Occupational Sedentary Behaviour and Mental Health among Software and Information Technology Workers in China: An Explanatory Sequential Mixed Method Design

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Abstract

Introduction: Excessive sedentary behaviour has been identified as a significant risk factor for physical health. However, the evidence concerning its impact on mental health is less consistent. While some studies suggest a detrimental association between total daily sedentary time and mental health, a growing body of inconsistent findings challenges this consensus, indicating that the relationship may be more complex and that not all forms of sedentary behaviour are equally harmful. Given that the workplace is a primary setting for extended daily sedentary periods, investigating the potential influence of occupational sedentary behaviour on mental health is therefore critical.

The Software and Information Technology (IT) industry in China is a large and rapidly growing workforce, characterised by predominantly computer-based work and a culture driven by efficiency. Consequently, employees in this sector are likely to spend substantial amounts of time being sedentary, and such inactivity could place them at risk of adverse physical and mental health outcomes. Crucially, there is a dearth of research that has specifically measured or collected data on their duration of occupational sedentary time. Concurrently, the absence of corresponding tailored intervention development for this population means both the scale of the problem and potential solutions remain unknown. Therefore, the overarching aim of this PhD research project was to develop evidence-based and theory-informed intervention strategies for Software and IT workers in China. The primary focus was on reducing occupational sedentary behaviour, while ensuring that implications for mental health remained a key consideration throughout the development of intervention strategies.

Methods: A systematic review and a two-phase explanatory sequential mixed-method design were conducted to achieve the overarching aim. The systematic review collated existing evidence and utilised the "Best-Evidence Synthesis" approach to determine the association between occupational sedentary behaviour and mental health symptoms among office workers. Phase 1 of the mixed-method study was a cross-sectional survey to: 1) examine the duration of

total and occupational sedentary behaviour and the level of mental health symptoms among Software and IT workers in China; 2) determine the association between occupational sedentary behaviour and common mental health symptoms; and 3) identify variables that may influence the association between occupational sedentary behaviour and common mental health symptoms. Phase 2 of the mixed-method study was a qualitative study to: 1) explore the barriers and facilitators of reducing occupational sedentary behaviour among Chinese Software and IT workers; and 2) understand Software and IT workers' perspectives on how occupational sedentary behaviour may influence their mental health. To inform the intervention recommendations, a weaving and joint display method were used to integrate findings from both phases.

Results: The systematic review showed mixed findings among office workers, with both positive and null associations between occupational sedentary behaviour and common mental health symptoms, suggesting insufficient evidence for a clear association.

The Phase 1 cross-sectional study found that Software and IT workers reported a mean occupational sedentary time of 427.9 (±133.2) minutes, while their total daily sedentary time reached 499.9 (±161) minutes on workdays. Occupational sedentary time accounted for 72.4% of working hours, equivalent to 347.52 minutes in an 8-hour day. The mental health outcomes indicated that Software and IT workers generally experienced low levels of perceived stress, while their average scores for depression and anxiety suggested a tendency towards mild symptom levels. Hierarchical regressions revealed that neither total or occupational sedentary behaviour showed a statistically significant association with depression or anxiety after adjusting for all potential confounding variables. However, total sedentary behaviour was significantly associated with stress. Occupational sedentary behaviour initially demonstrated a statistically significant association with stress, but the observed relationship between occupational sedentary behaviour and stress disappeared following adjustment for occupational variables (e.g., daily working hours, tenure, and job satisfaction) and poor sleep quality. Path analysis demonstrated that poor sleep quality potentially mediates the indirect

effect of occupational sedentary behaviour on stress. Longer tenure was identified as a confounding variable, demonstrating a negative association with both occupational sedentary behaviour and stress.

