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COVID-19 & Its Impact on Intimate Relationships

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Statement of Originality

I hereby certify that:

1. To the best of my knowledge, the content of this is my own work. This thesis has not been submitted for any other degree or other purposes.
2. All data presented in this thesis was collected according to ethical approval received from The University of Sydney Human Research Ethics Committee.
3. The intellectual content of this thesis is the product of my own work, and all assistance received in preparing this thesis has been acknowledged.

Liam Dacosta
23/10/2023

Authorship Attribution Statement

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Abstract

The COVID-19 pandemic significantly disrupted people's daily lives globally, including their sexual activities. The present studies explored changes in sexual behaviours, and related sexual health, during the COVID-19 pandemic across 18 countries. The Behavioural Immune System was used a guiding framework for these studies, while additional factors that may also impact sexual behaviours were incorporated. Study 1 examined changes in condom use in early 2020, during the initial lockdown in Sydney, Australia, finding a broad decline in condom use, particularly pronounced among single people. Study 2 expanded on these findings by examining changes in condom use at a latter timepoint in Sydney, Australia, and in 17 other countries. Results revealed a significant decline in Australia, and 5 other countries, and these declines were not differentiated by relationship status. Moreover, the strength of the declines across countries was significantly associated with lockdown stringency and vaccination uptake, but not historical prevalence of disease. Study 3 examined changes in a broader range of sexual behaviours – specifically, frequency of sexual intercourse, sexting, masturbation, and pornography use. Significant declines were observed across all behaviours – the only exceptions were increases in sexting in the UK and Spain. Changes in sexting and solitary behaviours were predicted by historical prevalence of disease, whereas intercourse frequency was predicted lockdown stringency. Taken together, these findings reinforce the evidence for a pervasive impact of disease threat on sexual behaviours, but also highlight how newly emergent pandemic-related factors can also play a significant role.

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CHAPTER 1: Background and Introduction

The shift to agrarian societies marked a pivotal juncture in the evolution of contemporary civilisations. The practice of crop cultivation in specific locals, allowing for trade with neighbouring settlements, laid the groundwork for socio-economic structures that continue to endure in modern societies. However, enhancements in communications and exchanges between different settlements inadvertently facilitated the propagation of pathogens (Dobson & Carper, 1996). Prior to agrarian societies, the spread of any emergent disease was majorly confined in terms of available hosts, severely hampering the efficacy of disease spread (Dobson & Carper, 1996). The expansion of trade relations amplified human encounters with unfamiliar individuals and their domesticated animals, allowing zoonotic pathogens – diseases that transition from non-human animals to humans – a wider source to propagate within (Piret & Boivin, 2021). The continuous expansion of urban spaces, coupled with increasingly efficient modes of transportation, has greatly expanded available hosts for emergent diseases, exponentially increasing the potential of infectious diseases. As a result, disease outbreaks have frequently occurred throughout history, occasionally leading to endemics, and, in extreme cases, pandemics (Lindahl & Grace, 2015).

A pandemic is characterised by the transborder spread of disease, typically on a global scale. Pathogens with pandemic potential are usually highly transmissible and are associated with elevated mortality rates. The first documented pandemic was the Justinian Plague (541-549 AD), which had a severe impact on the Byzantine Empire, significantly disrupting its expansion and resulting in an estimated 15 to 100 million deaths (Raoult et al., 2012). The Black Plague is perhaps the largest example of a pandemic, resulting in the estimated death of up to 150 million people over the span of 50 years (DeWitte, 2014). Even more contemporary examples still demonstrate the devasting toll on human lives – the Spanish flu (1918-1920) infected approximately a third of the global population at the time, with an estimated 50 to

100 million deaths (Aassve et al., 2020). Owing to their immense scale and devastating impact, pandemics are often considered among the most catastrophic events in human history (Benedictow, 2005).

Contemporary medical innovations, however, have substantially curtailed the capacity of many diseases to proliferate effectively, attenuating the impact of disease on present-day societies. This evolution in medical understanding and practices can be traced back to the seminal development of germ theory in the 1800s, which revolutionised understanding of how contagions spread, recognising that diseases could be spread directly (e.g., via airborne droplets) or indirectly (e.g., via surfaces contaminated by an infectious person; Lederberg, 2000). The widespread acceptance of germ theory transformed medical practices that still endure today – the most enduring of these being the introduction of mandatory handwashing for medical staff in hospitals (Steere-Williams, 2015). Concurrently, the advent of the smallpox vaccine marked a milestone in preventative medicine. Its widespread success led to mandatory vaccinations in England by 1851, culminating in the global eradication of smallpox by the 1980s (Stewart & Devlin, 2006). The ramifications of these medical advancements are highlighted in how effectively disease outbreaks have been contained in the 21st century. Severe Acute Respiratory Syndrome (SARS) was the first declared pandemic of the 21st century, but highly vigilant public health care systems effectively limited the spread of SARS to 10,000 cases largely concentrated in China and Hong Kong (Huremović, 2019). The swine flu pandemic in 2009 was the first major outbreak to utilise both vaccinations and antiviral medication to slow the spread and effectively treat infection (Piret & Boivin, 2021), resulting in swine flu infecting substantially fewer people than models predicted (Dawood et al., 2013). Indeed, slippages in pathogen surveillance and weaknesses in public health systems are often the catalyst for contemporary disease outbreaks. The Ebola outbreak in West Africa in the mid-2010s emerged due to poorer capacity to detect and treat

this disease but was effectively contained after these regions received foreign aid, increasing case detection capabilities and available treatments (CDC, 2014). In sum, the strides made in contemporary medicine and public health practice has significantly mitigated the dissemination of infection diseases, limiting the potential for a pandemic outbreak, particularly in Western countries.

While it is unquestionable that the global scale and severity of pandemics has been contained in recent decades, it is also noteworthy that these outbreaks have induced enduring modifications in social behaviours among affected communities. Perhaps the most salient example is that of the HIV/AIDS pandemic. Predominantly transmitted through sexual interactions, HIV/AIDS has had significant enduring behavioural impacts among men-who-have-sex-with-men (MSM). A meta-analysis unveiled that, during the 1990s (when HIV/AIDS spread was on the rise), MSM reported a later sexual debut compared to previous generations, reported a decrease in the number of sexual partners, and increased safe sex activities (e.g., using a condom) compared to their predecessors (Grunseit & Aggleton, 1998). Such evidence suggests that MSM were modifying their behaviours in a way to minimise potential HIV contact.

Similar trends are observed when younger MSM are simply reminded of the severe impact of HIV/AIDS. The use of pre-exposure prophylaxis (PrEP), which is highly efficient at preventing HIV transmission when taken regularly (CDC, 2022), increases for those individuals when the risks associated with HIV are communicated to them (Koester et al., 2021). This emphasises the enduring ripple effects of pandemic-induced behavioural changes within the queer community, extending to individuals who were not directly exposed to the peak of the HIV scare.

Other epidemiological contexts display similar patterns – residents in Hong Kong demonstrated sustained improvements in personal hygiene and health-protective behaviours

following the resolution of the SARS outbreak (Lau et al., 2005). These behavioural transformations are some examples that exemplify pandemics fundamentally shaping social behaviours, even when limiting to only those groups threatened by specific diseases. These behavioural shifts serve as compelling examples of how pandemics can fundamentally reshape social conduct.

Until now, the spread of major diseases has generally been confined geographically, or limited to certain communities. Most people in modern societies, particularly Western ones, have not been forced to confront significant pandemic threat. The onset of the COVID-19 pandemic, however, marks a notable deviation in recent history, representing a unique instance where advanced societies globally have grappled with ubiquitous pathogenic threat, unparalleled in its reach and impact in the modern world. Historical precedents of disease outbreaks have demonstrated that a surge in disease prevalence can engender enduring changes in behaviours. Considering the extensive and multifaceted implications of COVID-19 on a global scale, it is reasonable to surmise that social behaviours have been significantly influenced, and that the extent of these impacts differs across countries and contexts. This thesis is designed to delve into and elucidate the nature of these cross-cultural behavioural changes precipitated by the COVID-19 pandemic in the context of sex-related behaviours.

The COVID-19 Pandemic

In late December of 2019, a cluster of cases emerged presenting an unidentified form of pneumonia among the staff of a wholesale wet market located in Wuhan, China. The symptoms exhibited by these individuals ranged from fever and dry cough to fatigue and gastrointestinal issues (Huang et al., 2020). The following month witnessed the rapid expansion of this yet-to-be-identified disease, covering a vast majority of the provinces within China and infiltrating into several major cities (notably Beijing and Shanghai). This spread coincided with the annual Chinese New Year travels, contributing to its propagation

(Wu et al., 2020). As per retroactive epidemiological modelling, it is estimated that by the end of January 2020, the total count of symptomatic cases in China had exceeded 6000 (The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team, 2020). Following this alarming rise, the World Health Organisation (WHO) declared the newly classified coronavirus disease 2019, colloquially referred to as COVID-19, as a Public Health Emergency (WHO, 2020).

The global ramifications of COVID-19 swiftly became apparent. Predictive modelling conducted during the early stages of the outbreak estimated that within the confines of China, the caseload of COVID-19 was undergoing a twofold increase approximately every 6.4 days (Wu et al., 2020). This model underscored the role of asymptomatic transmission as a pivotal driver of this rapid rate of increase, thereby implying that international dissemination was not just probable but rather inevitable, and was likely already underway (Wu et al., 2020). In an effort to curtail this spread, nations worldwide initiated a mandatory 14-day quarantine period for all individuals travelling from China. This soon escalated to a near-total cessation of international travel by March 2020 (New York Times, 2020). By this time, at least one case of COVID-19 had been reported in every country spanning Europe and the Americas, with the daily tallies growing exponentially. Given this ubiquitous and uncontrollable spread, the WHO made the decision to officially designate COVID-19 as a pandemic (WHO, 2020).

The most significant driver behind this decision was the rate of COVID-19 spread, and the associated mortality rates. Individual countries were reporting alarming mortality rates at this stage. Italy, for example, recorded over 10,000 COVID-19-related deaths by the end of March 2020 (Di Donato et al., 2020). A concerning trend was identified in China, indicating an escalation in fatalities in correlation with hospitals reaching their maximum capacity, attributed to a reduction in the quality of patient care due to the strain on resources (Zhang et al., 2020). In the initial stages of the pandemic, the fatality rates in Wuhan soared

to 4.5%, significantly higher than the 0.5% documented in the rest of China. However, this rate declined as more medical resources were directed to Wuhan (Zhang et al., 2020). As with previous outbreaks in the 21st century, efficient and effective public health systems were the most viable method in reducing mortalities.

'Flattening the curve' by promoting hygiene behaviours

While public health systems were trying to adapt to the growing threat, it quickly became evident that the unchecked spread of COVID-19 would swiftly overwhelm them. Strategies aimed at 'flattening the curve' were gradually adopted on a global scale to respond to this escalating challenge. The central premise of these measures was to manage the rate of infection in such a way that it reduces the volume of individuals requiring hospitalisation at any given time (Kenyon, 2020). This approach prevents healthcare systems from being overwhelmed, increasing overall quality of patient care, and reducing mortality rates (Kenyon, 2020). Within the context of the COVID-19 pandemic, the implementation of basic preventive measures attempted to reduce the amount of people presenting at hospitals with COVID-19 – regular handwashing, consistent face mask use, and adherence to effective social distancing guidelines – constituted the primary measures contributing to flattening the curve (Feng et al., 2020). The intent behind these practices was to slow the transmission of the virus, thereby providing the healthcare system with the necessary time to manage the patient load effectively and avoid becoming inundated.

The primary mode of transmission of COVID-19 is through respiratory droplets emitted by infected individuals (He et al., 2020). Prior to the development of vaccines, the prevention strategies available were largely non-pharmaceutical interventions. Mask wearing and handwashing were prominently the most effective means in mitigating the spread of the virus. Breathing, talking, coughing and sneezing by an infected person releases a large volume of infectious droplets. Masks offer a degree of efficacy by functioning as a physical

barrier between infected and susceptible individuals, thus significantly impeding exchange of these droplets (Greenhalgh, 2020). However, these droplets also deposit on surrounding surfaces, including hands that may come into contact with these particles. Given the propensity of humans to frequently touch their faces, hands contaminated with particles can also transfer the virus to facial regions including the mouth, nose, and eyes (Przekwas & Chen, 2020). Routine and thorough hand washing is therefore an integral preventive strategy, as it eliminates these leftover particles.

Given that mask wearing and handwashing behaviours were not widespread in some cultures prior to the outbreak of COVID-19, the development and promotion of strategies to encourage these behaviours emerged as a fundamental aspect of public health in the pandemic. By mid-2020, a majority of countries had implemented some form of mask mandate, with the stringency of regulations varying from compulsory mask use in indoor spaces to necessitating mask wearing whenever individuals ventured outside the home (Masks4all, 2020). Public health messaging quickly adapted to repeatedly promoting uptake in these behaviours (Anwar et al., 2020). Mainstream and social media outlets also engaged in concerted efforts to promote these behaviours – for example, ensuring that masks adequately covered both mouth and nose, or emphasising the need to wash hands with soap and water for at least 20 seconds (Anwar et al., 2020). Furthermore, tech giants exhibited adaptability by modifying their products to reinforce these behaviours. Apple, for instance, tailored its Face-ID technology to be compatible with mask usage (Gartenberg, 2020), and both Apple and Samsung updated their smartwatch devices to notify users when they had spent an adequate amount of time washing their hands (Peters, 2020). Almost every form of modern life began to make large scale efforts to adapt societal behaviours to appropriately match the demands of the pandemic.

However, adaptation of these newly necessitated behaviours varied substantially across different cultural milieus. South-east Asian regions had very high rates of mask usage, and some regions – specifically, Taiwan, Japan, Hong Kong, Singapore, and South Korea – achieved near-universal mask wearing (Prather et al., 2020; Stutt et al., 2020). Notably, these countries had pre-existing strategies prepared to handle disease outbreak following SARS, facilitating a swift uptake of protective behaviours among their populaces (Prather et al., 2020).

In comparison, masks in the United States quickly became a contentious and politicised topic (Haischer et al., 2020), to the extent that anti-mask groups actively rallied against the uptake of this behaviour (Rains et al., 2021). Unsurprisingly, governmental authority and health recommendations then had little impact on mask uptake among Americans (Chan, 2021). Cross-cultural variation in these behaviours subsequently had a palpable impact on COVID-19 spread and mortality. In late May 2020, Taiwan (population ~24 million) reported 441 COVID-19 cases and 7 COVID-19-related deaths, while metropolitan New York alone (population ~20 million) reported over 353,000 cases and more than 24,000 fatalities (Prather et al., 2020). These stark contrasts underscore the critical role that cultural context had on the efficacy of social change.

Social distancing measures. While regions like Taiwan exemplify sufficiently slowing the spread with masks and other protective behaviours alone, COVID-19 spread too quickly in most other countries for these behaviours to substantially flatten the curve (Zhang et al., 2020). The remaining path to disease reduction was to limit the number of people that one individual person came into close contact with, known as social distancing. Social distancing measures refer to a wide number of behavioural changes aimed at reducing contact with other people – such as keeping a minimum two metres from other people, restricting dine-in eating options, closing non-essential businesses (e.g., bars, gyms), cancelling large

social gatherings (e.g., conferences, music concerts), closing schools, and even placing restrictions on how far and often people can leave their place of residence (Courtemanche et al., 2020). Social distancing measures represented perhaps the largest behavioural shift during the pandemic.

Among this array of social distancing measures, mandatory lockdowns emerged as the most prominent and impactful strategy for slowing COVID-19 spread. Wuhan was the first city to be put into lockdown in late January 2020, before quickly expanding to the entire Hubei province. Severe limits were placed on all forms of travel – from halting all non-essential air travel to placing roadblocks on major highways – and restrictions were placed on movement, in conjunction with the closure of all non-essential businesses (Griffiths & Woodyatt, 2020). In March 2020, Italy became the first to impose a nationwide lockdown, which entailed severe limits on mobility outside the home (i.e., only for medical reasons, groceries, or to perform essential services; Marziano et al., 2020). As COVID-19 continued to spread internationally, countries across the world increasingly adopted similar lockdown measures. By April 2020, approximately 90 countries/territories had enacted some form of lockdown. It was estimated that around 3.9 billion people – constituting over half the global population at the time – were living under lockdown conditions of some kind (Sandford, 2020).

From an epidemiological perspective, lockdowns emerged as a potent tool in decelerating the transmission of COVID-19, and subsequently flattening the curve of the pandemic. Data from Wuhan revealed that, while other non-pharmaceutical interventions (e.g., improved hygiene practices, at-home quarantining of potential and confirmed cases) were instrumental in mitigating the spread, only lockdowns were sufficient in effectively halting the exponential growth of COVID-19 (Pan et al., 2020). In line with this, Italian data suggested that the spread of COVID-19 came under control within two weeks of lockdown

commencement (Guzzetta et al., 2021). Further, a retrospective cross-country analysis demonstrated that countries that enforced lockdowns recorded substantially lower incidences of new cases compared to countries that refrained from adopting lockdown strategies (Alfano & Ercolano, 2020). These findings collectively illustrate how efficacious lockdowns were in controlling COVID-19 spread and mitigating the burden on public health.

Despite positive medical outcomes, the introduction and longevity of lockdowns significantly transformed daily life and had major repercussions in many areas of social life. While people strived to maintain connections and social activities via digital methods (e.g., attending music gigs or gym classes via Zoom), the lack of face-to-face interactions heightened feelings of social isolation and loneliness for many (Williams et al., 2021). Moreover, the emergence of pandemic-induced phenomena began to substantially impact daily functioning for many people – for instance, "Zoom fatigue" had a substantive negative impact on mental health strain during the pandemic (Shosahn & Wehrt, 2021). Much like the outbreaks of disease in the past, COVID-19 had large reaching impacts on social behaviours due to the global nature of the outbreak. Below I describe some areas in which the pandemic significantly altered typical social behaviours.

Remote work. Given that lockdowns curtailed physical mobility, the rapid adoption of remote work strategies emerged as a central necessity to safeguard employment status and maintain the ongoing functionality of many societal systems (Anakpo et al., 2023). This shift to remote working, often described as work-from-home (WFH), encapsulates a change in work environment from traditional office spaces to personal residences of employees as a result of lockdowns. The transition to WFH was facilitated through the use of digital communication platforms such as Zoom or Microsoft Teams, enabling the continuity of regular work patterns (Prasad et al., 2020). Throughout the pandemic, governments often encouraged – and in many cases, mandated – remote work for anyone who could transition to

such conditions, impacting a wide degree of white-collar workers. A systematic review concluded that WFH has largely had positive impacts on worker productivity, even when accounting for disruptive factors like managing childcare responsibilities (Anakpo et al., 2023). The positive impact of WFH conditions were further enhanced by removing the need for monotonous behaviours like daily two-way commutes, improving work-life balance and promoting wellbeing among workers. Unsurprisingly then, the practice of remote work has endured beyond the pandemic. Census data estimates that around one-fifth of American workers are working from home (United States Census Bureau, 2022). Indeed, data from Gallup suggest that full on-site work is diminishing significantly, and that hybrid work (a mix of in-office and at-home) will be the dominant mode in the forthcoming years (Wigert & Agrawal, 2022). Considering that prior to the pandemic more than 60% of employees were on-site full-time (Wigert & Agrawal, 2022), it is evident that the changing work practices precipitated by the pandemic have significantly shaped contemporary work behaviours.

Addiction. However, in other domains, COVID-19-related lockdowns served to exacerbate existing maladaptive behaviours. The escalation of substance abuse and addictive behaviours were of particular concern (Mallet et al., 2021). It is well-established that factors such as social isolation, mental health deterioration, and economic hardship were known predictors for the onset and progression of addictive behaviours (Daglis, 2021). Furthermore, lockdowns and the associated strain on public health systems disrupted the provision of vital healthcare services, exacerbating addictive behaviours (Nguyen et al., 2021). Consequently, alcohol consumption, tobacco and vaping use, and illegal substance misuse increased over the course of the pandemic (Glowacki et al., 2020). Moreover, there is evidence pointing to a rise in behavioural addictions. Online gambling activities became more prominent, subsequently leading to a surge in problematic gambling (Brodeur et al., 2021). Among the younger demographic, an increase in problematic behaviours related to gaming (López-Cabarcos et

al., 2020), social media (Luo et al., 2020), and general internet consumption was observed (Chopdar et al., 2022). Much like changes to working behaviours, problematic addictive behaviours persisted beyond the duration of lockdowns. For instance, poker machines in Australia witnessed a significant spike in usage once lockdown measures were relaxed, higher than pre-pandemic poker machine use (McDonald, 2020). These examples of remote work and addictive behaviours underscore the long-lasting impact of the pandemic on behavioural patterns, both positively and negatively.

Panic buying. Other behaviours seemingly reoccur when disease prevalence begins to rise. One of the most prominent is that of panic buying, which refers to instances where many people suddenly purchase an excessive amount of certain products (e.g., food, supplies, medical equipment) because they are concerned that a negative event is approaching (Taylor, 2021). In the case of pandemics and isolated disease outbreaks, panic buying consists of unnecessarily purchasing items that protect people from disease, or items that provide relief from symptoms (Taylor, 2021).

Historically, panic buying has been observed repeatedly in occurrences of pandemics or other disease outbreaks, highlighting how disease prevalence can motivate certain behavioural activations. During the 1918-19 Spanish flu pandemic, there were widespread media reports of people panic buying any products that prevented influenza, or relieved its symptoms (Schoch-Spana, 2004), particularly balms and other topical ointments (Taylor, 2019). Similar behaviours were observed in the 1968 Hong Kong flu pandemic, where shortages of medical supplies were reported in Guangzhou, China, and escalated to the point of inciting riots (Wilson et al., 2009). The SARS outbreak in 2003 also led to the re-emergence of panic buying disinfectants and antiviral medication (Taylor, 2019). SARS also illustrated how effectively rumours could influence panic buying, and how illogical the sentiment behind panic buying often is. In China, there were rumours of a prophetic child

who foretold that anyone who did not consume mung beans by midnight would be killed by SARS, leading to the panic buying of mung beans (Carmichael, 2003).

In line with historic disease outbreaks, panic buying re-emerged in March 2020. As lockdowns were gradually introduced, politicians and health authorities would often reinforce being personally well-stocked, triggering panic buying (Laato et al., 2020). Items that were targeted by panic buying included hand sanitiser, masks, cleaning supplies, and prescription medication (Micalizzi et al., 2020). Unlike previous outbreaks, panic buying extended to include food, likely motivated by fears of self-isolation and quarantining (Taylor, 2021). Similarly, foreign announcements of lockdowns appeared to influence panic buying domestically (Keane & Neal, 2020), indicating that panic buying behaviours quickly became a global phenomenon. Viral images of empty shelves and videos of people fighting over products quickly spread across social media, further escalating panic buying behaviour (Naeem, 2021). Cross-cultural data indicated that bursts of panic buying were observed for over a fortnight following local governmental announcements of lockdowns (Keane & Neal, 2022). While these subsided as lockdowns continued, there was a cyclical trend during the COVID-19 pandemic where a new wave of panic buying often followed new announcements of social distancing measures (Taylor, 2021). Notably, there was no scarcity of products at any time during the pandemic. Rather, panic buying behaviours were the primary reason behind short-term shortages, where stores were unable to restock at a fast enough rate (Nicola et al., 2020).

The Behavioural Immune System

The recursive nature of panic buying behaviours throughout history suggests an inherent human readiness to adjust behaviours in periods of pronounced disease prevalence. This aligns with the Behavioural Immune System (BIS) theory, which contends that people have evolutionarily acquired behavioural defences against pathogen threat, and that these

defences are cognitively activated when people become acutely aware of disease spread (Schaller, 2011, 2015). Evolutionarily, diseases connotates a high risk, as demonstrated from the pandemics across human history. Subsequently, developing a behavioural system that reduces exposure to the unperceivable threat of disease should increase evolutionary fitness, mitigating the need for the physiological immune system to invest resources to combating disease (Park et al., 2021; Schaller et al., 2022). In line with this, experimental evidence demonstrates that cognitive priming of disease (e.g., by exposing participants to unpleasant smells) can activate these BIS-motivated, pathogen-avoidance behaviours (Murray & Schaller, 2015).

The breadth of behavioural responses encapsulated under the BIS can be classified broadly into two categories: reactive and proactive. Reactive behaviours are those that promote avoidance of potential contagion sources. Typically, sources with the potential to transmit disease elicit a disgust or dislike response, which motivates avoidance of that source (e.g., an individual sneezing in close proximity). This instinctual aversion often stems from anxiety, further fuelling reactive behaviours (Bacon & Corr, 2020).

