social gender norms and the biological demands of rapid growth and, in many contexts, early childbearing. Nutritional deficits during adolescence can delay physical development and increase the risk of obstetric complications later in life (World Health Organization, 2006).

Across the life course, malnutrition poses significant metabolic health risks, increasing the likelihood of developing non-communicable diseases (NCDs), such as cardiovascular diseases, high blood pressure, stroke, diabetes, certain cancers, mortality, and morbidity (Ezzati et al., 2002; Ni Mhurchu, Rodgers, Pan, Gu, & Woodward, 2004; World Health Organization, 2024a). As a result, the health consequences of malnutrition extend beyond immediate nutritional deficiencies and contribute to the growing global burden of chronic disease. In 2021, NCDs caused over 43 million deaths and just under half of the population's disability-adjusted life years (DALYs) globally (World Health Organization, 2024). Among low-middle sociodemographic index countries, 53% of the DALY population developed an NCD in 2021

(Global Burden of Disease Collaborative Network, 2025). The number of DALYs for NCDs among men and women in countries with the same sociodemographic index increased by 19% and 13 %, respectively, from 2000 to 2021. During the same period, the number of NCD-related DALYs significantly increased in South Asia by 17%, which was quicker than that in sub-Saharan Africa. These trends highlight the growing health consequences of malnutrition.

Malnutrition also has intergenerational implications. Undernourished women with short stature and iron deficiency are more likely to give birth to low-birth-weight infants, with delays in child growth and development, and increased susceptibility to disease, and risk of death of the mother at delivery (R. E. P. Black et al., 2008). Maternal overweight and obesity also contributes to adverse birth outcomes, including low-birth-weight newborns and an increased risk of childhood obesity (R. E. Black et al., 2013). Malnutrition in women thus not only affects their health but also sets the trajectory for their children's lifelong health outcomes, reinforcing cycles of poverty and ill health across generations. Therefore, addressing adolescent malnutrition is critical for breaking the cycle of intergenerational disadvantage (Patton et al., 2016; Sahadevan, Dar Iang, & Dureab, 2023). In summary, women's nutritional status is shaped by the complex interplay of biological needs and societal structures. Addressing malnutrition in women requires a life-course approach that considers early adolescence, reproductive years, and beyond the reproductive years.

The Growing Challenges of the Double Burden of Malnutrition

Undernutrition has long been a major public health challenge, particularly in low-and middle-income countries (LMICs) (2018 Global Nutrition Report, 2026). Despite progress in reducing hunger and improving food security in many regions, undernutrition continues to affect millions of people worldwide, especially women and children in resource-constrained

settings. At the same time, many countries are experiencing rising levels of overweight and obesity (Figure 1). These changes in population health have contributed to the emergence of the double burden of malnutrition (DBM), where undernutrition coexist with overweight and obesity within the same populations (Miller et al., 2025, Seifu, Mare, Legesse, & Tebeje, 2024).

Driving these changes is the nutritional transition, steered by urbanisation and globalisation, which has led to changes in dietary patterns, including increased consumption of processed foods, sugars, and fats, coupled with reduced energy expenditure due to more sedentary lifestyles (Popkin, 2006; Popkin, Corvalan, & Grummer-Strawn, 2020, World Food Programme, 2024). The coexistence of underweight and overweight in many LMICs is a result of this, coupled with the epidemiological trend that describes the burden of disease and length of lifespans among populations (United Nations Children's, 2019; World Health, 2020).

Risk factors contributing to the DBM can be environmental, biological, social, and behavioural factors and influence these populations. More specifically, these factors include consumption of unhealthy foods, food insecurity, and social inequality (Otten & Seferidi, 2022, Reardon et al., 2021). Without treatment or prevention, DBM can lead to poor health and adverse health outcomes throughout life. In order to create effective public health interventions, it is essential to understand the contributing factors of both overweight and undernutrition by analysing the socioeconomic disparities and nutritional transitions of DBM.

Overweight and obesity occurs when a person consumes more energy than they expend, often due to the consumption of unregulated and processed foods and drinks, the lack of availability and affordability of healthy foods, and the adoption of sedentary lifestyles (World Food Programme, 2024, World Health Organization, 2024b). A previous analysis shows that overweight and obesity has shifted to poorer rural regions of affected countries across South Asia as per capita income increases in urban areas (Shekar, 2020). Furthermore, there has been a 55% rise in overweight and obesity, of which 80 to 90% is found in rural areas of Southeast Asia, Latin America, Central Asia, and North Africa, except Sub-Saharan Africa (Shekar, 2020). These findings and analysis from this study will demonstrate the need to develop interventions that will address the major determinants of overweight and obesity.

Conversely, undernutrition occurs when a person receives an insufficient amount of energy in their diet for their activity level. Deficiencies in iron, iodine, and vitamin A pose significant

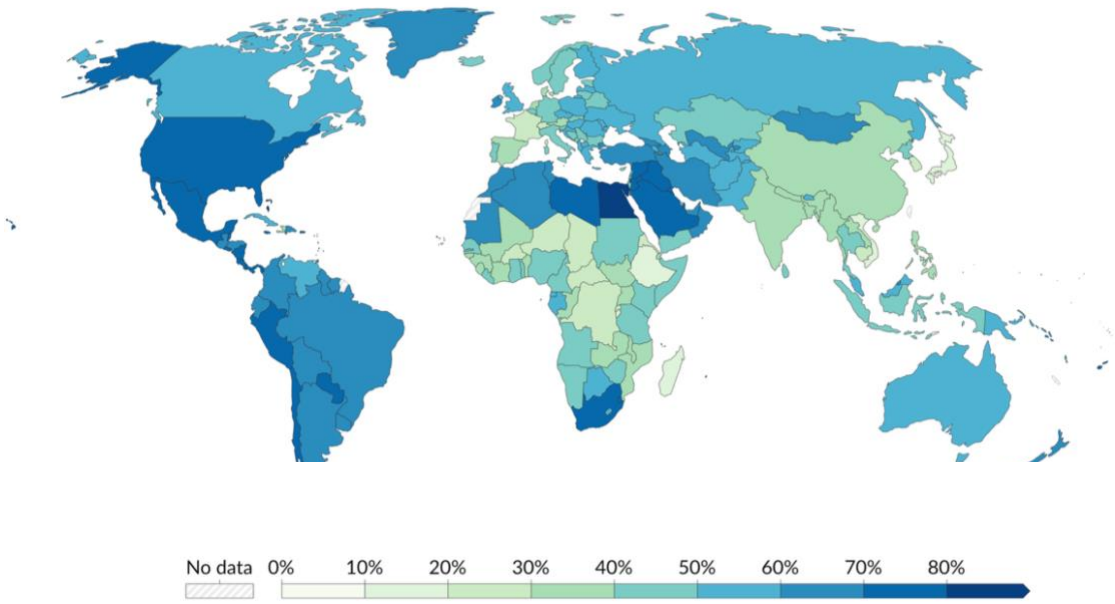
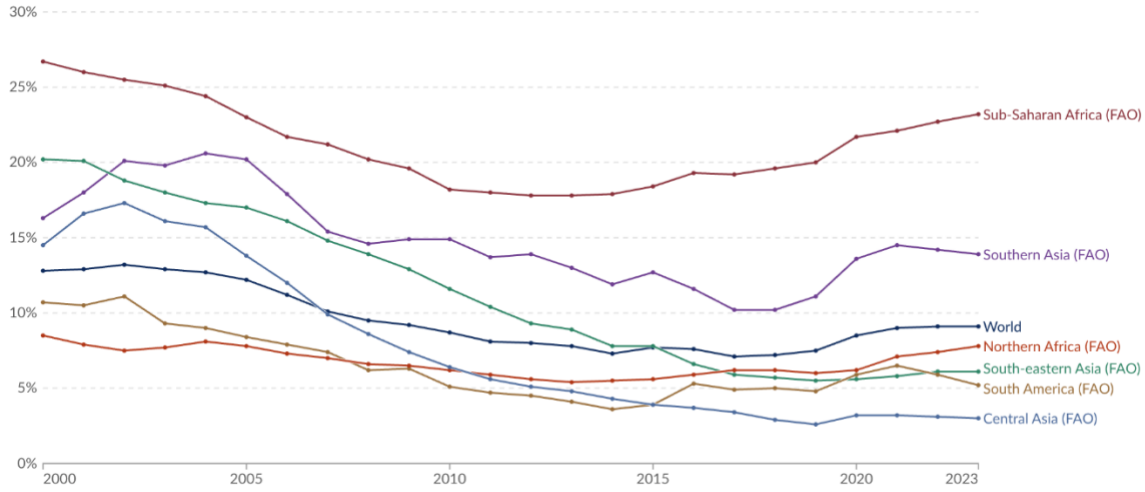


Figure 3: Geographical distribution of global overweight or obese women, 2022 *(*From Our World in Data with data source: World Health Organization – Global Health Observatory, 2025 OurWorldinData.org/obesity. CC BY 4.0)

risks to the health, growth, and development of populations worldwide, especially women and children in low-income countries (World Health Organization, 2024b).

Hunger has been a public health problem throughout history, with food shortages, malnutrition and famine occurring worldwide (Neti Gupta, 2015). The Food and Agricultrual Organization of the United Nations (FAO) reports undernourishment as a population with a dietary intake that receives insufficient calories to meet the energy needs of a healthy and active life (FAO, 2026). Data published in Figure 2, which combines national food supply data, demographic projections, and household consumption survey data, shows a steady global decrease (Ritchie H, 2023). In particular, the report on state of food security and nutrition in the world, states the prevalence of undernourishment in Southern Asia decreased over the 2020- 2022 period by 0.3% and 12.3% since 2005 (FAO, 2023). As the nutrition status transitions from overnutrition to undernutrition globally, it is shown to rapidly increase among LMICs and less so in high-income countries (Popkin, Adair, & Ng, 2012)

Figure 4: Undernourished populations by each global region since 2000



From Our World in Data with data source: World Health Organization – Global Health Observatory, 2025 (OurWorldinData.org/obesity). CC BY 4.0

Recognising these definitions and causes provides a foundation for exploring the socioeconomic disparities and shifting nutritional patterns affecting women's health in South Asian countries such as Pakistan, Bangladesh, India, the Maldives, and Nepal.

In many LMICs, gender roles and intra-household food allocation further compound this vulnerability. For example, in Bangladesh and India patriarchal structures dominate food distribution, resulting in women and girls often eating the least and last within households (Bharati, Pal, Sen, & Bharati, 2019; Harris-Fry et al., 2015). This gendered dynamic not only affects their nutritional status but also influences their children's health. Societal norms reinforcing these roles, such as expectations for women to prioritise family care over personal health, exacerbate inequalities and limit women's access to nutritious food, healthcare, and education (Banda, O., C., & and Muchiri, 2017; Sen & Östlin, 2008).

Despite ongoing efforts stimulated by the United Nations (UN) Sustainable Development Goals (SDG), global data show that DBM remains a growing public health challenge across countries of all income groups: high, middle, and low, with independent changes in each region, particularly impacting populations in LMICs in sub-Saharan Africa and South Asia (R. E. Black et al., 2013; R. E. P. Black et al., 2008; Mare, Sabo, Wengoro, & Lahole, 2025; Popkin et al., 2020; Shekar, 2020). Malnutrition can be conceptualised through social and economic determinants that shape nutritional outcomes across life stages. In South Asia, each country's health, development, and social justice systems frame the DBM. This underscores the inadequacy of siloed nutrition strategies that fail to simultaneously address both overnutrition and undernutrition. LMICs, where development programs have historically prioritised undernutrition, are now faced with rising rates of overweight and diet-related NCDs, for which programs have been insufficiently integrated into public health responses.

Social determinants of health and nutrition

Nutritional outcomes among women of reproductive age are shaped not only by biological and behavioural factors but also by social determinants, including household income, education, geographic location, access to healthcare, as well as gender norms and social status. These determinants shape women's ability to access adequate nutrition, particularly in LMICs, where structural inequalities are more distinct (Ishfaq, Anjum, Kouser, Nightingale, & Jepson, 2022; Kabir et al., 2020). For women of reproductive age in South Asia, nutritional outcomes are closely linked to socioeconomic position, early marriage, unequal intra-household food allocation, and limited decision-making power (Goudet, Murira, Torlesse, Hatchard, & Busch-Hallen, 2018; Miller et al., 2025).

Similar direct and indirect factors contribute to women's hunger and overnutrition, such as food affordability, distribution of people in rural and urban areas, and local or national specific dynamics, such as investments in agrifood systems and economic policies. Several indirect factors contribute to the significant global shift in dietary patterns and nutrition, including

- **Trade liberalization and advancements in technology** have led to the increased availability of modern retail foods dominated by ultra-processed foods (Baker et al., 2020),
- A persistent **lack of urban infrastructure** has resulted in increased transportation needs and a reduced number of outdoor public spaces, which limits opportunities for physical activity (Kim, Choe, Lee, Subramanian, & Kim, 2025; Rahaman, Kalam, & Al-Mamun, 2023)
- **Changes in the demand and supply of food systems** have affected the affordability and access to healthy food, leading to food insecurity. This issue is further exacerbated

by rural-to-urban migration (FAO, 2023), where women face a higher risk of food insecurity than men. (FAO, 2023; Jung, de Bairros, Pattussi, Pauli, & Neutzling, 2017)

- **Social and cultural norms** influenced by digital media and marketing have contributed to more frequent snacking and increased eating away from home (Shekar, 2020)

In addition to these indirect factors, direct factors such as shifting dietary patterns, decreased physical activity, early life nutrition, and genetics contribute to the rise in obesity (Shekar, 2020).

The coexistence of undernutrition and overnutrition in South Asian LMICs presents a significant challenge for health systems that have traditionally prioritised maternal and child undernutrition while underestimating the rising burden of diet-related NCDs. Health services are often ill-equipped to address this dual burden, lacking integrated care models, workforce training, and dedicated preventive strategies. The World Health Organisation (WHO) calls for integrated actions through its Double Duty Actions framework (WHO, 2017) and policies to leverage equity and agrifood systems transformation for healthy and sustainable diets (FAO, 2023).

This thesis focuses on DBM and the structural social determinants of health inequality, as outlined in the Commission of Social Determinants of Health (Figure 4), specifically education level, household wealth index and place of residence. For instance, higher levels of education has previously been positively associated with overnutrition and inversely associated with undernutrition (Mare, Sabo, Wengoro, & Lahole, 2025). However, relatively few studies comprehensively account for the broader set of interacting social and economic factors. Women's income, in particular, remains underexplored, despite evidence suggesting that

higher income is associated with increased overweight prevalence and limited progress toward reducing undernutrition in LMICs (Hasan et al., 2022).

Similarily, food insecurity affects both urban and rural populations globally with a higher prevalence observed in rural areas (32%) compared to urban areas (26%) (FAO, 2024). Despite this, place of residence has insufficiently examined as a differentiating factor in studies of women's malnutrition. Altogether, the evidence demonstrates that malnutrition is shaped by interconnected social, economic, and environmental determinants that operate across individual, household and structural levels, underscoring the importance of applying integrated social determinants of health frameworks to the study of DBM.

Global Frameworks on Maternal and Child Nutrition

UNICEF Conceptual Framework on Maternal and Child Nutrition

The United Nations International Children's Emergency Fund (UNICEF) 2020 Conceptual Framework for Maternal and Child Nutrition provides a comprehensive overview of each social determinant influencing nutrition outcomes, categorising them into enabling, underlying and immediate determinants (UNICEF, 2021). This framework assisted the direction of the analysis approach in this thesis as well as a completed literature review. The framework is shown in Figure 3 as a flow diagram.

At the broadest level, enabling determinants encompass the political, financial, social, cultural, and environmental conditions that create a foundation for good nutrition in women and children. These are further grouped into three categories:

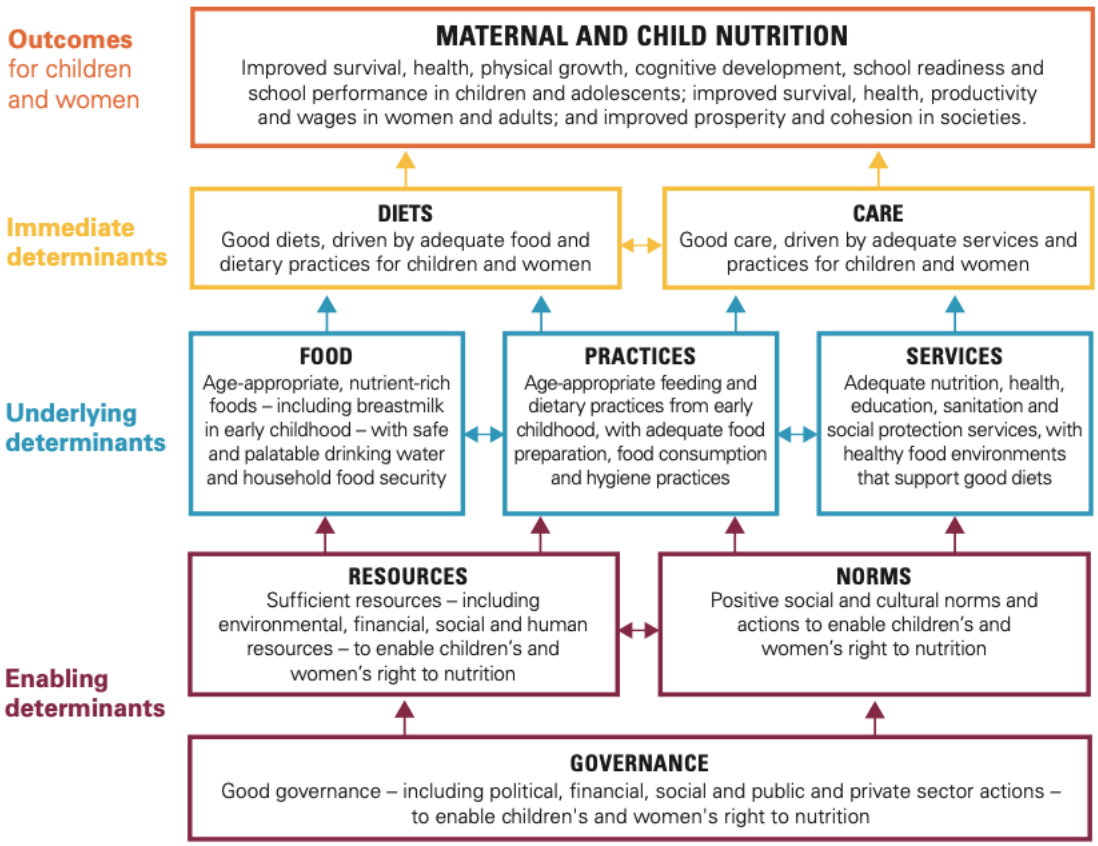
1. **Governance** relates to the collective efforts of governments, the private sector, and civil society to ensure the right to adequate nutrition.
2. **Resources**, including environmental, financial, social, and human assets, are needed to sustain nutrition security.
3. **Norms are the cultural, gender, and social expectations** that guide how people eat, feed, and provide care.