The Phase 2 qualitative study identified four themes capturing key factors influencing occupational sedentary behaviour, including barriers, facilitators, or both: (1) Industry-Driven Prolonged Sedentary Behaviour; (2) Company Influence on Occupational Sedentary Behaviour; (3) Automatic and Reflective Motivation to Reduce Occupational Sedentary Behaviour; and (4) Influence of Socialisation on Occupational Sedentary Behaviour. Three themes were identified to understand Software and IT workers' perspectives on how occupational sedentary behaviour may influence their mental health: (1) Physical Discomfort from Sedentary Work; (2) Pace of Software and IT Work; and (3) Beliefs about Occupational Sedentary Behaviour.

Conclusion: By employing a systematic review and an explanatory sequential mixed-methods design, several objectives were achieved through this programme of study: a better understanding of the relationship between occupational sedentary behaviour and mental health; the identification of factors influencing occupational sedentary behaviour in the Software and IT workplace in China; and the proposal of potential intervention strategies based on empirical and integrated findings. These findings contribute to the growing body of sedentary behaviour research and highlights the need for future research and practice. The thesis proposes that this could include exploring the mechanism between reducing sedentary behaviour and mental health outcomes; tailoring the intervention development in the workplace setting by taking into account the specific occupational characteristics of the target population; and discussing the potential for policy to mitigate the overtime culture that contributes to prolonged workplace sedentary behaviour. Future research and practice in Chinese workplaces can use the findings in this thesis as a basis for refining the intervention development.

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Thank my mom and dad, who may not be particularly interested in what I study but have always supported whatever I pursue. And thank you, Chufeng, for encouraging me to embark on this PhD journey. Without your inspiration, I might have become a mediocre comedian instead.

Author's Declaration

I declare that this thesis is my original work and has been composed entirely by myself. This work has not been submitted for any other degree or professional qualification. I confirm that the material presented in this thesis is my own, with the exception of content derived from jointly authored publications. My contribution and the contributions of all other authors to this collaborative work have been explicitly indicated below.

Publication

Chapter 2: Jin M, Swainson M, Wang C, Morris A. Systematic review: occupational sedentary behaviour and common mental health symptoms. Occup Med. 2025;75(6):275-81.

My contribution to this study, including leading all work, undertaking all analyses, and drafting the published paper, was 85%. Dr Morris and Dr Swainson contributed 10% in a supervisory capacity. Wang contributed the remaining 5% by conducting the dual-screening of papers for the systematic review.

Chapter 4: Jin M, Swainson M, Morris A. Exploring the pathway between occupational sedentary behaviour and mental health symptoms among software and information technology workers in China: a cross-sectional study with path analysis. [Under Review]

My contribution to this study, including leading all work, undertaking all analyses, and drafting the submitted paper, was 90%. Dr Morris and Dr Swainson contributed 10% in a supervisory capacity.

Chapter 5: Jin M, Swainson M, Morris A. Understanding the barriers, facilitators and experience of sedentary behaviour and perceived mental health in the software and information technology workplace in China: a qualitative study. [Under Review]

My contribution to this study, including leading all work, undertaking all analyses, and drafting the submitted paper, was 90%. Dr Morris and Dr Swainson contributed 10% in a supervisory capacity.

Communication

Chapter 2: Jin M, Swainson M, Wang C, Morris A. Exploring associations between occupational sedentary behaviour and mental health symptoms among adults: A systematic review [Oral presentation]. In: International Society for Physical Activity and Health (ISPAH) Congress; 2024 Oct 28–31; Paris, France.

My contribution to this study, including leading all work, undertaking all analyses, and drafting the published paper, was 85%. Dr Morris and Dr Swainson contributed 10% in a supervisory capacity. Wang contributed the remaining 5% by conducting the dual-screening of papers for the systematic review.

Chapter 1: Introduction

1.1 Background

1.1.1 Sedentary Behaviour and Health

Sedentary behaviour is defined as any waking behaviour characterised by an energy expenditure of ≤1.5 METs while in a sitting or reclining posture (1). This is a concept distinct from physical inactivity, which refers to not meeting the recommended level of regular physical activity (2). Physical activity, in turn, is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (3).