Proactive behaviours encompass preventative actions aimed at reducing the likelihood of pathogen exposure in one's immediate environment (Chapuisat, 2007). Over time, societies have developed taboos, rituals, and societal norms that reduce the overall risk of exposure to infections, such as improvements in personal hygiene or standards in food preparation. By maintaining these social norms, and degrading any person who violates them, the opportunity for exposure to disease is limited, acting as a proactive defence (Schaller et al., 2022). Combined, reactive behaviours minimise situational exposure to disease, while proactive behaviours limit overall exposure.

Discerning genuine pathogen threats from harmless ones is difficult, however, considering the invisible nature of pathogens and particularly when considering

asymptomatic spread. As such, BIS activation relies on imprecise perceptual cues (e.g., the sound of someone vomiting, or the visual of someone with facial blemishes; both are indicative of disease in some contexts, but do not unequivocally signify disease in every instance), which inevitably result in errors being made. In line with error management theory (Haselton & Buss, 2000), the BIS is then susceptible to both false-positive errors – where people incorrectly associate a benign source with infection risk – and false-negative ones – where people incorrectly perceive an actual infectious source to be deemed safe (Schaller et al., 2022). From an evolutionary perspective, false-negatives were inherently more detrimental than false-positives. As a result, the BIS has arguably evolved to become hypersensitive to cues that imply disease threat, resulting in a higher case of less costly false-positives.

However, the BIS being in a persistent state of hyperactivation, activated by constant perception of disease threat, would result in avoidance of most social behaviours. Such a state not only necessitates extensive cognitive resources, but also results in a drastic reduction of physical interactions (Tybur & Lieberman, 2016). Therefore, the BIS incorporates a principle of functional flexibility to navigate the balance between physical interaction and disease avoidance (Schaller et al., 2022). This involves a cost-benefit analysis which weighs the risks of pathogen exposure against the advantages of physical contact (Tybur & Lieberman, 2016). In this risk-reward paradigm, individuals assess factors, such as the likelihood of encountering an infectious source, the costs if infected with a pathogen (i.e., how severe the infection might be if encountered), and the inherent benefits of physical contact (Tybur & Lieberman, 2016).

Two domains display prominent examples of this functional flexibility. The first is childcare, which often involves regular contact with disgust-inducing stimuli (e.g., changing diapers). Despite this, parents often override their pathogen avoidance instincts to cater to

their needs of their child. Notably, this tolerance of potential pathogen exposure does not extend to other people's children (Case et al., 2006), which further attests to the adaptable nature of the BIS.

Sexual interactions also pose a similar contrast, as these interactions inherently pose a higher risk of disease transmission, yet the compelling biological drive for reproduction necessitates overcoming these perceived disease threats (Hlay et al., 2022). In line with this, when a sexually-arousing stimulus is presented before a disgust-inducing stimulus, participants report less disgust than those without an erotic prime (Borg & de Jong, 2012; Stevenson et al., 2011). In comparison, when a disgust-inducing stimulus is presented first, women display less genital sexual arousal compared to a control (Fleischman et al., 2015), emphasising the functional flexibility of the BIS. In sum, despite its predisposition towards hypersensitivity, the BIS exhibits adaptability, refining its reaction according to the demands of different contexts.

This BIS framework provides a useful scaffolding in our investigation how people can adapt their social behaviours to reduce potential exposure to pathogens. Notably, the degree of perceived disease threat is not homogenous across individuals – or even cultures – which further enhances changes to reduce disease transmission at a societal level. A notable example is that of improvements in personal hygiene (Fabrega, 1997). However, the hypervigilant nature of the BIS relies on perceived instances of disease threat, regardless of whether a threat is present. Behavioural defences can then be inappropriately activated, and then subsequently disproportionately amplified by individuals who have a heightened perceived vulnerability of disease.

Prejudice

This pattern of maladaptive behaviour is exemplified by prejudice. From an evolutionary perspective, discriminating against outgroup members is an effective strategic

means of limiting disease transmission, as unknown outsiders do not necessarily follow the same (disease-preventing) social norms or traditions as one's ingroup (Schaller et al., 2015). However, the hypersensitivity of the BIS extends these discriminatory behaviours towards minority groups. Generally, it seems that outgroups – specifically, those that bear physical dissimilarities to oneself – are perceived to pose an elevated risk of infection, promoting discrimination towards such outgroups (Bressan, 2021). Disease-related prejudice further intensifies when outgroups are perceived as breaching cultural norms (Hodson et al., 2013), and is consistently predicted by perceived vulnerability to disease (O'Shea et al., 2020; Park et al., 2003). Experimental evidence suggests that exposure to a disease-related prime – relative to a non-disease threat prime and a control – triggers heightened prejudice towards racial outgroups (O'Shea et al., 2020) and foreigners (Faulkner et al., 2004). This highlights one instance where the hypersensitivity and flexibility of the BIS inadvertently promotes maladaptive behaviours.

Conformity

This desire to adhere to societal norms as a protective measure against disease extends beyond the realm of prejudice, influencing broader aspects of social conformity. Within a social context, conformity relates to alignment of personal attitudes and behaviours to those in an immediate context (e.g., family, friends, political leaders), often taking precedence over one's own individual opinions (Mehrabian & Stefl, 1995). General threats tend to promote conformist behaviours (e.g., following governmental direction after a natural disaster), but experimental research – comparing disease threat, non-disease threat, and a control – finds that disease threats seem to have an especially pronounced effect on stimulating conformity, exceeding the impact of non-disease threats (Wu & Chang, 2012). Complementary evidence suggests that moral transgressors – those who are not following societal norms – are more negatively evaluated after a disease prime (Murray et al., 2019), further highlighting that

conformity promotes avoidance of possible disease carriers. Notably, an integral aspect of conformity involves the surveillance and copying of others' behaviours in a social context (Wu & Chang, 2012). Such monitoring allows individuals to witness detrimental consequences of diseases without having to contract the disease themselves, reinforcing social conformity (Chang et al., 2011).

Cross-cultural evidence further reinforces the impact of conformity on reduced disease transmission. Due to climate conditions, Asian countries tend to have a higher prevalence of disease compared to Europe or the Americas (Fincher et al., 2008; Murray & Schaller, 2010). Correspondingly, cross-cultural studies find that Asian people appear to conform more than other cultures (Bond & Smith, 1996). Isolated outbreaks further corroborate this trend. During the swine flu outbreak, Asian people reacted faster than those in Western countries, despite fatality being higher in North America (Hamamura & Park, 2010). This reinforces that perceived threat alone can trigger widespread conformist behaviours, and these can lead to dramatic cross-cultural differences in reactions to disease threat.

Sexual behaviours and attitudes

Of the numerous social behaviours, sexual behaviours are theoretically among the riskiest in terms of disease spread. First, interpersonal interactions, without sexual contact, already elevates the risk of exchanging of disease-causing respiratory droplets (e.g., talking to a colleague at work). This is exacerbated in sexual behaviours that involve direct transmission of respiratory droplets (i.e., kissing). Added disease risk during sexual intercourse comes from skin-to-skin contact, which is primarily how sexually transmitted infections (STIs) are spread (Hlay et al., 2022). Each new sexual partner then represents a new high-risk interpersonal interaction. In response, limiting sexual contact – especially with fewer sexual partners – can be an effective strategy to reduce potential contact with disease.

A series of correlational studies have reinforced connections between 19ensitivityy to disease, and disgust, with a reduced interest in sexual and romantic interactions. Higher perceived vulnerability to disease (PVD) scores were negatively predicted by openness towards casual sex (Duncan et al., 2009). Further research enhanced this effect, reiterating the negative association between PVD and short-term mating strategies, but expanding to find a positive association with longer-term mating (Murray et al., 2013). Notably, this study found that these effects were even stronger following a disease prime (Murray et al., 2013), reinforcing the enhancing impact of perceived disease threat among already germ avoidant people. Research on sexual disgust finds a similar association, where those with elevated sexual disgust reporting less interest in and openness towards casual sex (Al-Shawaf et al., 2015; O'Shea et al., 2019). Accordingly, modern dating and sexual interactions are influenced by individual differences in disease tolerance – for instance, Tinder users with more sensitivity to sexual disgust are less interested in using the app to facilitate hook-ups (Sevi, 2019; Sevi et al., 2018). Indeed, people who report higher PVD indicate less attraction towards dating partners generally (Sawada et al., 2018, Study 2), suggesting that the BIS is playing a notable role before explicit sexual interactions are apparent. Experimental research further compliments these findings. In a speed dating context, participants primed with disease were less interested in dating than those in the control, even when their partner was highly attractive (Sawada et al., 2018, Study 3). Moreover, when participants were exposed to an unpleasant smell, they reported more intention to use condoms in future sexual interactions, as a means to reduce potential exposure to STIs (Tybur et al., 2011).

The Behavioural Immune System during the time of COVID-19

These are just some instances of social behaviours that are altered by the threat of disease, among others. Much of the BIS theory is predicated on compelling experimental research, predominantly aided by behavioural defences being activated by perceived – not

actual – threat, allowing for genuine behavioural defences to be examined without legitimate risk (Schaller et al., 2022). However, there is limited research on activation of behavioural defences in the context of actual disease spread, due to the way in which modern developments have allowed for disease spread to be contained relatively quickly. Of the limited evidence available, it does appear that BIS-related behaviours are observed in times of outbreaks – for instance, during the 2014 Ebola outbreak, higher prejudice was exhibited by Americans who believed they were more vulnerable to Ebola (Kim et al., 2016). The global extent of the COVID-19 pandemic, coupled with the absence of effective treatment or vaccination for many months, presents the first opportunity to expand this research to a more naturalistic setting. The global relevance allows researchers to delve deeper into the influence of disease threat on social behaviours, considering that COVID-19 had a widespread and uncontrolled spread for a significant amount of time.

Certain emergent behaviours in the COVID-19 pandemic appear to relate to pre-existing evidence of behavioural defences. In April 2020, the Asian Australian Alliance reported nearly 400 incidences of anti-Asian racism in a two-week period, 40% of which were in a public setting (Zhou, 2020). One early study also found that anti-Asian discrimination was experienced more frequently by Asian participants wearing masks (Rzymski & Nowicki, 2020) – masks may attenuate behavioural defences, given their disease-related connotations, subsequently increasing prejudice. Early examination of Google Trends also data found that, as COVID-19-related searches increased, so did searches for anti-Chinese slurs (Vachuska, 2020). Notably, this same study found a corresponding increase in anti-Hispanic slurs (Vachuska, 2020), which aligns with BIS-related research on outgroup tensions amplifying during times of increased disease spread, regardless of the specific outgroup.

The panic buying behaviours observed during the pandemic also indicate disease-related behavioural activation. Unlike panic buying historically, toilet paper was among the most common products to be bought in the COVID-19 pandemic, which reoccurred in latter periods with more COVID-19 spread (Taylor, 2021). In a wider context, this behaviour is peculiar given that toilet paper did not minimise threat of COVID-19, but it was likely initially motivated by politicians and medical professionals encouraging stocking up of supplies in preparation for longer-term lockdowns (Taylor, 2021). Exacerbating this problem is likely the effect of conforming behaviour during disease-spread (Taylor, 2021), part of which is heavily influenced by mirroring the behaviours of those in their immediate vicinity (Wu & Chang, 2012). In line with this, early evidence indicates that those who are more prone to disgust displayed more panic buying of toilet paper (Taylor, 2021).

Sexual behaviours were also severely impacted as COVID-19 spread, and lockdowns began, which garnered significant media attention. The sales of sex toys increased by 300% in the US (Ghilarducci, 2022), dating apps like Tinder reported their highest usage ever in 2020 (Jamal, 2021), and pornography websites reported receiving large rises in corresponding regions that had entered lockdown (Pornhub Insights, 2020). Promotion of digital sexual activities were further supported by government recommendations. For instance, New York City released a memo encouraging use of sex toys and solo play (Frishberg & Hauswirth, 2020), and, in Australia, the New South Wales government went as far as to recommend mask wearing in all hook up scenarios (Christmass, 2021).

Other sources, however, were highlighting the negative impacts on sex and relationships. Divorce rates spiked in Wuhan in March 2020 (Prasso, 2020), a trend that was observed in other regions as they went into lockdown (Hoehn-Velasco et al., 2023). Durex reported a significant decline in condom sales in almost every market in March 2020, indicative of people being less concerned about STI transmission, and/or engaged in less

interactive sex generally (BBC, 2020). In the domains of prejudice and conformity, the link to BIS-related defences seemed apparent based on emergent trends. Sex-related behaviours, however, were broader and more far-reaching, displaying positive adaptive changes in some areas but negative adaptations in others. For instance, early empirical evidence found declines, not increases, in pornography use (Nelson et al., 2020). Further, these changes were less clearly connected to disease prevalence, and may have been related to other pandemic-induced factors instead, such as the influence of lockdowns. As such, the study into the nature of sexual behaviours and attitudes, and their connection to disease threat, needs examination in the context of the COVID-19 pandemic.

The Present Thesis

The primary research aim of this thesis was to investigate potential changes in sexual behaviours during the COVID-19 pandemic. When this research was conceived in March 2020, there were no formal publications addressing any social behaviours in the pandemic, let alone sex-specific ones. Thus, the BIS framework laid the foundational scaffolding for this thesis. However, it also became imperative to consider novel factors, such as the ramifications of lockdowns, which were already speculated to have lasting imprints on behaviours. As a result, behavioural alterations discussed in this thesis are evaluated with both disease threat and other pandemic-related parameters in mind. Further, it is well established that the impact of disease threat on specific behaviours can vary substantially across cultures (e.g., Schaller & Murray, 2008). Similar patterns were mirrored during the pandemic, where media reports indicated differences in reactions to the spread of COVID-19 across nations – for instance, the stark difference in mask uptake in South-East Asia compared to the US, as discussed above. To account for these potential cross-cultural variations in behavioural modifications, data was collected from 18 different countries as part of this thesis.

The structure of this thesis is as follows: First, Chapter 2 delves into the research's methodological design, detailing survey development and the process of the international data collection. The following two chapters then explore the dynamics of one protective sexual health behaviour – condom use during the pandemic – initially examining changes to condom use in Australia in the immediate aftermath of lockdown conditions (Chapter 3), before extending this same examination to a wider international sample (Chapter 4). The focus then broadens to investigate changes in a wider range of general sexual behaviours (i.e., frequency of intercourse, sexting, pornography use, and masturbation behaviours) across different cultural settings (Chapter 5). Finally, Chapter 6 reflects on implications drawn from the preceding chapters, highlighting areas for future research while considering the juxtaposing influences of disease threat and other pandemic-related factors.

CHAPTER 2: Methodological design

Recruitment of international collaborators

Ethics approval for this study was granted by the Human Research Ethics Committee at The University of Sydney in May 2020 (see Appendix A). Part of this ethics approval included collecting data internationally. Contact of potential international collaborators subsequently began at this time, concurrently with data collection in Sydney, Australia. The initial goal of this international data collection was to enlist at least one collaborating researcher per continent. The supervisory team initiated the first wave of recruitment by reaching out to academic colleagues. These prospective collaborators were asked to collect a minimum 200 participants, with the incentive of co-authorship on two academic papers (i.e., Chapters 4 and 5 of this thesis). Collaborators were also given the opportunity to lead additional publications and invite any other colleagues who may be interested. This preliminary outreach yielded two teams of researchers agreeing to collaborate – one in the United Kingdom and another in Louisiana, USA.

Subsequent recruitment efforts involved querying databases, such as Google Scholar, to identify scholars with a publication record that intersected with the themes or measures of the survey. A total of 128 researchers across 58 countries were contacted, leading to 38 researchers from 23 different regions initiating data collection. In this initial contact, collaborators were also asked to back translate the survey if their institution taught in any language other than English (see Appendix B). As such, the survey was translated into Portuguese, Spanish (European and Latin American dialects), Slovak, Serbian, Croatian, Chinese, Thai, Vietnamese, Hungarian, and Lithuanian, for the respective countries.

While some collaborators fell short of the target sample size, they still contributed substantially (i.e., over 100 participants). Therefore, they retained their co-authorship, although the data from their specific regions were not included in the final analysis (i.e.,

Japan, Singapore, Iran, India, and Melbourne, Australia). Ultimately, data from 18 countries, including Australia, constituted the final dataset. A comprehensive list of collaborating countries, co-authors, and associated data collection timelines can be found in Chapters 4 and 5.

Participants.

A full breakdown of the entire sample is presented as part of Chapter 5. As such, it is not discussed here to avoid repetition of this information.

Materials

As mentioned in Chapter 1, the primary aim of this thesis was to examine changes in sexual behaviours, and the extent to which this was related to disease threat versus other factors. However, the present survey was also intended to inform future research and projects beyond this thesis. Consequently, while the complete survey is provided below, not all variables are elaborated upon, as they fall outside the thematic focus of this thesis. Variables pertinent to this thesis, and their reliability and validity, are specifically addressed and included in their respective chapters.

Demographics

General demographics. All participants provided their age, birth sex, gender identity, political orientation, religious orientation, level of religiosity, sexual attraction (on a Kinsey scale; Kinsey et al., 1948), sexual orientation label (e.g., straight), and relationship status.

COVID-19 demographics. All participants provided a series of COVID-19-related details that was particularly relevant in early 2020. This included whether they had personally been diagnosed with COVID-19, whether they knew someone else diagnosed with COVID-19, if they lived with an at-risk person (e.g., elderly/immunocompromised), the extent to

which they were social distancing, how often they left the house, their current work status, and current living arrangements.

Relationship demographics. Participants who were in a relationship were asked a series of questions about their relationship – the type and length of their current relationship, how many (if any) children they had, the number of rooms in their house, if anyone beside their partner lived with them (e.g., in-laws), how motivated they were to maintain their current relationship, and whether they had to self-isolate from their partner. Participants who indicated they were in a non-monogamous relationship were instructed to answer the survey about their primary partner only.

Changes in behaviour & attitudes during the pandemic

For each of the below measures, participants were asked each item twice – once regarding their behaviour "before COVID-19", and the second "during COVID-19". Both sets of items were displayed on the same page to allow participants to directly contrast their behaviours across time periods. Further, they were explicitly asked to answer identically across both items if they believed that the behaviour/attitude did not change.

Sex drive. Two items were used to measure libido (e.g., "I have a strong sex drive"; Lippa, 2009). Both items were rated on a 7-point Likert scale from 1 (*Disagree*) to 7 (*Agree*).

Motivations to have sex. We used a 6-factor scale to measure different motivations for having sex (Cooper et al., 1998). Participants were given a list of reasons they may have sex, and asked to rate how frequently this was a motivation in their own sex lives, on a 5-point scale from 1 (*Never/almost never*) to 5 (*Always/almost always*). The six motivational factors consisted of hedonism (e.g., "Feel horny"), intimacy (e.g., "Make emotional connection"), affirmation (e.g., "Feel better about myself"), coping (e.g., "Feel better when lonely"), insecurity (e.g., "Afraid partner will leave if don't have sex"), and peer influence (e.g., "Because friends are having sex").

Frequency of sexual behaviours. Nine items were used to measure the frequency of a range of sexual behaviours (Hogue et al., 2019) – specifically, kissing, caressing/touching, oral sex (giving to a partner), oral sex (receiving from a partner), giving manual stimulation (touching or massaging a partner's genitals), receiving manual stimulation (a partner touching or messaging your genitals), manual stimulation (masturbation; alone), sexual intercourse with vaginal penetration, and sexual intercourse with anal penetration. Each item was rated on a 7-point scale – 1 (*Never*), 2 (*Once or twice*), 3 (*Once a week*), 4 (*2-3 times a week*), 5 (*4-5 times a week*), 6 (*Once a day*), 7 (*More than once a day*).

Condom use. A single item was used to assess condom use, reading "How frequently do you engage in the following behaviours: Using a condom during penetrative sex?". It was rated on a 7-point Likert scale from 1 (*Never*) to 7 (*Very frequently/Almost always*).

Pornography engagement. Three items were used to assess pornography-related behaviours – specifically, how often they "watched pornography", "watched interactive pornography (e.g., camming websites)", and "made pornographic content". Each item was rated on a 7-point Likert scale from 1 (*Never*) to 7 (*Very frequently/Almost*).

Sexting behaviours. We included eight items from Parker et al. (2013) to measure frequency of sending and/or receiving sexually explicit messages and images. An example item includes "When texting a romantic or sexual partner, how often do you: Send/receive texts that insinuate sex or imply sex (double entendre)". Each item was rated on a 7-point Likert scale from 1 (*Never*) to 7 (*Very frequently/Almost always*).

Sexual coercion. Part of the Sexual Coercion in Intimate Relationships Scale was used to measure instances of sexual violence. For brevity, we only included the 13-item Resource Manipulation/Violence subscale (e.g., "My partner threatened violence against me if I did not have sex with them"). The original response scale specified how often these behaviours occurred in the past month, but we adapted this to be "an average month". As

such, all items were rated on a 6-point scale – 1 (*Act did not occur in an average month*), 2 (*Act occurred 1 time in an average month*), 3 (*Act occurred 2 times in an average month*), 4 (*Act occurred 3-5 times in an average month*), 5 (*Act occurred 6 to 10 times in an average month*), 6 (*Act occurred 11 or more times in an average month*).

Psychological wellbeing. Overall participant wellbeing was measured using the 5-item Satisfaction With Life scale (e.g., "In most ways, my life is close to ideal"; Diener et al., 1985). Each item was rated on a 7-point Likert-scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Psychological illbeing. The 21-item version of the Depression, Anxiety, Stress Scale (DASS; Lovibond & Lovibond, 1995) was used to measure mental health outcomes. Sample items include "I couldn't seem to experience any positive feelings at all" for the Depression subscale, "I felt I was close to panic" for Anxiety, and "I found it difficult to relax" for Stress. Each item was rated on a 4-point scale – 1 (*Never*), 2 (*Sometimes*), 3 (*Often*), 4 (*Almost always*).

Loneliness. The 15-item Social and Emotional Loneliness Scale for Adults (SALSA; DiTommaso & Spinner, 1993) was used to measure three aspects of loneliness: romantic (e.g., "I have an unmet need for a romantic partner"), familial (e.g., "I feel alone when I'm with my family"), and social loneliness (e.g., "I don't have a friend(s) who shares my views, but I wish I did"). Each item was rated on a 7-point Likert scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Boredom. A boredom scale (Fahlman et al., 2013) was used to measure two subscales: disengagement (9 items; e.g., "I wish I was doing something more exciting") and time perception (2 items; e.g., "Time is moving very slowly"). Each item was rated on a 7-point Likert scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Relationship satisfaction. The 4-item relationship satisfaction scale (Murray et al., 1996) was used to assess participant satisfaction in their current relationship (e.g., "I am extremely happy with my current romantic relationship"). Accordingly, only participants who self-identified being in a relationship were presented with these items. All items were rated on a 9-point scale ranging from 1 (*Not at all true*) to 9 (*Completely true*).

Sexual satisfaction in relationships. A 5-item measure was used to assess how sexually satisfied participants were in their current relationship. The overall instructions were "How would you describe your overall sexual relationship with your partner?", followed by 5 responses scales with different anchors. Specifically, these response scales were: 1 (*Very bad*) to 7 (*Very good*); 1 (*Very unpleasant*) to 7 (*Very pleasant*); 1 (*Very negative*) to 7 (*Very positive*); 1 (*Very unsatisfying*) to 7 (*Very satisfying*); 1 (*Very worthless*) to 7 (*Very valuable*). As above, these items were only asked of participants currently in a relationship.

Dating behaviours. A series of 11 items were used to assess a range of dating-related behaviours, which were developed by the supervisory team. Specifically, they were asked about general desire to date; how frequently they were dating generally; whether their dating partners were strangers, acquaintances, or ex-partners; how often their dates were in-person, and virtual; how frequently they were using dating apps and websites; and how often they were sending and receiving messages with a romantic/sexual-connotation. Each item was asked on a 7-point Likert scale from 1 (*Never*) to 7 (*Very frequently/Almost always*). These items were only displayed to participants who self-identified as single.

Trait-like measures

At conceptualisation, it was expected that some measures would be more trait-like – i.e., they were less likely to change across the course of the pandemic. As such, unlike the above measures, these items were only asked once.

Sociosexuality. Sociosexuality was assessed using the Sociosexuality Orientation Inventory Revised (SOI-R; Penke & Asendorpf, 2008). This measure comprises of three subscales (behaviour, attitudes, and desire) each with three items. The behavioural subscale assessed previous sexual behaviours (e.g., "With how many different have you had sex with in the past 12 months?") rated on a scale of 1 (*0 partners*) to 9 (*20 or more partners*). The attitudinal subscale measured attitudes towards non-committal sexual relationships (e.g., "Sex without love is OK") rated on a 7-point Likert scale (1 = *Strongly disagree*, 7 = *Strongly agree*). The desire subscale assessed fantasies about casual sex (e.g., "In everyday life, how often do you have spontaneous fantasies about having sex with someone you just met?") on a Likert-like scale consisting of 1 (*Never*), 2 (*Very seldom*), 3 (*About once every two or three months*), 4 (*About once a month*), 5 (*About once every 2 weeks*), 6 (*About once a week*), 7 (*Several times a week*), 8 (*Nearly every day*), 9 (*At least once a day*).