Underlying determinants refer to the conditions in households and communities that directly impact nutrition. These include

- **Food**, which refers to year-round household food security, access to safe water, and nutrient-rich diets, including breast milk for infants.
- **Practices related to appropriate breast-feeding behaviours**, such as breastfeeding, complementary feeding, and food hygiene.
- **Services comprising access to healthcare, sanitation, education, social protection, and healthy living environments**.

Finally, the immediate determinants of nutritional status are **diet and care**. Optimal health requires adequate food availability and accessibility, but also reliable and consistent access to essential health services.

Figure 5: The UNICEF Conceptual Framework on the Determinants of Maternal and Child Nutrition, 2020



From UNICEF Conceptual Framework on Maternal and Child Nutrition by UNICEF (https://www.unicef.org/documents/conceptual-framework-nutrition). CC BY 4.0

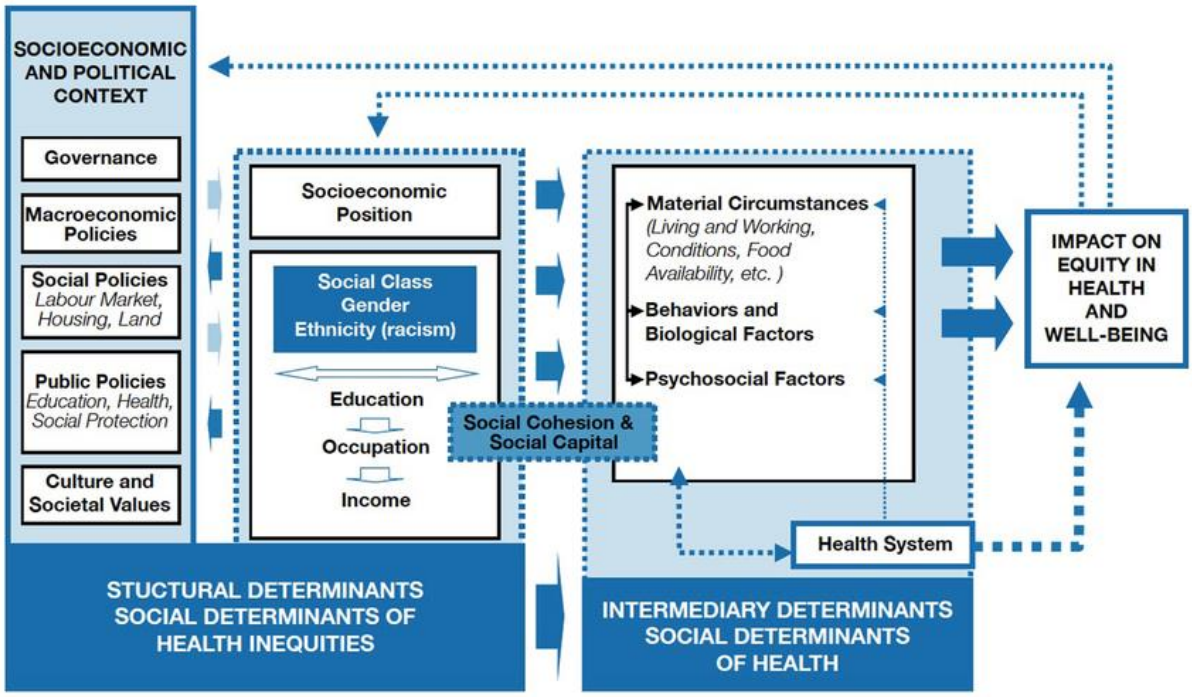
Improved nutrition delivers lifelong benefits throughout the life course. Nutrition enhances growth, survival, and cognition, and thus education in childhood and throughout each life stage. It also promotes health, productivity, income, and societal well-being in adulthood across socioeconomic levels.

Conceptual Framework for Action on the Social Determinants of Health

Global frameworks, such as the WHO's 2010 Conceptual Framework for Action on the Social Determinants of Health, distinguish between structural determinants, such as socioeconomic and political context, and intermediary determinants, such as material conditions, psychosocial factors, and health behaviours (World Health Organization, 2010). As illustrated in Figure 4, the model provides a useful demonstration for understanding how entrenched social hierarchies

are, including social status, income, and gender, and how they intersect to produce unequal health and nutrition outcomes across population groups, directing this study towards three structural socioeconomic determinants of health inequalities: education, income and place of residence.

Figure 6: The Commission on Social Determinants of Health, WHO 2010



From *A Conceptual Framework for Action on the Social Determinants of Health, Social Determinants of Health Discussion Paper 2* by the World Health Organization, 2010 (https://www.who.int/publications/i/item/9789241500852). CC BY 4.0.

Commission's findings and includes four key recommendations to tackle health inequities globally (World Health Organization, 2025b)

1. Addressing economic inequality and investing in universal health services,
2. Tackling structural discrimination, conflict, and displacement, especially during emergencies, migration, and conflict,

3. Steering global megatrends such as climate change and digitalization toward equity goals, and
4. Transforming approaches to prioritise community-led solutions and monitoring through data governance.

This updated framework reinforces the need for multisectoral, equity-driven approaches that extend beyond individual-level interventions. In line with these global models, several South Asian countries have developed national frameworks that reflect the growing recognition of the need to integrate nutrition policy with broader social protection and development goals. Examples include India and Bangladesh's National Nutrition Strategy and Nepal's Multi-Sector Nutrition Plan, both highlighting the importance of addressing the underlying socioeconomic determinants of malnutrition (Government of India Ministry of Health and Family Welfare, 2017; Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh, 2015; National Planning Commission, 2017). This thesis applies these conceptual insights to investigate how undernutrition and overweight among women of reproductive age are distributed and have changed over time across key social factors in five South Asian countries.

This thesis draws on both the Global Framework for Maternal and Child Nutrition and the WHO Commission on Social Determinants of Health framework (2010) to guide the conceptual understanding of nutritional inequalities. These frameworks highlight how broader structural and socioeconomic factors shape health and nutrition outcomes through pathways such as resources, services, and social conditions. In particular, they informed the selection of key structural determinants examined in this thesis, education, household wealth, and place of residence, which influence access to food, health services, and caregiving environments. Drawing on these frameworks, this thesis examines how undernutrition and overweight among

women of reproductive age are socially patterned and how these patterns have changed over time across these key determinants in five South Asian countries. By applying a social determinants perspective, the analysis aims to better understand the socioeconomic inequalities underlying the double burden of malnutrition (DBM) among women in the region and provides the conceptual basis for the inequality analyses presented in subsequent chapters.

Context of the Study Countries

The South Asian countries of Pakistan, Bangladesh, India, Nepal, and the Maldives face overlapping nutritional challenges, where shared socioeconomic conditions, fragile health systems, and distinct policy landscapes shape the DBM.

Bangladesh

Bangladesh has a population of more than 178 million, with 18.7% living below the national poverty line (World Bank Group, 2025). It has made notable progress, with an increased life expectancy of 75 years and a stable fertility rate of 2.1 births per woman (Asian Development Bank, 2025). Goods and services, such as fuel and food, are the predominant sources of employment and income, with imports and exports relying on robust economic growth (International Monetary Fund, 2023).

There has been little progress on maternal malnutrition indicators, such as reducing anaemia among women which may be caused by monotonous diets with low consumption of animal-sourced food, pulses, and dark green leafy vegetables (Andrews et al., 2022; Global Nutrition Report, 2022; Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh, 2017). However, the prevalence of obesity among men and women remains the lowest in the world, it is still rapidly increasing, especially among women (Global Nutrition

Report, 2022). In addition, climate change has impacted 22% of rural households due to floods and riverbank erosion, forcing many to migrate to urban areas which in turn affects one's food environment (FAO, 2023).

National policies include the National Nutrition Policy, which started in 2015, the National Food Policy in 2006, and the National Health Policy in 2011, as well as the ongoing Scaling Up Nutrition (SUN) initiative from 2016 to 2025 (Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh, 2015). The SUN specifically tackles malnutrition as policies are accepted and planned for action at the national level. Yet programs such as the outreach of social safety net programs are in fact not reaching groups of pregnant and lactating women (Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh, 2015). Similar to Pakistan, Bangladesh has the capacity for integrated and targeted nutrition interventions.

India

India is the most populous South Asian country, with a population of 1.45 billion and an ongoing increase in population growth of 0.9% in 2024 (World Bank Group, 2025). The country has one of the fastest-growing economies and has significantly reduced the pace of extreme poverty in recent decades (World Bank Group, 2025). Although significant regional and socioeconomic disparities persist, they are exacerbated by urbanisation and wealth inequalities (United Nations, 2024).

Among women living in India from 1990 to 2022, the prevalence of underweight decreased by 28%, whereas obesity increased by 8.6% (Phelps et al., 2024). Previous studies have shown that wealth disparities continue to cause DBM in urban and rural areas, especially within slum

households with a concentration of undernutrition among women living in poorer and rural households (Nguyen et al., 2021; Prithishkumar et al., 2024). Meanwhile, overweight and obesity have increased to 20.7% and 4.2%, respectively, especially among wealthier, educated urban dwellers (Luhar, Mallinson, Clarke, & Kinra, 2018; Ng et al., 2014).

India has ardently addressed DBM through several programs but with limited success. The WHO has supported regulations for initiating national-level front-of-pack food labelling and regulating food advertisements to follow WHO global guidelines. In 2020, the Food Safety and Standards Regulations of India initiated restrictions on the sale and marketing of food products high in saturated fats or trans-fats, added sugars, or sodium on school and university premises (WHO South-East Asia Region. New Delhi: World Health Organization, 2022). The National Nutrition Strategy, supported by the Ministry of Health and Family Welfare, was released in 2017 with the objective of reducing anaemia in women of reproductive age and in children and adolescents. This involves implementing several schemes to prevent malnutrition, such as vitamin supplementation, promotion of breastfeeding, and awareness campaign days (Government of India Ministry of Health and Family Welfare, 2017). However, larger movements fighting malnutrition, such as the SUN initiative, only involve 4 out of 28 states in India, leaving the majority of the population's global nutrition targets off course to reach the SDGs (Global Nutrition Report, 2022; Scaling Up Nutrition). With notable progress in reducing hunger in India, the focus must be shifted to more state-wide programs in preventing non-communicable diseases.

Maldives

The Maldives is classified as an upper-middle-income country with 187 smaller coral islands and just over half a million people. The country has witnessed a significant increase in life

expectancy, which has risen by 10 years since 2000 (World Bank Group, 2024). Tourism is expected to drive continued economic growth; however, fiscal vulnerabilities, particularly high public debt and reliance on subsidies in key sectors, pose risks to economic stability. Rising food prices, largely driven by global exports and imports, have further highlighted these structural challenges (World Bank Group, 2025). A growing aging population strains the health care system, as well as climate vulnerability, and high stress on natural resources (United Nations Children's Fund, 2022).

There is limited evidence on micronutrient deficiencies in the Maldives due to the irregular reporting of national demographic surveys. Yet from the data available, there is a DBM, with concern for no improvement (Ferdausi, Al-Zubayer, Keramat, & Ahammed, 2022; Miller et al., 2025). A previous study showed that women in lower wealth quintiles were more likely to be underweight in the Maldives, while higher education levels were associated with underweight and lower levels of overweight/obesity. In urban and rural areas of the islands, being overweight was approximately five times more common than being underweight (Hashan, Rabbi, Haider, & Das Gupta, 2020). The DBM in the Maldives continues to be of concern, caused by sporadic accessibility of fresh and healthy foods, especially on the more-remote islands (United Nations Children's Fund, 2022). Hence, there has been limited progress towards reaching global health targets as of 2022 (Global Nutrition Report, 2022).

The cost of a healthy diet in the Maldives has increased by 0.5% since 2017, with 1.2% of people unable to afford a healthy diet as of 2021 (FAO, 2023). The Health Master Plan 2016-2025 includes action plans for NCDs and nutrition programs; however set targets or initiatives remain vague (Ministry of Health Republic of Maldives, 2022). In contrast, a 20% tax on imported and locally produced sugar-sweetened beverages was implemented in 2017,

supported by the WHO. This tax revenue was set aside for funding programs promoting good nutrition and physical activities in the future (WHO South-East Asia Region. New Delhi: World Health Organization, 2022).

Nepal

Nepal has a population of almost 30 million, predominantly in rural areas (World Bank Group, 2024). The World Bank Group states that, over the past three decades, the country has made significant progress in reducing poverty. However, it now faces the challenge of sustaining economic growth, job employment rates, and continued investment in infrastructure and tourism (World Bank Group, 2025). Nepal is also vulnerable to natural disasters such as floods, earthquakes, and disease outbreaks, which have previously disrupted infrastructure, health services, and agriculture, in turn severely disrupting access to services for women and children (World Bank Group, 2025).

Similar to the other countries presented, women have experienced a decrease in underweight prevalence by 25.9% since 1990, and a slow increase of 8.7% in obesity (Phelps et al., 2024). Urbanised areas, as well as richer quintiles and educated women, show rates of overweight/obesity. Whereas in rural municipalities, women were more likely to be underweight (Ghimire & Vatsa, 2021; National Planning Commission, 2017; Rana et al., 2022; Sutradhar et al., 2021). Women's malnutrition is likely caused by diets lacking essential nutrients due to poor water quality, limited healthcare access, economic constraints, gender-based violence and cultural taboos (National Planning Commission, 2017).

The Government of Nepal has instituted several nutrition-related policies, including the National Nutrition Policy and Strategy in 2004, the Nepal Health Sector Strategy 2016-2021,

and the Food and Nutrition Security Plan of Action 2014-2024. These policies have kept Nepal's global nutrition targets on course to achieve reduced rates of undernutrition; however, little focus has been placed on preventing NCDs in women.

Pakistan

Pakistan has a population of over 250 million, with an outstanding younger population of almost 80% aged below 40 years (World Bank Group, 2024). Despite improvements in economic stabilisation and poverty reduction since 2000, Pakistan continues to experience poor socioeconomic conditions. There are very high rates of school-age children who are out of school, along with protectionist trade policies and a challenging agribusiness environment (World Bank Group, 2025). The 2023 Population and Housing Census reported that men have higher literacy rates than women, at 68% and 53%, respectively. Furthermore, rapid urbanisation has led to higher education levels in urban areas, with 56% of the population living in slums, predominantly in the Punjab province (Pakistan Bureau of Statistics, 2023; World Bank Group, 2024). These vulnerabilities are further exacerbated by political instability and climate-related disasters, such as the 2022 floods.

Pakistan has made progress on selected maternal nutrition indicators but continues to face challenges in addressing the DBM, particularly among women. National data show that 13.4% of women and 7.5% of men are obese, highlighting the rising rates of overnutrition. However, at the same time, micronutrient deficiencies are common; for example, anaemia among women of reproductive age is not on track to meet the global nutrition targets set by the WHO, signalling gaps in both dietary quality and access to health services. Although indicators such as exclusive breastfeeding and the prevalence of undernourishment are on track, food insecurity continues to increase and complicate this progress. In 2022, 15.1% of the Pakistani

population experienced severe food insecurity. However, households headed by women are less likely to experience this in Pakistan instead lower monthly income, perceived socioeconomic status, and higher perceived stress are associated with increased food insecurity (Ahmed et al., 2024; World Bank Group, 2024).

Achieving the SDGs set by the UN depends on integrated, equity-focused nutrition strategies and comprehensive policies. Successful examples include the SUN initiative and strengthened partnerships across education, agriculture, and women's empowerment (Ahmed et al., 2024; United Nations Pakistan, 2018).