Although defined physiologically by energy expenditure and posture, sedentary behaviour is recognised as a complex construct occurring across four specific domains, including leisure, transport, household, and occupation (4). Moreover, researchers further distinguish between "mentally passive" (e.g., watching television) and "mentally active" sedentary behaviours (e.g., computer use or paperwork) (5). This distinction is important because, whereas mentally passive leisure sitting typically involves lower cognitive demand, mentally active occupational sedentary behaviour is characterised by sustained attention and ongoing cognitive load. Consequently, these forms of sedentary behaviour may constitute distinct exposures with differing psychological implications, beyond their shared physiological definition.

In China, the national physical activity guidelines recommend adults to achieve 150–300 minutes of moderate-intensity aerobic activity or 75–150 minutes of vigorous-intensity aerobic activity per week, or an equivalent combination of both (6). In addition, muscle-strengthening activities should be performed at least two days per week. The guidelines also emphasise the importance of reducing sedentary time. One of the overarching principles of these guidelines is to limit sedentary behaviour and maintain an active lifestyle on a daily basis. Critically, an individual may meet the recommended levels of physical activity yet still spend a large proportion of their time engaging in sedentary behaviours (7).

A growing body of evidence has revealed associations between prolonged sedentary behaviour and an increased risk of non-communicable diseases, including Type 2 diabetes (8), cardiometabolic disease (9), certain cancers (10), as well as all-cause mortality (11). Furthermore, evidence indicates that sedentary behaviour may represent an independent risk factor for both physical and mental health (12-14), regardless of physical activity levels. These findings highlight the importance of reducing sedentary behaviour. Although some studies have shown that high levels of moderate-intensity physical activity (i.e., about 60–75 minutes per day) may attenuate or even eliminate the increased risk of mortality (15-17), reducing sedentary behaviour remains important because the required activity levels are unlikely to be realistic for many individuals. For example, the suggested daily volume (i.e., about 60–75 minutes moderate-intensity physical activity) exceeds the upper limit of the physical activity guidelines in China, which recommend an equivalence level of 150–300 minutes of moderate-intensity aerobic activity per week. This is reflected in a study of 2,500 adults aged 20–79 years showed that only about half of the participants (56.8%) met the minimal national physical activity guideline in China (i.e., 150 minutes of moderate-to-vigorous physical activity) (18).

Given the health risks associated with sedentary behaviour, it has been identified as an economic burden for health systems globally. For example, an estimated total cost of £0.7 billion in the UK was attributable to prolonged sedentary behaviour in 2016–2017 (19). Costs attributable to high sedentary behaviour totalled roughly €1.5 billion in Finland in 2017 (20). A 2021 analysis conducted in Canada estimated that the economic burden associated with excessive sedentary behaviour reached $2.2 billion CAD (based on an 8-hours-per-day threshold), accounting for 1.6% of the nation's total illness-related costs (21). In China, although there were no direct estimations for sedentary behaviour, physical inactivity is imposing a substantial economic burden on the country, as it is responsible for more than 15% of the medical and non-medical yearly costs of the main non-communicable diseases (22). Sedentary behaviour was, therefore,

identified as a significant target for the primary and secondary prevention of multiple non-communicable diseases (23-25).

1.1.2 Sedentary Behaviour in the Workplace Context

Excessive sedentary time (≥ 6h) is highly prevalent in modern workplaces (26). With rapid technological development and heavy reliance on computers, many office workers spend a substantial portion of their adult lives in full-time desk-based employment, which leads to prolonged sedentary behaviour (27). Reducing sedentary behaviour is particularly important in the workplace.

Empirical evidence consistently highlights the high proportion of time office workers spend sedentary during working hours. For instance, one study (n=193) revealed that 77% of working hours of office workers were spent sedentary (28), and another study (n=231) found the figure to be 79% (29). Beyond these overall prevalence rates, a more detailed accelerometer-based study among 50 office workers in Australia has shown that office workers not only spend a high proportion of their work time sedentary (81.8%) but also engage in significantly longer uninterrupted bouts of sitting (≥30 minutes) and take fewer breaks (30).