Big-5 Personality factors. The Ten Item Personality Inventory (TIPI: Gosling et al., 2003) was used to measure the Big-5 personality factors. Participants were presented with 10 items, each comprising a pair of traits. They were asked the extent to which each pair applied to them personally, for each of the five personality factors – i.e., extraversion (e.g., "Extraverted, enthusiastic"), agreeableness (e.g., "Sympathetic, warm"), conscientiousness (e.g., "Dependable, self-disciplined"), emotional stability (e.g., "Calm, emotionally stable"), and openness to experience (e.g., "Open to new experiences, complex"). Each personality factor comprised of two items, rated on 7-point Likert scale from 1 (*Disagree strongly*) to 7 (*Agree strongly*).

Dark Triad. The 12-item Dark Triad Dirty Dozen (Jonason & Webster, 2010) was used to measure each of the Dark Triad personality traits – psychopathy (e.g., "I tend to lack remorse"), narcissism (e.g., "I tend to be cynical"), and Machiavellianism (e.g., "I have used

deceit or lied to get my way"). Each item was rated on a 5-point Likert-like scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*).

Perceived vulnerability to disease. The 15-item Perceived Vulnerability to Disease Questionnaire (Duncan et al., 2009) was used to measure concerns about spread of novel pathogens, comprising two subscales: germ aversion (e.g., "It does not make me anxious to be around sick people") and perceived infectability (e.g., "I am more likely than the people around me to catch an infectious disease"). To measure concerns about COVID-19 spread specifically, we added an adapted version an existing item to be COVID-19-related (i.e., "I am more likely than the people around me to catch COVID-19"). Each item was rated on a 7-point Likert-scale from 1 (*Disagree strongly*) to 7 (*Agree strongly*).

Adult attachment orientation. The 29-item Adult Attachment Style Questionnaire (Karantzas et al., 2010) measured avoidant and anxious attachment styles. A sample item for Avoidance included "I prefer to depend on myself rather than other people", and "I often worry that I do not fit in with other people" for Anxious. Each item was rated on a 6-point Likert-like scale from 1 (*Strongly disagree*) to 6 (*Strongly agree*).

Procedure

An online survey was disseminated to researchers across the targeted regions. All participants, irrespective of their country, received a consistent Participant Information Statement. The only modification of this statement was the inclusion of contact details for respective local academics. At the outset, participants were forewarned about the sexual coercion items, and that there was an option to bypass these questions. First, all participants were asked general and COVID-19-related demographic questions, then participants in a relationship were asked relationship-related demographics. Then, all participants were presented with the trait-like measures. After this, participants were instructed to answer the remaining questions both 'before COVID-19' and 'during COVID-19'. All participants then

responded to the sex-related behaviour questions, followed by the mental health items, the boredom, and loneliness measures. Participants in a current relationship then responded to the relationship-only items, while single participants responded to the dating-related questions. Finally, participants were informed that the final questions related to sexual coercion, alongside relevant counselling services in their relevant region should they become distressed. Only participants who opted to view these items were presented with them; others skipped to the survey's conclusion. All participants were finally debriefed. In total, the survey took about 30 minutes to complete.

CHAPTER 3: Condom Use During COVID-19: Findings from an Australian Sample of Young Adults

This chapter was published in *Sexologies*:

Dacosta, L., Pinkus, R. T., Morandini, J., & Dar-Nimrod, I. (2021). Condom use during COVID-19: Findings from an Australian sample of heterosexual young adults. *Sexologies, 30*(1), e43-e48.

At the time of submission, the manuscript was cited 24 times (Google Scholar).

Introduction

Condoms are a vital and effective health tool in combating the spread of sexually transmitted infections (STIs). Condoms are widely available and can functionally prevent the spread of STIs when used correctly (Holmes et al., 2004). Despite this, cases of STIs continue to proliferate. Globally, approximately half a billion new STI cases are reported every year (WHO, 2019). In Australia, cases of gonorrhoea and syphilis have tripled and doubled, respectively, over the past decade (Kirby Institute, 2018). Chlamydia has also become the most prevalent infectious disease in Australia, due, in part, to asymptomatic spread among young adults (NSW Health, 2019). It seems then that condoms, despite their effectiveness and availability, are not used adequately enough to stem the rise of STI cases.

Motivating factors of condom use and non-use are subjects of much empirical research. Alcohol (Leigh, 2002) and substance use (Poulin & Graham, 2001), sensation seeking (Aicken et al., 2011), increased amounts of casual sex and sexual partners (Parkes et al., 2007), poorer sex education (Milhausen et al., 2013), and perceptions of condoms impeding pleasure (Braun, 2013; Farrington et al., 2016) are recurring risk factors that predict lower condom use. The less studied protective factors predictive of condom use include higher self-esteem (Miller et al., 2000), tertiary education aspirations (Peterson & Huebner, 2003), parental support (Baumer, 2001), and decision-making skills (Tevendale et al., 2009). In line with the cohort that show the largest increases in STI infections, much of this research centres on young adults, whose newly emerging sexual and romantic experiences inform their future condom use.

The age group of young people (15–24-year-olds) accounts for half of total STIs reported annually (Wolfers et al., 2011), yet only 41% of young people report regular condom use (WHO, 2019). Whereas condoms provide a dual protection against STIs and unwanted pregnancy, young adults report greater concern for unwanted pregnancies than

STIs (Milhausen et al., 2013). Accordingly, an overreliance on hormonal contraception is apparent among young people (O'Sullivan et al., 2010). Alarmingly, younger people frequently report low accuracy about STI knowledge (Carrotte et al., 2016; Milhausen et al., 2013), and unfounded optimistic bias, wherein they perceive themselves as relatively invulnerable to STIs (Pollack et al., 2013; Wolfers et al., 2011). Poorer STI knowledge, the presence of optimistic bias, and a preference for hormonal contraception subsequently predicts reduced condom use overall (Pollack et al., 2013), in turn, facilitating the disproportionate spread of STIs in this age group.

The above mentioned literature suggests that young people's reduced condom use is, at least partially, rooted in discounting the threat of STIs. But perceived threat from diseases in general may have increased with the rapid spread of COVID-19 and its related media focus. The Behavioural Immune System (BIS) theory argues that humans have acquired behavioural defences (e.g., avoiding people who display pathogen-cues, such as sneezing or coughing) against infection through evolutionary processes, and these behaviours are activated when people reflect on perceived illnesses (e.g., Schaller, 2011, 2015). Importantly, these defensive, pathogen-avoidant behaviours have been induced experimentally by priming the concept of disease using cognitive-based instructions (e.g., Murray & Schaller, 2016; Schaller et al., 2015). The research evidence suggests that exposure to the disease concept by itself can lead to cascading defensive behaviours through the activation of the BIS. COVID-19 is currently an omnipresent disease-concept reminder and a clear, natural chronic disease-construct prime. As such, COVID-19 is likely to increase reflections on disease, in turn increasing the likelihood of BIS activation. But would such activation affect condom use?

There is very limited research on condom use as a behavioural response to reflections on diseases. A single study found that when presented with a pathogen prime in a laboratory setting, participants self-reported an increased intention to use condoms (Tyber et al., 2011).

Based on that study, one may predict that, as COVID-19 has likely been priming pathogen threat to many people, one should find an increase in the use of condoms during the pandemic.

A potential detriment to condom use, in contrast, is the higher frequency of health messaging guidelines broadcast during the pandemic. Emerging research suggests that monotonous and repetitive health messaging can lead to fatigue (So et al., 2017). In turn, recipients' attitudes towards the target behaviour becomes increasingly unfavourable and avoidance of the message increases (Dillard & Shen, 2005; Kim & So, 2018; Rains & Turner, 2007). Ultimately, fatigued recipients are at risk of forgoing the advice of these health campaigns. Condom use has already been identified as one health guideline negatively impacted by message fatigue (Frew et al., 2013; So et al., 2017). The introduction of additional health guidelines likely risks accelerating fatigue. Indeed, safe sex campaigns in Australia have incorporated social distancing guidelines (NSW Health, 2020) and existing research has cautioned against multi-message campaigns as they seemingly accelerate fatigue (So et al., 2017). Avoiding or forgoing these health guidelines has a cascade of health risks, facilitating both unprotected sex *and* ignoring social distancing, risking exposure to both STIs *and* COVID-19. Therefore, on one hand, COVID-19 may pose a significant health threat to individuals, thereby increasing condom use. On the other hand, the bombardment of health guidelines may inadvertently diminish condom use.

As such, the present study sought to uncover any changes in condom use during a COVID-19-related lockdown. To assess support for the competing predictions of the BIS theory versus message fatigue, exploratory analyses were conducted on changes in condom use before and during the outbreak of COVID-19. It was also expected that perceived vulnerability to COVID-19 would be positively associated with any observed changes in

condom use – that is, an increase in condom use would be associated with vulnerability to COVID-19, while a decrease would correlate with invulnerability to COVID-19.

Method

Participants

Participants were recruited from an Australian university psychology participation pool. In total, 269 participants completed the study, but 97 were removed after reporting no instances of sexual contact over the past 12 months, leaving 172 participants (116 female) for the final analyses. Age ranged from 17 to 34 years (M = 20.12; SD = 2.60).

In terms of relationship status, 39.0% reported being single, 59.3% in a relationship, and 1.7% married. Of those in a relationship, 11.5% reported living with their partner. Participants were also asked for their current sexual orientation identity label – 87.2% identified as straight, 5.8% as bisexual, 2.9% as gay/lesbian, 2.9% as queer, 0.6% as pansexual, and 0.6% as demisexual.

All participants completed the survey in late May to early June, 2020, in New South Wales, Australia. Data collection took place following a couple of months of heavy media focus on COVID-19; at the time, few restrictions had been lifted – cafés, restaurants and shops were re-opened and up to 10 people were allowed in one premises at a time, but working from home and social distancing were still strongly encouraged.

Materials

Demographics. Participants indicated their age, sexual orientation identity, and relationship status.

Perceived vulnerability to COVID-19. A single-item capturing perceived threat from COVID-19 was adapted from the Perceived Vulnerability to Disease Scale (Duncan et al., 2009) to be COVID-19-specific (i.e., “I am more likely than the people around me to

catch COVID-19"). This item was rated on a 7-point Likert scale from 1 (*Disagree strongly*) to 7 (*Agree strongly*).

Condom use. A single item assessing the use of condoms 'before COVID-19' and 'during COVID-19' was included. In both instances, the item read "How frequently do you engage in the following behaviours: Using a condom during penetrative sex", rated on a 7-point Likert scale from 1 (*Never*) to 7 (*Very frequently/Almost always*).

Sexual frequency. Two items were used to ask about the frequency of penetrative intercourse, both 'before COVID-19' and 'during COVID-19'. The items read "How often did you and your partner engage in the following behaviours: Sexual intercourse with vaginal penetration" and "Sexual intercourse with anal penetration". Both items were rated on a 7-point Likert scale, specifically 1 (*Not at all*), 2 (*Once or twice*), 3 (*Once a week*), 4 (*2-3 times a week*), 5 (*4-5 times a week*), 6 (*Once a day*), 7 (*More than once a day*).

Procedure

Participants signed up to the study online and were given the link to the online survey. Condom use questions were part of a larger survey assessing changes in sex, dating, and relationship behaviours during COVID-19-related lockdown conditions. The condom use question was asked twice on the same page. Participants were informed that the first instance of the question was about their condom use before COVID-19, and the second was during COVID-19 (i.e., at the time of completing the survey). They were asked to respond identically across both questions if the behaviour had not changed. The survey took approximately 30 minutes to complete. Participants were awarded course credit upon completion.

Analysis strategy

An analysis of covariance (ANCOVA) was used to test the main hypotheses relating to potential changes in condom use after the onset of COVID-19. The assumptions of the

ANCOVA were met, and there were no outliers. A Pearson correlation was also used to test the hypothesis of pathogen threat being related to changes in condom use.

Results

Changes in condom use

A mixed method 2 (relationship status (between participants): single versus coupled) × 2 (condom use (within-participants): before COVID-19 versus during COVID-19) ANCOVA was used to assess changes in condom use. To account for frequency of penetrative intercourse, vaginal and anal intercourse items were added together to create a composite variable for penetrative intercourse both 'before COVID-19' and 'during COVID-19'. A difference score of sexual frequency was then calculated from these new composite variables, such that negative scores indicated an increase in sexual frequency and positive scores indicated a decrease. Participants reported a general decline in the frequency of penetrative sex, $t(170) = 5.107$, $p < .001$. This change in sexual frequency score was included as a covariate.

This analysis revealed a general decline in condom use, $F(1, 167) = 35.384$, $\eta_p^2 = .175$, $p < .001$. Prior to COVID-19, single ($M = 4.88$; $SD = 2.40$) and coupled ($M = 3.89$; $SD = 2.56$) participants already displayed middling condom use. During COVID-19, both single ($M = 3.49$; $SD = 2.76$) and coupled ($M = 3.47$; $SD = 2.67$) individuals reported reduced condom use. Between-subjects analyses revealed no significant differences between single and coupled participants' condom use, $F(1, 167) = 1.257$, $\eta_p^2 = .007$, $p = .264$.

There was a significant interaction between relationship status and changes in condom use, $F(1, 235) = 7.147$, $\eta_p^2 = .030$, $p = .008$. As Figure 1 shows, simple effect analyses used to probe the interaction found that, although both single and coupled participants reported a decline in condom use, the strength of this effect was greater among single people, $F(1, 67) = 44.766$, $\eta_p^2 = .211$, $p < .001$, than coupled, $F(1, 101) = 6.627$, $\eta_p^2 = .038$, $p = .011$.

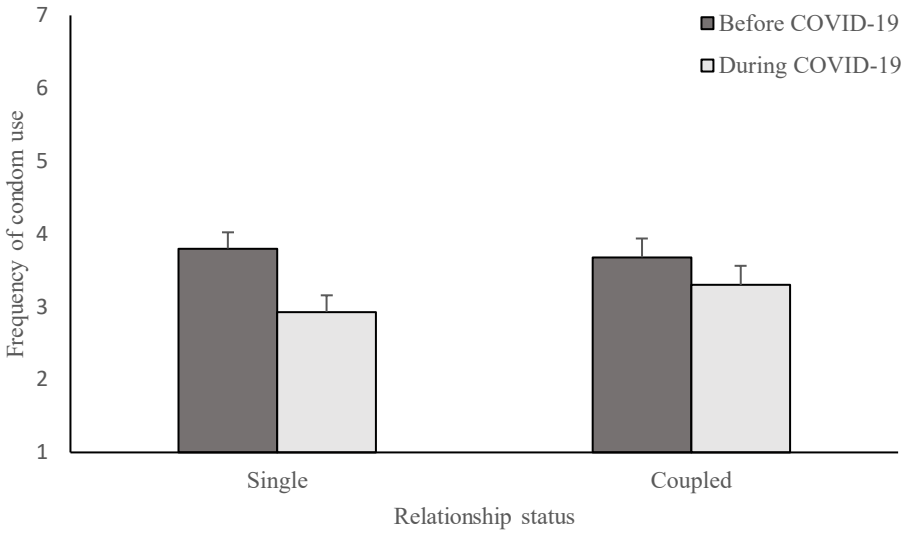

Figure 3.1. Mean condom use 'before COVID-19', and 'during COVID-19', for both single and coupled participants.

Perceived vulnerability to COVID-19 and condom use

For the correlational analysis, a difference score was calculated between condom use before and during COVID-19 for each participant, such that negative scores indicated an increase in condom use and positive scores indicated a decrease. Intercorrelations between variables and descriptive statistics are reported in Table 1. Contrary to expectations, changes in condom use were not significantly related to perceived vulnerability to COVID-19 (r = -.06, p = .421).

Table 3.1. *Correlations and descriptives of key variables*.

	M (SD)	1.	2.	3.	4.	5.
1. Perceived invulnerability to COVID-19[a]	2.52 (1.46)	-				
2. Condom use before COVID-19[b]	4.30 (2.53)	-0.12	-			
3. Condom use during COVID-19[b]	3.48 (2.69)	-0.07	0.78**	-		
4. Penetrative intercourse before COVID-19[c]	4.64 (1.97)	-0.03	-0.19*	-0.02	-	
5. Penetrative intercourse during COVID-19[c]	3.99 (2.19)	-0.07	-0.30**	-0.10	0.69**	-

* $p < .05$; ** $p < .001$

[a] 1: Disagree strongly, 7: Agree strongly.

[b] 1: Never, 7: Very frequently/Almost always.

[c] Means are representative of the composite score with vaginal and anal intercourse items added together, with possible scores ranging from 2 to 14. Original item anchors were 1: Not at all, 2: Once or twice, 3: Once a week, 4: 2-3 times a week, 5: 4-5 times a week, 6: Once a day, 7: More than once a day

Discussion

The main objective of the present study was to investigate potential changes in condom use during the COVID-19 pandemic. Analyses revealed that condom use declined after the outbreak of COVID-19, and that this decline was more pronounced among single people than coupled. A secondary aim was to examine whether such changes in condom use were related to perceived threat from COVID-19. Unexpectedly, there was no indication that the decline in condom use was associated with perceived vulnerability to contracting COVID-19.

The burden of additional health guidelines was speculated to impede condom use, and the observed results are in line with this notion. Fatigue had been negatively associated with safe sex campaigns previously (Frew et al., 2013; So et al., 2017). Emerging research has identified similar quarantine-related fatigue that diminishes the stringency of following distancing guidelines (Zhao et al., 2020). Young adults, who were already using condoms irregularly, may have been overloaded by new sources of health-messaging fatigue and subsequently reduced their condom use even further. Indeed, quarantine-related fatigue is a distinct concern as the disregard of health advice that precedes fatigue would be necessary for any sexual contact for much of the present sample (who were largely either single or in a relationship with a non-cohabiting partner). Such sexual contact necessitates tolerance of risk, and this tolerance may then extend to unprotected sex. When combining this line of reasoning with previous knowledge of inconsistent condom use in young adults (Milhausen et al., 2013), *and* condom use messaging being at risk of producing counterproductive effects (Frew et al., 2013), it offers an explanation for the current findings of condom use reduction during the pandemic. Further inquiries into quarantine-related fatigue and its associated risks may strengthen this explanation. It may also potentially reveal other at-risk behaviours that have worsened – or emerged – during lockdown conditions.

A second analysis tested the prediction that an increase in condom use is positively associated with perceived vulnerability to COVID-19; this was not supported. Instead, changes in condom use had no significant relationship with perceived vulnerability to COVID-19. Young adults tend to underestimate threats from disease generally (Lapsley & Hill, 2010), and STIs specifically, even with unfamiliar sexual partners (Pollack et al., 2013; Wolfers et al., 2011). Combined with young adults reporting more concern about unwanted pregnancy than STIs (O'Sullivan et al., 2010), it appears that the threat of COVID-19 is not much of a factor in the decision to use a condom for young adults. Indeed, this may widely apply to young people's behaviour during the pandemic. The WHO (2020) has attributed new clusters of the virus in many countries to young adults who are undisturbed by the threat of COVID-19 and continue to behave as normal. As such, COVID-19 may not pose an adequate threat to young people, due, in part, to their general sense of invulnerability or the nature of the virus itself. Future research involving vulnerable populations, for whom infections are more of a threat, may uncover different associations.

Analyses also revealed that single people, compared to those in a relationship, reported a sharper decline in condom use. Such a result is concerning when single people are likely having sexual contact with less well-known partners and might subsequently continue the trend of increasing STI rates (WHO, 2019), even during the pandemic. Indeed, much of the invulnerability literature notes that optimistic bias in young adults facilitates risk-taking behaviours (Lapsley & Hill, 2010; Ravert et al., 2009). Thus, for single people in this sample, a general sense of invulnerability is an important facilitator, as they are risking contact with an unfamiliar partner who may not be aware of (or accurately disclose) their COVID-19 status. If they can tolerate this higher degree of risk, it is then plausible they would be tolerant of the increased risk of STIs that arise from unprotected sex. Coupled people, in comparison, can safely discuss condom and other contraception use with their partner, with far less

involved risk. Those in a relationship may have weighed the consequences with their partner and made an informed decision to use condoms less – indeed, this is a common trajectory for young adults in newer relationships (El Bcheraoui et al., 2013). In that case, social isolation guidelines may have facilitated an acceleration of that process as the individuals in the relationship may have been driven closer by reduced social contacts with other individuals in line with medical messaging. Future studies are needed to probe those potential explanations.

Limitations & implications

One limitation of the present study was its use of self-reported recall of condom use prior to the outbreak of COVID-19; however, there is evidence that one can accurately recall their condom use for up to three months (as in the current situation; Noar et al., 2006). Despite this, pre- and post-COVID-19 data collection of condom use is the most reliable measure of any changes; research that had collected such data prior to the outbreak would be highly valuable. Second, while informative as a starting point, the present study used a single-item measure of perceived vulnerability to COVID-19. Future research should focus on developing a psychometrically-valid measure of perceived vulnerability to COVID-19.

The results of the present study also indicate a potential dual spread of infections – COVID-19 *and* STIs. STIs were already proliferating before the outbreak, and the present findings of diminished condom use, despite continued sexual contact, imply that their risk of spread has not changed during the pandemic (Lindberg et al., 2020). However, STI testing clinics in Australia have reported a substantial decline in STI tests, attributed to COVID-19-related lockdown (Tregenza, 2020). Indeed, as STIs were previously increasing annually and condom use may have declined among young adults during the lockdown, it is possible that there may be an undetected spike in STI cases due to reduced testing – particularly when many people with STIs report no symptoms (Farley et al., 2003). These speculations may all be addressed with epidemiological data collected in the near future.

Sexual and romantic relationships, already tumultuous for young adults in non-pandemic conditions, have become even more complex to navigate during a pandemic that emphasises social distancing. Young adults are still forming connections with one another during the pandemic, but their sexual health may have been silently and negatively impacted. Results of the present study suggest that sexual health awareness may have taken a hit during the pandemic. Neglecting condom use among young adults has potential implications that extend beyond COVID-19, ranging from long-term health effects to unplanned pregnancies. Novel and engaging safe sex campaigns, which take message fatigue into account, are therefore clearly needed during the pandemic to protect young adults' sexual health.

CHAPTER 4: University students' condom use during the COVID-19 pandemic: Cross-cultural differences and what predict them

This chapter is currently under review at the Journal of Cross-Cultural Psychology. Full authorship details are provided below.

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Introduction

The continued proliferation of sexually transmitted infections (STIs) remains a global concern. The World Health Organisation (WHO; WHO, 2022) estimates that one million STIs are newly acquired each day. A significant amount of new cases are attributed to asymptomatic spread (Mayaud & Mabey, 2004). Consistent condom use is subsequently highly recommended by the WHO (2022), as condoms are the most effective tool for preventing STIs when used correctly (Holmes et al., 2004). Despite decades of messaging about the benefits of condom use (Frew et al., 2013), STI infection rates have increased over the past decade, suggesting condoms are not used adequately or frequently enough.

Young people – those in late adolescence to early twenties – are of a primary concern, as the rise in STIs is most pronounced in this age group (Shannon & Klausner, 2018). Condom use is highly inconsistent among young people (WHO, 2022), leading to this age group accounting for half of total STIs annually (Wolfers et al., 2011). Condoms have the benefit of warding against both STIs and unwanted pregnancies; however, young people are more concerned about pregnancy than STIs (Milhausen et al., 2013), and they have a strong preference for hormonal contraception, rather than barrier methods of contraception (e.g., condoms: O'Sullivan et al., 2010). Young people's poor knowledge of STIs (Carrotte et al., 2016; Milhausen et al., 2013) and sense of invulnerability to STIs (Pollack et al., 2013; Wolfers et al., 2011) allow them to underestimate the harmful impact of STIs, promoting condomless sex. Indeed, young people are so unconcerned with STIs that they often delay seeking treatment even when aware of possible exposure (Malek et al., 2013). With these factors in mind, it is unsurprising that, in practice, only 41.5% of young women and 26.7% of young men report always using a condom during casual sex (Copen, 2017). Such a pattern is concerning when young people tend to have more sexual partners during this period of their

life (Westerman et al., 2021). Low condom use and more sexual partners then allows STIs to disproportionately spread among this age group.