Literature Search Strategy

A structured literature search was undertaken to identify studies examining trends and social determinants in undernutrition and overnutrition among women of reproductive age in South Asia. Searches were conducted in the electronic database PubMed, chosen for the coverage of public health, epidemiology and social science research. The search strategy combined keywords related to nutritional outcomes (e.g. body mass index (BMI), maternal nutrition, nutritional status, underweight, thinness, overweight, obesity), population characteristics (e.g. women, reproductive age, maternal, female), geographic region (e.g. South Asia, Asia, developing countries, LMIC, Bangladesh, India, Pakistan, Nepal, Maldives) and social determinants (e.g. education, wealth, socioeconomic status, urban, rural). Searches were limited to studies published in English between 2000 and 2025, reflecting both post-millennium period relevant to this thesis. Reference lists of included articles and relevant reviews were also screened to identify additional studies. Studies were included if they i) examined women aged 15-49 years; ii) reported outcomes related to undernutrition (thinness) and/or overweight or obesity; iii) focused on South Asian countries; and iv) used population-

based or nationally representative data. Studies were excluded if they focused exclusively on children or men, lacked BMI-based outcomes or did not disaggregate findings by relevant social determinants.

Rationale of the Study

Understanding the DBM is essential for addressing the health needs of reproductive-age women in South Asia. Despite growing concern over underweight prevalence alongside rising obesity rates, there is limited region-wide evidence on how the trends of these nutritional outcomes vary over time in the South Asian region and whether they are associated with key social determinants such as wealth, education, and place of residence (Jiwani et al., 2020, Wariri, Alhassan, Mark, Adesiyan, & Hanson, 2021, Yaya, Anjorin, & Okolie, 2022, Nglazi & Ataguba, 2022). A recent study examined data from Central and Southeast Asia and found a similar increasing trend in female obesity. However, this study did not examine obesity trends across different social determinants of health (Thapa et al., 2024). Existing studies often focus on single-country analyses or lack disaggregated data that reveal the depth of socioeconomic inequalities with majority of papers originating from countries other than South Asia (Ahmad, Rahman, & Nadia, 2020, Talukder, Kelly, Sayeed, Gray, & Sarma, 2025). This study addresses this gap by analysing national survey data from five South Asian LMICs: Pakistan, Bangladesh, India, the Maldives, and Nepal. Each faces unique demographic, economic, and health system challenges. Nationally representative datasets, such as the Demographic and Health Surveys (DHS) (The DHS Program), provide comparable and robust evidence that enables the tracking of trends and disparities across countries and over time. Using harmonised data from multiple LMICs, this study provides a comprehensive cross-country perspective that can inform targeted, equity-driven nutrition policies and programs in each country's government.

Research Goal and Objectives

The goal of this research is to contribute further evidence to the growing global concern surrounding the DBM among women in LMIC.

To achieve this goal, the thesis has the following objectives:

1. To examine trends in overweight and obesity (overnutrition) among women of reproductive age over a 17-year post-millennium period in five South Asian LMICs: Pakistan, Bangladesh, India, the Maldives, and Nepal.
2. To examine trends in thinness (undernutrition) among women of reproductive age over a 22-year post-millennium period in the same five South Asian countries.
3. To investigate socioeconomic inequalities in women's nutritional status, focusing on three key structural determinants: household wealth, education level, and place of residence (urban or rural).
4. To assess how these inequalities have changed over time and how they contribute to the double burden of malnutrition among women in South Asia.

Methodology

Data sources

In this chapter, we analysed the DHS (The DHS Program) data from surveys conducted between 2000 and 2022 in the five countries in South Asia, as mentioned above. The DHS are nationally representative household surveys conducted in over 90 low- and middle-income countries, providing data on population health, nutrition, and socio-economic indicators. Supported primarily by USAID DHS surveys follow standardized methodologies, enabling cross-country comparisons and trend analyses over time. The DHS employ a standardised

multistage survey design that produce national estimates representative of the country at the time of the survey. It uses a-four-stage cluster sampling procedure:

- Stage 1: survey design and preparation, involves defining the sampling frame and designing the questionnaires tailored to country contexts, typically over a six-month period,
- Stage 2: training and fieldwork, includes training interviewers and field staff and conducting household interviews using multiple field teams composed of interviewers, field editors and team leaders, data collection generally lasts four to six months,
- Stage 3: data processing and reporting, begins during fieldwork and includes data editing, validation, tabulation and report writing which may continue for up to one year,
- Stage 4: dissemination and data use, focuses on public releases of datasets and analytical reporting and typically lasts six to seven months.

Within this process, households are selected using a two-stage cluster sampling approach. In the first stage, clusters (primary sampling units based on census-defined geographic areas) are selected from nationally defined sampling frames, stratified by urban and rural residnce. In the second sampling stage, households are systematically selected within each cluster and eligible women are invited to participate in individual interviews. Anthropometric data was collected following the standardized measurement protocols of the DHS Program including height and weight measurements for women aged 15-49 years. These were obtained by trained field staff using internationally validated equipment that meets WHO and UNICEF specifications, including calibrated weighing scales measured to 0.1kg and standardized height boards. All equipment was newly procured for each survey and routinely calibrated throughout data collection to minimize measurement error. Field staff completed intensive training that included hands-on practice and formal exercises to assess measurement accuracy and precision against a gold-standard assessor then only those meeting performance thresholds were

deployed to the field. Data quality was further reinforced through supervision, use of technical checklists, real-time consistency checks and re-measurement of a subset of respondents to identify and correct implausible values. Summary indicators of anthropometric data quality are reported in each DHS final survey reports, showing reliability and comparability of measurement protocols across countries and survey years (The DHS Program, 2019).

DHS Survey Methodology

The DHS uses a standardised, rigorous methodology to generate nationally and sub-nationally representative data. Each survey employed a stratified two-stage cluster sampling design. In the first stage, the country is divided into strata, typically by major administrative regions and urban–rural residence, creating regions of residence domains. Within each stratum, a fixed number of primary sampling units, usually clustered census sampling units or primary sampling units, are selected with a probability proportional to size. In the second stage, a systematic household sample was drawn from each selected cluster. All eligible women aged 15–49 years in the selected households were invited to participate in interviews and anthropometric measurements with overall response rates ranged from 77% in the Maldives to 89% and above for the remaining countries.

This stratified design improves the precision of the estimates by ensuring the representation of both densely and sparsely populated areas, while clustering improves efficiency by reducing survey fieldwork costs. Sampling weights were adjusted for unequal probabilities of selection, non-response, and population distribution, allowing for valid inference at the national and subnational levels. Anthropometric data were collected by trained staff using standardised procedures and calibrated equipment to minimise measurement errors. The consistent methodology across survey rounds ensures comparability over time and across countries,

making the DHS a gold-standard data source for examining trends and socio-economic inequalities in nutritional status and socio-economic inequalities.

Selection of Countries and Social Determinants for Analysis

This study focuses on five LMICs, Bangladesh, India, Nepal, Maldives, and Pakistan, which are South Asian countries with multiple DHS that include anthropometric measurements of women of reproductive age. The availability of repeated survey rounds in this cross-country analysis enables the comparison of estimates and unique insight of temporal trends and socioeconomic inequalities in nutritional status.

The inclusion criteria required the availability of data on height and weight for women aged 15–49 years across at least two DHS survey waves. Afghanistan and Sri Lanka were excluded because their DHS lacked data on nutritional status, precluding estimates of undernutrition or overweight prevalence. The selected countries together represent a large proportion of the South Asian population and encompass diverse socioeconomic and cultural settings, supporting a comprehensive regional analysis. The consistent DHS sampling approach across countries ensures the comparability of estimates and allows pooled analyses to identify common patterns and disparities, which is crucial for informing regional nutrition policies.

To inform the selection of social determinants examined in this thesis, a structured screening of the existing literature was undertaken as part of the literature review. Following the database searches described earlier in this chapter, relevant studies examining undernutrition, overweight, obesity and the DBM among women of reproductive age in South Asia were screened to identify commonly assessed sociodemographic factors.

During this literature review, studies were extracted based on social determinants most frequently associated with nutritional status. Determinants consistently examined across the literature included household wealth, educational attainment and place of residence (urban-rural). These factors were repeatedly identified as key drivers of both undernutrition and overnutrition in LMIC settings around the world, particularly within South Asia.

The results of this literature search informed the development of the study's research questions, specifically the selection of determinants as primary explanatory variables that guided the theoretical relevance of nutrition transition and DBM. This approach ensured that the analysis was grounded in existing evidence while allowing for a systemic examination of long-term trends and inequalities using nationally representative data.

Sample Size

Table 1 summarises the number of women of reproductive age with valid anthropometric data included in each survey round from Bangladesh, India, Nepal, Maldives, and Pakistan. The sample sizes reflect the scale and representativeness of the DHS in each country.

Table 1: Sample size in each round of survey

	Survey year						
Country	**2000-01**	**2004-06**	**2007-09**	**2011-12**	**2014-15**	**2016-17**	**2021-22**
Bangladesh	9,020	20,862	20,042	32,048	32,956	36,656	18,426
India	-	223,562	-	-	1,294,336	-	1,321,482
Nepal	15,568	20,006	-	11,600	-	12,138	14,014
Maldives	-	-	10,346	-	-	13,334	-
Pakistan	-	10,023	-	8,340	-	7,444	-

Bangladesh contributed data from seven DHS rounds, with sample sizes increasing over time from 9,020 women in 2000–01 to over 36,656 in 2016–17, before declining slightly to 18,426 in 2021–22 due to a smaller survey. Nepal has four survey rounds with anthropometric data, ranging from approximately 11,600 to over 20,000 women per round. India provides the largest sample sizes, with over 1,3 million women in the 2015–16 survey and almost 1.3 million again in 2019–21, enabling detailed disaggregation by socio-economic and geographic characteristics. The Maldives contributed two DHS surveys (2007–09 and 2016–17) with around 10,000 to 13,000 women, while Pakistan provided three rounds, each including approximately 7,400 – 10,000 women.

These large and nationally representative samples provide sufficient statistical power to estimate prevalence rates, track trends, and analyse socioeconomic inequalities in nutritional status across a 22-year period and multiple countries.

Study Variables

The outcome variables for all sections of this thesis were overweight, obesity, and thinness among women of reproductive age (15-49 years). Overweight or obesity was defined as BMI $\geq 25 kg/m^2$, thus including both overweight BMI $25 – 29.9 kg/m^2$ and obesity BMI $\geq 30 kg/m^2$, and thinness was defined as BMI $<17 kg/m^2$. BMI was calculated and recorded as weight in kilograms divided by height in meters squared (World Health Organization, 2025a). BMI is a well-established population-level indicator that has been widely used to assess nutritional status and to compare prevalence and trends across time, countries and population groups. The WHO BMI classifications were refined following an expert consultation in 1997 and subsequently adopted by the United States National Heart, Lung and Blood Institute (Katherine M. Flegal, 2023). The indicator remains the most applied standards in epidemiological research

and global surveillance systems, including the DHS. In South Asian contexts, including India, evidence suggests that BMI alone may underestimate metabolic risk (Roger Shrimpton, 2012, C S Yajnik, 2004). Although measures such as weight-to-hip ratio, waist-to-height ratio and waist circumference, provide an independent predictor of morbidity, BMI remains more effective due to its methodological advantages and standardised measurement protocols (Riaz & Lodhi, 2025). Replacing BMI with alternative measures would limit comparability with existing studies, future research and global benchmarks.

We also examined the trends of overweight, obesity, and thinness across different social determinants of health, including household wealth index, women's level of education, place of residence, and demographic data collected for each survey year from 2000 to 2022. The household wealth index, a gauge of socioeconomic status, was determined through principal component analysis, encompassing various indicators such as asset ownership, housing type, sanitation services, and water access (The DHS Program). Households were classified into quintiles based on the household wealth index, with the first quintile being the poorest group and the fifth quintile being the richest group. The level of education was categorised into two levels: no schooling and secondary or higher education. Finally, place of residence was categorised as either urban or rural.

Structure of the Thesis

This thesis is structured into four chapters. **Chapter 1** describes the problem, the context of each country studied, the social determinants studied, and the research aims and design. **Chapter 2** studies the trends and socio-economic inequalities of overweight and obesity in the selected countries (as mentioned above). **Chapter 3** examines the trends and socio-economic

inequalities of thinness among women in the selected countries (as mentioned above). **Chapter 4** summarises all the chapters and highlights the key milestones that relate to the overall research aim, including a call to action.

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Chapter 2: Trends and socio-economic inequalities of overweight and obesity among women of reproductive age in South Asian countries: Pakistan, Bangladesh, India, Maldives and Nepal

Introduction

Overweight and obesity, defined as a body mass index (BMI) of ≥25 kg/m^2 is the leading cause of coronary and ischaemic heart disease and other high risk non-communicable diseases (Ni Mhurchu, Rodgers, Pan, Gu, & Woodward, 2004, Asia Pacific Cohort Studies Collaboration, 2007, World Health Organization, 2021). Studying overweight and obesity together is important because both conditions significantly increase the risk of cardiovascular disease and other non-communicable diseases (Rieger, 2016). Both represent excess body weight and share similar metabolic risk pathways, including hypertension, dyslipidaemia, insulin resistance, and systemic inflammation, which contribute to the development of chronic diseases. Among women of reproductive age, excess body weight is associated with increased risk of pregnancy complications such as pre-eclampsia, congenital anomalies, and stillbirth (Lash & Armstrong, 2009, Leddy, Power, & Schulkin, 2008).

The prevalence of overweight and obesity continues to steadily rise on a global scale. In 2014, obesity among women and men surpassed underweight in 165 and 136 countries worldwide with severe obesity exceeding in 135 countries among women and 113 countries among men (NCD-Risk Factor Collaboration & Sunyer Deu, 2016). While the burden remains highest in affluent regions such as the United States of America, Polynesia, Micronesia, the Middle East, Sub Saharan Africa and Central Europe, post-millennium trends indicate a rapid rise in overweight and obesity across low-and-middle-income regions including Southeast Asia, Latin

America and the Caribbean (NCD-Risk Factor Collaboration & Sunyer Deu, 2016, Acosta-Cazares et al., 2017, Martorell, Kettel Khan, Hughes, & Grummer-Strawn, 2000, Zhou et al., 2024).

Globally, women bear a disproportionately higher burden of obesity, with the number of women living with obesity increased by more than five times over recent decades, with an estimated rise of 321 million obese adult women 1975 to 2016 (Ng et al., 2014, Di Cesare et al., 2016, Peters, Muntner, & Woodward, 2019, Boyd et al., 2011, Acosta-Cazares et al., 2017). Sex-disaggregated data from several South Asian countries show that prevalence rates of obesity were more than double that of men in 2022 (World Obesity Federation, 2026). The higher prevalence of overweight and obesity among women may reflect a combination of biological and social influences. Physiological changes related to pregnancy, childbirth and hormonal variation can increase susceptibility to weight gain, while gendered roles and caregiving responsibilities may reduce opportunities for physical activity (Jee & Sawal, 2024). In many settings, women also face structural constraints in access to employment and decision-making, which can shape dietary choices and long-term nutritional outcomes (O'Meara et al., 2025).

A landmark Lancet study reported a consistent increase in the mean BMI of women in Southeast Asian countries by over 1kg/m^2 per decade, with a more pronounced surge after 2000 compared with earlier periods and by 2014, an alarming count of 375 million women globally were reported obese (NCD-Risk Factor Collaboration & Sunyer Deu, 2016, WHO, 2014). Projections estimate that low-income countries like Maldives and Bhutan will become the highest future burden of overweight and obesity in the region, with over 69 million women at

risk of obesity complications by 2030 in the Southeast Asian region (Lobstein, Brinsden, & Neveux, 2022).

These shifts have contributed to the emergence of the double burden of malnutrition (DBM), characterized by the simultaneous presence of undernutrition and overweight or obesity within the same countries, communities, households and individuals (Ng et al., 2014, Swinburn et al., 2011). The coexistence underscores the complexity of nutritional challenges in South Asia, where longstanding structural drivers of malnutrition are layered upon poverty, gender inequality and limited access to health services. In South Asia, this phenomenon also reflects rapid socioeconomic and dietary transitions occurring alongside persistent poverty, food insecurity, and inequitable access to nutritious diets. Historically dominated by undernutrition, South Asian health profiles have changed markedly over recent decades. Understanding trends in overweight and obesity is therefore critical not only for tracking the growing burden of NCDs but also for contextualising these patterns within the broader DBM. Trend analyses provide insight into how nutritional risks evolve over time and identify population subgroups disproportionally affected by both forms of malnutrition.

Studies consistently have shown that overweight and obesity vary by age, gender, place of residence, education level and wealth quintile (Ng et al., 2014, Boyd et al., 2011). Other studies discuss determinants for the obesity epidemic to be due to the food environment, supply of energy-dense foods combined with sedentary lifestyles (Ng et al., 2014, Boyd et al., 2011, Acosta-Cazares et al., 2017, Stevens et al., 2012). Examining socio-economic inequalities in overweight and obesity, is therefore vital for pinpointing structural inequities, understanding the complex factors driving divergent nutritional outcomes, and designing effective, targeted interventions (Harris-Fry, Shrestha, Costello, & Saville, 2017).

This study aims to quantify and compare the trends in the prevalence of overweight and obesity across five South Asian countries over a 17-year post-millennium period (2000 – 2022) with a focus on three specific social determinants: household wealth quintile, education attainment and urban-rural residence. By situating overnutrition within the context of persistent undernutrition, the findings will contribute to further understanding of the DBM and inform equity-focused health policies and resource allocation for and health promotional programs across South Asia.

Methodology

Data sources and participants

The study analysed Demographic and Health Surveys data, carried out between 2000 and 2022 from five countries in the South Asian region. Countries were selected based on the data availability for the variables of interest. The DHS surveys are nationally representative cross-sectional household surveys that collect data for a wide range of population health indicators including nutritional status of men and women in low-to-middle-income countries.