Although high levels of moderate-intensity physical activity may attenuate the harm of sedentary behaviour to health (15), current data show that working adults spend a very small proportion (about 4%) of their day engaged in moderate to vigorous physical activity (31). Moreover, since work productivity is typically regarded as a key priority for employers, and workplace health interventions are evaluated not only by health outcomes but also by their potential influence on work productivity (32), reducing sedentary time may be a more realistic goal than expecting employees to substantially increase physical activity in the workplace setting (32). For example, workplace interventions focusing on standing have generally not been found to significantly influence productivity, while interventions incorporating walking and cycling have sometimes demonstrated negative impacts on productivity outcomes (33). Moreover, individuals who are highly sedentary during work hours often do not compensate by increasing physical activity outside

of work (34). This suggests that reducing sedentary behaviour during working hours may be one of the few opportunities to mitigate the associated health risks.

For these reasons, workplace strategies that aim specifically at reducing sedentary behaviour, such as replacing sitting with standing or light physical activity, are considered both important and more realistic for improving employee health and well-being.

1.1.3 Software and Information Technology Workplace in China

China's software and information technology services industry (hereafter referred to as the Software and IT industry) is a rapidly growing sector centred on software, integrating information technology with digital applications (35). In 2024, it generated 13,727.6 billion Chinese yuan in revenue, a 10% increase compared with the previous year (36), and employed over 9.4 million workers, constituting the world's largest Software and IT workforce (37).

The Software and IT industry primarily involves computer-based operations, which are widely recognised as desk-based work. Given their reliance on prolonged computer use, Software and IT workers in China may be exposed to high levels of occupational sedentary behaviour. However, no research to date has examined sedentary behaviour levels among Software and IT professionals in China.

Professionals in this industry often describe their occupational culture as driven by the pursuit of efficiency and the aspiration to deliver optimal outcomes for clients (i.e., software users) (38). Such a demanding culture may translate into long working hours, as exemplified by the "996" working pattern commonly observed in this sector in China, expecting employees to work from 9 am to 9 pm, six days a week (39). This high intensity work culture, combined with the rapid pace of technological obsolescence in the software sector, may contribute to a preference for a younger workforce. This is reflected in employers frequently favouring younger professionals, typically under the age of 35 (40), based on perceived physical stamina to sustain prolonged working hours and cognitive agility in acquiring new programming skills. Together, these factors underpin the so-called "age 35 phenomenon" in China's technology labour market (40).

Studies in the Chinese workplace have revealed that such prolonged working hours are associated with elevated risk of depressive symptoms and even all-cause mortality (41, 42). Moreover, psychological factors such as work pressure, depressive symptoms, and job satisfaction, often shaped by these working conditions, significantly influence the health status of Software and IT workers (43). Against this background, a comprehensive health focus may therefore need to prioritise the mental health of this growing population, as it underpins overall well-being and productivity in the industry (44).

Despite the intense work pressure, the software industry in China, particularly large internet enterprises, has increasingly adopted modern corporate wellness strategies to attract and retain talent in a highly competitive labour market (45). In contrast to traditional manufacturing or administrative sectors, these technology driven workplaces often feature more flexible organisational structures and open office layouts, such as flexible work arrangements (46), which may make them more receptive to non-traditional health interventions.

1.2 Problem Statement

The software and IT industry in China is a large and rapidly growing workforce, characterised by predominantly computer-based work and a culture driven by productivity. Employees in this sector are likely to spend substantial time sitting and to experience elevated work-related pressure, placing them at risk of adverse physical and mental health outcomes.

Given these characteristics, focusing on the health behaviours and mental health of Chinese Software and IT workers is essential. This aligns with the goals of the Healthy China 2030 National Strategy (47), which emphasises the promotion of healthy lifestyles, the prevention and control of non-communicable diseases, and the improvement of mental health at the population level. Developing evidence-based interventions tailored to this population is particularly important to reduce occupational sedentary behaviour and to support psychological well-being, while maintaining workplace productivity.