The advent of the COVID-19 pandemic, and its related lockdowns particularly, has further complicated STI spread among young people. After the introduction of lockdown conditions, STI clinics observed a significant drop in daily patients (Ogunbodede et al., 2021; Tao et al., 2021). However, even months after lockdown conditions ended, global STI testing rates have not returned to pre-pandemic levels (Chow et al., 2021; Sentís et al., 2021). Despite these low STI rates, young people still engaged in penetrative sex with non-cohabiting partners, even when social distancing measures were in place (Ballester-Arnal et al., 2021; Gillespie et al., 2021; Herbenick et al., 2022). Given young people's already inconsistent condom use, and the increased difficulty of access to condoms during lockdowns (Herbenick et al., 2022; Lewis et al., 2021), the pandemic likely disrupted condom use further, propagating STI spread. Therefore, the current incidence of STIs is likely severely underreported.

Inconsistent condom use has been primarily attributed to young people disregarding the threat of STIs (Wolfers et al., 2011). However, the COVID-19 pandemic might have made pathogens more salient to young people, which may alter their perception of STIs and their condom use in unexpected directions. The Behavioural Immune System (BIS) theory posits that humans have evolutionarily acquired behavioural defences to novel diseases, which are activated when the presence of illness is especially salient (Schaller et al., 2015). Experimental evidence has demonstrated that people think and act differently when the threat of a novel infection is psychologically induced (e.g., by displaying disease-related behaviours, such as sneezing: Schaller, 2011; Schaller et al., 2015). Pathogen threat has generally been mitigated by the advancement of antibiotics and other easily accessible medical treatments (Schaller et al., 2022); young people’s blasé approach to condom use and

appropriate STI treatment (Nguyen, 2019) reflects their perception that the threat from STIs is minimal and/or manageable. Prior to the development of a vaccine, COVID-19 posed a threat without treatment or prevention, dramatically increasing the salience of pathogen threat, exacerbated by the high degree of media attention COVID-19 received (Bridgman et al., 2020). In turn, this higher pathogen threat may impact a range of disease preventative measures, including condom use. Indeed, one study has found people increase their intention to use condoms after being experimentally exposed to a pathogen prime (Tybur et al., 2011). If COVID-19 has had the expected impact on awareness of disease threat, attitudes towards condom use may have shifted in a more beneficial direction.

In line with this reasoning, an infodemiological study found the expected pattern across 102 countries – when there was a higher level of COVID-19 related concerns online (e.g., on social media) in a given week, condom-related Google searches significantly increased in comparison to the previous week (Ma & Ye, 2021). Research into actual sexual behaviours among men who have sex with men (MSM) also provided some support for the BIS. In Israel, MSM were more likely to use condoms after the spread of COVID-19 (Shilo & Mor, 2020). MSM in America also reported a decline in condomless anal sex during the pandemic (Starks et al., 2020). As such, there is some evidence of the expected increase in condom use following pathogenic threat from COVID-19, as posited by the BIS theory.

However, studies among heterosexual people specifically are not in line with MSM-related research, suggesting that heterosexual condom use has declined during the pandemic. A quantitative Australian study found a decline in condom use among young people in lockdown, and this decline was more marked among single people than coupled (Dacosta et al., 2021). A qualitative Australian study further supported this, wherein participants reported being more concerned about possible COVID-19 exposure than STI spread, resulting in irregular condom use (Okeke, 2022). Unpartnered college students in an American study also

reported a significant decline in condom use (although this was collated across sexual orientation groups, the sample was predominately heterosexual; Herbenick et al., 2022). A similar trend was observed in the United Kingdom, where a quarter of young people surveyed reported a significant decline in access and use of condoms during lockdown (Lewis et al., 2021). However, increases of condom use among MSM, and decreases among heterosexual people, are not consistent across all research – stable condom use has been found among American MSM (Sanchez et al., 2020) and young heterosexuals (Firkey et al., 2022). As it stands, there is not a clear pattern of condom use during the COVID-19 pandemic, even when limiting to a sole sexual orientation group. As such, the current studies seek to explore changes in condom use across time and countries among heterosexual populations to disentangle this conflicting research.

Factors associated with changes in condom use

By conducting research on condom use across countries, the present study also aims to explore potential cross-cultural factors that may contribute to changes in condom use. Historical prevalence of disease is an index of pathogen pervasiveness over the past eighty years (Murray & Schaller, 2010), which can be used to uncover how disease prevalence impacts different cultures. This index has been utilised to explain cross-cultural reactions to COVID-19 during the pandemic. One study found that this index can partly account for how different regions reacted to COVID-19 – regions with higher historical prevalence of disease predicted faster and tighter COVID-19 restrictions by governments, and predicted population adherence to these restrictions (Lu et al., 2021). Historical prevalence of disease has also been linked to sexual behaviours across regions – people in areas with a higher prevalence of disease have a higher preference for physically attractive partners (Gangestad & Buss, 1993), as people cognitively infer positive health outcomes from physical attractiveness (Gangestad et al., 2003). Given that this index has been linked to both the COVID-19 pandemic and sexual behaviours, it is possible that higher prevalence of disease be associated with an

increase in condom use. Specifically, people in regions with a higher prevalence of disease may be more sensitive to activation of pathogen concerns (e.g., in the form of COVID-19 typical news cycles) which translate to other domains of health protective behaviour (e.g., condom use).

Second, the effect of stringent and prolonged lockdowns on sexual behaviours cannot be ignored. Early evidence indicates that lockdowns inadvertently promote a range of unhealthy behaviours. When faced with stricter lockdowns, young people report an increase in alcohol intake (among both casual and binge drinkers; Niedzwiedz et al., 2021), increased tobacco and e-cigarette smoking, and poorer dietary choices (Naughton et al., 2021), significantly less time spent exercising, and poorer sleep quality (Czenczek-Lewandowska et al., 2021). In line with such a reduction in non-COVID-19-related health behaviour, it is possible that lockdowns may also inadvertently promote unhealthy sexual behaviours, including condomless sex. Some research also indicates that young people in stricter lockdowns were seeking casual sex among their existing social groups (e.g., friends, acquaintances, previous sexual partners), rather than strangers (Herbenick et al., 2022). Casual sex with known partners, compared to strangers, was a predictor of lower condom use prior to the pandemic (Choi et al., 2016; Cooper & Orcutt, 2000; Macaluso et al., 2000; Parks et al., 2011). More severe lockdowns may then promote the unhealthy behaviour of condomless sex, further exacerbated by young people having sex with known partners than strangers in lockdowns.

Finally, pre-occupation with the threat of COVID-19 may result in a lack of attenuation towards the threat of STIs. A core component of the Behavioural Immune System is detection of immediate pathogen threat (Rachman, 2016; Schaller & Park, 2011). The proliferation of COVID-19 globally, being in COVID-19-related lockdown, and the associated media coverage likely activated behavioural responses to pathogens, increasing

avoidance of potential sources of COVID-19. However, this may not necessarily translate to increased behavioural responses in other domains. Condom use is a known behavioural response to STIs (Ma & Ye, 2021; Tybur et al., 2011) but likely does not overlap with the behaviours promoted by threat of COVID-19 (e.g., mask wearing, hand washing). As such, engrossment with COVID-19 may diminish the perceived threat of other pathogens, including STIs. This theme was noted among Australian participants who reported being less concerned with STIs than COVID-19, resulting in less motivation to use condoms (Okeke, 2022). Vaccination rate across different regions may partially indicate how threatening COVID-19 is perceived to be in a given region, as receiving vaccination is the dominant protection against new pathogens in modern society (Schaller et al., 2022). As such, increased uptake of vaccinations may be negatively associated with condom use by indicating cognitively preoccupation with COVID-19 at the cost of attention to the threat of other pathogens.

Overall, the present study sought to explore changes in heterosexual condom use cross temporally and cross-culturally as a result of the COVID-19 pandemic. Despite disagreement over the direction of change internationally, we expect condom use to decline on average, given previous findings among other heterosexual samples (Dacosta et al., 2021; Herbenick et al., 2022; Lewis et al., 2022; Okeke, 2022). It was also expected that an overall decline will be predicted by historical prevalence of disease, stringency of lockdown conditions, and total vaccination percentages – specifically, it was expected that each of these would correlate with declines in condom use.

Method

Participants

Participants were recruited from universities across 18 different countries. An initial sample of 12,131 participants took part in the survey, of which 11,041 were complete and

valid. Non-heterosexual participants (n = 1777; 16.21%) were removed for two reasons. First, reasons to, or even the need for, condom usage varies substantially across sexual orientation groups (Sarkar, 2008). Second, homosexual men's condom use would be of noteworthy investigation, as discussed above, but there was only an average of 13 homosexual men per country. Non-sexually active participants were also removed, leaving a final sample of 3972 (M_{age} = 21.80; SD = 6.47). At the time of survey completion, most participants reported being single (55.5%) – 37.7% were in a relationship, 6.8% were married or in a de facto relationship, 0.6% were separated or divorced, and 0.1% were widowed. The demographic breakdown for each country is reported in Table 4.1.

Materials

Items were translated from English in countries where any language other than English was the primary language used for instruction in local universities using the back translation method (i.e., items were translated from English back to the relevant regional language). Items were translated to Portuguese, Spanish (European and Latin American dialects), Slovak, Serbian, Chinese, Thai, Vietnamese, Hungarian, and Lithuanian, for their respective countries.

Demographics. Participants reported their age, gender, sexual orientation identity, and relationship status.

Condom use. A single item capturing the use of condoms 'before COVID-19' and 'during COVID-19' was included. Both items read "How frequently do you engage in the following behaviours: Using a condom during penetrative sex", rated on a 7-point scale from 1 (*Never*) to 7 (*Very frequently/Almost always*).

Table 4.1. *Sample demographics and data collection information*

				Exclusion characteristics			Final sample characteristics		
	N	Collection start	Collection end	Sexually inactive	Non-heterosexual	*n (included)*	Mean age (*SD*)	Single / Coupled	Male / Female / Other
Netherlands	285	7th Nov 2020	22nd Dec 2020	46	46	190	27.46 (10.91)	62 / 128	60 / 130 / 0
Hong Kong	274	7th Sept 2020	19th Nov 2020	192	51	63	19.98 (0.91)	20 / 43	12 / 51 / 0
Thailand	953	9th Feb 2021	12th Mar 2021	803	167	106	20.75 (1.42)	69 / 37	42 / 56 / 8
Canada	1083	23rd Sept 2020	15th Mar 2021	376	199	484	22.16 (4.90)	149 / 335	98 / 386 / 0
Portugal	464	30th Oct 2020	31st Dec 2020	143	62	259	26.43 (10.27)	87 / 172	92 / 166 / 0
Hungary	194	12th Nov 2020	27th Nov 2020	38	49	119	39.65 (10.69)	25 / 94	47 / 70 / 2
United Kingdom	300	15th Oct 2020	27th Nov 2020	105	61	154	20.92 (4.38)	71 / 83	29 / 125 / 0
Lithuania	187	8th Oct 2020	21st Apr 2021	64	35	111	24.09 (6.25)	11 / 90	13 / 88 / 0
Philippines	211	1st Aug 2020	17th Apr 2021	169	39	30	26.30 (8.45)	10 / 20	11 / 19 / 0
Serbia	646	17th Feb 2021	30th Apr 2021	192	60	389	25.00 (7.86)	134 / 255	176 / 212 / 1
Vietnam	3361	1st Apr 2021	17th Apr 2021	2659	460	547	19.93 (1.80)	177 / 370	153 / 386 / 7
Uganda	403	Jan 2021[a]	Mar 2021[a]	93	98	233	n/a[b]	54 / 179	164 / 68 / 1
Croatia	190	12th May 2021	31st May 2021	66	29	102	27.63 (10.22)	8 / 94	36 / 66 / 0
United States[c]	1348	12th Sept 2020	6th May 2021	519	146	712	19.46 (3.18)	348 / 364	231 / 480 / 1
Spain	433	28th Apr 2021	19th May 2021	136	171	171	23.24 (5.77)	55 / 116	44 / 126 / 1
Colombia	232	12th May 2021	30th May 2021	96	34	110	23.77 (5.99)	37 / 73	38 / 72 / 0
Taiwan	186	16th Apr 2021	18th June 2021	112	32	63	31.22 (9.30)	10 / 53	15 / 48 / 0
Australia	291	23rd Oct 2020	3rd Dec 2020	129	32	129	20.62 (3.26)	59 / 70	57 / 72 / 0

[a] Dates are not available as surveys were distributed via paper format.
[b] Age was collected in groups – specifically, there were 64 participants aged 18-22, 152 aged 23-27, 70 aged 28-32, 44 aged 33-37, 29 aged 38-42, and 44 over the age of 44.
[c] Samples were collected across 4 states: Iowa (n = 223), Texas, (n = 276), Louisiana (n = 326), and Tennessee (n = 523)

Sexual frequency. Two items assessing frequency of penetrative intercourse 'before COVID-19' and 'during COVID-19' were included. The items read "How often did you and your partner engage in the following behaviours: Sexual intercourse with vaginal penetration" and "Sexual intercourse with anal penetration". Both items were rated on a 7-point scale that read 1 (*Not at all*), 2 (*Once or twice*), 3 (*Once a week*), 4 (*2-3 times a week*), 5 (*4-5 times a week*), 6 (*Once a day*), 7 (*More than once a day*).

Historical prevalence of disease index. A measure of historical prevalence of disease was obtained from Murray and Schaller (2010), who assessed the prevalence of 9 disease-causing pathogens (leishmania, schistosoma, trypanosoma, leprosy, malaria, typhus, filaria, dengue, and tuberculosis) across 230 regions worldwide. A score of zero on this index is representative of the mean. Positive scores indicate disease prevalence that is higher than average, and negative scores indicate disease prevalence below the mean.

COVID-19 stay-at-home restrictions index. A measure of government policy on stay-at-home orders and household lockdowns was obtained from Our World in Data (https://ourworldindata.org/covid-stay-home-restrictions) at the corresponding dates of data collection per country. Each country's lockdown severity was sorted into one of four categories: no measures in place, recommended to not leave the house, required to not leave the house with exceptions (e.g., for exercise or grocery shopping), and required to not leave the house with minimal exceptions (e.g., only allowed to leave once every few days).

COVID-19 vaccination. A percentage of COVID-19-vaccinated people for each country was obtained from Our World in Data (https://ourworldindata.org/covid-vaccinations).

Procedure

The Australian authors invited international colleagues from tertiary institutes to participate in a cross-cultural study about the impacts of the COVID-19 pandemic on dating,

sexual, and relationship-related behaviours. A core questionnaire was approved by the ethics committee at The University of Sydney (approval number: 2020/312), and online survey links were distributed to students in each country. The survey was translated to respective languages when the language of instruction at each given institution was not English - specifically, in Portugal, Spain, Colombia, Slovakia, Serbia, Taiwan, Thailand, Vietnam, Hungary, and Lithuania.

Participants were informed of the goal of the study and provided with the contact details for the academics responsible for data collection in their corresponding country, before providing their consent. As part of this larger study, participants were asked to rate their condom use 'before COVID-19', and then 'during COVID-19', on the same page. They were instructed to answer identically if they did not believe the behaviour had changed. The survey took approximately 30 minutes to complete.

Results

A series of mixed method 2 (Relationship status – between participants: Single vs. Coupled) x 2 (Time of condom use – within participants: Before COVID-19 vs. During COVID-19) ANCOVAs were used to examine changes in condom use. The assumptions of the ANCOVAs were met in most countries, except for Hong Kong and Hungary. Vaginal and anal intercourse items were totalled to create a composite variable to account for frequency of penetrative intercourse, both 'before COVID-19' and 'during COVID-19'. A difference score was then created to account for changes in sexual frequency, such that negative scores indicated an increase while positive scores indicated a decrease. Change in sexual frequency was included as a covariate. Participants in all countries reported a decline in penetrative sex ($ps < .05$), except in the Netherlands ($p = .454$), Serbia ($p = .299$), Croatia ($p = .959$), and the US ($p = .499$).

Results from these analyses are displayed in Table 4.2. Overall, participants reported modest condom use before the onset of the pandemic. Participants in Australia, Canada, Portugal, Vietnam, Uganda, and Taiwan reported a significant decline during the COVID-19 outbreak. The effects in these countries were not moderated by single versus coupled people. Notably, results from the Australian data partially replicated a decline in condom use from a previous Australian study (Dacosta et al., 2021). Participants in all other countries did not report a significant change to their condom use. A cumulative global analysis also revealed an overall decline in condom use, $F(1, 3415) = 38.971$, $p < .001$.

Spearman correlations were utilised to explore potential factors contributing to this decline in condom use (see Figures 4.1, 4.2, & 4.3). These correlational analyses explored relationships between the effect size (i.e., partial eta squared) of changes in condom use across countries, and a number of indices – namely, historical prevalence of disease, stringency of lockdowns, and vaccination percentage. Data from Hong Kong and Hungary were excluded due to violating the assumptions of the ANCOVA. Responses from Ugandan participants were also excluded due to difficulties accessing vaccination in Uganda (Echoru et al., 2021) which undermines the interpretation of the variable as an indication of heightened concern with COVID-19. As expected, significant relationships between changes in condom use were observed with lockdown stringency ($r_s = .465$, $p < .001$) and vaccination percentage ($r_s = .695$, $p < .001$). The higher lockdown stringency and higher vaccination percentage, the greater the decline in condom use (i.e., with the difference score calculated such that positive values indicate decreases in condom usage). However, there was no significant association between changes in condom use and historical prevalence of disease ($r_s = -.023$, $p = .148$). Post-hoc analyses did reveal that the ratio of non-sexually active to sexually active participants (coded as ‘0’ and ‘1’, respectively) was negatively associated with historical prevalence to disease ($r_s = -.363$, $p < .001$).

Table 4.2. *Analysis of covariance (ANCOVAs) for changes in condom use per country*

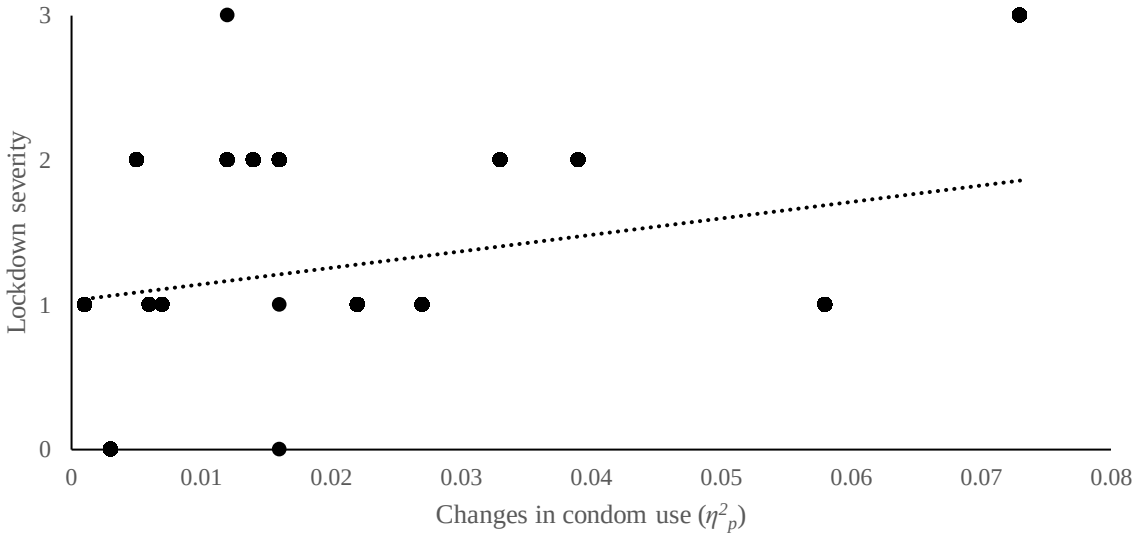
	Single		Coupled								
	Mean 'before COVID' (*SD*)	Mean 'during COVID' (*SD*)	Mean 'before COVID' (*SD*)	Mean 'during COVID' (*SD*)	*F (single + coupled)*	*df*	*p*	η^2_p	HPDI[a]	Lockdown severity[b]	Vacci-nation %
Netherlands	4.34 (2.47)	4.43 (2.44)	2.20 (2.09)	1.87 (1.76)	1.367	1, 187	.244	.007	-0.87	1	70.7
Hong Kong	4.80 (2.22)	4.10 (2.49)	5.14 (2.53)	5.25 (2.49)	6.348	1, 60	.423	.011	0.27	1	64.8
Thailand	4.92 (2.12)	4.77 (2.26)	4.61 (2.32)	4.63 (2.35)	0.014	1, 103	.905	.001	0.64	1	69.4
Canada	4.01 (2.44)	3.61 (2.53)	3.75 (2.60)	3.26 (2.61)	19.537	1, 481	<.001	.039	-1.31	2	79.8
Portugal	4.28 (2.49)	4.18 (2.47)	3.22 (4.44)	2.87 (2.35)	4.257	1, 256	.040	.016	0.47	2	89.4
Hungary	5.19 (2.00)	4.42 (2.66)	3.36 (2.60)	3.08 (2.65)	1.729	1, 116	.191	.015	-1.00	2	62.7
United Kingdom	4.45 (2.44)	4.08 (2.67)	3.27 (2.55)	3.11 (2.54)	3.405	1, 151	.067	.022	-1.01	1	72.3
Lithuania	5.27 (2.45)	4.64 (2.91)	4.22 (2.69)	4.01 (2.77)	1.190	1, 98	.278	.012	-0.75	2	66.7
The Philippines	2.60 (2.01)	1.80 (1.88)	2.50 (2.42)	2.40 (2.26)	0.142	1, 27	.709	.005	0.50	2	54.6
Serbia	4.49 (2.25)	4.32 (2.38)	3.44 (2.42)	3.37 (2.45)	2.253	1, 386	.134	.006	-0.23	1	47.0
Vietnam	4.30 (2.54)	3.83 (2.59)	4.37 (2.51)	3.93 (2.66)	16.306	1, 544	<.001	.029	0.61	1	73.9
Uganda	4.74 (1.49)	4.04 (1.69)	4.06 (2.23)	3.63 (2.14)	14.610	1, 230	<.001	.060	1.05	2	4.40
Croatia	5.63 (2.00)	5.63 (2.07)	4.60 (2.50)	4.41 (2.61)	0.326	1, 99	.596	.003	-0.44	0	54.7
United States	4.57 (2.42)	4.55 (2.38)	3.70 (2.50)	3.66 (2.55)	0.273	1, 709	.602	.001	-0.89	1	64.3
Spain	5.25 (2.33)	5.72 (1.98)	4.52 (2.62)	4.46 (2.66)	2.432	1, 168	.121	.014	-0.05	2	80.9
Colombia	4.69 (2.33)	4.62 (2.68)	3.62 (2.45)	2.96 (2.50)	3.602	1, 107	.060	.033	0.27	2	63.0
Taiwan	5.80 (1.99)	4.90 (2.77)	4.15 (2.68)	3.94 (2.74)	4.703	1, 60	.034	.073	0.30	3	74.0
Australia	4.91 (2.17)	4.64 (2.52)	4.66 (2.37)	4.07 (2.44)	7.697	1, 125	.006	.058	-0.25	1	94.1

[a] Historical prevalence of disease index

[b] 0 = no measures in place, 1 = recommended to not leave the house, 2 = required to not leave the house with exceptions (e.g., for exercise or grocery shopping), 3 = required to not leave the house with minimal exceptions (e.g., only allowed to leave once every few days)

Figure 4.1.

Association of changes in condom use with lockdown severity, across 18 countries



[a] Lockdown severity was sorted in 4 groups: 0 = no measures in place, 1 = recommended to not leave the house, 2 = required to not leave the house with exceptions (e.g., for exercise or grocery shopping), 3 = required to not leave the house with minimal exceptions (e.g., only allowed to leave once every few days)

Figure 4.2.