The DHS surveys maintain uniform methodologies for gathering data and employ similar questionnaires, enabling easy comparison across different countries. The surveys employ a standardised multistage cluster sampling design to generate nationally representative estimates at the time of each survey. In brief, clusters (primary sampling units defined by census geographic areas) are first selected from nationally defined sampling frames, stratified by urban and rural residence. In the second stage, households are systematically sampled within each selected cluster, and all eligible women aged 15–49 years are invited to participate in individual

interviews. Further details of the survey design, training procedures, data processing and dissemination phases are described in Chapter 1 (Methodology) and in DHS technical documentation (The DHS Program, 2025).

All DHS surveys are conducted in accordance with strict ethical standards. Informed consent is obtained from all participants prior to data collection, with respondents clearly informed about the purpose of the survey, the right to refuse or withdraw at any time without consequence, all data are collected privately and fully anonymised before being made available for secondary analysis. Ethical approval for DHS survey protocols is obtained by the ICF Institutional Review Board and by relevant national ethics committees in each participating country. The present study used de-identified secondary data accessed through formal authorisation from the DHS Program and did not require additional institutional ethics approval, in accordance with international guidelines. Access to the DHS datasets was obtained upon formal approval from DHS Program (see Appendix 1).

Sample size of cohorts

Our final dataset comprised 1,571,113 women of reproductive age from 19 survey rounds (see Table 1). In the current study, we selected all surveys post 2000 up until 2022 in the five selected countries including India (2005, 2015, 2021), Bangladesh (2000, 2004, 2007, 2011, 2014, 2017, 2022), Pakistan (2012, 2017), Maldives (2009, 2016) and Nepal (2001, 2006, 2011, 2016, 2022). The unit of analysis was women of reproductive age (15–49 years old). We extracted the women's records (IR) of each country and appended them.

Study Variables

The outcome variable for the current study was overweight and obesity in women of reproductive age (15-49 years). Overweight or obesity were defined as BMI ≥ 25kg/m^2, thus including both overweight (BMI 25 – 29.9kg/m^2) and obesity (BMI ≥30kg/m^2). BMI levels were calculated and recorded as weight in kilograms divided by height in metres squared in accordance with the WHO guidelines (WHO, 2018). There are studies that have used reduced BMI thresholds (e.g. ≥23 kg/m^2 for overweight), which have been proposed for South Asian populations due to their higher cardiometabolic risk at lower BMI levels (World Health Organization Expert Consultation, 2004). However, these lower cut-offs were not applied in the present study. Instead, the WHO international BMI classification was retained to ensure consistency with DHS reports, which uniformly use conventional thresholds across countries and survey waves. Maintaining the standard classification enhances comparability across settings and over time, allows direct comparison with existing global estimates, and supports alignment with international monitoring frameworks. Although lower thresholds may improve sensitivity for identifying risk within specific populations, the use of globally standardised cut-offs strengthens methodological consistency and the validity of cross-country comparisons.

Anthropometric data was collected following the standardized measurement protocols of the DHS Program including height and weight measurements for women aged 15-49 years. These were obtained by trained field staff using internationally validated equipment that meets WHO and UNICEF specifications, including calibrated weighing scales measured to 0.1kg and standardized height boards. All equipment was newly procured for each survey and routinely calibrated throughout data collection to minimize measurement error, see Chapter 1 Methodology for more detail.

This study was theoretically informed by the nutrition transition, which refers to the long-term shift toward energy-dense diets and more sedentary lifestyles accompanying urbanisation and socioeconomic change, resulting in rising overweight and obesity alongside persistent undernutrition. The analysis was further guided by the UNICEF 2020 Conceptual Framework for Maternal and Child Nutrition and the WHO Conceptual Framework for Action on the Social Determinants of Health (United Nations Children's Fund (UNICEF), 2021; World Health Organization, 2010), which together provide a logic linking structural and socioeconomic conditions to intermediate behavioural pathways (e.g., diet, physical activity, access to resources) which in turn influence nutritional outcomes. Guided by these conceptual frameworks, trends in overweight and obesity were examined across key social determinants of health, including household wealth, women's education level and place of residence.

We also examined the trend of overweight and obesity across different social determinants of health including household wealth index, women's level of education and the place of residence. The household wealth index, a gauge of socio-economic status, was determined through principal component analysis, encompassing various indicators like asset ownership, housing type, sanitation services, and water access. Based on household wealth index, households were classified into quintiles, with the first quintile (Q1) being the poorest group and the fifth quintile (Q5) being the richest group. The level of education was categorized into two levels: No education and higher education. The lowest and the highest education and wealth groups were included in the analysis to estimate the magnitude and absolute gaps in inequity. Place of residence was categorized into urban or rural setting.

Statistical analysis

We used Stata 16.1 (StataCorp, College Station, Texas, USA) for all statistical analysis. The survey command (svy) was used to account for sampling weight and the cluster sampling in all analyses. The absolute difference (AD) and average annual rate of change (AARC) in the prevalence of overweight or obesity were estimated across countries with corresponding confidence intervals, stratified by social determinants, following approaches used in prior epidemiological analyses (Jiwani et al., 2020, Amugsi, Dimbuene, Mberu, Muthuri, & Ezeh, 2017, Assaf, 2019). To calculate the AD, we subtracted the latest overweight and obesity rate from the earliest overweight and obesity rate. The AARC in overweight and obesity was estimated using regression-based methods. When prevalence estimates were available for multiple survey years, log regression models were fitted with the social determinant (e.g. education attainment level) included as the covariate. This was calculated using the following formula

$$AARC=1-\exp(\beta)$$

β symbolizes the coefficient derived from a simple linear regression analysis, representing the average annual proportion change in prevalence. This coefficient is obtained by regressing the natural logarithm of prevalence (ln(Yi)ln(Yi)) against time (ti). This approach assumes a constant rate of change in prevalence over time and allows for comparability of trends across countries and population subgroups.

Results

Our final dataset comprised 1,561,090 women of reproductive age from sixteen survey rounds (see Table 1 below). These surveys spanned a period of 22 years in Bangladesh, India, and Nepal, and 17 years in the Maldives and Pakistan. The earliest data points were from Bangladesh and Nepal in 2000, while the most recent were collected in 2022 from Bangladesh,

Nepal, and India. There were seven survey rounds conducted in Bangladesh, five in Nepal, three in India, and two in both the Maldives and Pakistan. The sample size in different round of surveys ranged from 3,722 in Pakistan in 2016-2017 to 660,741 in Indian in 2014-2015.

Table 2: Sample size of cohorts

	2000-2001	**2004-2006**	**2007-09**	**2011-2012**	**2014-2015**	**2016-2017**	**2021-22**
Bangladesh	4,510	10,431	10,021	16,024	16,478	18,328	9,213
India	-	111,781	-	-	647,168	-	660,741
Nepal	7,784	10,003	-	5,800	-	6,069	7,007
Maldives	-	-	5,173	-	-	6,667	-
Pakistan	-	10,023	-	4,170	-	3,722	-

The overall trend across survey rounds for overweight and obesity prevalence in the five study countries are presented in Figure 5 and Table 2. We found a significant increase in the prevalence of overweight and obesity across all the studied countries, except for the Maldives. Between 2000 and 2006, the prevalence of overweight and obesity substantially increased from 4.5% to 12.6%. Between 2016 and 2022, the prevalence ranged from 32.1% to 36.5%. This increase is particularly pronounced in Bangladesh, with an AD of more than a quarter (32.0%) between 2000 and 2022 and an annual average increase of 10.08% (Table 2). Nepal reported an AD of 22.9% between 2000 and 2022 with an annual average increase of 8.0%. India and Pakistan reported similar increases, with an AARC of 5.2% and 5.3%, respectively. Maldives reported the most modest increase with an AD of 4% between 2007 and 2016, and an AARC of 1.2%.

Table 3: The overall prevalence, AD, AARC and direction of trend of overweight and obesity among women of reproductive age in South Asian countries with confidence intervals, sample size: 1,561,090

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh	4.48 (3.72-5.40)	8.82 (7.80-9.95)	11.83 (10.61-13.17)	16.36 (15.39-17.39)	23.77 (22.29-25.31)	32.13 (31.09-33.19)	36.48 (35.15 – 37.84)	32.00	10.08	↑
India	-	12.65 (12.17-13.14)	-	-	20.67 (-)	-	24.02 (23.76 – 24.28)	11.37	5.15	↑
Maldives	-	-	45.47 (43.24-47.73)	-		49.44 (47.68-51.19)	-	3.97	1.20	→
Nepal	6.37 (5.34-7.59)	8.54 (7.25-10.03)	-	13.38 (11.77-15.17)	-	22.11 (20.36-23.97)	29.26 (27.28 – 31.34)	22.89	7.97	↑
Pakistan	-	-	-	40.19 (37.21-43.23)	-	52.13 (48.83-55.40)	-	11.94	5.34	↑

*AD: Absolute Difference, AARC: Average Annual Rate of Change

Figure 5: Bivariate scatter plot showing the prevalence trend of overweight and obesity rates among women of reproductive age in five South Asian countries

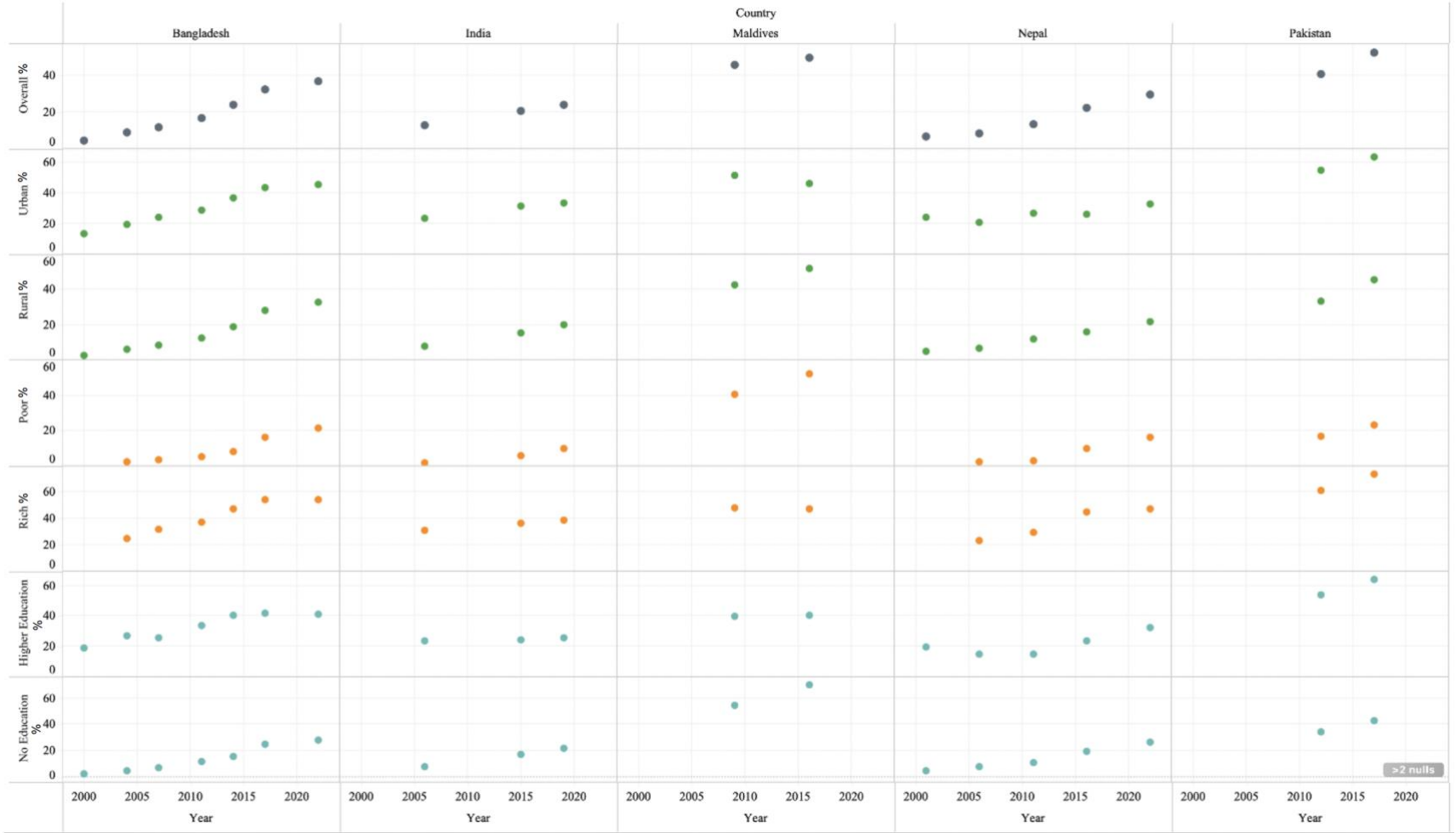

Table 4: The prevalence, AD, AARC and direction of trend of overweight and obesity across place of residence among women of reproductive age in South Asian countries with confidence intervals, sample size: 1,568,113

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh										
Urban	13.13 (10.60 -16.17)	19.54 (16.72 - 22.71)	24.19 (21.34 - 27.29)	28.90 (26.47 - 31.36)	36.39 (33.79 - 39.07)	43.41 (41.47 - 45.38)	45.53 (42.73 - 48.36)	32.40	5.91	↑
Rural	2.59 (2.03 - 3.30)	5.75 (4.98 - 6.63)	8.16 (7.13 - 9.33)	12.11 (11.11 - 13.19)	18.79 (17.27 - 20.42)	28.03 (26.81 - 29.30)	32.85 (31.4 - 34.33)	30.26	12.37	↑
India										
Urban	-	23.48 (22.57 -24.43)	-	-	31.35 (30.82 - 31.88)	-	33.26 (32.72 - 33.81)	9.78	2.80	↑
Rural	-	7.43 (7.09 - 7.78)	-	-	15.06 (14.83 - 15.29)	-	19.68 (19.43 - 19.93)	12.25	7.84	↑
Maldives										
Urban	-	-	51.25 (46.29 - 56.19)	-	-	45.67 (42.33 -49.05)	-	-5.58	-1.63	↓
Rural	-	-	42.75 (40.79 - 44.74)	-	-	52.11 (50.40 -53.82)	-	9.36	2.87	↑
Nepal										
Urban	24.07 (19.97 - 28.70)	20.74 (17.83 – 23.99)	-	26.34 (23.05 - 29.91)	-	26.16 (23.70 - 28.78)	32.73 (30.11 - 35.46)	8.66	1.67	↑
Rural	4.53 (3.67 - 5.57)	6.27 (5.04 - 7.79)	-	11.38 (9.65 - 13.37)	-	15.44 (13.26 - 17.90)	21.67 (19.66 - 23.83)	17.14	8.03	↑
Pakistan										
Urban	-	-	-	54.34 (51.04 - 57.61)	-	62.94 (59.13 - 66.59)	-	8.60	2.98	↑
Rural	-	-	-	33.01 (29.81 - 36.37)	-	45.17 (40.73 - 49.70)	-	12.16	6.47	↑

*AD: Absolute Difference, AARC: Average Annual Rate of Change

Table 4 presents the prevalence of overweight and obesity across urban and rural settings in the five countries studied. From 2000 to 2006, the prevalence in rural settings ranged from 2.6% in Bangladesh to 7.4% in India, while in urban settings it ranged from 13.1% in Bangladesh to 24.1% in Nepal. Subsequently, in 2021-22, the prevalence in rural settings ranged from 19.7% in India to 32.9% in Bangladesh, whereas in urban settings it ranged from 32.7% in Nepal to 45.5% in Bangladesh. The AARC across the five studied countries varied from 2.9% in the Maldives to 12.4% in Bangladesh in rural settings and from a negative 1.6% in the Maldives to 5.9% in Bangladesh in urban settings.

Table 5: The prevalence, AD, AARC and direction of trend of overweight obesity across level of education among women of reproductive age in South Asian countries with confidence intervals, sample size: 1,568,113

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh										
No education	2.08 (1.50 - 2.86)	4.77 (4.04 - 5.61)	7.08 (6.11 - 8.18)	11.15 (10.04 -12.35)	15.79 (13.73 -18.10)	25.00 (23.22 -26.87)	28.15 (25.43 – 31.04)	26.07	12.71	↑
High Education	18.53 (14.76 – 23.00)	26.82 (22.44 - 31.70)	25.80 (22.68 - 29.18)	33.35 (30.35 - 36.49)	39.99 (36.98 - 43.08)	41.45 (39.32 -43.61)	41.10 (38.6 – 43.4)	22.57	3.78	↑
India										
No education	-	7.28 (6.88 - 7.71)	-	-	16.84 (16.51 - 17.17)	-	21.55 (21.19 – 21.91)	14.27	8.88	↑
High Education	-	23.78 (22.57 – 5.02)	-	-	24.20 (23.67 - 24.73)	-	25.23 (24.75 – 25.71)	1.45	0.41	→
Maldives										
No education	-	-	54.04 (50.78 - 57.27)	-	-	69.97 (62.42 - 76.57)	-	15.93	3.76	↑
High Education	-	-	39.33 (32.04 - 47.13)	-	-	40.24 (36.55 – 44.04)	-	0.91	0.33	→
Nepal										
No education	19.31 (14.39 - 25.40)	14.54 (12.11-17.36)	15.05 (13.10 - 17.24)	-	-	23.60 (20.70 - 26.75)	26.39 (23.63 – 29.34)	22.20	9.33	↑
High Education	4.19 (3.41 - 5.14)	7.37 (6.13 - 8.82)	10.78 (8.77 - 13.18)	-	-	19.57 (17.34 – 22.02)	32.37 (28.71 – 26.26)	13.10	3.02	↑
Pakistan										
No education	-	-	-	34.15 (30.80 - 37.65)	-	43.02 (39.27 - 46.85)	-	8.87	4.73	↑
High Education	-	-	-	54.01 (49.73 - 58.22)	-	63.57 (58.69 - 68.18)	-	9.56	3.31	↑

*AD: Absolute Difference, AARC: Average Annual Rate of Change

Table 5 presents the prevalence of overweight and obesity among women with secondary or higher education compared with those with low or no education. Between 2000 and 2006, rates ranged from 4.2% in Nepal to 26.8% in Bangladesh among women with secondary or higher education, while those with low or no education ranged from 2.1% in Bangladesh to 19.3% in Nepal. Over the subsequent decade, a notable increase in the prevalence of overweight and obesity was observed in both educational groups. In 2021-22, the prevalence of overweight and obesity ranged from 25.2% in India to 41.1% in Bangladesh among women with secondary or higher education, while among those with low or no education, it ranged from 21.55% in India to 28.2% in Bangladesh and a staggering 70% in the Maldives for years 2016-17.