Association of changes in condom use with vaccination uptake, across 18 countries

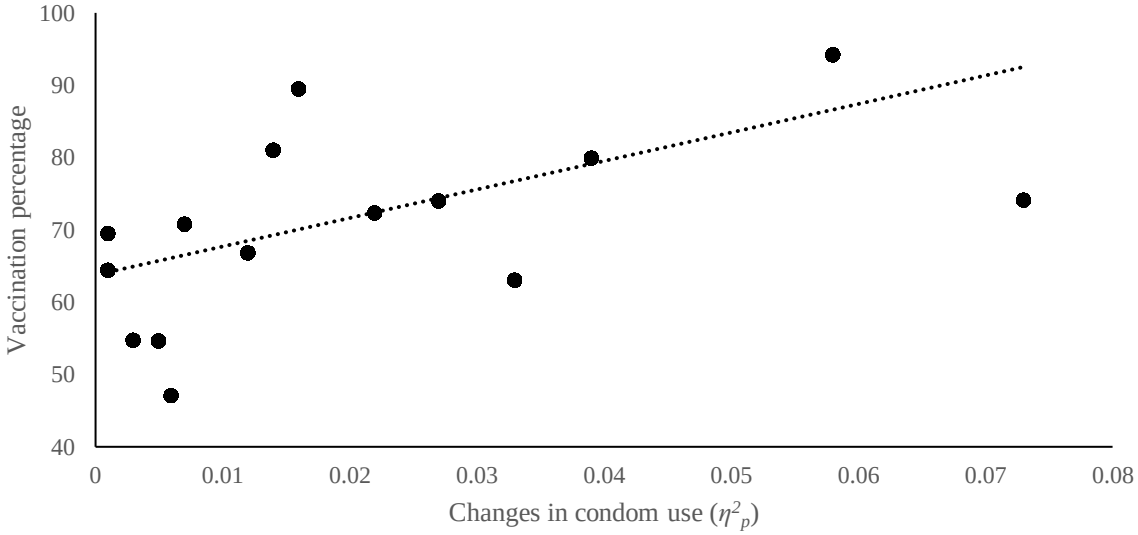
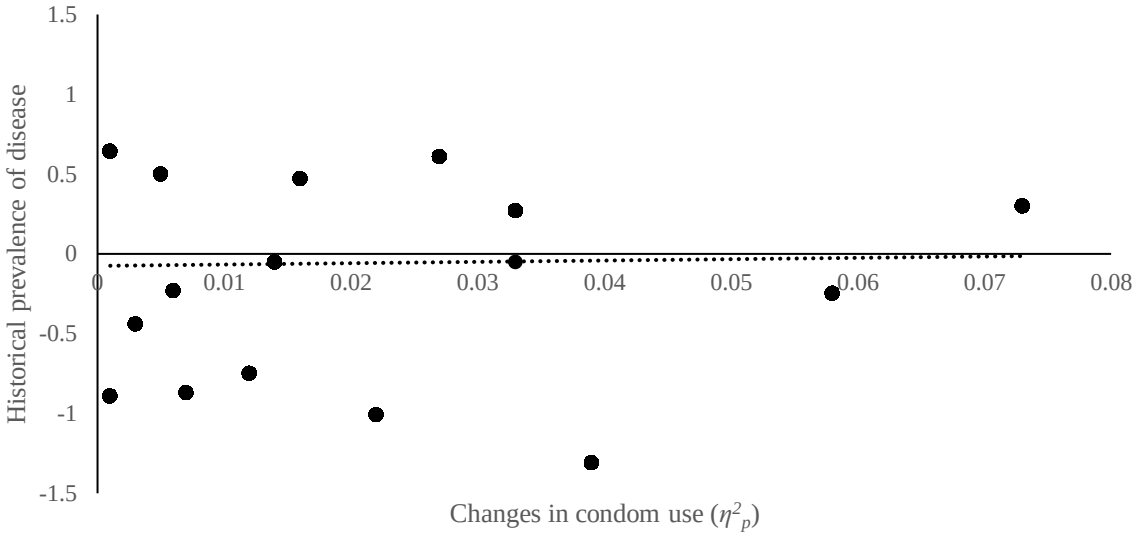


Figure 4.3.

Association of changes in condom use with historical prevalence of disease, across 18 countries



Discussion

Results of the current study revealed a nominal decline in the use of condoms in all the countries in the survey, with six of the 18 countries showing a significant decline. Notably, not a single country demonstrated even a nominal increase in the use of condoms during the pandemic. As such, there is no support for the BIS-derived prediction that increased cognitive activation of pathogens due to COVID-19 will increase health-protective behaviour in the sexual realm. In addition, two country-level variables, vaccination percentage and lockdown stringency, accounted for a significant amount of the variability in the size of the decline cross-culturally, although historical prevalence of disease did not.

The current study found evidence of a decline in condom use globally – namely, in Australia, Canada, Portugal, Vietnam, Uganda, and Taiwan. Further, despite non-significant observations in all other regions, there was no evidence of an increase in condom use after the onset of the pandemic. That is, despite evidence that pathogen threat generally (Tybur et al., 2011), and COVID-19 specifically (Ma & Ye, 2021), increases intention to use condoms, this seemingly does not translate to actual behavioural adoption of condom use during a

pandemic. Previous research has indicated that disgust – the emotion most closely related to pathogen threats, as it triggers avoidance of potential infection (Aunger & Curtis, 2013; Lieberman & Patrick, 2014) – can be attenuated by sexual arousal (de Jong et al., 2013). For instance, young men and women find disgust-inducing stimuli to be significantly less disgusting when they are sexually aroused (Borg & de Jong, 2012; Stevenson et al., 2011). People may report intentions to use condoms following pathogen threats, but being in a sexually arousing situation may interfere with translating this intention to behaviour, contributing to the decline in condom use cross-culturally.

Limited research during lockdowns already indicated that people increased a range of unhealthy behaviours (Czenczek-Lewandowska et al., 2021; Naughton et al., 2021; Niedzwiedz, et al., 2021), and the present study extends this research to decreased condom use. Indeed, the increase in drug and alcohol use during lockdowns may play a notable role in the use of condoms, as drug and alcohol use was a strong predictor of sexual risk taking, including condomless sex, prior to the pandemic (Berry & Johnson, 2018; Rehm et al., 2012; Scott-Sheldon et al., 2016). Relatedly, more severe lockdowns greatly reduced mobility and limited opportunities for casual sex (Coombe et al., 2021), leading to younger people seeking out sexual partners within their social circles (Okeke, 2022), another known predictor of reduced condom use (Choi et al., 2016; Cooper & Orcutt, 2000; Macaluso et al., 2000; Parks et al., 2010). Lockdowns may have inadvertently created conditions that allowed condomless sex to increase as indicated by the present results. Future research is needed to further distil the pathways that connect lockdown guidelines to condom use.

Vaccination uptake was a strong predictor of COVID-19-related reduced condom use across countries. The BIS postulates that people are particularly attuned to immediate pathogen threat rather than a distal one (Schaller & Park, 2011; Rachman, 2016). In the context of the pandemic, and the extensive media coverage, COVID-19 was obviously more

salient than potential threats from STIs. Consequently, people may have been prioritising COVID-19 protection strategies (e.g., vaccines) over other infections, like STIs (e.g., condoms). Low STI clinic attendance during lockdowns (Ogunbodede et al., 2021; Tao et al., 2021), and this continued lower attendance after lockdowns (Chow et al., 2021; Sentís et al., 2021), further provide evidence of STIs being less salient during this time. Even in countries in the current study that did not report a significant change, participants still reported middling condom use. This is concerning as these rates among young people pre-pandemic were not high enough to stem the spread of STIs (Shannon & Klausner, 2018). In sum, these findings indicate that the STI endemic may have worsened since the onset of COVID-19. Epidemiological data collected as STI clinics return to motivating STI testing will further illuminate these results.

Contrary to expectations, there was no association between the change in condom use and historical prevalence of disease. It was expected that experiences with previous infections would lead to greater increase in current behavioural responses (i.e., condom use), but this was not supported. This null finding may indicate that the chronic activation of disease risk that COVID-19 brought about did not interact with historical sensitivity to pathogens to a meaningful degree. Alternatively, the subset of sexually-active individuals from the countries that have greater historical pathogen prevalence, which was smaller than the sexually-active subsamples in the countries that have lower prevalence, may be less sensitive to the BIS activation cues in their environment.

A notable limitation of the current research is the lack of LGBTQI+ participants - especially, MSM. We speculated above that a preoccupation with COVID-19 may distract from the threat posed by STIs, but this may not extend to other sexual orientation groups. Limited findings among MSM suggest a trend of increased condom use during the pandemic (Shilo et al., 2020; Starks et al., 2020), implying that the activation of protective sexual

behaviour (e.g., condom use) among MSM during COVID-19 may have been in line with BIS predictions. One potential explanation may be MSM's more pronounced historical experience with HIV, where condom use is an appropriate counter to this serious virus. As such, MSM's behavioural defences may be more readily available, and more generalisable, compared to their heterosexual peers, who have not experienced a pathogen threat as severe as HIV in recent history. Future research should investigate cross-cultural changes in condom use among MSM to explore this potential explanation.

The results of the present study continue to present a worrying trend among young heterosexual people, wherein condom use either remained poor or diminished even further during the pandemic. Indeed, the present research adds to the growing phenomenon of lockdowns having a significant negative impact on young people's health, even beyond the lockdowns themselves. Considerable efforts had been placed into promoting lockdowns and other behaviours safeguarding against COVID-19 (e.g., hand washing, mask wearing), in turn neglecting messaging about STI prevention, testing, and treatment. This is concerning when cases of STIs are often asymptomatic (Farley et al., 2003), and can have significant health implications if left untreated (Tsevat et al., 2017). As more regions return to 'normal' with the introduction of COVID-19 vaccines, governments and health organisations need to explore effective messaging about STIs in a post-restriction world that may be exhausted of health messaging.

CHAPTER 5: Cross-cultural examination of university students' sexual behaviours during the COVID-19 pandemic

This chapter is currently under review at The Journal of Sex Research. Full authorship details are provided below.

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Introduction

Novel pathogens have posed a high degree of risk for human societies for time immemorial. To adapt to this threat, humans have evolutionarily acquired an array of defences against infections. The most evident of these defences is the physiological immune system, with its intricate set of immunological barriers to combat disease. However, the reliability of the immune system in averting diseases is far from absolute, and the metabolic expenditure required to mount a successful defence can be substantial (Park, 2021; Parkin & Cohen, 2001). Subsequently, humans have also evolutionarily acquired a suite of psychological defences to disease, collectively known as the Behavioural Immune System (BIS: Schaller et al., 2015). These defences are stimulated when pathogenic threat increases, activating an array of behaviours with the primary of goal avoiding potential sources of infection.

Disease threat is believed to influence the manifestation of many social behaviours through activation of behavioural defences, aiming to curtail potential disease spread. These defences are activated in the face of perceived – not actual – disease threat, given the invisible nature of pathogens. This allows experimental manipulations to examine the ways in which disease threat can influence social behaviours without exposing participants to actual infections (Schaller et al., 2022). Many studies have demonstrated that when disease-related stimuli (e.g., an auditory cue of vomiting) are cognitively primed, a range of pathogen-avoidant behaviours are activated (Schaller et al., 2022). For instance, a heightened sense of disease threat can motivate increased prejudice towards outgroups (Faulkner et al., 2004) and promote avoidance of crowded spaces (Wang & Ackerman, 2019), both examples of social tactics that reduce exposure to potential novel infections. Indeed, the influence of disease threat on social behaviours is so prominent that it has been argued to affect cross-cultural variations – extraversion across countries, for example, is negatively correlated with

indicators of disease prevalence, even when controlling for other country-level factors (Murray & Schaller, 2008).

Within this framework, sexual behaviours present pronounced risks for disease transmission due to the inherent vulnerabilities associated with intimate physical contact. Not only do risks associated with everyday interactions – for instance, the exchange of respiratory droplets – persist during sexual activities, but sexual contact further introduces the risks of skin-to-skin contact and transmission of sexually-transmitted infections (STIs), making sexual behaviours one of the most pathogen-prone social behaviours (Hlay et al., 2022). As such, curtailing sexual activities seems like one adaptive response to pathogen threat. Supporting this, research demonstrates that individuals with higher germ aversion typically exhibit a diminished inclination toward short-term mating, and a heightened proclivity for long-term mating strategies (Murray et al., 2013). These effects are even more pronounced under disease threat (Murray et al., 2013). Further, individual differences in sexual disgust – the emotional response that deters from potentially pathogenic sexual activities (Crosby et al., 2020) – can be predictive of sexual activities. Those less sensitive to sexual disgust tend to be more receptive to casual sexual encounters (Al-Shawaf et al., 2015; O'Shea et al., 2019). Combined, such findings demonstrate how individual disease tolerance can change interest in sexual activities, and how perceived disease presence can modulate this effect.

Variation in sexual behaviours across cultures further reinforces this pattern. Cultures with a higher prevalence of romantic kissing tend to have a lower occurrence of pathogens – arguably due to the risk of disease transmission involved with kissing behaviours (Murray et al., 2017). Similarly, a study spanning 48 countries illustrated an inverse relationship between the prevalence of casual sex and the spread of HIV/AIDS – higher rates of HIV transmission corresponded with decreased interest in casual sex (Barber, 2008). Therefore, research

suggests that contexts with either perceived or actual heightened pathogen risks lead individuals to adjust their sexual behaviours to minimise potential disease transmission.

Sexual behaviours during the COVID-19 pandemic

For most people, COVID-19 represented the first global experience of a disease outbreak for which an immediate effective remedy or immunization was unavailable. Given the BIS framework, it is plausible that the proliferation and associated risk of COVID-19 perceptibly influenced sexual behaviours. However, other emerging factors in the pandemic that were previously unaccounted for within the BIS, or the scientific literature generally, such as the rapid introduction of lockdowns, may also wield significant influence on sex lives. There is a burgeoning body of literature documenting pandemic-inspired changes to sexual behaviours, and exploring potential factors that account for any observed changes. An early British study found that frequency of sexual intercourse increased as a function of the number days spent in isolation (Jacob et al., 2020). Another British study mirrored these findings of a general increase in sexual activities but revealed that decreases were more common among single people and those not living with their partner, due to social distancing measures (Mercer et al., 2022). Both studies emphasise the impact of lockdowns on these observed changes, perhaps providing more opportunities for sexual encounters when living with one's spouse. Concurrently, a Chinese study reported overall increases in sexual intercourse, and these changes were positively associated with diminished concern for contracting COVID-19 (Zhang et al., 2021) – notably, providing early evidence that concerns over viral transmission were impacting sexual behaviours.

Evidence from other regions depicts a different pattern, wherein lockdown conditions predicted reduced sexual behaviours. A multinational study of four countries found that most participants reported a downturn in sexual frequency, attributable to lockdowns limiting opportunities for sexual contact (Lehmiller et al., 2020). Similar lockdown-related decreases

in sexual activity were reported by American men-who-have-sex-with-men (MSM; Sanchez et al., 2020). A Singaporean study observed a similar pattern, where sexual activity was reduced overall; this reduction was more pronounced among single people, again attributed to social distancing measures (Tan et al., 2021). Some research also implicates disease threat in decreases of sexual behaviours. First, a Turkish study observed an overall decrease in sexual intercourse, motivated by concerns of COVID-19 transmission (Baran & Aykac 2020). Second, a meta-analysis of sexual dysfunction in the pandemic found that partnered sexual activity declined in the majority of included studies (Masoudi et al., 2022). Most strikingly, this meta-analysis revealed that fear of being infected with COVID-19 was the most potent predictor of sexual dysfunction during the pandemic, further providing preliminary evidence for the BIS in the context of COVID-19.

The impact of lockdowns was not only observed in changes in partnered sexual activities, but also in solitary behaviours (i.e., pornography use and masturbation). Early empirical evidence suggested that a quarter of young adults self-reported increases in their masturbation behaviours and pornography use, but otherwise were mostly unchanged (Li, Li et al., 2020; Li, Tang et al., 2020; Nelson et al., 2020). Longitudinal studies provided more insight that reflected these trends. One such study noted that the majority of people reported reduced porn consumption over the pandemic – even the small percentage in their sample that increased their consumption eventually returned to pre-pandemic levels (Grubbs et al., 2022). Another longitudinal study found such slight decreases in masturbation and pornography use that they noted relative stability in these behaviours (Böthe et al., 2022). To our knowledge, however, no existing study has examined whether these changes are associated with pathogenic threat.

Finally, sexting behaviours – the act of sending or receiving sexually explicit messages – were less directly impacted by the introduction of lockdowns, due to the digital

nature of these sexual interactions. Accordingly, few studies suggest that those interactions increased during lockdowns. First, a multinational study found that a fifth of their sample expanded their sexual repertoire while in lockdown, and that sexting was the second most added behaviour (behind trying new sexual positions; Lehmiller et al., 2020). A Singaporean study also found a general increase in sexting behaviours, most notably among single people and those not living with their partner, due to social distancing measures (Tan et al., 2022). A British study expanded on these findings, noting that sexting behaviours increased among participants who had reported any sexual activity prior to lockdowns (Mercer et al., 2022). Finally, an Austrian study identified social isolation as a key factor related to increases in sexting, implying that sexting may be amplified more prominently in extended, stricter lockdowns (Thomas et al., 2022).

Despite many studies implicating lockdown severity, or concern about COVID-19 transmission, in changes in sexual behaviours, to date no study has compared the two to discern which has the prominent influence on certain sexual behaviours. Similarly, many of these studies are limited to findings from one region, and some changes in sexual behaviours (specifically, sexting and solitary) have not been investigated in relation to disease threat. Accordingly, the aims of the present study are to examine cross-cultural changes in sexual behaviours during the pandemic, and to what extent these changes are predicted by certain country-level factors – specifically, historical prevalence of disease and lockdown severity.

Factors predicting changes in sexual behaviour

A broad range of research suggests that prevalence of disease serves as the origin for differences in behaviours across countries (see Murray & Schaller, 2010), including in differing expressions of sex-related interactions. For instance, regions with higher disease prevalence tend to exhibit less romantic kissing (Murray et al., 2017) and a lower willingness to engage in casual sexual relationships (Schaller & Murray, 2008) – both relevant strategies

in reducing exposure to disease. Preliminary evidence suggests that this index can also account for cultural variations in responses to COVID-19. Regions with higher disease prevalence implemented COVID-19-related lockdowns more rapidly and stringently and exhibited stronger adherence to these measures (Lu et al., 2021). Given the separate associations of this index with both COVID-19-related behaviours and sexual behaviours, it is probable that cross-cultural changes in sexual behaviour are at least partially attributable to the historical prevalence of disease. As such, the current study utilised this index to further explore associations with changes in sexual behaviours.

Nevertheless, the threat of COVID-19 alone may not sufficiently account for the observed changes in sexual behaviour when social distancing measures were implemented to differing degrees across the world. It is apparent that COVID-19-related lockdowns greatly impacted various aspects of daily life, including sex lives. In fact, most existing research on changes in sexual behaviour during the pandemic has attributed such alterations to the introduction, and length, of lockdown measures (Jacob et al., 2020; Lehmiller et al., 2020). However, this perspective does not consider the varying degrees of lockdown implemented across different countries. Particularly prior to the widespread availability of COVID-19 vaccines, nations adopted diverse strategies ranging from basic recommendations to limit social contact, to strict enforcement of daily social movement (Mathieu et al., 2020). Consequently, it is essential to investigate changes in sexual behaviour while taking into account cross-cultural differences in lockdown conditions.

Accordingly, the present study aimed to explore cross-cultural changes in various sexual behaviours - specifically, the frequency of sexual intercourse, sexting, pornography use, and masturbation. In accordance with previous studies on changes in sexual frequency, we expected a decline in the average frequency of sexual intercourse. Likewise, we anticipated an increase in sexting behaviours. We also predicted decreases in pornography

use and masturbation, although we expected these declines to be less pronounced than those observed for sexual frequency, given previous evidence (Böthe et al., 2022; Grubbs et al., 2022). Finally, we hypothesised that any observed changes in these behaviours would be predicted by historical prevalence of disease and lockdown severity.

Method

Participants

Ethics approval for international data collection was obtained from the Human Research Ethics Committee at The University of Sydney. Participants were students recruited from universities across 18 different countries who were compensated with course credit. An initial sample of 12,691 participated in the survey, and 11,310 responses had less than 5% data missing (M_{age} = 21.80; *SD* = 6.47). Most participants self-identified as a woman (67.5%), being sexually inactive over the past 12 months (53.5%), and as single (54.8%). The remaining were in a relationship (37.5%), married or de facto (6.0%), separated or divorced (0.5%), or widowed (0.1%). Most participants reported living with their family (49.4%), followed by living with housemates (20.7%), living with their partner (15.1%), and living alone (14.8%). The full breakdown of demographics per country is displayed in Table 5.1.

Materials

In countries where the primary language of instruction was not English, bilingual researchers translated the survey items using the back translation method. Thus, participants completed the surveys in their native countries' language (i.e., English, Portuguese, Spanish [European and Latin American dialects], Slovak, Serbian, Chinese, Thai, Croatian, Vietnamese, Hungarian, and Lithuanian).

Table 5.1. *Sample demographics and data collection information*

	N	Collection start	Collection end	Sexually inactive	Mean age (*SD*)	Single / Coupled	Male / Female / Other
Netherlands	285	7th Nov 2020	22nd Dec 2020	46	28.17 (11.65)	110 / 175	98 / 183 / 4
Hong Kong	274	7th Sept 2020	19th Nov 2020	192	19.72 (1.35)	181 / 93	60 / 210 / 4
Thailand	953	9th Feb 2021	12th Mar 2021	803	20.58 (1.28)	614 / 339	229 / 597 / 125
Canada	1083	23rd Sept 2020	15th Mar 2021	376	21.83 (4.80)	454 / 575	233 / 798 / 14
Portugal	464	30th Oct 2020	31st Dec 2020	143	27.37 (11.74)	203 / 259	155 / 301 / 3
Hungary	194	12th Nov 2020	27th Nov 2020	38	39.78 (11.55)	49 / 145	78 / 102 / 13
United Kingdom	300	15th Oct 2020	27th Nov 2020	105	20.38 (3.70)	178 / 122	62 / 237 / 1
Lithuania	187	8th Oct 2020	21st Apr 2021	64	23.12 (5.36)	57 / 129	31 / 151 / 4
Philippines	211	1st Aug 2020	17th Apr 2021	169	22.30 (6.57)	140 / 71	57 / 139 / 15
Serbia	646	17th Feb 2021	30th Apr 2021	192	25.41 (9.06)	281 / 365	260 / 375 / 9
Vietnam	3361	1st Apr 2021	17th Apr 2021	2659	19.66 (1.40)	2279 / 1082	792 / 2434 / 129
Uganda	403	Jan 2021[a]	Mar 2021[a]	93	n/a[b]	107 / 296	254 / 147 / 2
Croatia	190	12th May 2021	31st May 2021	66	25.15 (9.17)	64 / 126	58 / 129 / 1
United States[c]	1348	12th Sept 2020	6th May 2021	519	19.29 (6.92)	784 / 510	380 / 899 / 15
Spain	433	28th Apr 2021	19th May 2021	136	22.60 (6.41)	201 / 232	134 / 281 / 16
Colombia	232	12th May 2021	30th May 2021	96	24.24 (6.92)	100 / 132	71 / 157 / 4
Taiwan	186	16th Apr 2021	18th June 2021	112	29.97 (9.57)	85 / 101	52 / 130 / 4
Australia	265	21st May 2020	19th June 2020	129	19.88 (2.58)	135 / 131	80 / 185 / 1

[a] Exact dates are not available as surveys were distributed via paper format.
[b] Age was collected in groups – specifically, there were 64 participants aged 18-22, 152 aged 23-27, 70 aged 28-32, 44 aged 33-37, 29 aged 38-42, and 44 over the age of 44.
[c] Samples were collected across 4 states: Iowa (n = 223), Texas, (n = 276), Louisiana (n = 326), and Tennessee (n = 523)

Demographics. Participant reported their age, gender, sexual orientation identity, and relationship status.

Sexual frequency. Frequency of penetrative intercourse was assessed by two items. Both items were asked 'before COVID-19' and 'during COVID-19'. The items read "How often did you and your partner engage in the following behaviours: Sexual intercourse with vaginal penetration" and "Sexual intercourse with anal penetration". These items were rated on a 7-point scale - 1 (*Not at all*), 2 (*Once or twice*), 3 (*Once a week*), 4 (*2-3 times*), 5 (*4-5 times a week*), 6 (*Once a day*), 7 (*More than once a day*).

Masturbation. A single item assessing frequency of masturbation 'before COVID-19' and 'during COVID-19' was included. The item read "On average, how often do you engage in the following behaviours: Manual stimulation (masturbation; alone)" and was rated a 7-point scale that read 1 (*Not at all*), 2 (*Once or twice*), 3 (*Once a week*), 4 (*2-3 times*), 5 (*4-5 times a week*), 6 (*Once a day*), 7 (*More than once a day*).

Pornography use. A single item measuring frequency of pornography use 'before COVID-19' and 'during COVID-19' was included. This item read "How frequently do you engage in the following behaviours: Watched pornography" and was rated on a 7-point scale that ranged from 1 = *Never* to 7 = *Very frequently/Always*.

Sexting. Eight items assessing the frequency of sending and receiving sexual messages was adapted from Parker et al. (2013) – e.g., "When texting a romantic or sexual partner, how often do you: Send nude photos or videos". Each item was asked 'before COVID-19' and 'during COVID-19' and was rated on a 7-point scale from 1 (*Never*) to 7 (*Very frequently/ Almost always*). Each country displayed excellent Cronbach's alpha estimates of internal consistency (αs > .91).

Historical prevalence of disease index. Murray and Schaller (2010) measured the historical prevalence of 9-disease causing pathogens (leishmania, schistosoma, trypanosoma,

leprosy, malaria, typhus, filaria, dengue, and tuberculosis) across 230 regions worldwide over a 70-year period to calculate an index of historical prevalence of disease. A score of zero represents the mean. Positive scores represent disease prevalence that is higher than the mean, while negative scores represent prevalence below. This index is a well-accepted measure of pathogen load across included countries.

COVID-19 stay-at-home restrictions index. A measure of social distancing behaviours and regional lockdowns was sourced from Our World in Data (https://ourworldindata.org/covid-stay-home-restrictions). Each country's social distancing measure was sorted into one of four groupings: no measures in place, recommended to not leave the house, required to not leave the house with exceptions (e.g., for exercise or grocery shopping), and required to not leave the house with minimal exceptions (e.g., only allowed to leave once every few days) for the time that corresponded with the data collection.

Procedure

The researchers from The University of Sydney obtained ethical approval from their institutional committee for a larger questionnaire that included the foci variables in this manuscript. Colleagues from tertiary institutions around the world were then invited to assess the impacts of COVID-19 on dating, sexual, and relationship-related behaviours in their own institutions. Online survey links were distributed to each country. Participants were provided the contact details for the academics responsible for data collection in their given region, and the overall goal of the study, before providing consent. As part of that wider study, participants were asked to rate their frequency of sexual intercourse, masturbation behaviours, pornography use, and sexting behaviours. In each instance, each item was asked 'before COVID-19' and then 'during COVID-19' on the same page to allow for direct comparisons. Participants were explicitly asked to answer identically if the behaviour had not changed across instances. This survey took approximately 30 minutes to complete.

Results

First, vaginal and anal intercourse items were combined to create a composite variable for frequency of penetrative intercourse, among sexually active participants only. Second, as masturbation and pornography use both represent solitary behaviours (that often overlap), the relevant items were combined to create an amalgamated single solitary sexual behaviour variable (αs > .72 in all countries, indicating substantial co-variation). Subsequently, a series of mixed effect, 2 (Time – within participants: Before COVID-19 vs. During COVID-19) x 2 (Gender – between participants: Man vs. Woman) x 2 (Relationship status – between participants: Single vs. Coupled) ANOVAs were used to examine changes in sexual intercourse frequency, sexting, and solitary sexual behaviours.

Main effect results are described in Tables 5.2, 5.3, and 5.4. First, changes in frequency of sexual intercourse were analysed, where eight of the 18 countries reported a significant decline – specifically, in Australia, Canada, Portugal, Hungary, The Philippines, Vietnam, Colombia, and Taiwan. Next, solitary behaviours also significantly declined in Thailand, Vietnam, Spain, Lithuania, Uganda, and Taiwan. Finally, sexting behaviours significantly declined in several countries – namely, Australia, Thailand, Hungary, Lithuania, Vietnam, and Uganda – but significantly increased in Spain and the UK.

Table 5.2. *Analysis of variance (ANOVA) for changes in sexual frequency per country*

	Mean 'before COVID' (*SD*)	Mean 'during COVID' (*SD*)	*F*	*df*	*p*	η^2_p
Australia	2.32 (0.99)	1.99 (1.09)	23.196	1, 165	<.001	.123
Netherlands	4.62 (1.73)	4.58 (1.80)	2.215	1, 226	.138	.010
Hong Kong	4.07 (1.98)	3.82 (2.10)	2.657	1, 77	.107	.033
Thailand	5.15 (2.49)	5.01 (2.55)	1.447	1, 112	.232	.013
Canada	4.60 (1.88)	4.23 (1.89)	32.567	1, 605	<.001	.051
Portugal	4.59 (1.91)	4.29 (1.92)	13.382	1, 297	<.001	.043
Hungary	4.63 (1.75)	4.27 (1.74)	27.630	1, 139	<.001	.166
United Kingdom	4.58 (1.59)	4.09 (2.02)	3.251	1, 189	.073	.017
Lithuania	3.88 (1.22)	3.21 (1.55)	3.679	1, 102	.051	.022
The Philippines	3.66 (1.53)	3.07 (1.59)	12.784	1, 34	<.001	.273
Serbia	4.87 (2.52)	5.08 (2.74)	1.626	1, 425	.203	.004
Vietnam	4.46 (2.55)	4.11 (2.72)	11.172	1, 626	<.001	.018
Uganda	5.04 (2.41)	4.75 (2.49)	.821	1, 303	.366	.003
Croatia	4.94 (1.64)	4.95 (1.74)	.232	1, 117	.631	.002
United States	4.48 (2.03)	4.48 (2.12)	.076	1, 797	.782	.001
Spain	4.63 (1.91)	4.36 (2.00)	3.705	1, 264	.055	.014
Colombia	5.20 (1.96)	4.55 (2.11)	15.487	1, 127	<.001	.109
Taiwan	3.93 (1.35)	3.59 (1.26)	8.014	1, 69	.006	.104

Table 5.3. *Analysis of variance (ANOVA) for changes in solitary sexual behaviours (i.e., pornography use and masturbation) per country*

	Mean 'before COVID' (*SD*)	Mean 'during COVID' (*SD*)	*F*	*df*	*p*	η^2_p
Australia	2.96 (1.62)	3.03 (1.76)	1.317	1, 261	.252	.005
Netherlands	3.06 (1.50)	3.07 (1.62)	.196	1, 276	.659	.001
Hong Kong	2.39 (1.45)	2.38 (1.50)	.782	1, 266	.377	.003
Thailand	2.32 (1.45)	2.21 (1.46)	14.537	1, 807	.001	.018
Canada	2.96 (1.62)	2.98 (1.73)	.099	1, 833	.753	.001
Portugal	2.69 (1.49)	2.65 (1.62)	.864	1, 439	.353	.002
Hungary	3.34 (1.65)	3.21 (1.77)	.210	1, 171	.120	.014
United Kingdom	2.90 (1.63)	2.87 (1.62)	.194	1, 288	.194	.006
Lithuania	2.89 (1.61)	2.83 (1.66)	5.325	1, 172	.022	.030
The Philippines	2.35 (1.63)	2.40 (1.70)	.804	1, 188	.371	.004
Serbia	3.02 (1.79)	3.02 (1.85)	.002	1, 617	.962	.001
Vietnam	1.65 (1.21)	1.60 (1.18)	23.519	1, 3121	<.001	.007
Uganda	1.87 (1.67)	1.69 (1.11)	10.847	1, 395	.001	.027
Croatia	2.74 (1.64)	2.73 (1.68)	.101	1, 179	.751	.001
United States	2.69 (1.70)	2.67 (1.75)	1.995	1, 1269	.158	.002
Spain	3.33 (1.67)	3.23 (1.68)	4.996	1, 401	.026	.012
Colombia	2.91 (1.56)	2.91 (1.63)	.380	1, 218	.538	.002
Taiwan	2.71 (1.65)	2.56 (1.70)	4.538	1, 178	.035	.025

Table 5.4. *Analysis of variance (ANOVA) for changes in sexting behaviours per country*

	Mean 'before COVID' (*SD*)	Mean 'during COVID' (*SD*)	*F*	*df*	*p*	η^2_p
Australia	2.41 (1.40)	2.22 (1.51)	7.383	1, 261	.007	.028
Netherlands	2.07 (1.09)	2.07 (1.21)	.025	1, 275	.874	.001
Hong Kong	1.66 (1.07)	1.68 (1.18)	.594	1, 266	.441	.002
Thailand	1.66 (1.04)	1.56 (1.01)	33.562	1, 803	<.001	.040
Canada	2.62 (1.53	2.52 (1.63)	6.726	1, 824	.010	.008
Portugal	2.43 (1.43)	2.36 (1.48)	2.036	1, 430	.154	.005
Hungary	2.38 (1.46)	2.00 (1.43)	13.277	1, 168	<.001	.073
United Kingdom	2.70 (1.56)	2.85 (1.81)	5.625	1, 287	.018	.019
Lithuania	2.28 (1.42)	2.10 (1.37)	6.626	1, 171	.011	.037
The Philippines	1.85 (1.34)	1.75 (1.34)	2.612	1, 185	.108	.014
Serbia	2.51 (1.44)	2.50 (1.58)	.001	1, 618	.992	<.001
Vietnam	1.53 (1.08)	1.46 (1.06)	78.653	1, 3139	<.001	.024
Uganda	2.89 (1.56)	2.53 (1.38)	11.722	1, 395	<.001	.029
Croatia	2.42 (1.33)	2.42 (1.40)	.873	1, 177	.352	.005
United States	2.50 (1.58)	2.54 (1.68)	2.204	1, 1267	.138	.002
Spain	2.76 (1.51)	2.97 (1.72)	8.533	1, 398	.004	.021
Colombia	2.98 (1.48)	3.00 (1.68)	.001	1, 223	.992	.001
Taiwan	1.78 (1.14)	1.70 (1.17)	3.178	1, 177	.076	.018

The interacting effects of gender and relationship status were also investigated. Overall, very few (< 10%) were statistically significant, and those ones did not display a discernible cross-cultural pattern, beyond single people reporting a larger decline in sexual frequency than coupled. Subsequently, these effects are not discussed further. See Appendix C for the full breakdown of these effects.

Predictions with country-level factors

Linear regression modelling was used to investigate potential cross-cultural factors predicting these observed changes. Behavioural change scores were calculated using Before scores minus During scores, such that positive values indicated decreases in the relevant behaviour. Three regressions examined whether lockdown severity and/or historical prevalence of disease predicted changes in sexual frequency, solitary behaviour, and sexting, respectively. Given that living with a partner likely altered declines in these behaviours (and were not distributed evenly between the countries), we removed 1664 participants who reported living with a partner during the pandemic.

First, lockdown severity significantly predicted changes in sexual frequency (β = .136, t(3977) = 4.716, p < .001, η_p^2 = .075), but historical prevalence of disease did not (β = -.020, t(3977) = -.910, p = .363, η_p^2 = -.014). Second, both lockdown severity (β = .056, t(9225) = 3.194, p = .001, η_p^2 = .033) and historical prevalence of disease (β = .026, t(9225) = 2.099, p = .036, η_p^2 = .022) predicted changes in solitary behaviours. Finally, sexting behaviours were significantly predicted by historical prevalence of disease (β = .055, t(9214) = 4.118, p < .001, η_p^2 = .043), but not by lockdown severity (β = .050, t(9214) = 1.193, p < .233, η_p^2 = .012).

Discussion

The current research explored changes in sexual behaviours during the COVID-19 pandemic across 18 countries. Consistent with our hypothesis, a significant decline in the frequency of sexual intercourse was observed in eight of the 18 surveyed countries, and a nominal decrease was noted in all but two. Similarly, slight but significant declines in solitary behaviours were observed in six of the countries. An expected increase in sexting behaviour was only observed in Spain and the UK, but a significant decline was reported in seven other countries. Finally, changes in these behaviours were predicted by certain country-level indicators – changes in intercourse were predicted by lockdown stringency, changes in sexting behaviours were predicted by historical prevalence of disease, and changes in solitary behaviours were predicted by both.

Findings from this study demonstrate a decline in sexting behaviours across six countries, with only two countries supporting previous findings that indicated an increase (Mercer et al., 2022; Tan et al., 2021). Notably, changes in sexting behaviours were predicted by historical prevalence of disease rather than the severity of lockdown measures. Before the pandemic, empirical evidence indicated that priming disease could lead to more avoidant social behaviours, including in face-to-face romantic contexts (Sawada et al., 2018). The

influence of disease in prompting these avoidant behaviours was so pronounced that it persisted even when replicated in digital settings (e.g., an online dating paradigm; Sawada et al., 2018). This inclination towards avoiding social behaviours when under threat of disease may explain the observed pattern in our study, providing some support for the BIS theory during the pandemic. Individuals may be eschewing sexting in regions with a historical higher prevalence of disease as sexting itself still requires approaching a partner. Meanwhile, the varied extent of social distancing did not restrict opportunities for sexting, given its digital nature, which may explain why lockdown stringency did not directly inform sexting trends. Future research could further explore these potential explanations by examining sexting behaviours while under a disease threat in a more controlled environment.

The stringency of lockdowns was clearly relevant in other sex-related behaviours. In alignment with earlier research (e.g., Baran & Aykac, 2021; Lehmiller et al., 2020; Tan et al., 2021), the present study also uncovered a widespread decrease in the frequency of sexual intercourse. Further, these changes were predicted by the intensity of lockdown measures, rather than historical prevalence of disease. This trend is intuitively consistent, as social distancing measures inherently curtailed opportunities for physical sexual encounters (Sanchez et al., 2020). Consequently, the restrictive environment created by lockdown conditions compelled reductions in sexual intercourse, overshadowing the conventional influence attributed to disease prevalence.

Finally, solitary behaviours significantly declined in six of the 18 surveyed countries, and these changes were predicted by both historical prevalence of disease *and* lockdown severity. Unlike sexting behaviours, solitary behaviours inherently operate without necessitating interaction with a partner. In regions with a more pronounced history of disease prevalence, it seems participants were primed to adapt their sexual interests more broadly. Historically, curbing such sexual interests has been a strategic response to diminish exposure

to emerging pathogens, and these findings continue to suggest this extends even to digital behaviours (due to the evolutionary nature of the BIS; Hlay et al., 2022). Equally important, however, was the influence of lockdown measures on these solitary behaviours. In this study, over 80% of participants indicated they shared their living space with family or housemates. As lockdown measures intensified –compelling people in participants' homes to also stay-at-home – the private window for engaging in solitary behaviours likely narrowed. Consequently, this could account for lockdown stringency also predicting changes in solitary behaviours.

Combined, the current study finds some evidence supporting the BIS, while also underscoring the substantial role of emerging factors during the pandemic. Researchers prior to the pandemic noted that BIS research was limited by confinement to laboratory settings or contexts with localised outbreaks, and that expansion to more naturalistic designs would likely add to our understanding of disease threat (Beall et al., 2016). The current study supports this speculation. Global lockdowns seemingly had a significant impact on physical sexual interactions in particular, but could not have been considered in the literature prior to their global introduction during the pandemic. Equally, however, this does not diminish the traditionally understood impact of disease threat. As such, future research should consider both disease threat and lockdowns, among other emergent factors, when examining behavioural change during the pandemic.

Strengths & limitations

A strength of this study was its comparison across distinct cultural contexts, emphasising the proposition that country-specific factors are instrumental in accounting for variations in sexual behaviours. The divergence in sexting behaviours, observed both within this study as well as when contrasted with ancillary findings from other studies (Mercer et al., 2022; Tan et al., 2021), calls for particular attention. These contrasts emphasise that, among

the sexual behaviours examined in this study, sexting might be the most susceptible to cultural influences. Differing cultural norms, societal expectations, privacy regulations, and attitudes towards sexual expression likely play pivotal roles in the prevalence and nature of sexting (Baumgartner et al., 2014; Widmer et al., 1998). Such findings reinforce the need for cross-cultural investigations into changes in sexual – and more widely, social – behaviours in the pandemic, as there is likely complex interplay between individual actions and cultural context in the manifestation of these behaviours.

This study is not without its limitations. One primary limitation centres around the study's reliance on retrospective recall for behaviours preceding the onset of the pandemic, an approach that could be susceptible to memory biases or distortions. The study's design asked participants to respond to both sets of items ('before' and 'during') on a single page and instructed them to contrast their behaviours, indicating perceived decreases, increases or no changes. Although this method offers the advantage of discerning the directional nature of changes, it is also prone to inaccuracies when it comes to quantifying the precise extent of such changes. Limited research into recall of sexual behaviours indicates that there is a moderate association between both recall and daily reporting (Mark et al., 2016). Despite this consideration, it is also notable that many of the patterns identified in the current study are consistent with prior research, including longitudinal data (Böthe et al., 2022; Grubbs et al., 2022). Such congruity serves as an assurance, reinforcing the validity of our results. Furthermore, the directionality of these effects were largely consistent – increases were only observed in one particular behaviour (i.e., sexting) in two countries. It highlights that, notwithstanding the potential for recall bias, the overall trends identified provide a reliable perspective on the behavioural shifts occurring in the pandemic.

Another limitation of this study is the application of the historical prevalence of disease index (Murray & Schaller, 2010). This index is typically used to understand how past

pathogen exposure has influenced cultural norms and practices, subsequently affecting regional differences in individual behaviours (e.g., extraversion; Schaller & Murray, 2008). However, this study used the index to explore the impact of historical pathogenic threats on sexual behaviours specifically. Such an application of this index represents a deviation from its usual use and introduces a conceptual limitation. The findings then should be interpreted with caution. Future investigations would especially benefit from examining the role of other country-level factors – particularly those pertaining to cultural norms – on individual differences related to sexual behaviours (e.g., sociosexuality).

The current study continues to add to our understanding of how the COVID-19 pandemic negatively impacted young's people sex lives. These findings reinforce that, while lockdowns certainly have a significant impact on social behaviours, disease threat also plays a notable role. As such, future research into sexual behaviours – and wider social behaviours – during the pandemic should investigate the interplay between the pandemic, lockdowns, and disease threat. Such an approach would yield a more nuanced understanding of behavioural changes in the face of a global health crisis.

CHAPTER 6: General discussion, conclusions, and future directions

At the advent of the COVID-19 pandemic, the mainstream media immediately began to report on actual – and speculative – changes to people's sex lives and the associated sexual health. An array of sexual behaviours was commented on during this time, ranging from needed adaptations in dating (e.g., by moving to a more virtual space) to sexualised consumption behaviours (e.g., strip clubs adopting from-home viewing options; Breslin, 2020). However, at the conceptualisation of the research in this thesis, there had been no published investigation into potential changes in sex lives during a global pandemic, or potential factors that could explain these changes. The present thesis therefore aimed to examine such changes in various sexual-related behaviours that may have been impacted during the pandemic, driven by the framework provided by the Behavioural Immune System (BIS) theory. The three studies within this thesis represent just a few examples of how sexual behaviour adapted to the conditions of the pandemic, and how much disease threat did – or in some cases, did not – motivate these adaptations.

Summary of empirical findings

Chapter 3 reported changes in condom use among an Australian sample in the immediate aftermath of COVID-19 spread, and an associated lockdown. At this early stage of the pandemic, it was not clear if the impact on condom use would be positive or negative, if there was an impact at all, nor if the novel disease threat of COVID-19 would motivate any observed changes. The results revealed an overall decline in condom use after the introduction of lockdown conditions, and this effect was larger among single compared to coupled people. Notably, perceived vulnerability to COVID-19 was not significantly related to these observed decreases. It was speculated that the sudden bombardment of new health-related precautionary behaviours – such as hand washing for 20 seconds, wearing a mask in certain contexts, isolation rules for positive cases, and so forth – became a dominant factor in

the minds of Australians, leading to a neglect in previously promoted health behaviours like using a condom.

Chapter 4 expanded on the findings of Chapter 3 by investigating changes in condom use during the pandemic at a later time point in Australia, and broadly across 17 other countries. First, a significant decline in condom use was observed in an Australian sample recruited in late 2020, despite lockdown conditions being lifted. A significant decline was also observed in 5 of the 17 other countries – specifically, Canada, Portugal, Vietnam, Uganda, and Taiwan. At least a nominal decrease was observed in every country in the study. Notably, however, there was no differentiation in the decline as a function of relationship status, as observed in Chapter 3. These decrease rates were associated with vaccination percentage and lockdowns across countries, but not with historical prevalence of disease. These observations imply that the pandemic-induced factors had a greater influence on the reduction in condom use than the threat of disease.

Chapter 5 further explored changes in a broader range of behaviours across the pandemic – namely, sexual intercourse, sexting, pornography use, and masturbation behaviours – across the same 18 countries as Chapter 4. Further, the predictive values of lockdown severity and historical prevalence of disease in relation to the changes in these behaviours were assessed. Results revealed a broad decline in all behaviours across most of the surveyed countries – the only significant increase found was in sexting behaviours among participants from Spain and the UK. Moreover, historical prevalence of disease appeared to be more relevant for sexting behaviours, while lockdown stringency was more relevant to physical interactions. Finally, changes in solitary sexual behaviours were predicted by both. These results continue to add evidence that emergent factors in the pandemic were impacting sexual behaviours, but also that historical disease threat is partially accounting for changes in digital sexual behaviours.

In sum, key findings from all three studies illuminate the overall suppressive impact that the pandemic had on sexual behaviours on the one hand, but also clear cultural heterogeneity in such impacts. Findings related to sexual health suggest a latent risk of STI proliferation that may have been overshadowed during the pandemic period. More generally, the trends in this thesis are concerning when even simple sexual interactions are associated with positive physical and psychological outcomes (Brody, 2010).

The Behavioural Immune System during the COVID-19 pandemic

Findings from Chapter 5, in particular, highlight the expected role of disease prevalence in the expression of some sexual behaviours. Specifically, declines in sexting and solitary behaviours were both predicted by historical prevalence of disease. Given the digital nature of these behaviours, they were not impeded by lockdown measures in the same manner as physical sexual behaviours, perhaps allowing for a clearer relationship with disease threat to emerge. This suggests that regions with more pronounced histories of disease outbreaks displayed a more pronounced decrease in sexual interest during the pandemic, consistent with the BIS. The reduction in sexting particularly underscores the profound influence of disease threat on approach-oriented social interactions, even within digital spaces (Sawada et al., 2019). These insights accentuate the modulating role of disease threat on sexual behaviours during the pandemic. Indeed, one empirical study has directly found evidence for COVID-19 threat impacting sexuality, wherein they found the expected decrease in favourability towards casual sex following a COVID-19 disease prime (Moran et al., 2021). Therefore, the findings from Chapter 5 add to the growing literature demonstrating expected relationship between disease threat and sexual behaviours. A promising avenue for future research could involve exploring sexting and solitary behaviours within a controlled laboratory setting, thereby offering a deeper understanding of how COVID-19 threat specifically influences these sexual behaviours.

Condom use. Intriguingly, historical disease prevalence did not appear to impact condom use as it did with some sexual behaviours in this research. Based on pre-existing research prior to COVID-19 (Tybur et al., 2011), it was expected that condom use would become more valued. One study post-outbreak reinforced this BIS-related finding, wherein condom-related searches increased globally as COVID-19-related concerns increased (Ma & Yi, 2021). Evidence presented in Chapters 3 and 4, however, indicate that the actual condom use across two timepoints in Australia, and across some other countries, was negatively impacted. This is in line with other studies that were published in parallel with the development of this thesis (Firkey et al., 2022; Herbenick et al., 2022; Lewis et al., 2021; Okeke, 2022). Further, observed changes in condom use in both Chapters 3 and 4 suggest that these changes were not meaningfully explained by COVID-19 threat, or historical disease threat.

The functional flexibility of the BIS may account for these discrepancies. This principle dictates that people weigh the positives and the negatives of potential exposure to disease. For young heterosexual people in particular, the risk of contracting a STI is not particularly threatening when the most common STIs (e.g., chlamydia, gonorrhoea) are treatable with easily accessible medication (WHO, 2023). As such, disease threat may not be a sufficient motivator for increased condom use in a naturalistic setting – indeed, this is reinforced by condom use being generally middling in Chapters 3 and 4 even before the COVID-19 pandemic. Similarly, despite some early evidence suggesting COVID-19 can be sexually transmitted, there is no current evidence that it is a STI (Tur-Kaspa, 2021). Correspondingly, young heterosexuals may not have perceived increased disease risk from sexual intercourse during the pandemic, potentially explaining their decrease in condom use. Indeed, the BIS is often metaphorically related to the physiological immune system, and these findings may further reinforce this. In the same way that the immune system adopts

specific antigen responses in the face of corresponding pathogen threat (e.g., contracting influenza produces antibodies for that specific strain only), behavioural defences may also be tailored to context-dependent cues. Young heterosexual people in modern societies have not been exposed to serious disease threat in sexual situations, and so they do not implicitly fall back on safe sex behaviours in the face of disease threat.

Temporal discrepancies in condom use. While findings presented in Chapters 3 and 4 are largely complementary to one another, a notable difference is the effect of relationship status in Chapter 3 – single people experienced a greater decrease in condom use, relative to those in relationships, and this was not mirrored in any country in Chapter 4, even in second assessment in Sydney, Australia. First, there is the possibility that the differentiation by relationship status in Chapter 3 is a spurious finding, particularly when these data were collected prior to other published work on condom use during a pandemic. As such, this result, in particular, should be interpreted with caution, and future replications are needed.