Table 6: The prevalence, AD, AARC and direction of trend of overweight obesity across wealth quintile among women of reproductive age in South Asian countries with confidence intervals, sample size: 1,568,113

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh										
Wealthiest	-	24.79 (22.17 - 27.60)	31.39 (28.79 - 34.15)	36.52 (34.26 – 38.85)	46.67 (44.27 - 49.08)	53.96 (51.91 – 56.00)	53.50 (50.47 – 56.51)	28.71	4.65	↑
Poorest	-	2.12 (1.51 – 2.95)	3.21 (2.39 - 4.30)	4.96 (4.07 - 6.05)	8.35 (7.00 – 9.94)	16.22 (14.86 - 17.69)	21.22 (19.06 – 23.56)	19.10	14.55	↑
India										
Wealthiest	-	30.47 (29.56 - 31.40)	-	-	36.17 (35.59 - 36.75)	-	38.63 (38.03 – 39.23)	8.16	1.85	↑
Poorest	-	1.80 (-)	-	-	5.83 (5.64 – 6.03)	-	10.00 (9.73 – 10.29)	8.20	14.07	↑
Maldives										
Wealthiest	-	-	48.01 (41.78 - 54.30)	-	-	46.99 (42.46 - 51.56)	-	-1.02	0.33	→
Poorest	-	-	40.56 (37.12 - 44.09)	-	-	51.88 (49.01 - 54.74)	-	11.32	3.58	↑
Nepal										
Wealthiest	-	23.02 (20.17 - 26.14)	-	29.51 (26.20 – 33.04)	-	44.86 (40.81 – 48.98)	46.74 (42.84 – 50.68)	23.72	3.71	↑
Poorest	-	2.45 (1.63 - 3.67)	-	3.05 (2.08 - 4.45)	-	9.83 (7.89 - 12.17)	15.88 (13.79 – 18.21)	13.43	13.60	↑
Pakistan										
Wealthiest	-	-	-	60.58 (56.43 - 64.59)	-	72.67 (67.85 – 77.02)	-	12.09	3.71	↑
Poorest	-	-	-	16.79 (12.82 - 21.69)	-	23.04 (17.91 - 29.11)	-	6.25	6.53	↑

*AD: Absolute Difference, AARC: Average Annual Rate of Change

Table 6 shows the prevalence of overweight and obesity across the highest- and lowest-wealth quintiles. From 2004 to 2006, the prevalence in the poorest households ranged from 1.8% in India to 2.5% in Nepal, whereas in the wealthiest households, it varied from 23.0% in Nepal to 30.5% in India. The most recent data from 2021 revealed that among the lowest wealth quintiles, the prevalence ranged from 10.0% in India to 21.2% in Bangladesh. Concurrently, those in the highest wealth quintile had prevalence rates ranging from 38.6% in India to 53.5% in Bangladesh with a very high 72.7% in Pakistan from the years 2016-17.

Discussion

Overall Trends: Steadily Increasing

The study revealed a significant and consistent increase in the prevalence of overweight and obesity in South Asian low-to middle-income countries. These findings are consistent with previous literature. Peeters et al. reported accelerated increases in BMI across South Asia for both sexes from 1975 to 2016, while Stevens et al. found the prevalence of obesity nearly doubled over a shorter time-period (1980 to 2008). Together these studies provide continued evidence that overweight and obesity constitute a public health concern (Zhou et al., 2024, Peeters, 2017, Stevens et al., 2012). More specifically, among women of reproductive age, overweight and obesity have increased significantly since the 2000s across similar socio-economic determinants, including urban-rural areas, education and wealth (Chowdhury, Adnan, & Hassan, 2018, Mehboob, Safdar, & Zaheer, 2016, Sutradhar et al., 2021). A recent paper examining data from Central and Southeast Asia also found a similar rising trend in female obesity. However, the paper did not examine obesity trends across different social determinants of health (Thapa et al., 2024). These findings contrast with those of pre-millennium studies that showed less significant increases in South Asian overweight and

obesity rates (Martorell, Kettel Khan, Hughes, & Grummer-Strawn, 2000, Stevens et al., 2012).

Urban-Rural Differences

Across the LMICs studied, the prevalence of overweight and obesity remained consistently higher in urban areas than in rural areas; however, the rate of increase in rural areas was notably faster in rural populations. These outcomes align with results from previous studies conducted in South Asian countries including Bangladesh, India, the Maldives, Pakistan and Nepal (Zahangir, Hasan, Richardson, & Tabassum, 2017, Popkin, Adair, & Ng, 2012, Hashan, Das Gupta, Day, & Al Kibria, 2020, Griffiths & Bentley, 2005, Waghmare, Chauhan, & Sharma, 2022, Awasthi, Panduranga, & Deshpande, 2023, Sutradhar et al., 2021). Several factors may contribute to this emerging trend.

Rural populations often have limited access to diverse and healthy foods, particularly in remote mountainous or hilly areas, a contrast that has also been associated with undernutrition and low birth weights among mothers (Kanade, Rao, Kelkar, & Gupte, 2008, Pressler et al., 2022). As urbanization accelerates, driven by greater earning opportunities and improved infrastructure in cities, residential and occupational patterns are shifting away from physically demanding jobs. Manual labor and agricultural employment are increasingly being replaced by sedentary forms of work. This is evident in the 10% decline in female employment in rural agriculture between 2011 to 2025 (World Bank Group, 2025). This type of employment reduces overall energy expenditure and increasing vulnerability to weight gain. Additionally, the increased availability of processed foods in rural areas has driven increasing sales remarkably grown in South Asian countries (Baker et al., 2020). Household consoumption of processed foods is already high in Bangladesh, Indonesia, Nepal and Vietnam with projected high growth rates averaging to 63% in rural areas and 74% in urban areas (Thomas Reardon & Chaoran Hu,

2014). This dietary shift towards and declines in physical activity are accelerating the rise in obesity in rural communities of LMICs (Subramanian, Perkins, & Khan, 2009). These patterns highlight the need for place-based prevention strategies, indicating that regional policies and interventions targeting rural food environments, physical activity opportunities and the penetration of ultra-processed foods may be critical to slowing the rapidly rising burden of overweight and obesity in rural communities within the study region.

Socioeconomic Disparities

In most countries studied, women from wealthier households experienced more rapid increase in overweight and obesity compared to their poorer counterparts. These findings are consistent with previous studies conducted in Asian LMICs including Bangladesh and India (Khanam et al., 2018, Shetty, 2002, Jones-Smith, Gordon-Larsen, Siddiqi, & Popkin, 2012, Kamal, 2022). This pattern likely reflects the nutritional transitions accompanying economic development and urbanisation, which is associated with substantial shifts in dietary behaviours and lifestyle patterns. For example, between 1972 to 2001 in India, consumption of cereal grains declined among low-income groups while pulse consumption decreased across all income groups (P. Ramachandran).

Economic development has also driven lifestyle changes, including reduced physical activity due to increasingly sedentary jobs and the convenience of urban transportation. When combined with higher-calorie diets, these behavioural shifts contribute to rising obesity prevalence. Women of low socioeconomic status generally have lower level of education, which, as reported here, are associated with an increased prevalence of overweight and obesity, potentially due to limited health literacy, reduced access to nutrition information, and constrained opportunities for healthy lifestyle choices. Conversely, women with higher

education may obtain professional yet sedentary jobs and have greater exposure to westernized diets (Kamal, 2022), both of which have strong potential to contribute to a higher BMI.

Together, these dynamics reflect the influence of wealthier urban environments that often encourage the consumption of fast foods and convenience foods that are rich in fats and sugars but low in nutrients, further contributing to overweight and obesity. This pattern has been well documented in India and developing countries, where rapid urbanization and rising incomes have led to accelerated dietary transitions (Subramanian, Perkins, & Khan, 2009, Kamal, 2022). Overall, these findings point to the importance of socio-economically differentiated interventions, suggesting that nutrition policies addressing obesogenic urban environments, dietary quality, and sedentary lifestyles among wealthier households may help mitigate the escalating burden of overweight and obesity within the study region.

Education and Nutritional Status

Educational attainment also played a significant role, with higher prevalence of overweight and obesity observed primarily among women with secondary or higher levels of education. These findings are consistent with national-level studies conducted in India and Bangladesh (Jones-Smith, Gordon-Larsen, Siddiqi, & Popkin, 2012, Popkin, Corvalan, & Grummer-Strawn, 2020). In contrast, a multi-country analysis of 39 low-income countries reported an increased prevalence of overweight in groups with the lowest education level (Kamal, 2022), highlighting hetergeneity in the eduction and obesity relationship across contexts. Education attainment is closely linked to household socioeconomic status and influences dietary choices, health literacy and lifestyle behaviours. National policy interventions that strengthen consumer education such as including nutrition science in school curricula and providing nutrition counselling

through health practitioners may reduce the prevalence rates of overweight and obesity among women with higher and lower levels of education attainment (Baker et al., 2020).

Strengths and Limitations

Our study's primary strength lies in its use of cross-country nationally representative DHS data on reported social determinants that has strong generalisability for broader populations. However, data on overweight and obesity prevalence are not available for several other South Asian countries, including Afghanistan, Bhutan, and Sri Lanka. Furthermore, the availability of variables varied between countries, with DHS surveys typically conducted every five years, but not systematically released in the same year across all nations. For example, the Maldives and Pakistan had only two data points during the study period. This inconsistency creates data gaps and asynchronous trend patterns, complicating comparative analyses. Additionally, the use of cross-sectional data limits the causal inferences between social determinants and nutritional status, as the analysis relies on population-level associations rather than individual-level, thereby raising the potential for ecological fallacy.

Conclusion

This study provides robust, nationally representative evidence that overweight and obesity among women of reproductive age have increased markedly across South Asian low-to-middle-income countries in the 21st century with the steepest increases observed among wealthier, more educated women and in rural populations experiencing rapid socioeconomic change. While urban areas maintain the highest obesity rates, the accelerated increase in rural communities highlights the urgent need for place-based interventions. The observed positive association between higher education, household wealth, and BMI further suggests that current

economic gains are translating into sedentary lifestyles and Westernized dietary patterns rather than corresponding improvements in improved health health-protective behaviours.

Our findings underscore the need for equity-focused policies addressing the socio-economic drivers of rising overweight and obesity, particularly those related to urbanisation, educational attainment and household wealth. Based on these results, priority should be given to preventing further increases of overweight and obesity through tailored policy interventions targeting food systems and environmental factors. National strategies must shift toward equity-focused approaches, such as incorporating nutrition science into school curricula to decouple educational attainment from poor dietary choices and implementing fiscal policies to regulate calorie-dense foods in transitioning rural markets. Additionally, urban planning should promote societal behavioral changes by prioritizing infrastructure that encourages physical activity. By aligning these environmental and systemic shifts with the specific socioeconomic contexts of urbanization and wealth, these countries can mitigate the rising burden of noncommunicable diseases and protect the long-term reproductive health of women across the region.

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Chapter 3: Trends and socio-economic inequalities of undernutrition among women of reproductive age in South Asian countries: Pakistan, Bangladesh, India, Maldives and Nepal

Introduction

Maternal and child health are greatly affected by undernutrition. Despite ongoing global efforts to improve public health and nutrition, maternal undernutrition remains prevalent. Maternal undernutrition, commonly referred to as underweight, is defined by a BMI of <18.5 kg/m^2. A more severe form of underweight, termed thinness, is defined as a BMI below 17.0 kg/m^2 (World Health Organization, 2025). Underweight is associated with a moderate risk of morbidity in both male and female adults and may result in micronutrient deficiencies and diet-related non-communicable diseases, such as cardiovascular diseases, high blood pressure, and certain cancers (Jayalakshmi, Sewor, & Kannan, 2023; World Health Organization, 2024).

In addition, maternal underweight or thinness may contribute to foetal undernutrition, intrauterine growth restriction, or iron deficiency anaemia, thereby increasing the risk of adverse perinatal outcomes, including delivery complications, preterm birth, and potentially contributing to neonatal deaths (Acosta-Cazares et al., 2017; Bhutta et al., 2008; Jayalakshmi et al., 2023; United Nations, 2023; World Health Organization, 2024, 2025). Economically, undernutrition reduces women's productivity and ability to participate in the workforce, which lowers household income and national economic output (World Health Organization, 2024). It also increases healthcare costs due to complications during pregnancy and poor child health

outcomes. Over time, children born to undernourished mothers may experience impaired cognitive development and reduced educational attainment, leading to lower lifetime earnings and reduced human capital, thereby slowing overall economic development.

Although the global prevalence of underweight and thinness has declined between 1990 and 2022 the total number of underweight adults reached a staggering 390 million worldwide in 2023 (United Nations, 2023). Undernutrition remains a major concern in South and Western Asia, the Caribbean, and Central, Eastern, and Western Africa (Acosta-Cazares et al., 2017; United Nations, 2023). Notable reductions in undernutrition have been observed in other parts of Asia, including Central and South Asia, and in Latin America (Acosta-Cazares et al., 2017; Stevens et al., 2022; United Nations, 2023).

South Asia has long been identified as one of the regions with the highest prevalence of underweight among women. A global analysis by Onis et al highlighted South-Central Asia (Onis, Ezzati, Mathers, & Rivera, 2008) as a region with particularly high level of low BMI, with countries such as India, Bangladesh, classified as having a "critical" prevalence of underweight among women (Onis et al., 2008). In addition, a recent Lancet study highlighted the rising double burden of overnutrition and undernutrition in low-to-middle-income countries, particularly in South Asia (Phelps et al., 2024; R. O. f. S.-E. A. World Health Organization, 2022). Although overweight and obesity are increasing globally, underweight remains a pressing concern in several South Asian countries, highlighting the continuing importance of addressing maternal undernutrition alongside emerging nutrition transitions (Phelps et al., 2024).

Socio-economic gradients in women's nutrition vary across South Asian countries, reflecting differing patterns by education, wealth and urban-rural context. Previous studies examining socio-economic inequalities of underweight women in Bangladesh and India have reported higher prevalence in rural areas, among less educated women and living in poorer economic class groups (Al Kibria, Swasey, Hasan, Sharmeen, & Day, 2019b; Biswas, Rahman, Khanam, Baqui, & Ahmed, 2019; Hossain, Khudri, & Banik, 2022; Pengpid & Peltzer, 2019; Rahman et al., 2022; Sunuwar et al., 2020). Conversely, lower rates have been observed in Nepal and the Maldives among women from similar socioeconomic backgrounds and those living at greater distances from urban cities (Hossain et al., 2022; Sunuwar et al., 2020). Another study in 2019 from Nepal found that women in the low wealth quintiles faced a higher risk of being underweight (Rai, Gurung, Thapa, & Saville, 2019).

Overall, since the turn of the millennium, there has been a gradual global decline in the prevalence of maternal undernutrition. However, progress has been notably slow due to persistent barriers such as the COVID-19 pandemic, continued population growth, socioeconomic inequalities, including food insecurity, climate change, and geopolitical tensions (United Nations, 2023). To address this, global health policies have been developed, including the UN Decade for Action on Nutrition and Sustainable Development Goals "zero hunger" and "good health and well-being". These initiatives continue to drive investments and commitments aimed at eliminating all forms of malnutrition by 2030 (United Nations, 2023; World Health Organization, 2024). Interventions such as supplementation with iron folate, vitamin A and zinc, calcium, various micronutrients, and proteins can improve maternal health and birth outcomes (Bhutta et al., 2008; Onis et al., 2008). However, monitoring programs show limited progress in universal supplementation with persistent gaps in nutritional research (Bhutta et al., 2008). At the programmatic level, individual- and community-based

interventions are essential for improving access to weight management services, promoting behaviour change, enhancing monitoring and front-line counselling, and increasing access to nutritional supplements (Goudet, Murira, Torlesse, Hatchard, & Busch-Hallen, 2018).

This chapter aims to examine the temporal trends from 2000 until 2022 in undernutrition among women of reproductive age and analyses how these trends vary across different social determinants in five South Asian low- and middle-income countries: Pakistan, Bangladesh, India, Maldives, and Nepal.