Alternatively, this finding may represent a unique behavioural shift. Data in Chapter 3 was collected in Australia in May 2020 – earlier than the data collection in any other country. As such, data from Chapter 3 may be more relevant to the sudden shift to lockdown conditions, compared to the individuals in latter samples who have had time to acclimate to such conditions. This potentially highlights that, in the domain of sexual health, single people are particularly at risk of worse outcomes in the event of sudden shifts to lockdown. A qualitative study in Australia during the same timepoint as Chapter 4 (i.e., the first lockdown in Sydney in 2020) provides one potential explanation – single people in this study were reporting less interest in casual sex partners, and instead were having sex with acquaintances or previous partners (Okeke, 2022). As such, due to now knowing their sexual partners on a more personal level, it was speculated that they felt less need to use condoms. A similar phenomenon may have occurred among the participants in Chapter 3 – to minimise sources

of infection, single people may have been approaching more known partners, and subsequently diminishing their condom use. Future research could probe such a phenomenon by examining whether single people change their preferred sexual partners (e.g., strangers versus acquaintances) in the face of disease threat.

The role of pandemic-induced factors on changes in sex-related behaviours

The potential role of newly introduced health campaigns during the pandemic highlight how pandemic-induced factors can impact changes in a range of behaviours. The most prominent of such factors was the widespread implementation of lockdown conditions. Even before lockdowns became a widespread preventative measure, experts speculated about the negative effects such conditions could have on physical and mental health (Wahlquist, 2020). Chapters 4 and 5 contribute to the understanding of the potentially detrimental effects of lockdown on sexual and public health behaviours. Chapter 4 explicitly linked lockdown severity to decreases in condom use cross-culturally – regions with more severe instances of lockdown indicated a larger decrease in condom use. Multiple condom manufacturers during this time noted that sales of condoms declined during this time, and that there was no shortage of condoms at any stage (Porter, 2020; Tan, 2022; Taylor, 2020), further implicating lockdowns in the decrease of condom use, instead of a supply problem. Chapter 5 broadened the impact of lockdowns to more general sexual behaviours, finding associations between lockdown severity and changes in certain sexual behaviours – specifically, decreases in frequency of sexual behaviour, and solitary sexual behaviours. The negative impact of lockdowns was speculated in the early months of the pandemic (Wahlquist, 2020), but the research in this thesis finds empirical support for this claim in the domain of sexual activity.

This research also illustrated that COVID-19 vaccination uptake – another significant pandemic-related factor – was also related to declines in condom use across the included 18 countries. In Chapter 4, vaccination uptake across cultures served as a proxy measure for how

threatening COVID-19 was perceived in that region (assuming that regions that were more concerned about COVID-19 would display higher vaccination rates). Results suggested that concerns about COVID-19 were associated with diminishing concerns about condom use, and this may have had implications beyond condom use. For instance, commentary from researchers noted that increased expenditure towards COVID-19 prevention negatively impacted existing health eating campaigns (McGurk et al., 2021). Subsequent research during the pandemic has found expected trends of increases in unhealthy eating habits (Naughton et al., 2021) and obesity (Stavridou et al., 2021; Wu et al., 2022). Investigations of potential changes in health-related behaviours such as these as a function of vaccination uptake (controlling for other relevant variables, such as restricted movement due to regulation when assessing BMI changes) would provide further insight into how various health behaviours were disrupted in the wider pandemic.

While the present research used vaccination as a country-level indicator, concurrent studies indicate that vaccination uptake might also function as a salient predictor of future sexual activity at the individual level. One study found that MSM participants saw an uptick in their average number of sexual partners post-vaccination compared to their pre-vaccination period (Prestage et al., 2022). Such a finding aligns with the BIS, as speculated in the introduction to this thesis – the paucity of medical interventions for COVID-19 may have heightened BIS-related defences (e.g., fewer sexual partners), but as vaccines became more available, these defences began to wane. Thus, the implications of vaccination uptake transcend mere cultural shifts, offering insights into individual behavioural changes. The current thesis was able to consider vaccination on a country-level but was unable to assess individual vaccination due to data collection commencing prior to the development and rollout of COVID-19 vaccinations. Early research suggests, however, that including vaccination uptake at the individual level may be fruitful for future BIS-related research.

In sum, the present research provides some support for previously established links between disease threat and diminished sexual activity, but elsewhere illuminates areas in which other factors may be more notable than disease threat alone. Prior to the pandemic, researchers noted that evidence amidst a genuine disease outbreak would be necessary to further collective understanding of the BIS (Schaller et al., 2022). This thesis reaffirms that, while BIS-related motivations remain implicated in a pandemic situation, other factors need to be considered as well.

Limitations

LGBTQIA+ experiences. A recurring limitation of this thesis has been the exclusion of LGBTQIA+-specific experiences. Despite intentions to include a diverse sample within countries, only 4.8% of the current sample identified using a label other than 'straight' (see Table 6.1 for details). The lack of sufficient representation from LGBTQIA+ is, first and foremost, a function of their prevalence in the population – in the US, for instance, only 7.1% openly identify as LGBTQIA+ (Jones, 2022). Relatedly, the required minimum sample of 200 per country further minimised the likelihood of recruiting a sufficient sample of LGBTQIA+ people per country. This difficulty in recruitment of LGBTQIA+ people was further supplemented by the unequal acceptance across the sample countries. Of the 18 countries sampled, only 8 have legalised same-sex marriage. As such, it was likely difficult to recruit participants who freely reported being LGBTQIA+ in countries where such experiences are not socially or legally acceptable. Further, much research discussed in this thesis has included gay men's condom use – however, there were, on average, only 13 gay-identifying men across all countries. As such, this thesis did not isolate LGBTQIA+ experiences, as almost every country had insufficient sample sizes.

Nonetheless, the experiences of LGBTQIA+ during a time of significant disease spread will expand the findings of this research, particularly in relation to condom use. In

Chapters 3 and 4, we speculated that MSM's condom use might increase due to the relevance of this behaviour during the HIV/AIDS pandemic. In line with this hypothesis, there is early evidence of MSM adapting HIV-relevant sexual behaviours to the COVID-19 pandemic. Prior to development of COVID-19 vaccines, gay and bisexual men reported screening their sexual partners on whether they had recently been tested for COVID-19, an adaptation of screening partners based on recency of HIV/AIDS testing prior to COVID-19 (Gaspar et al., 2022). Similarly, after widespread availability of COVID-19 vaccines, MSM reported 'vaccine sorting' their sexual partners – that is, sorting potential sexual partners based on whether they had received two doses of COVID-19 vaccination (Daroya, 2022). Such sorting is particularly reminiscent of MSM sorting potential partners based on whether they are using PrEP (Martinez & Jones, 2019). Broadly, this provides evidence that MSM may have acquired certain behavioural defences against HIV/AIDS spread, and subsequently adapted those defences to be COVID-19-relevant. Specifically, it appears that the functional flexibility aspect of the BIS is most prominent with MSM, as MSM are seemingly adapting relevant sex-related behaviours from a HIV-setting to a COVID-19 one. Alternatively, future research could utilise the traditional experimental study design of cognitively priming COVID-19 threat to explore differences in intention to use condoms across heterosexual and homosexual men.

Table 6.1. *Number of non-heterosexual participants by gender per country*

	Gay/lesbian			Bisexual			Queer			Pansexual			Questioning			Asexual			Other		
	Male	Female	Other	Male	Female	Other	Male	Female	Other	Male	Female	Other	Male	Female	Other	Male	Female	Other	Male	Female	Other
Australia	5	5	0	4	30	0	3	8	0	0	6	0	3	4	0	0	2	0	0	1	0
Netherlands	4	6	0	4	18	0	2	1	0	2	1	1	0	1	0	1	3	0	1	1	0
Hong Kong	11	3	0	3	18	0	0	4	0	1	1	0	3	7	0	0	0	0	0	0	0
Thailand	20	30	2	8	33	0	2	11	0	5	44	0	1	3	0	2	4	0	1	11	1
Canada	16	27	0	12	75	0	1	18	0	4	10	0	1	11	0	1	9	0	1	3	0
Portugal	14	4	0	2	20	0	1	0	0	0	8	0	1	6	0	1	2	0	0	11	0
Hungary	19	2	0	2	8	0	0	1	0	1	4	0	0	4	0	1	5	0	1	5	0
UK	5	4	0	5	33	0	0	0	0	2	3	0	0	5	0	0	3	0	0	1	0
Lithuania	3	1	0	0	15	1	0	1	0	0	5	0	1	1	0	0	2	0	0	5	0
Philippines	4	1	0	5	13	0	2	1	0	0	7	0	1	2	0	2	0	0	0	1	0
Serbia	7	4	0	4	16	0	1	0	0	0	5	0	4	5	0	1	4	0	4	5	0
Vietnam	90	61	9	30	97	0	11	31	0	2	14	0	11	58	0	10	8	1	5	14	4
Uganda	1	1	0	9	4	0	1	0	0	0	3	0	15	10	0	7	1	0	20	26	0
Croatia	4	2	0	0	5	0	0	1	0	0	4	0	1	7	0	0	2	0	2	1	0
USA	15	15	0	11	63	0	1	4	0	1	13	0	0	15	0	1	4	0	1	3	0
Colombia	8	3	0	2	9	0	1	0	0	1	1	0	2	5	0	0	0	0	1	1	0
Taiwan	8	11	0	2	6	0	1	1	0	1	1	0	0	1	0	0	0	0	0	0	0
Spain	10	11	0	24	85	0	1	1	0	1	1	2	4	7	0	5	10	0	4	3	0
Total	244	191	11	127	548	1	28	83	0	21	131	3	48	152	0	32	59	1	41	92	5

Age. Another salient factor related to COVID-19 threat is age. Prior to the development of the vaccine, COVID-19 mortality rates increased substantially with age (Davies et al., 2020). In response to this, older populations seemed to adopt preventive measures, such as mask wearing, more rapidly. Initial COVID-19 incidence had a median age of 46, but this swiftly declined to 37, implying successful infection prevention among the older cohort (Boehmer et al., 2020). Conversely, the 20-29 age group registered the highest case rate across the pandemic, and this demographic was often associated with resurgences of COVID-19 across regions (Monod et al., 2020; Sasson, 2020). These findings suggest that young people, in particular, may have developed a certain tolerance towards the COVID-19 threat, given the lower morality rate at this age. This tolerance might have rendered other pandemic-induced factors more influential on sexual behaviours within the current thesis, as compared to the disease threat of COVID-19. Emerging studies among older populations will likely shed more light on these effects. For instance, it is plausible that disease threat might account for a larger portion of the observed variability in the decline of sexual activity among older individuals.

Recall bias. The largest limitation of this research is its reliance on recall of sexual behaviours. Participants in this research may have inaccurately recalled their sexual behaviours prior to the pandemic, either over- or underestimating reported changes in sexual behaviours. Such an approach is not ideal – however, at conceptualisation of this thesis, COVID-19 had already become a global issue, so we were unable to collect pre-COVID-19 data. Further, recollection of sexual behaviours has proved fruitful in some domains in the past – for instance, during the 1980s, recalling risk-taking sexual behaviours was a crucial first step in understanding the spread of HIV/AIDS (Coates et al., 1986; Joseph et al., 1987; Martin, 1986; McLaws et al., 1990; Saltzman et al., 1987). In a similar sense, it is hoped that

the research presented in this thesis is used to help inform future studies on sexual behaviours during COVID-19, or pandemics more generally.

Furthermore, modern research on recall of sexual behaviours provides evidence for its accuracy. When directly comparing recall behaviours to the same participant's diary entries, multiple studies have found a substantial association between recall and diary entries (Lachowsky et al., 2019; Lim et al., 2009; Mark et al., 2016). Further, results across this thesis suggest the directionality of effects is consistent. Declines in condom use were consistent temporally in Australia, at least over the first year of the pandemic, and nominal declines were observed in every included country. Similarly, significant decreases were observed over a range of sexual behaviours in multiple countries – increases were only observed in sexting behaviours in two countries (i.e., the UK and Spain). The near uniformity in directions across the current research reinforces the validity of these results, despite the potential bias in recalling behaviours.

It is also important to consider that these retrospective self-reports may have been subject to varying interpretations among participants. Consequently, the data might not exclusively represent actual behavioural changes but could also reflect participants' subjective perceptions of how their behaviours were altered during the pandemic, potentially swayed by external influences. For instance, widespread media coverage discussed declines in sexual behaviours (e.g., BBC, 2020), which may have shaped participants' recollections and assessments of their own sexual behaviours. Therefore, while providing valuable initial insights, the change scores reported in this thesis should be approached with caution. Specifically, there is a possibility that the effect sizes related to behavioural changes might be amplified or diminished due to these subjective interpretations.

Single item measures. It is important to note that condom use was assessed using a single-item measure for each time period (before and during COVID-19) in Chapters 3 and 4.

While single-item measures offer certain advantages, including brevity, they are typically more prone to random measurement error than multiple-item measures. This inherent limitation means that the reported changes in condom use might carry a higher degree of variability, potentially affecting the precision and reliability of the findings. Such measurement considerations have implications for the statistical power and interpretative confidence of the results, and underscore the need for cautious interpretation and further research employing more robust multi-item scales to capture changes in condom use.

Inconsistencies in dates of data collection. Another crucial methodological limitation is the variability in the interpretation of the 'during COVID-19' period. Unlike Chapter 3, where data collection occurred within a relatively narrow timeframe, the broader range of data collection dates in Chapters 4 and 5 (November 2020 to May 2021) introduces a degree of ambiguity regarding what constitutes 'during' COVID-19. Participants may have interpreted this phrase to mean various things, such as the current moment, an average across the past year, or the peak period of the pandemic prior to widespread vaccine availability. To minimise the impact of differing interpretations, the stay-at-home orders and vaccination rates were calibrated to specific dates of data collection in each country. Despite this, the potential misalignment between these objective measures and participants' subjective interpretation of the 'during' period still complicates the interpretation of the change scores themselves. Recognising this, future research should strive for more precise temporal definitions and consider the implementation of methodologies that minimize ambiguity in participants' interpretation of time periods. This might include providing explicit timeframes or events to anchor responses.

Limits of the historical prevalence of disease index. In Chapters 4 and 5, the historical prevalence of disease index (Murray & Schaller, 2010) was utilised to gauge historical pathogen threat across different regions. This index typically informs how historical

pathogen exposure has shaped cultural norms and practices, leading to individual differences regionally (e.g., extraversion; Schaller & Murray, 2008). However, in this thesis, it was employed to assess the effect of historical pathogenic threat on specific *behaviours* like condom use and sexual activities – a use that deviates from the norm and presents a conceptual limitation. Consequently, the findings of Chapters 4 and 5 associating behaviours with historical disease prevalence reported warrant cautious interpretation, pending further research that more definitively elucidates these relationships. Future research would particularly benefit from examining the mediating role of other country-level variables, particularly those related to cultural norms or cross-cultural individual differences.

Limits of the Behavioural Immune System. The BIS theory has been the primary framework guiding the investigation of changes in sexual behaviours in this thesis. However, Ackerman and colleagues (2021) note that modern pandemics present significantly different challenges compared to historical pathogen threats. A critical issue is the evolutionary mismatch. While our behavioural immune systems have evolved to detect visible cues of infection, they have not evolved in such a way as to incorporate modern aspects like asymptomatic spread (which is a recent scientific development that an evolutionary system, like the BIS, could not yet feasibly incorporate). This discrepancy suggests that the BIS might not fully account for, or effectively respond to, the complexities of the COVID-19 pandemic. Indeed, this is further supported by the findings of this thesis, such that factors like lockdowns had a more pronounced impact on sexual behaviours.

Additionally, Ackerman et al. (2021) highlight the profound influence of historical disease prevalence on the development of cross-cultural practices and norms. They argue that the BIS, while useful, may not be a sufficient standalone framework to understand behaviours across different contexts due to the diverse ways in which cultures and societies have adapted to pathogenic threats. The findings of this thesis, with the observed cross-cultural variations

in sexual behaviours, underscore this point. The BIS may have varying applicability across contexts, necessitating either adapted BIS frameworks for different cultural settings, or new theories altogether. As future research continues to explore the role of the BIS in response to pandemics, a more nuanced or contextually tailored understanding of pathogen-avoidant behaviour is anticipated.

Future directions

A noteworthy caveat of this research pertains to its inception during the early stages of the COVID-19 pandemic. The unprecedented global implications of the pandemic have inevitably incited countless empirical investigations into similar sexual behaviours in relation to the BIS, mirroring the scope of this thesis. Indeed, some studies referenced in this thesis have discussed how the concern of COVID-19 transmission motivates sexual behaviours (like frequency of intercourse), without directly invoking the wider BIS literature (Baran & Aykac 2020; Masoudi et al., 2022; Zhang et al., 2021), highlighting the expansive nature of COVID-19-motivated research into sexual behaviours alone. Although the cross-cultural approach of this research enriches and corroborates the findings, future meta-analytical approaches will prove crucial to furthering collective understanding of the interplay between the BIS and behavioural shifts during the pandemic.

Building upon this understanding, it is imperative to consider the findings of Chapter 3 within the evolving landscape of pandemic-related research. Chapter 3 presents initial findings that suggest message fatigue might have played a significant role in the observed decrease in condom use during the pandemic. It is important to note that this chapter was developed early in the pandemic, preceding much of the published work in this area. Consequently, the conclusions drawn should be viewed as preliminary. Recognising that behavioural changes, especially in the context of a global health crisis, are influenced by a complex interplay of factors — including but not limited to financial strain, stress, anxiety,

and interpersonal dynamics — it is apparent that message fatigue is unlikely to be the sole determinant of changes in condom use. Future research will undoubtedly uncover a more nuanced and comprehensive understanding of the various drivers affecting condom use during the pandemic and similar crises.

Another key discrepancy in this thesis, compared to pre-pandemic research, is that of disease threat's impact on condom use. This previous research found that disease threat promoted intentions to use condoms (Tybur et al., 2016), and complimentary evidence during the pandemic found similar patterns (Ma & Ye, 2021). However, the current research notably asked people to report actual condom use, rather than intentions to use condoms. This distinction potentially uncovers a pivotal area for subsequent exploration. Indeed, prior literature has highlighted the capacity of sex drive to supersede concerns related to disease threats (Al-Shawaf et al., 2019). As such, people in a pandemic may genuinely report an increased intent to use condoms while under disease threat, but this is overridden by sexual arousal, leading to diminished actual condom use. Understanding this dynamic is imperative to limit increases in STI spread, considering the likelihood of future disease outbreaks.

Real-world applications. In May 2023, the WHO proclaimed the end to the COVID-19 global health emergency (Wise, 2023). Initially, this might seem to limit the relevance of this research, considering its specific focus on disease threat and lockdown conditions. However, even before the emergency of COVID-19, epidemiologists have documented a rising trend in zoonotic diseases (Jones et al., 2008; Pike et al., 2014) propelled largely by climate change (Rupasinghe et al, 2022). As the climate changes, host animals migrate to new environments, introducing novel diseases to new hosts and broadly expanding the range of potential hosts for emergent infectious diseases (Rupasinghe et al., 2022). This dynamic can lead to unknown diseases entering human environments through displaced animals, subsequently transmitting these diseases to human populations. Indeed, current scientific

consensus posits that COVID-19 followed this pathway, jumping from animal hosts to humans at least twice in late 2019 (Pekar et al., 2022).

While it is hoped that future disease outbreaks will be contained, the likelihood of new outbreaks occurring, at least in isolated instances, is all but certain. One critical lesson from the COVID-19 pandemic pertains to the efficacy of lockdown measures. Despite their negative impacts – illustrated in this research alone – early and rapid implementation of lockdowns has proven effective in reducing disease case numbers and fatalities (Loewenthal et al., 2020). Therefore, it is plausible that similar measures will be employed to manage emergent diseases beyond COVID-19. Thus, the insights garnered from this research may prove valuable in identifying some areas requiring attention during future lockdowns – for instance, health campaigns promoting condom use, especially among young people, remain crucial during such health emergencies.

Final conclusions

The COVID-19 pandemic stands as one of the most profound global health crises in contemporary history, with far-reaching ramifications on various facets of human social behaviours. This thesis highlights the instrumental role of lockdowns in driving changes in sexual behaviours, while also enhancing our understanding of the cross-cultural implications of disease threat. While there is some evidence pointing to the influence of historical disease prevalence on sexual behaviours, the severity of lockdown measures consistently emerges as a more dominant factor in most sex-related domains in this thesis. Through this work, we gain a richer perspective on the multifaceted determinants shaping sexual behaviours amid expansive disease outbreaks.

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Appendix A: Ethics approval

THE UNIVERSITY OF SYDNEY

Research Integrity & Ethics Administration
HUMAN RESEARCH ETHICS COMMITTEE

Friday, 15 May 2020

Dr Ilan Dar-Nimrod
Psychology; Faculty of Science
Email: ilan.dar-nimrod@sydney.edu.au

Dear Ilan,

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

I am pleased to inform you that after consideration of your response, your project has been approved.

Details of the approval are as follows:

Project No.:	**2020/312**
Project Title:	**COVID-19 & Its Impact on Intimate Relationships**
Authorised Personnel:	**Dar-Nimrod Ilan; Dacosta Liam; Morandini James; Pinkus Rebecca;**
Approval Period:	**15 May 2020** to **15 May 2024**
First Annual Report Due:	**15 May 2021**

Documents Approved:

Date Uploaded	Version Number	Document Name
13/05/2020	Version 1	Research Data Store Management Plan
13/05/2020	Version 2	Participant Information Statement
16/04/2020	Version 1	Consent form
16/04/2020	Version 1	List of survey questions
16/04/2020	Version 1	Debriefing statement
16/04/2020	Version 1	SONA advertisement
16/04/2020	Version 1	Social media advertisement

Condition/s of Approval

- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
  - Serious or unexpected adverse events (which should be reported within 72 hours).
  - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).
- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.
- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.

- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of Research*, applicable legal requirements, and with University policies, procedures and governance requirements.
- The Ethics Office may conduct audits on approved projects.
- The Chief Investigator has ultimate responsibility for the conduct of the research and is responsible for ensuring all others involved will conduct the research in accordance with the above.

This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Associate Professor Helen Mitchell Chair
Human Research Ethics Committee (HREC 1)

The University of Sydney of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2007) and the NHMRC's Australian Code for the Responsible Conduct of Research (2007)

Appendix B: Invitation to collaborators

Dear [name],

I hope this email finds you well. I'm writing about an exciting project that I hope you might want to join as a collaborator. Together with colleagues listed below, we plan to conduct cross-national research on how dating, relationship, and sexual behaviour have been impacted by the outbreak of COVID-19. The University of Sydney team has secured an ethics approval, which allows for global collaboration and recruitment. We are currently inviting international researchers who could widen the scope of collaborating countries. We would be delighted to have you collaborate with us on this project. If you wish to also add one additional colleague (or student), please let me know as well.

As part of collaborating, we would ask that you are able to provide a minimum of 200 student participants and/or N > 400 community participants. The survey protocol has already been developed and ethically approved, so you may only need to disseminate the existing survey (~30 minutes in length), if your institute allows such dissemination for an externally approved study. If your institution also teaches primarily in a language other than English, we would ask that you translate the survey in advance as well. You are welcome to add items to the existing protocol (at the tail end), but this would not be covered by the existing University of Sydney ethics and would require approval from your own institution.

Being a collaborator will receive co-authorship on at least 2 multi-nation publications. Opportunities to lead some additional papers may present themselves as well at a later stage. Collaborating on this study provides a unique opportunity to understand changes in dating, relationship, and sexual behaviour during a global pandemic.

If you are interested in collaborating and can get access to a sufficient sample of participants, please send me a quick email, preferably over the next three working days, to let me know.

The core international collaborating group consists of:

Dr. Ilan Dar-Nimrod (The University of Sydney)
A/Prof. Damian Murray (Tulane University)
Dr. Rebecca Pinkus (The University of Sydney)
Dr. Veronica Lamache (The University of Essex)
Dr. James Morandini (The University of Sydney)
Mr. Liam Dacosta, PhD Candidate (The University of Sydney)

Appendix C: Supplementary material for Chapter 5

Table S1a. Gender and relationship status differences in changes in sexual frequency

	Gender					Relationship status				
	Women_B (M/SD)	Women_D (M/SD)	Men_B (M/SD)	Men_D (M/SD)	*p*-value	Single_B (M/SD)	Single_D (M/SD)	Coupled_B (M/SD)	Coupled_D (M/SD)	*p*-value
Australia	4.60 (1.82)	3.93 (2.00)	4.71 (2.29)	4.09 (2.53)	.887	3.75 (1.80)	2.84 (.154)	5.22 (1.88)	4.74 (2.22)	.194
Netherlands	4.70 (1.67)	4.75 (1.68)	4.49 (1.92)	4.31 (1.99)	.225	4.14 (1.55)	3.84 (1.74)	4.86 (1.75)	4.97 (1.70)	.018
Hong Kong	3.91 (1.86)	3.70 (1.92)	4.35 (2.00)	4.12 (2.69)	.885	3.96 (1.95)	3.56 (2.44)	4.02 (1.87)	3.91 (1.92)	.647
Thailand	4.85 (2.41)	4.55 (2.39)	5.58 (2.50)	5.65 (2.61)	.249	4.84 (2.26)	4.79 (2.34)	5.80 (2.74)	5.53 (2.86)	.398
Canada	4.58 (1.87)	4.26 (1.93)	4.81 (1.88)	4.19 (1.76)	.301	4.27 (2.04)	3.49 (1.79)	4.79 (1.77)	4.59 (1.84)	.007
Portugal	4.61 (1.93)	4.48 (2.01)	4.48 (1.80)	3.98 (1.73)	.196	4.40 (2.26)	3.69 (2.01)	4.66 (1.64)	4.65 (1.79)	.002
Hungary	5.05 (1.71)	4.54 (1.74)	4.25 (1.75)	4.06 (1.77)	.052	5.00 (1.73)	3.70 (1.81)	4.63 (1.77)	4.47 (1.72)	<.001
United Kingdom	4.51 (1.55)	3.97 (2.05)	4.89 (1.78)	4.59 (1.85)	.224	4.28 (1.50)	3.36 (1.41)	4.84 (1.64)	4.72 (2.26)	.005
Lithuania	2.11 (0.94)	1.92 (0.91)	2.06 (0.91)	2.00 (1.36)	.659	1.42 (0.70)	1.25 (0.58)	2.40 (0.86)	2.24 (1.00)	.189
The Philippines	3.57 (1.78)	3.21 (1.86)	3.87 (1.13)	3.07 (1.22)	.251	3.25 (1.29)	2.25 (0.55)	3.88 (1.63)	3.58 (1.79)	.087
Serbia	4.44 (2.07)	4.61 (2.31)	5.38 (2.85)	5.61 (3.06)	.650	4.61 (2.31)	4.53 (2.58)	5.00 (2.58)	5.35 (2.75)	.044
Vietnam	4.02 (2.32)	3.63 (2.39)	5.20 (2.84)	4.95 (3.18)	.418	4.35 (2.61)	4.14 (2.90)	4.41 (2.52)	4.00 (2.64)	.131
Uganda	4.98 (2.67)	4.91 (2.94)	5.08 (2.27)	4.69 (2.23)	.194	5.04 (2.14)	4.93 (2.61)	5.05 (2.48)	4.72 (2.45)	.427
Croatia	5.02 (1.57)	5.00 (1.67)	4.78 (1.79)	4.93 (1.85)	.728	4.08 (1.55)	4.23 (1.79)	5.05 (1.63)	5.06 (1.70)	.840
United States	4.43 (1.95)	4.41 (2.04)	4.60 (2.22)	4.57 (2.29)	.867	4.08 (2.03)	3.92 (2.13)	4.88 (1.98)	5.00 (1.98)	.068
Spain	4.67 (1.79)	4.26 (1.74)	4.26 (1.58)	4.19 (1.73)	.104	4.37 (1.90)	3.94 (1.69)	4.64 (1.67)	4.37 (1.74)	.799
Colombia	5.22 (1.92)	4.51 (2.00)	5.26 (2.05)	4.59 (2.26)	.645	5.27 (2.19)	4.48 (2.57)	5.21 (1.81)	4.70 (1.93)	.283
Taiwan	3.84 (1.24)	3.47 (1.23)	4.33 (1.57)	4.06 (1.26)	.812	3.73 (1.42)	3.00 (1.00)	4.00 (1.33)	3.73 (1.27)	.099

Table S1b. Interaction between gender and relationship status, on differences in changes in sexual frequency

	Single women_B (M/SD)	Single women_D (M/SD)	Coupled women_B (M/SD)	Coupled women_D (M/SD)	Single men_B (M/SD)	Single men_D (M/SD)	Coupled men_B (M/SD)	Coupled men_D (M/SD)	*p*-value
Australia	3.88 (1.86)	2.92 (1.56)	5.16 (1.59)	4.72 (1.96)	3.35 (1.58)	5.32 (2.31)	5.22 (1.88)	4.76 (2.61)	.583
Netherlands	4.29 (1.59)	4.09 (1.73)	4.86 (1.68)	5.02 (1.58)	3.89 (1.47)	3.43 (1.71)	4.85 (1.75)	4.85 (1.98)	.747
Hong Kong	4.25 (2.27)	3.69 (2.54)	3.79 (1.71)	3.71 (1.70)	3.55 (1.37)	3.36 (2.38)	4.02 (1.87)	5.50 (2.88)	.379
Thailand	4.82 (2.38)	4.57 (2.41)	4.90 (2.50)	4.52 (2.42)	4.88 (2.11)	5.09 (2.25)	5.80 (2.74)	6.63 (2.95)	.686
Canada	4.13 (2.05)	3.39 (1.76)	4.76 (1.76)	4.60 (1.88)	4.61 (1.98)	3.74 (1.85)	4.97 (1.80)	4.54 (1.61)	.704
Portugal	4.44 (2.35)	3.85 (2.20)	4.68 (1.71)	4.77 (1.85)	4.35 (2.16)	3.49 (2.19)	4.60 (1.46)	4.40 (1.61)	.958
Hungary	5.07 (1.53)	3.40 (1.18)	5.05 (1.75)	4.80 (1.74)	4.92 (2.02)	4.08 (2.39)	4.10 (1.66)	4.06 (1.62)	.239
United Kingdom	4.09 (1.45)	3.16 (1.32)	4.82 (1.55)	4.57 (2.29)	4.83 (1.53)	3.96 (1.52)	5.00 (2.18)	5.64 (1.91)	.284
Lithuania	1.38 (0.71)	1.22 (0.50)	2.40 (0.86)	2.20 (0.88)	1.58 (0.70)	1.25 (0.58)	2.36 (0.91)	2.47 (1.50)	.110
The Philippines	2.67 (1.03)	2.00 (0.00)	3.88 (1.90)	3.65 (2.00)	3.83 (1.33)	2.50 (0.55)	3.88 (1.63)	3.44 (1.42)	.546
Serbia	4.30 (2.04)	4.19 (2.46)	4.51 (2.09)	4.80 (2.23)	4.90 (2.52)	4.85 (2.66)	5.70 (3.02)	6.13 (3.21)	.856
Vietnam	4.14 (2.52)	3.72 (2.62)	3.97 (2.23)	3.60 (2.29)	4.63 (2.72)	4.71 (3.18)	5.72 (2.86)	5.16 (3.19)	.077
Uganda	4.67 (1.74)	5.00 (3.16)	5.08 (2.91)	4.88 (2.88)	5.26 (2.32)	4.88 (2.88)	5.04 (2.41)	4.64 (2.22)	.473
Croatia	3.83 (1.17)	4.33 (1.03)	5.12 (1.56)	5.05 (1.71)	4.29 (1.89)	4.14 (2.34)	4.88 (1.79)	5.09 (1.72)	.379
United States	3.96 (1.84)	3.78 (1.89)	4.83 (1.96)	4.95 (2.02)	4.29 (2.31)	4.16 (2.48)	5.02 (2.02)	5.13 (1.86)	.854
Spain	4.50 (2.00)	3.87 (1.72)	4.74 (1.69)	4.42 (1.73)	4.04 (1.60)	4.08 (1.64)	4.36 (1.57)	4.24 (1.79)	.389
Colombia	5.36 (2.16)	4.11 (2.11)	5.16 (1.81)	4.70 (1.94)	5.17 (2.27)	4.48 (2.57)	5.35 (1.85)	4.70 (1.94)	.335
Taiwan	3.43 (1.51)	2.86 (1.07)	3.90 (1.21)	3.56 (1.24)	4.25 (1.26)	3.25 (0.96)	4.36 (1.69)	4.29 (1.27)	.326

Table S2a. Gender and relationship status differences in changes in sexting behaviours

	Gender					Relationship status				
	Women_B (M/SD)	Women_D (M/SD)	Men_B (M/SD)	Men_D (M/SD)	*p*-value	Single_B (M/SD)	Single_D (M/SD)	Coupled_B (M/SD)	Coupled_D (M/SD)	*p*-value
Australia	2.38 (1.40)	2.22 (1.48)	2.46 (1.43)	2.23 (1.58)	.661	2.12 (1.34)	1.92 (1.43)	1.92 (1.43)	2.54 (1.53)	.926
Netherlands	2.05 (1.06)	2.07 (1.18)	2.08 (1.10)	2.04 (1.25)	.348	2.35 (1.14)	2.35 (1.36)	1.89 (1.00)	1.89 (1.06)	.649
Hong Kong	1.52 (0.88)	1.52 (0.99)	2.17 (1.45)	2.21 (1.58)	.831	1.50 (1.00)	2.09 (1.51)	1.99 (1.12)	2.10 (1.30)	.301
Thailand	1.46 (0.84)	1.34 (0.79)	2.08 (1.21)	2.00 (1.24)	.132	1.47 (0.88)	1.38 (0.84)	1.91 (1.16)	1.78 (1.15)	.364
Canada	2.63 (1.53)	2.56 (1.63)	2.58 (1.58)	2.40 (1.55)	.378	2.50 (1.61)	2.35 (1.63)	2.72 (1.47)	2.67 (1.60)	.496
Portugal	2.33 (1.41)	2.28 (1.48)	2.58 (1.43)	2.50 (1.48)	.734	2.47 (1.58)	2.39 (1.63)	2.37 (1.30)	2.32 (1.36)	.558
Hungary	2.41 (1.54)	2.02 (1.59)	2.35 (1.39)	1.99 (1.26)	.506	2.53 (1.50)	2.24 (1.60)	2.34 (1.46)	1.93 (1.40)	.461
United Kingdom	2.78 (1.57)	2.91 (1.83)	2.40 (1.50)	2.61 (1.74)	.487	2.41 (1.45)	2.31 (1.57)	3.13 (1.62)	3.63 (1.86)	.005
Lithuania	2.25 (1.34)	2.13 (1.37)	2.40 (1.63)	2.05 (1.39)	.323	2.13 (1.51)	1.83 (1.23)	2.33 (1.34)	2.23 (1.42)	.417
The Philippines	1.68 (1.25)	1.58 (1.13)	2.29 (1.51)	2.12 (1.61)	.636	1.61 (1.15)	1.50 (1.17)	2.33 (1.57)	2.18 (1.43)	.716
Serbia	2.31 (1.36)	2.27 (1.49)	2.75 (1.51)	2.27 (1.49)	.087	2.47 (1.38)	2.94 (1.64)	2.51 (1.48)	2.53 (1.58)	.552
Vietnam	1.38 (0.87)	1.31 (0.85)	1.99 (1.45)	1.88 (1.43)	.019	1.40 (0.96)	1.36 (0.95)	1.78 (1.25)	1.65 (1.22)	<.001
Uganda	2.80 (1.65)	2.71 (1.51)	2.92 (1.47)	2.41 (1.29)	.035	3.00 (1.35)	2.69 (1.10)	2.83 (1.60)	2.46 (1.47)	.999
Croatia	2.40 (1.39)	2.43 (1.46)	2.50 (1.20)	2.44 (1.29)	.321	2.02 (1.30)	1.89 (1.31)	2.62 (1.31)	2.68 (1.39)	.071
United States	2.44 (1.58)	2.48 (1.65)	2.65 (1.58)	2.69 (1.72)	.801	2.32 (1.54)	2.29 (1.57)	2.88 (1.75)	2.92 (1.76)	.070
Spain	2.78 (1.42)	3.09 (1.68)	2.57 (1.57)	2.67 (1.77)	.153	2.44 (1.40)	2.60 (1.64)	2.95 (1.50)	3.26 (1.73)	.356
Colombia	2.98 (1.41)	3.04 (1.63)	2.87 (1.56)	2.85 (1.74)	.890	2.88 (1.55)	2.73 (1.66)	3.00 (1.38)	3.16 (1.66)	.128
Taiwan	1.71 (1.07)	1.61 (1.09)	2.00 (1.32)	1.95 (1.37)	.656	1.43 (0.98)	1.37 (1.01)	2.10 (1.20)	1.98 (1.25)	.443

Table S2b. Interaction between gender and relationship status, on differences in changes in sexting behaviours

	Single women_B (M/SD)	Single women_D (M/SD)	Coupled women_B (M/SD)	Coupled women_D (M/SD)	Single men_B (M/SD)	Single men_D (M/SD)	Coupled men_B (M/SD)	Coupled men_D (M/SD)	*p*-value
Australia	2.07 (1.31)	1.85 (1.31)	2.76 (1.42)	2.67 (1.56)	2.28 (1.45)	2.11 (1.75)	2.58 (1.42)	2.32 (1.47)	.376
Netherlands	2.26 (1.15)	2.34 (1.38)	1.94 (1.00)	1.93 (1.03)	2.48 (1.11)	2.34 (1.38)	1.76 (0.99)	1.80 (1.11)	.101
Hong Kong	1.31 (0.80)	1.24 (0.73)	1.88 (0.92)	2.00 (1.18)	2.04 (1.32)	2.09 (1.51)	2.55 (1.76)	2.60 (1.78)	.315
Thailand	1.34 (0.74)	1.25 (0.67)	1.68 (0.98)	1.51 (0.94)	1.84 (1.14)	1.76 (1.12)	2.43 (1.22)	2.36 (1.33)	.237
Canada	2.52 (1.62)	2.38 (1.66)	2.71 (1.46)	2.68 (1.61)	2.44 (1.60)	2.25 (1.54)	2.77 (1.55)	2.61 (1.55)	.673
Portugal	2.29 (1.61)	2.25 (1.65)	2.35 (1.27)	2.29 (1.36)	2.76 (1.48)	2.62 (1.58)	2.41 (1.36)	2.40 (1.38)	.401
Hungary	2.56 (1.63)	2.15 (1.65)	2.37 (1.52)	1.98 (1.58)	2.49 (1.37)	2.35 (1.59)	2.30 (1.40)	1.88 (1.14)	.412
United Kingdom	2.49 (1.48)	2.33 (1.59)	3.17 (1.60)	3.66 (1.85)	2.17 (1.33)	2.24 (1.52)	2.91 (1.75)	3.45 (1.94)	.668
Lithuania	2.08 (1.42)	1.82 (1.18)	2.31 (1.31)	2.25 (1.43)	2.31 (1.85)	1.88 (1.46)	2.46 (1.52)	2.16 (1.38)	.888
The Philippines	1.41 (0.93)	1.30 (0.85)	2.19 (1.56)	2.10 (1.37)	2.09 (1.45)	1.98 (1.63)	2.64 (1.57)	2.38 (1.58)	.684
Serbia	2.21 (1.26)	2.06 (1.34)	2.39 (1.42)	2.42 (1.57)	2.83 (1.47)	2.94 (1.64)	2.68 (1.54)	2.69 (1.58)	.035
Vietnam	1.24 (0.70)	1.20 (0.68)	1.65 (1.10)	1.53 (1.08)	1.87 (1.37)	1.80 (1.37)	2.29 (1.60)	2.10 (1.55)	.342
Uganda	2.80 (1.39)	2.63 (1.20)	2.81 (1.77)	2.75 (1.64)	3.17 (1.30)	2.74 (1.02)	2.85 (1.51)	2.31 (1.34)	.505
Croatia	1.89 (1.28)	1.84 (1.36)	2.64 (1.38)	2.70 (1.43)	2.33 (1.32)	2.01 (1.20)	2.57 (1.16)	2.63 (1.30)	.317
United States	2.26 (1.55)	2.19 (1.52)	2.69 (1.59)	2.88 (1.75)	2.47 (1.52)	2.51 (1.65)	2.99 (1.65)	3.04 (1.81)	.096
Spain	2.68 (1.43)	2.91 (1.58)	2.86 (1.42)	3.22 (1.74)	2.05 (1.28)	2.09 (1.60)	3.19 (1.68)	3.35 (1.73)	.994
Colombia	2.82 (1.44)	2.67 (1.55)	3.08 (1.39)	3.26 (1.65)	2.97 (1.72)	2.83 (1.84)	2.76 (1.37)	2.88 (1.65)	.839
Taiwan	1.36 (0.91)	1.26 (0.83)	1.95 (1.10)	1.84 (1.18)	1.55 (1.09)	1.55 (1.25)	2.61 (1.39)	2.48 (1.37)	.571

Table S3a. Gender and relationship status differences in changes in solitary behaviours

	Gender					Relationship status				
	Women_B (M/SD)	Women_D (M/SD)	Men_B (M/SD)	Men_D (M/SD)	*p*-value	Single_B (M/SD)	Single_D (M/SD)	Coupled_B (M/SD)	Coupled_D (M/SD)	*p*-value
Australia	2.60 (1.49)	2.65 (1.63)	3.81 (1.60)	3.91 (1.75)	.606	2.79 (1.61)	2.91 (1.82)	3.15 (1.62)	3.15 (1.70)	.350
Netherlands	2.69 (1.33)	2.68 (1.45)	3.73 (1.56)	3.79 (1.69)	.659	3.21 (1.48)	3.20 (1.66)	2.96 (1.50)	2.98 (1.60)	.440
Hong Kong	2.07 (1.17)	2.07 (1.27)	3.52 (1.74)	3.47 (1.77)	.135	2.28 (1.51)	2.24 (1.54)	2.60 (1.30)	2.66 (1.39)	.564
Thailand	1.95 (1.21)	1.84 (1.16)	3.28 (1.60)	3.21 (1.70)	.425	2.11 (1.41)	2.02 (1.40)	2.70 (1.46)	2.57 (1.52)	.248
Canada	2.66 (1.49)	2.68 (1.50)	4.03 (1.61)	4.03 (1.78)	.502	2.98 (1.71)	3.11 (1.91)	2.94 (1.55)	2.87 (1.58)	.014
Portugal	2.28 (1.27)	2.25 (1.23)	3.49 (1.56)	3.45 (1.65)	.953	2.87 (1.56)	2.85 (1.57)	2.55 (1.42)	2.51 (1.43)	.336
Hungary	2.58 (1.36)	2.43 (1.47)	4.31 (1.49)	3.94 (1.58)	.243	3.77 (1.90)	3.64 (2.04)	3.21 (1.56)	3.08 (1.67)	.783
United Kingdom	2.64 (1.51)	2.62 (1.47)	3.85 (1.74)	3.79 (1.82)	.271	2.86 (1.60)	2.87 (1.67)	2.95 (1.69)	2.87 (1.54)	.039
Lithuania	2.66 (1.43)	2.66 (1.52)	3.95 (1.97)	3.63 (2.05)	.041	3.24 (1.86)	3.06 (1.84)	2.74 (1.48)	2.73 (1.58)	.138
The Philippines	1.81 (1.22)	1.86 (1.24)	3.67 (1.77)	3.73 (1.92)	.694	2.23 (1.59)	2.28 (1.66)	2.58 (1.69)	2.63 (1.76)	.694
Serbia	2.43 (1.57)	2.43 (1.61)	3.85 (1.75)	3.86 (1.86)	.838	3.01 (1.84)	3.00 (1.93)	3.02 (1.75)	3.03 (1.79)	.769
Vietnam	1.40 (0.91)	1.36 (0.88)	2.44 (1.63)	2.33 (1.60)	.047	1.61 (1.19)	1.56 (1.15)	1.75 (1.25)	1.68 (1.24)	.973
Uganda	1.93 (1.51)	1.72 (1.17)	1.83 (1.17)	1.67 (1.07)	.779	1.80 (1.33)	1.57 (1.04)	1.89 (1.29)	1.73 (1.13)	.614
Croatia	2.35 (1.43)	2.39 (1.48)	3.63 (1.76)	3.53 (1.85)	.202	2.64 (1.75)	2.69 (1.81)	2.78 (1.59)	2.75 (1.62)	.653
United States	2.17 (1.42)	2.17 (1.49)	3.91 (1.68)	3.83 (1.78)	.198	2.68 (1.66)	2.68 (1.74)	2.71 (1.76)	2.65 (1.77)	.662
Spain	2.85 (1.45)	2.77 (1.49)	4.35 (1.67)	4.19 (1.64)	.414	3.49 (1.71)	3.36 (1.71)	4.48 (1.63)	3.12 (1.64)	.298
Colombia	2.55 (1.43)	2.62 (1.54)	3.70 (1.57)	3.55 (1.64)	.237	3.09 (1.70)	3.08 (1.78)	2.78 (1.44)	2.78 (1.49)	.622
Taiwan	2.34 (1.42)	2.16 (1.45)	3.63 (1.84)	3.95 (1.77)	.312	2.64 (1.77)	2.51 (1.79)	2.76 (1.55)	2.61 (1.63)	.879

Table S3b. Interaction between gender and relationship status, on differences in changes in solitary behaviours

	Single women_B (M/SD)	Single women_D (M/SD)	Coupled women_B (M/SD)	Coupled women_D (M/SD)	Single men_B (M/SD)	Single men_D (M/SD)	Coupled men_B (M/SD)	Coupled men_D (M/SD)	*p*-value
Australia	2.57 (1.57)	2.67 (1.72)	2.63 (1.38)	2.62 (1.53)	3.45 (1.54)	3.65 (1.95)	4.05 (1.62)	4.10 (1.59)	.891
Netherlands	2.82 (1.48)	2.80 (1.70)	2.62 (1.24)	2.61 (1.30)	3.77 (1.30)	3.78 (1.42)	3.70 (1.76)	3.80 (1.89)	.626
Hong Kong	1.86 (1.15)	1.79 (1.12)	2.42 (1.14)	2.56 (1.35)	3.52 (1.78)	3.56 (1.85)	3.50 (1.67)	3.20 (1.52)	.017
Thailand	1.80 (1.15)	1.69 (1.06)	2.26 (1.27)	2.13 (1.29)	3.02 (1.68)	2.99 (1.77)	3.66 (1.39)	3.53 (1.55)	.392
Canada	2.54 (1.53)	2.69 (1.74)	2.74 (1.46)	2.68 (1.50)	4.06 (1.65)	4.14 (1.91)	3.99 (1.57)	3.88 (1.58)	.967
Portugal	2.45 (1.44)	2.36 (1.31)	2.16 (1.14)	2.18 (1.18)	3.53 (1.53)	3.62 (1.65)	3.45 (1.59)	3.28 (1.65)	.030
Hungary	2.83 (1.63)	2.52 (1.70)	2.51 (1.26)	2.40 (1.40)	4.97 (1.51)	5.08 (1.49)	4.11 (1.44)	3.94 (1.58)	.114
United Kingdom	2.52 (1.41)	2.49 (1.45)	2.79 (1.62)	2.79 (1.47)	3.86 (1.71)	4.01 (1.78)	3.82 (1.83)	3.29 (1.85)	.024
Lithuania	2.93 (1.72)	2.56 (1.30)	2.56 (1.30)	2/58 (1.41)	4.29 (1.98)	3.71 (2.03)	3.74 (1.98)	3.58 (2.12)	.310
The Philippines	1.71 (1.07)	1.78 (1.11)	2.00 (1.45)	2.00 (1.46)	3.50 (1.93)	3.50 (2.10)	3.98 (1.43)	4.15 (1.51)	.371
Serbia	2.40 (1.62)	2.37 (1.63)	2.46 (1.54)	2.47 (1.59)	3.84 (1.79)	3.86 (1.97)	3.86 (1.72)	3.87 (1.77)	.662
Vietnam	1.33 (0.83)	1.31 (0.81)	1.53 (1.02)	1.47 (1.01)	2.40 (1.63)	2.28 (1.59)	2.53 (1.63)	2.45 (1.62)	.120
Uganda	1.77 (1.41)	1.52 (1.03)	2.00 (1.55)	1.82 (1.22)	1.82 (1.28)	1.61 (1.06)	1.83 (1.14)	1.68 (1.08)	.994
Croatia	2.32 (1.72)	2.44 (1.86)	2.37 (1.29)	2.37 (1.29)	3.34 (1.65)	3.24 (1.62)	3.78 (1.82)	3.68 (1.97)	.608
United States	2.11 (1.35)	2.16 (1.50)	2.25 (1.51)	2.19 (1.48)	3.87 (1.61)	3.77 (1.72)	3.98 (1.80)	3.94 (1.90)	.112
Spain	3.03 (1.55)	2.98 (1.66)	2.71 (1.36)	2.62 (1.34)	4.25 (1.71)	3.96 (1.63)	4.48 (1.63)	4.45 (1.63)	.131
Colombia	2.59 (1.44)	2.58 (1.62)	2.53 (1.43)	2.64 (1.50)	3.87 (1.80)	3.86 (1.77)	3.50 (1.24)	3.20 (1.42)	.248
Taiwan	2.23 (1.50)	2.08 (1.56)	2.42 (1.36)	2.22 (1.38)	3.37 (1.99)	3.27 (1.93)	3.98 (1.60)	3.95 (1.77)	.582