Methodology

Data sources and participants

This study analysed the DHS data (The DHS Program) collected between 2000 and 2022 from five South Asian countries. Countries were selected based on the data availability for the variables of interest. DHS surveys are nationally representative cross-sectional household surveys that collect data on a wide range of population health indicators, including the nutritional status of women in low- and middle-income countries. The DHS surveys employ standardised methodologies and core questionnaires, facilitating comparability across countries and over time (The DHS Program, 2025). Each DHS survey used a multistage stratified sampling design that produced estimates representative at the national level. In the first stage, enumeration areas (clusters) are selected from the national sampling frame using probability proportional to size. In the second stage, households are systematically selected within each cluster, and eligible women aged 15–49 years in selected households are invited to participate. This sampling approach produces estimates representative at the national level. (The DHS Program, 2025). Further details of the survey design are described in Chapter 1.

Surveys are conducted with strict ethical standards including 1) informed consent before obtaining data collection from participants, 2) the right to refuse or withdraw at any time without consequence, 3) collected data is fully anonymised before being made available to others. Ethical approval for the survey protocols was obtained by the ICF Institutional Review Board and national ethics committees in each participating country. This study used de-identified secondary data accessed through formal authorisation from the DHS Program (see Appendix 1) and in accordance with international guidelines, did not require additional institutional ethics approval.

Sample size of cohorts

Our final dataset comprised 1,571,113 women of reproductive age from 19 survey rounds (see Table 1). This study included all available DHS surveys conducted after 2000 up until 2022 in the five selected South Asian countries: India (2005, 2015, 2019), Bangladesh (2000, 2004, 2007, 2011, 2014, 2017, 2022), Pakistan (2006, 2012, 2017), Maldives (2009, 2016), and Nepal (2001, 2006, 2011, 2016, 2022), as shown in Table 1. The unit of analysis was women of reproductive age (15–49 years old). For each country and survey year, individual women's records (IR files) were extracted and appended to create a pooled dataset for the analysis.

Study Variables

The primary outcome variable for the current study was grade 2 thinness in women of reproductive age (15-49 years), defined as a BMI of less than 17 kg/m², consistent with the WHO classification (World Health Organization, 2025). BMI was calculated by dividing weight in kilograms by height in meters squared. Grade 2 thinness was used instead of the underweight threshold (BMI <18.5 kg/m²) to capture more severe and clinically meaningful

undernutrition. This cut-off provides a more specific indicator of chronic energy deficiency relevant to maternal and public health outcomes.

The choice of social determinants was guided by the UNICEF 2020 Conceptual Framework for Maternal and Child Nutrition and the WHO Conceptual Framework for Action on the Social Determinants of Health, which together provide a logic linking structural and socioeconomic conditions to intermediate behavioural pathways and nutritional outcomes. In line with these frameworks, trends in thinness were examined across social determinants of health, including household wealth, women's education level and place of residence. The household wealth index, a gauge of socio-economic status, was determined through principal component analysis, encompassing various indicators like asset ownership, housing type, sanitation services, and water access (The DHS Program). Based on household wealth index, households were classified into quintiles, with the first quintile (Q1) being the poorest group and the fifth quintile (Q5) being the richest group. The level of education was categorized into two levels: No schooling and secondary education completed. The lowest and the highest education and wealth groups were included in the analysis to estimate the magnitude and absolute gaps in inequity. Finally place of residence was categorized into urban or rural setting.

Statistical analysis

We used Stata 16.1 (StataCorp, College Station, Texas, USA). The survey command (svy) was used to account for the complex survey design, including clustering and stratification. Descriptive analyses were used to estimate the prevalence of thinness among women of reproductive age (15–49 years), and the results were reported with 95% confidence intervals. The average annual rate of change was calculated using established methods described in previous studies (Jiwani et al., 2020). Particularly, the AD and AARC in the prevalence of

thinness were estimated over time using established methods with corresponding confidence intervals, stratified by social determinants following approaches used in prior epidemiological analyses (Amugsi, Dimbuene, Mberu, Muthuri, & Ezeh, 2017; Assaf, 2019). To calculate the absolute change, we calculated the difference between the most recent and earliest prevalence estimates of thinness in each country. To calculate the AARC, we performed simple linear regression of the natural logarithm of thinness prevalence on time (survey year). When prevalence estimates were available for multiple survey years, log regression models were fitted with the social determinant (e.g. education attainment level) included as a covariate. The following formula was used

$$AARC=1-\exp(\beta)$$

where β is the coefficient obtained from a simple linear regression analysis, representing the average annual proportion change in prevalence. This coefficient is obtained by regressing the natural logarithm of prevalence (ln(Yi)ln(Yi)) against time t_i . This approach assumes a constant rate of change in prevalence over time and allows for comparability of trends across countries and population subgroups.

Results

Our final dataset comprised 1,561,090 women of reproductive age from 19 surveys (Table 6). These surveys spanned 22 years in Bangladesh, India, and Nepal and 11 years in the Maldives and Pakistan. The earliest data points were from Bangladesh and Nepal in 2000, while the most recent surveys were conducted in 2022 in Bangladesh, Nepal and India. There were seven survey rounds in Bangladesh, five in Nepal, three in India, and two each in the Maldives and Pakistan. The sample sizes across the survey rounds ranged from 3,722 (Pakistan, 2016-2017) to 660,741 (India, 2014-2015). The overall trend in the prevalence of thin women in the five countries is presented in Figure 1 and Table 2. We observed a substantial and steady decline in

the prevalence of thinness among women in Bangladesh, Nepal, India, and Pakistan, with the exception of the Maldives which showed a slight increase.

Table 7: Sample size of cohorts

	Survey year						
	2000-01	**2004-06**	**2007-09**	**2011-12**	**2014-15**	**2016-17**	**2021-22**
Bangladesh	4,510	10,431	10,021	16,024	16,478	18,328	9,213
India	-	111,781	-	-	647,168	-	660,741
Nepal	7,784	10,003	-	5,800	-	6,069	7,007
Maldives	-	-	5,173	-	-	6,667	-
Pakistan	-	10,023	-	4,170	-	3,722	-

Table 8: Overall prevalence, absolute difference, AARC and direction of trend of thin women with confidence intervals, sample size: 1,561,090

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh	45.36 (43.19-47.55)	34.32 (32.84-35.83)	29.66 (28.16-31.20)	24.19 (22.92-25.50)	18.57 (17.36-19.85)	11.89 (11.22-12.60)	10.02 (9.34-10.74)	-35.34	-6.90	↓
Nepal	26.67 (24.27-29.20)	24.42 (21.98-27.04)	-	18.19 (16.13-20.45)	-	17.24 (15.62-18.99)	13.36 (12.18-14.64)	-13.31	-3.28	↓
India	-	35.56 (35.02-36.10)	-	-	22.89 (22.66-23.12)	-	18.68 (18.49-18.88)	-16.88	-4.82	↓
Maldives	-	-	7.46 (6.56-8.47)	-	-	10.67 (9.56-11.78)	-	3.21	5.25	→
Pakistan	-	-	-	13.88 (11.91-16.11)	-	8.50 (7.12-10.11)	-	-5.38	-9.34	↓

*AD: Absolute Difference, AARC: Average Annual Rate of Change

In Bangladesh, the proportion of thin women decreased markedly from 45.36% in 2000–2001 to 10.02% in 2021–2022. This represents the largest absolute reduction (–35.34 percentage points) and a steep average annual rate of change (AARC) of –6.90, indicating a substantial and sustained downward trend. In Nepal, thinness declined from 26.67% in 2000–2001 to 13.36% in 2021–2022, with an AD of –13.31 and an AARC of –3.28. Similarly, India experienced a notable decline, from 35.56% in 2004–2006 to 18.68% in 2021–2022, with an AD of –16.88 and AARC of –4.82.

Pakistan also showed a downward trend, with prevalence dropping from 13.88% in 2011–2012 to 8.50% in 2016–2017, corresponding to an AD of –5.38 and an AARC of –9.34, although fewer data points were available. In contrast, the Maldives showed a modest increase in the prevalence of thinness from 7.46% in 2007–2009 to 10.67% in 2021–2022, with an AD of +3.21 and a positive AARC of +5.25, indicating a stable or slightly increasing trend. Overall, most countries experienced a significant decline in the burden of thinness among women, with Bangladesh achieving the most pronounced improvement over the two-decade period.

Figure 6: Bivariate scatter plot showing time trends in the prevalence of thinness among women in five South Asian countries, by social determinant

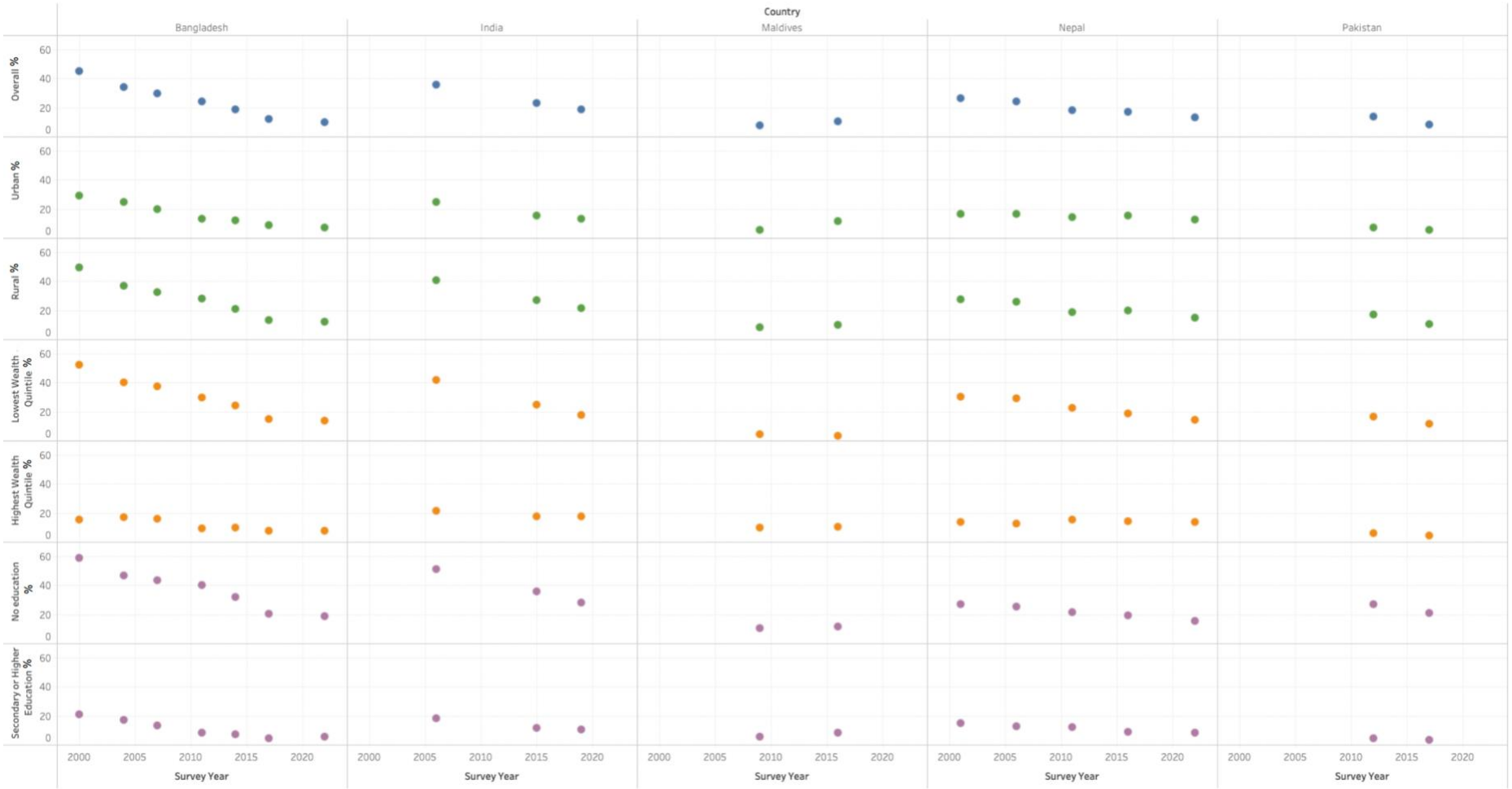

Table 9: The prevalence, AD, AARC and direction of trend of thin women across place of residence among women of reproductive age in South Asian countries with confidence intervals, sample size: 1,568,113

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh										
Urban	29.91 (26.51-33.54)	25.02 (22.24-28.02)	19.62 (17.27-22.21)	13.51 (11.92-15.29)	12.18 (10.26-14.41)	8.65 (7.78-9.60)	6.64 (5.62-7.83)	-23.27	-6.60	↓
Rural	48.74 (46.33-51.15)	37.06 (35.43-38.72)	32.63 (30.95-34.36)	27.97 (26.58-29.41)	21.11 (19.76-22.52)	13.17 (12.32-14.07)	11.37 (10.53-12.26)	-37.37	-6.52	↓
Nepal										
Urban	16.83 (13.06-21.42)	16.57 (13.46-20.22)	-	14.14 (11.88-16.74)	-	15.66 (13.77-17.76)	12.72 (11.20-14.41)	-4.11	-1.16	↓
Rural	27.75 (25.17-30.49)	25.90 (23.20-28.80)	-	18.85 (16.50-21.44)	-	19.95 (17.23-22.98)	14.76 (13.07-16.63)	-12.99	-2.88	↓
India										
Urban	-	25.01 (24.14-25.90)	-	-	15.51 (15.12-15.90)	-	13.25 (12.93-13.57)	-11.76	-4.81	↓
Rural	-	40.65 (39.98-41.32)	-	-	26.76 (26.51-27.02)	-	21.23 (21.00-21.46)	-19.42	-4.79	↓
Maldives										
Urban	-	-	5.29 (3.91-7.11)	-	-	11.81 (9.8-14.16)	-	6.52	12.11	↑
Rural	-	-	8.49 (7.42-9.69)	-	-	9.81 (8.92-10.78)	-	1.32	2.05	→
Pakistan										
Urban	-	-	-	7.44 (5.78-9.54)	5.44 (4.08-7.22)	-	-	-2.00	-5.76	↓
Rural	-	-	-	17.14 (14.50-20.14)	10.46 (8.44-12.90)	-	-	-6.68	-9.29	↓

*AD: Absolute Difference, AARC: Average Annual Rate of Change

Table 9 presents the prevalence of thinness among women in urban and rural settings across the five countries. All countries, except the Maldives, showed a declining trend in the prevalence of thin women across both urban and rural settings. From 2000 to 2006, the prevalence of thin women in rural settings ranged from 49% in Bangladesh to 26% in Nepal, while in urban settings, it ranged from 30% in Bangladesh to 17% in Nepal. By 2021-22, the prevalence had dropped to between 21% in India and 11% in rural Bangladesh, and between 13% in India and 7% in urban Bangladesh. The decline was generally more pronounced in rural areas, with AD ranging from –6.7 to –37.4 percentage points and AARC between –2.9% and –9.3%. In urban areas, the AD ranged from –4.1 to –23.3 percentage points, and the AARC from –1.2% to –6.6%. In contrast, the Maldives experienced an increasing trend, particularly in urban areas, where the prevalence of thin women rose from 5.3% to 11.8%, corresponding to an AD of +6.5 percentage points and an AARC of +12.1%. In rural areas, the increase was smaller, with an AD of +1.3 and an AARC of +2.1%, suggesting a relatively stable or slightly worsening trend.

Table 10: The prevalence, AD, AARC and direction of trend of thinness across level of education among women of reproductive age in South Asian countries with confidence intervals, sample size: 1,568,113

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh										
No education	52.13 (49.17-55.08)	40.07 (38.26-41.90)	37.58 (35.49-39.72)	29.77 (27.82-31.79)	24.09 (22.06-26.26)	15.06 (13.58-16.68)	13.28 (11.40-15.42)	-38.85	-5.22	↓
High education	15.28 (11.46-20.08)	17.32 (14.09-21.11)	16.23 (13.82-18.98)	9.47 (7.97-11.21)	9.77 (8.23-11.56)	7.88 (6.85-9.04)	7.49 (6.36-8.80)	-7.79	-7.19	↓
Nepal										
No education	30.42 (27.65-33.33)	29.04 (25.84-32.47)	-	22.64 (19.53-26.08)	-	18.66 (16.32-21.25)	14.34 (12.60-16.28)	-16.08	-2.66	↓
High education	12.95 (9.2-17.94)	12.83 (10.19-16.05)	-	15.17 (12.33-18.53)	-	14.47 (12.25-17.01)	10.69 (8.82-12.90)	-0.23	-2.89	↓
India										
No education	-	41.66 (40.88-42.44)	-	-	24.63 (24.30-24.96)	-	17.55 (17.24-17.86)	-24.11	-4.47	↓
High education	-	21.77 (20.76-22.81)	-	-	17.89 (17.50-18.28)	-	17.64 (17.24-18.06)	-4.13	-4.33	↓
Maldives										
No education	-	-	4.23 (3.08-5.78)	-	-	3.26 (1.49-6.99)	-	0.97	1.19	→
High education	-	-	10.00 (6.26-15.62)	-	-	10.59 (8.08-13.75)	-	0.59	5.33	→
Pakistan										
No education	-	-	-	16.82 (14.30-19.68)	11.74 (9.48-14.45)	-	-	-5.08	-4.81	↓
High education	-	-	-	6.31 (4.51-8.76)	4.16 (2.76-6.24)	-	-	-2.15	-6.76	↓

*AD: Absolute Difference, AARC: Average Annual Rate of Change

Table 10 presents the prevalence of thinness among women from 2000 to 2022, stratified by education level. A declining trend in thinness was observed across both groups—women with no education and those with higher education—in all countries except the Maldives, where the trend remained stable or slightly increased. Between 2000 and 2006, the prevalence of thinness among women with secondary or higher education ranged from 15% in Bangladesh to 22% in India, while among those with low or no education it ranged from 29% in Nepal to 52% in Bangladesh. Over the subsequent decade, a notable decrease in the prevalence of thin women was observed in both high and lowest educational groups. In 2021-22, the prevalence of thinness ranged from 7.5% in Bangladesh to 18% in India among women with secondary or higher education, similarly among those with low or no education, it ranged from 17.5% in India to 13% in Bangladesh. The AARC across the five studied countries varied from negative 7% in Bangladesh to just over 5% among Nepalese women holding secondary or higher education and a minor difference among women with low or no education, from a -5% in Bangladesh to 1.2% in Nepal.

Table 11: The prevalence of thinness across wealth quintile among women of reproductive age in South Asian countries with confidence intervals, sample size: 1,568,113

	2000-2001	2004-2006	2007-09	2011-2012	2014-2015	2016-2017	2021-22	AD	AARC	Direction
Bangladesh										
Wealthiest	-	17.24 (15.33-19.34)	13.35 (11.46-15.50)	8.42 (7.33-9.65)	6.96 (5.98-8.09)	4.36 (3.61-5.26)	4.63 (3.68-5.81)	-12.61	-4.15	↓
Poorest	-	47.10 (44.54-49.68)	43.35 (40.10-46.67)	40.10 (37.85-42.39)	32.18 (29.43-35.05)	20.49 (18.88-22.20)	18.50 (16.61-20.55)	-28.60	-6.25	↓
Nepal										
Wealthiest	-	25.08 (21.41-29.15)	-	21.53 (17.42-26.30)	-	19.03 (16.37-22.02)	15.32 (12.94-18.04)	-4.34	0.15	→
Poorest	-	12.70 (10.77-14.92)	-	11.85 (9.68-14.43)	-	8.53 (6.89-10.52)	8.36 (6.65-10.45)	-9.76	-3.67	↓
India										
Wealthiest	-	18.22 (17.53-18.94)	-	-	11.56 (11.15-11.99)	-	10.39 (10.04-10.75)	-7.83	-1.70	↓
Poorest	-	51.52 (-)	-	-	35.83 (35.41-36.25)	-	28.01 (27.60-28.44)	-23.51	-6.33	↓
Maldives										
Wealthiest	-	-	5.74 (3.95-8.25)	8.15 (5.64-11.64)	-	-	-	2.41	0.82	→
Poorest	-	-	10.37 (8.31-12.88)	11.3 (9.67-13.16)	-	-	-	0.93	-3.39	↓
Pakistan										
Wealthiest	-	-	-	4.43 (2.93-6.64)	3.06 (1.93-4.83)	-	-	-1.37	-7.99	↓
Poorest	-	-	-	26.97 (21.18-33.66)	21.15 (16.85-26.20)	-	-	-5.82	-6.82	↓

AD: Absolute Difference, AARC: Average Annual Rate of Change

Table 11 shows the prevalence of thinness across the highest and lowest wealth quintiles. From 2004 to 2009, the prevalence in the poorest households ranged from 51.5% in India to 10.4% in the Maldives, whereas in the wealthiest households, it varied from 25% in Nepal to 5.7% in the Maldives. The most recent data from 2022 revealed that among the lowest wealth quintiles, the prevalence ranged from 28% in India to 8% in Nepal. Concurrently, those in the highest wealth quintile had prevalence rates ranging from 15% in Nepal to 4.6% in Bangladesh. The absolute difference was demonstrated to be the highest among women living in poorer conditions in Bangladesh (29 %) and the lowest among the wealthiest women in the Maldives. The AARC decreased the most in wealthy households in Pakistan by negative 8% and mildly increased again among the wealthiest women in the Maldives.

Discussion

This study analysed the time trend of thinness among over 1.5 million women of reproductive age across 19 survey rounds from national demographic data in South Asian countries, including Bangladesh, India, Nepal, Pakistan, and Sri Lanka. The findings from 2000 to 2022 show patterns of prevalence in thinness and social determinants that offer an understanding that will assist in informing national nutrition policies and guiding health promotional strategies to improve women's nutrition.

Overall Trends: Declining but Still Prevalent

This study shows a consistent decline in thinness among women of reproductive age in Bangladesh, Nepal, India, and Pakistan indicating regional progress in undernutrition. The largest reduction was observed in Bangladesh, with previous studies showing similar results as well as reductions in Pakistan and Nepal (Hasan et al., 2022). These shifts are likely driven by

the ongoing implementation of the national nutrition plan that includes the promotion of food dietary guidelines, community awareness of micronutrient supplementation, and a strong advocacy and communications framework with existing multi-stakeholder engagement. Evidently, in Bangladesh for example, more efforts are needed to focus on addressing socioeconomic inequalities, particularly those related to wealth and education which in turn influence women's nutritional outcomes and are linked to women's empowerment and poverty alleviation (Kabir et al., 2020; Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh, 2017; Scaling Up Nutrition). Similarly, in Nepal and India, where substantial declines were prevalent, this was likely due to strong campaign These findings indicate that nutrition policies in South Asia may benefit from geographically work for supplementation initiatives, improving access to health services for women and out-of-school girls, and social welfare programs focusing on empowering women in communities; however, many Indian States and regions in Nepal have minimal experience of these (Government of India Ministry of Health and Family Welfare, 2017; National Planning Commission, 2017). In Pakistan, the downward trend was more modest but still notable, likely due to strong partnerships between authorities and stakeholders in education, agriculture, and women's empowerment; however, financing for domestic expenditures and budget tracking are not on track (Ahmed et al., 2024; Scaling Up Nutrition; United Nations Pakistan, 2018). However, the Maldives saw a rise in thinness, especially in urban areas, making it an outlier in the region. This may be due to limited access to affordable and healthy foods, poor nutrition education and awareness, and lack of food quality control (Ministry of Health Republic of Maldives, 2022). Overall, the study population shows progress in alleviating malnutrition in the past decade; however, there is capacity for improved food literacy education, agricultural stakeholder engagement, and ongoing financial support, which would all lead to developing food security to a sustainable level for all, including women. These findings highlight the need

for context-specific, equity-focused nutrition policies that prioritise women in socioeconomically disadvantaged and urbanising settings, strengthen the implementation and financing of existing national nutrition strategies and integrate nutrition education, social protection, and women's empowerment into coordinated, regionally tailored public health interventions.

Urban Rural Divide in Nutritional Progress

Urbanised areas of South Asia show a continuous yet insignificant decrease in thinness among women, whereas women living in rural areas consistently had higher rates, underscoring geographic disparities in food security, healthcare access, and infrastructure. However, the narrowing of this gap in LMICs (Kim, Choe, Lee, Subramanian, & Kim, 2025) such as Bangladesh and India points to the potential effectiveness of rural-targeted interventions, such as increasing human resources for nutrition service delivery (Government of India Ministry of Health and Family Welfare, 2017; Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh, 2017). In the Maldives, however, the urban prevalence of thinness increased more sharply than that in rural areas. While our study cannot directly identify the underlying causes of this pattern, it may reflect the unique geographic context of the country, where populations are dispersed across small and geographically isolated islands, which may influence access to food systems, services, and markets (Ministry of Health Republic of Maldives, 2022). Overall our findings suggest that nutrition policies in South Asia may benefit from geographically differentiated strategies that account for observed rural-urban patterns in thinness. Such approaches may include strengthening nutrition service delivery in rural settings while also monitoring emerging vulnerabilities in geographically unique contexts such as small island states.

Education and Nutritional Status

Education was a constant social factor influencing the nutritional status of women of reproductive age across all countries studied. Women who had completed higher education were consistently more likely to be underweight than their less educated peers, in line with previous research (Alem et al., 2023, Mare, Sabo, Wengoro, & Lahole, 2025).

This association underscores how education can enhance health and food literacy, improve dietary knowledge, and open pathways to higher-paying jobs (Raghupathi & Raghupathi, 2020; Vamos, Wacker, Welter, & Schlüter, 2021). While thinness rates decreased over time in both education groups, the relative burden remained lower among women with low education levels. For example, in Bangladesh and Nepal, women with no education were negatively associated with underweight. Similar findings for South Asian countries were presented by Kamal et al and Ferdausi et al (Ferdausi, Al-Zubayer, Keramat, & Ahammed, 2022; Kamal, Hassan, & Alam, 2015).

There are several explanations for the decreasing trend of underweight, such as women with higher knowledge and education working less in physically demanding workplaces and household roles combined with a higher probability of health literacy and fewer financial restrictions, enabling healthier dietary choices (Raghupathi & Raghupathi, 2020; Rana et al., 2022). This persistent gap highlights the importance of integrating nutrition education for women and girls into school curricula, continuing community campaigns, and empowering women across all education levels. Addressing education-based inequalities is essential for improving population health and achieving lasting reductions in undernutrition. These results underscore the need for multisectoral strategies that integrate education, nutrition literacy and

women's economic empowerment to address persistent education-based inequalities in undernutrition.

Socioeconomic Disparities: Wealth-Based Inequities

The findings of this study show a long-standing disparity in nutritional outcomes linked to household wealth. In every country studied, women in the lowest wealth quintiles consistently showed a higher prevalence of thinness than those in high-income groups, reaffirming the well-documented link between poverty and undernutrition (Siddiqui, Salam, Lassi, & Das, 2020; United Nations, 2023) including in LMICs (Alem et al., 2023). While thinness generally declined, the extent and rate of decline differed distinctly across the economic groups. For example, the poorest women experienced the most pronounced reduction in thinness in Bangladesh (Sayeed et al.), suggesting the effective implementation of national nutrition plans (Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh, 2017). In contrast, the disparity between the wealthiest and poorest women remained in Pakistan (Waghmare, Chauhan, & Sharma, 2022) and India (Yaya & Ghose, 2020), suggesting inequitable access to nutrition programs (Government of India Ministry of Health and Family Welfare, 2017; Scaling Up Nutrition).

Similar views were found in both countries, where a systematic decrease in underweight women was observed within lower wealth quintiles (Al Kibria, Swasey, Hasan, Sharmeen, & Day, 2019a; Kamal et al., 2015). The Maldives represents a distinct case, where rates of thinness rose slightly, most notably among the wealthiest women. This highlights the need to interpret national trends within the context of health behaviours and local access to food markets to address equity-focused policies (Ministry of Health Republic of Maldives, 2022). It is crucial to prioritise implementing interventions that align with sector-specific goals,

including agricultural and fishery programs, as well as food safety and quality control systems, to improve food security (Ministry of Health Republic of Maldives, 2022). Addressing malnutrition and wealth disparities must remain a priority in national nutrition strategies to ensure that all groups are not neglected. Collectively, these findings highlight the need for equity-oriented nutrition policies that explicitly target women in the lowest wealth quintiles through strengthened social protection and access to affordable, nutritious foods while also accounting for country specific contexts, such as emerging diet-related vulnerabilities among wealthier groups in the Maldives, ensuring inclusive and effective national nutrition strategies.

Strengths and Limitations

The main strength of our study is the use of nationally representative DHS data on BMI and reported social determinants, thus creating strong generalisability for other studies and broader populations. The reliance on cross-sectional data also limits the ability to draw causal inferences between social determinants and nutritional status, as the analysis is based on population-level associations and does not adjust for individual-level trends, raising the potential for ecological fallacy. Another limitation is the lack of systematic survey rounds, such as in the Maldives and Pakistan, causing variation in frequency and difficulty in comparability between countries and years. This inconsistency in reporting creates data gaps and asynchronous trend patterns, which in turn complicates comparative analyses. Third, data on BMI levels were not available for several other countries in South Asia, including Afghanistan, Bhutan, and Sri Lanka. Another potential weakness of this study is that the measurement of BMI was significantly higher than the measurement results we concluded which was using WHO standard BMI levels (Al Kibria et al., 2019a). This also shows inconsistency in the reporting structure and may cause bias when relating to other studies using the same outcome measurement.

Conclusion

Despite observed declines in thinness among women in South Asia, undernutrition remains a significant public health concern in the 21st century, particularly among rural, less educated, and economically disadvantaged populations. These findings underscore the importance of addressing the structural and social determinants of nutrition while sustaining progress through inclusive and equitable health interventions. Therefore, priority should be given to food and nutrition policy interventions that strengthen food security, improve access to affordable and healthy foods, and promote women's empowerment to prevent the persistence of undernutrition and accumulation of burden of disease. Future research should continue to monitor nutritional trends, explore underlying causal pathways, and evaluate the effectiveness of multisectoral strategies aimed at improving women's nutritional status and overall health across South Asia.

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Chapter 4: General Discussion and Conclusion

This thesis addresses two critical and interrelated factors of nutritional status among women of reproductive age in South Asia: the prevalence and trends of overweight and obesity and it's socioeconomic inequalities, and the prevalence and trends of undernutrition and its socioeconomic inequalities.

Analysing two decades of nationally representative data from Pakistan, Bangladesh, India, Nepal, and the Maldives, this research examines how women's nutritional status has evolved within a regional context characterised by persistent poverty, rapid urbanisation, economic growth and profound social change.

The findings from our thesis indicate that undernutrition and overnutrition are not isolated phenomena but coexist within the same populations, shaped by overlapping social determinants that collectively define a pronounced double burden of malnutrition (DBM).

The results demonstrate both progress and obstacles. On one hand, the rate of thinness has declined in most countries, particularly in Bangladesh and Nepal, suggesting success in combating chronic undernutrition among those in rural and poorer households. On the other hand, the rates of overweight and obesity have surged, specifically in Bangladesh, India, and Pakistan, creating new health burdens, disproportionally affecting urban, wealthier and more educated women. With overnutrition and undernutrition coexisting within the same population, this research highlights the dynamics of DBM.

Emerging Patterns of the DBM among Women in South Asia

This study highlights a substantial increase in the prevalence of overweight and obesity among women in South Asia over the past two decades. The results indicate that the rise has occurred across all countries in the region studied, apart from the Maldives. These were particularly pronounced among women living in urban areas, those with higher levels of education, and those from wealthier households. These findings reflect broader regional trends associated with economic development, urbanisation, dietary transitions, and increasingly sedentary lifestyles (Md Mehedi Hasan et al., 2022, Alem et al., 2023).

In contrast, the prevalence of thinness has generally declined across the region, most notably in Bangladesh, India, and Nepal. The greatest reductions were observed among women with lower levels of education and those living in rural and poorer households, suggesting gradual improvements in food security, socioeconomic conditions, and access to health services. The findings from this analysis align with results shown in previous studies conducted in LMICs and South Asia (Biswas et al., 2019; Md Mehedi Hasan et al., 2022; Mare et al., 2025). Despite the improvements in reducing thinness, several studies using comparable methodologies suggest that many countries remain off track to achieve nutrition-related Sustainable Development Goals (SDGs) by 2030 (Biswas et al., 2019; Di Cesare et al., 2016; Md Mehedi Hasan et al., 2022).

Together, these findings highlight the complex nutritional transition occurring in South Asia, where progress in reducing undernutrition is increasingly accompanied by a growing burden of overweight and obesity.

Socioeconomic Determinants

Education

Education is a powerful determinant of women's nutritional status. In this study, women with higher levels of education in Nepal and Bangladesh were found to have lower levels of thinness. This likely reflects their greater access to resources, employment opportunities, and health information, which in turn enable healthier and more informed dietary practices (Raghupathi & Raghupathi, 2020; Talukder, Kelly, Gray, & Sarma, 2025). Conversely, this thesis found lower levels of education were consistently associated with higher rates of thinness. This outcome is consistent with previous studies conducted in South Asia (Tanwi, Chakrabarty, & Hasanuzzaman, 2019; Al Kibria, Swasey, Hasan, Sharmeen, & Day, 2019) highlighting the role of education in improving women's access to resources, knowledge, and decision-making capacity related to nutrition and health.

On the other hand, higher levels of education had a positive association with overweight and obesity, particularly in Bangladesh and Nepal. Similar patterns have been observed in previous studies in LMICs, where higher socioeconomic status and educational attainment are often linked to a greater risk of overweight (Mendez, Monteiro, & Popkin, 2005). These associations may be explained by lifestyle changes accompanying socioeconomic advancement, including more sedentary occupations, increased television viewing, urban living, and greater consumption of energy-dense foods high in fat and sugar (Sarma et al., 2016).

Overall, education appears to have a dual effect on women's nutritional status in South Asia. While higher educational attainment protects against thinness, it may simultaneously increase the risk of overweight and obesity. This relationship underscores the need for context-specific

nutrition education that goes beyond basic schooling and addresses dietary quality, lifestyle behaviours, and food literacy.

Wealth and Income

Women's wealth status and household income play a pivotal role in shaping nutritional outcomes across South Asia, with distinct patterns of thinness and obesity observed across the socioeconomic spectrum. The analysis indicates that thinness remains more prevalent among women in lower wealth quintiles, particularly in Bangladesh. Similar patterns have also been reported in previous studies analysing data from India (Al Kibria et al., 2019). In contrast, Pakistan and India showed relatively smaller disparities in thinness over the time, with the Maldives recording a marginal increase among women in wealthier households. These patterns likely reflect inequalities in access to healthy foods, health services, and nutrition related programs. Limited access to nutrition-sensitive programmes such as those linked to fisheries and food supply chains may contribute to persistent undernutrition among poorer households.

At the same time, higher wealth quintiles experienced significant increases in overweight and obesity, particularly in Bangladesh and Pakistan. Similar trends have been documented in South Asia including in Bangladesh (Sarma et al., 2016) and India (Al Kibria et al., 2019). Women in higher-income households may be more likely to consume energy-dense diets, including greater intake of animal products, fats, and oils, while also engaging in more sedentary lifestyles associated with urban living and occupational changes. The increasing availability and convenience of processed foods in rapidly urbanising environments further contribute to these patterns, a trend widely observed across India and other LMICs (Baker et al., 2020).

Together, these findings illustrate the persistence of the DBM across wealth groups in South Asia. While poorer households continue to face challenges related to food insecurity and undernutrition, wealthier groups are increasingly affected by overweight and obesity. Addressing this dual challenge requires targeted strategies that both improve food security and dietary diversity among disadvantaged populations and promote healthier diets and active lifestyles among more affluent groups.

Urban–Rural Differences

Place of residence was an important determinant of women's nutritional status. Women living in rural areas had higher rates of thinness compared with those living in urban areas, particularly in Bangladesh and Nepal, although these rates declined significantly over time. These findings are consistent with previous global evidence from the developing world, which also reported higher levels of undernutrition among rural women (Mendez, Monteiro, & Popkin, 2005). The continued presence of undernutrition in rural populations, occurring alongside increasing levels of overweight and obesity, illustrates the evolving dynamics of the DBM in South Asia (Tanwi, Chakrabarty, & Hasanuzzaman, 2019). These patterns likely reflect persistent challenges in food supply infrastructure, limited dietary diversity, and ongoing food security constraints in rural and remote areas.

In contrast, overweight and obesity were consistently more prevalent in urban settings, with the most notable, albeit moderate, increases observed in Bangladesh. Similar patterns have been reported in another study conducted in the similar context (Sarma et al., 2016). Urban environments often promote lifestyle changes associated with economic development, including reduced physical activity, greater access to processed foods, and shifts away from traditional diets. Evidence from other LMIC contexts further supports these patterns. For

example, a study conducted in Africa found overweight and obesity more prevalent in urban areas with higher parity and residence in female-headed households identified as additional risk factors (Were, Kyeremeh, Annor, Campbell, & Stranges, 2024). These trends are driven by a combination of factors, including improvements in food security, the globalisation of food production systems, and gradual shifts away from traditional diets towards more energy-dense foods. Overall, these findings highlight the urban–rural divide as a central feature of South Asia's DBM and emphasise the need for place-sensitive nutrition policies and interventions that address the distinct challenges faced by rural and urban populations.

Country-Specific Narratives

Bangladesh

Bangladesh presents one of the most striking examples of nutritional transition among the countries examined and potentially within South Asia more broadly. Between 2000 and 2022, the country recorded the steepest decline in thinness, with absolute reductions exceeding 30 percentage points. This substantial improvement reflects the impact of targeted nutrition programmes and broader poverty alleviation efforts. Government initiatives focusing on maternal nutrition and health have contributed to improvements in women's energy intake, antenatal care utilisation, and micronutrient consumption (Ministry of Health and Family Welfare, Government of the People's Republic of Bangladesh, 2017).

Despite these improvements, women in poorer households remain vulnerable to undernutrition and thinness, often due to persistent food insecurity, rising food prices, and unequal intra-household food allocation. Meanwhile, wealthier and more educated women are increasingly exposed to the consequences of rapid urbanisation, which has contributed to rising levels of

overweight and obesity. Similar findings have been reported in previous studies (Ahammed, Sarder, Kundu, Keramat, & Alam, 2022).

The growing availability of inexpensive processed foods, particularly in expanding peri-urban and rural markets, has further accelerated these trends. Comparable dietary transitions have been documented in other developing countries (Tuhin Biswas, Uddin, Mamun, Pervin, & P Garnett, 2017, Du, Mroz, Zhai, & Popkin, 2004).

Together, these patterns illustrate the coexistence of declining undernutrition and rising overweight and obesity, highlighting Bangladesh as a clear example of the DBM. Social protection strategies, including healthy food vouchers and conditional cash transfer programs focusing on maternal nutrition, may help mitigate these emerging challenges while continuing to reduce undernutrition among vulnerable groups.

India

India presents one of the most complex manifestations of the DBM in South Asia. Over the past two decades, India has experienced a steady decline in thinness among women, reflecting the impact of national nutrition initiatives and broader social and health programmes (Government of India Ministry of Health and Family Welfare, 2017). However, undernutrition remains prevalent among rural women, particularly those with limited education and from poorer households. Similar findings have been reported in recent studies examining socioeconomic determinants of the DBM in India (Prithishkumar et al., 2024). These persistent disparities reflect structural inequalities, including limited access to diverse diets, ongoing socioeconomic disadvantage, and variations in health literacy.

Overweight and obesity have increased steadily, particularly in urban areas. These trends are consistent with findings reported by Jayalakshmi et al. and Prithishkumar et al, who document the rising prevalence of overweight and obesity among Indian women. Rapid economic growth has increased disposable incomes, but this shift has often been accompanied by increased consumption of calorie-dense foods rather than nutrient-rich diets. Wealthier and more educated women continue to show higher prevalence of obesity; however, the burden is gradually shifting towards middle-and lower-income groups as processed foods become more affordable and widely available (Singh, Karun, Chakrabarty, Chandra, & Singh, 2025).

India's experience therefore highlights the complexity of addressing malnutrition in all its forms. While progress has been made in reducing undernutrition, the simultaneous rise in overweight and obesity presents new public health challenges, underscoring the need for integrated strategies that address both extremes of malnutrition.

Nepal

Nepal also demonstrates clear evidence of the DBM, although recent trends suggest that overweight and obesity are becoming increasingly prominent drivers of this transition. Between 2000 and 2022, overweight and obesity increased by more than 20 percentage points, a pattern consistent with earlier cross-sectional analyses (Rana et al., 2022). Additional studies have reported increasing prevalence of intra individual DBM with age, indicating a growing overlap between undernutrition and overnutrition within the same populations (Jayalakshmi, Sewor, & Kannan, 2023).

Despite these emerging challenges, Nepal has made notable progress in reducing undernutrition. However, thinness remains relatively higher than in several neighbouring

countries, particularly among poorer and less educated women (Ferdausi, Al-Zubayer, Keramat, & Ahammed, 2022). Improvements in maternal and child nutrition have been attributed to community-based nutrition interventions, investments in women's education, and expanded maternal health services (National Planning Commission, 2017). Strong community health worker networks have also played an important role in improving nutritional awareness and access to healthcare services.

During the same study period, overweight and obesity are increasing among urban and wealthier women, consistent with findings from other studies conducted in Nepal (Ferdausi et al., 2022; Sunuwar, Singh, & Pradhan, 2020; Bishwajit, 2017). Rapid urban expansion has contributed to lifestyle changes, including increased sedentary employment, reduced physical activity, and greater consumption of processed foods.

Meanwhile, access to diverse and nutritious agricultural foods remains constrained in some regions. Staple crops such as maize dominate local food systems, and dietary diversity is often limited by market access, climate variability, and economic pressures (FAO, 2024). Addressing the DBM in Nepal therefore requires a balanced strategy that builds on progress in reducing undernutrition while simultaneously preventing the rapid rise of overweight and obesity.

Pakistan

Among the countries examined, Pakistan shows one of the highest prevalence rates of overweight and obesity among women of reproductive age. Between 2011 and 2017, obesity increased by approximately 10 percentage points. This rise has been particularly evident among women in wealthier households and certain rural populations, where increasing availability of

processed foods has begun to replace traditional diets (Baxter et al., 2023; Moore, Hall, Harper, & Lynch, 2010).

However, previous studies have also identified higher prevalence of overweight and obesity among urban women with secondary education (Naz, Ali, Yasmin, & Trueha, 2025). These mixed findings suggest that obesity in Pakistan may be influenced by a complex interaction of socioeconomic, environmental, and behavioural factors. At the same time, many rural women remain engaged in agriculture and physically demanding household activities, which may help maintain more active lifestyles and healthier body mass index (BMI) levels (Naz et al., 2025). Alongside rising overweight and obesity, thinness has declined moderately, particularly among rural and less educated women. This trend suggests some progress in reducing severe food insecurity (Waghmare, Chauhan, & Sharma, 2022). Nevertheless, undernutrition remains a concern among low-income households, where women often depend on limited household income and face increasing food insecurity due to rising staple food prices (Naz et al., 2025; FAO, 2024).

Pakistan currently lacks large-scale, coordinated nutrition programmes, and existing initiatives are often fragmented across ministries with limited institutional coordination (Pakistan Bureau of Statistics, 2023). Strengthening partnerships between government sectors, agricultural stakeholders, and public health institutions may therefore be essential for addressing both undernutrition and rising obesity simultaneously.

Maldives

The Maldives presents a distinctive case within the region, showing relatively modest changes in both thinness, overweight and obesity over the study period. However, important

disparities emerge when examining urban and rural populations. In this study, overweight and obesity decreased among urban women but increased among rural women, suggesting emerging inequalities. These patterns may reflect food security challenges across remote islands, where limited agricultural production and dependence on imported foods influence dietary patterns. Similar disparities have been reported among richer and educated women, highlighting the role of financial constraints and food literacy in shaping nutritional outcomes (Ferdausi et al., 2022).

Other studies conducted in the Maldives report somewhat different patterns. For example, Hashan, Rabbi, Haider, and Das Gupta (2020) found that overweight and obesity were prevalent in both rural and urban settings, particularly among older, married, and less educated women. In contrast to the findings of the present study, women in the richest wealth quintile were reported to have a substantially lower likelihood of underweight during the 2016–2017 survey period.

These differences suggest that nutritional inequalities in the Maldives are complex and may vary depending on survey periods, methodologies, or population characteristics. Addressing these challenges requires policies tailored to the country's unique geographic and economic context. Strengthening local food production, particularly through small-scale fisheries and community-level food initiatives combined with nutrition education and micronutrient supplementation programmes may improve dietary quality and access to healthy foods (Ministry of Health Republic of Maldives, 2022).

Cross-Country Comparison and Regional Implications

A comparison of trends across Pakistan, Bangladesh, India, Nepal, and the Maldives reveals both shared patterns and important contextual differences in the evolution of the DBM among women in South Asia. Across all countries, declining levels of thinness alongside rising prevalence of overweight and obesity reflect a broader regional nutrition transition associated with economic development, urbanisation, and changing food environments.

However, the pace and distribution of these changes vary considerably between countries. Bangladesh demonstrates the most rapid decline in thinness, suggesting significant progress in reducing chronic undernutrition. Nepal and Pakistan show more moderate improvements, while India continues to face persistent inequalities linked to socioeconomic disadvantage and rural–urban disparities.

At the same time, the rise in overweight and obesity appears to be a common trend across the region, although its distribution differs by country. In Bangladesh and India, overweight and obesity remain concentrated among urban, wealthier, and more educated women. In contrast, Pakistan and the Maldives demonstrate more heterogeneous patterns, with obesity emerging in both urban and certain rural populations.

These patterns suggest that while the underlying drivers of the DBM are broadly similar across South Asia, such as urbanisation, increased availability of processed foods, and shifts towards sedentary lifestyles, the ways in which these drivers interact with existing social and economic inequalities differ between countries.

Public Health Implications

The findings of this thesis have important implications for public health policy and programming aimed at addressing the DBM among women of reproductive age in South Asia. By integrating evidence on both undernutrition and overnutrition, this research highlights the need for coordinated, multisectoral responses rather than siloed interventions targeting single nutritional outcomes.

Analyses of long-term sociodemographic trends provide policymakers with critical insights to identify populations at greatest risk and to allocate resources more equitably. The results demonstrate that nutritional risks are not uniformly distributed across populations but are strongly shaped by education, wealth, and place of residence. Consequently, policy responses must be tailored to the specific needs of different population subgroups.

First, the rapid rise in overweight and obesity among urban, wealthier, and more educated women, particularly in Bangladesh, India, Nepal, and Pakistan, signals an urgent need for preventive strategies targeting overnutrition. Public health responses should include reforms in food systems that regulate the marketing and availability of ultra-processed foods while promoting healthier dietary environments. Urban planning and transport policies that support active lifestyles, such as walkable cities and improved public transport infrastructure, may also help reduce sedentary behaviour. In addition, nutrition education programmes should increasingly focus on dietary quality, food literacy, and healthy lifestyle behaviours among populations undergoing rapid socioeconomic change.

Second, the continued decline in thinness, particularly among rural and poorer women in countries such as Bangladesh and Nepal, reflects the positive impact of investments in maternal

and child health programmes, community-based nutrition interventions, and broader poverty reduction initiatives. However, the persistence of undernutrition among socioeconomically disadvantaged women highlights the need to sustain and strengthen food security initiatives, social protection programmes, and nutrition-sensitive agricultural policies that improve access to diverse and nutrient-rich foods.

Importantly, the coexistence of declining thinness and rising overweight and obesity within the same populations demonstrates that progress in reducing undernutrition may be undermined if emerging risks related to overnutrition are not addressed simultaneously. This reinforces the necessity of integrated DBM-focused strategies that balance efforts to eliminate hunger with measures aimed at preventing diet-related non-communicable diseases. Women's empowerment, including access to education, employment opportunities, and healthcare, should remain central to these strategies, given its strong influence on nutritional outcomes across the life course.

Overall, the evidence presented in this thesis supports a shift toward equity-oriented, gender-sensitive, and context-specific public health approaches. Addressing the DBM in South Asia will require sustained political commitment and coordinated action across multiple sectors, including health, agriculture, education, social protection, and urban development, to ensure that improvements in women's nutritional status are both inclusive and sustainable.

Strengths and Limitations of the Thesis

Several limitations should be considered when interpreting the findings. First, the study relies on cross-sectional survey data, which limits the ability to establish causal relationships between socioeconomic determinants and nutritional outcomes. While the analyses identify strong

associations at the population level, they cannot capture individual-level trajectories or causal pathways over time. Second, variations in survey timing across countries may affect comparability of trend analyses, particularly where intervals between survey rounds differ substantially. However, the use of standardised DHS sampling and measurement methodologies helps mitigate this concern and ensures a high level of comparability across datasets. Third, the absence of BMI data for several South Asian countries, including Afghanistan, Bhutan, and Sri Lanka, restricts the geographic scope of the analysis. As a result, the findings cannot be fully generalised to the entire South Asian region. Finally, differences in BMI classification and reporting across studies may introduce challenges when comparing the findings of this thesis with other studies. Although this analysis uses World Health Organisation standard BMI cut-offs to ensure consistency, some studies employ alternative definitions or population-specific thresholds, which may influence comparative interpretations.

Despite these limitations, the large-scale, nationally representative nature of the data and the consistent analytical approach provide robust insights into long-term nutritional trends and socioeconomic inequalities among women in South Asia, directly addressing the objectives of this thesis.

Conclusion

This thesis contributes important evidence to the growing body of literature on the nutritional transition affecting women in South Asia. The findings reveal simultaneous progress and emerging risks: while undernutrition has declined in several countries, overweight and obesity have increased rapidly. Together, these trends illustrate the growing DBM, which poses significant risks for women's health, intergenerational nutrition outcomes, and national health systems.

Between 2000 and 2022, the study demonstrates:

- a substantial increase in overweight and obesity among women of reproductive age in Pakistan, Bangladesh, India, the Maldives, and Nepal
- accompanied by an overall decline in thinness across much of the region.

Consistent with the research aims outlined in Chapters 2 and 3, clear social gradients were observed in these trends. Overweight and obesity increased most rapidly among urban, wealthier, and more educated women, while the greatest reductions in thinness occurred among women with lower levels of education and those living in rural and poorer households.

These patterns highlight how social determinants shape divergent nutritional trajectories within the same populations. By systematically analysing long-term trends in both undernutrition and overnutrition across multiple South Asian countries, this research provides valuable evidence to inform policies and programmes addressing the DBM.

Addressing this challenge will require integrated approaches that combine food system reforms promoting affordable and nutritious diets, strengthened social protection programmes supporting vulnerable populations, sustained investments in women's empowerment, and health promotion initiatives targeting both undernutrition and overnutrition. Urban planning policies that encourage active living and healthier food environments may also be increasingly important.

Without coordinated multisectoral action, South Asia risks reinforcing existing inequalities while facing a growing burden of non-communicable diseases. Although substantial progress has been made in reducing thinness, this progress is increasingly accompanied by rising levels

of overweight and obesity. These rapidly changing trends underscore the urgency of developing equitable, gender-sensitive, and context-specific strategies capable of addressing the full spectrum of malnutrition among women in the region.

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Appendix

Appendices 1: Access to datasets authorisation letter

Nov 05, 2021

Miranda Hendry
University of Sydney
Australia
Request Date: 11/05/2021

Dear Miranda Hendry:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "Examining the trends inequality and determinants of obesity and overweight among women of reproductive age in low and middle income countries":

Bangladesh, India, Maldives, Nepal, Pakistan

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Also, be aware that re-distribution of any DHS micro-level data, either directly or within any tool/dashboard, is not permitted. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program

530 Gaither Road, Suite 500, Rockville, MD 20850 USA +1.301.407.6500 +1.301.407.6501 fax icf.com