1.3 Conceptual and Theoretical Framework

1.3.1 Sedentary Behaviour and Mental Health Symptoms

The World Health Organisation (WHO) defines mental health as a state of well-being in which individuals are able to cope with the stresses of life, realise their potential, learn and work productively, and contribute to their communities (48). Recognised as an essential component of overall health, mental health underpins both individual and collective capacities to make decisions, foster relationships, and influence societal development (48). The support and promotion of mental health have become an emerging and important demand in the workplace because negative mental health conditions generate significant economic and productivity burdens for employers and society (49). In recognition of these challenges, the WHO has emphasised the need to prioritise preventive strategies and the promotion of mental health in order to mitigate the rising burden of mental disorders (50).

While the broad definition of mental health encompasses positive well-being, the focus of this thesis centres on the symptomatology of mental health problems, specifically depression, anxiety, and stress. This focus is grounded in an occupational health framework, where sedentary behaviour is investigated as a potential risk factor. In this context, detecting adverse outcomes (symptoms) serves as a critical preventive strategy, as mitigating psychological distress is the foundational prerequisite for achieving positive well-being.

Furthermore, the conceptualisation of mental health symptoms requires nuance, particularly regarding the distinction between stress and the more chronic states of depression and anxiety. Conventionally, stress is conceptualised as an immediate psychophysiological response to environmental demands (i.e., an acute reaction) (51), whereas depression and anxiety are typically characterised as enduring emotional states. This distinction informed the initial conceptual framework of this PhD programme. However, in high-demand occupational contexts such as the Software and IT sector, stressors are rarely transient. When “immediate” responses are repeatedly elicited without adequate recovery, stress

may develop into a cumulative, chronic burden (52). Accordingly, in this thesis, stress is conceptualised not merely as a transient reaction but as a potential indicator of accumulated occupational strain. This perspective facilitates an exploration of whether sedentary behaviour associates differently with stress compared to depression and anxiety, a complexity that is further explored in the Discussion chapter.

Existing studies increasingly explore the association between sedentary behaviour and mental health, suggesting that sedentary behaviour may be a potential risk factor for common symptoms such as depression, anxiety, and stress (53-55). For example, a cross-sectional study of 3,233 US adults and older adults applied an integrated statistical analysis of the 24-hour day, including sleep, sitting, and physical activity, and reported a detrimental association between sedentary behaviour and increased depressive symptoms (56). A randomised controlled intervention on physically active young adults was conducted to investigate the impact of inactivity on mental health (57). The intervention demonstrated a significant rise in anxiety scores after one week of experimentally increased sedentary behaviour (by eliminating exercise and limiting daily steps to ≤5000), with scores subsequently decreasing upon resumption of normal physical activity patterns. Furthermore, a cross-sectional study using wearable devices to assess daily sedentary behaviour in 61 healthy adults found that higher amounts of sedentary behaviour were associated with heightened stress reactivity, as indicated by diastolic blood pressure, total peripheral resistance, interleukin-6, and cortisol responses to an acute psychological stress test (55). Collectively, these studies provide converging evidence across diverse populations and methodological approaches that higher sedentary behaviour is linked to adverse mental health outcomes.

However, the findings have become increasingly inconsistent, as emerging evidence suggests that not all contexts of sedentary behaviour are associated with adverse mental health outcomes across different populations. For instance, a cross-sectional study examining device-assessed total and prolonged sitting time, moderate-to-vigorous physical activity, and mental health outcomes in adults

reported that higher total and prolonged sitting times were linked to elevated depression scores and poorer health-related quality of life, but not to anxiety, even after accounting for moderate-to-vigorous physical activity (58). Similarly, a longitudinal study with a two-year follow-up of older adults evaluated the impact of various sedentary behaviours, including television viewing, internet use, and reading, on mental health outcomes such as depressive symptoms and cognitive function. The study concluded that prolonged passive sedentary behaviour, such as television viewing, was associated with poorer mental health, whereas cognitively stimulating sedentary behaviours, such as internet use, were linked to more favourable mental health outcomes (59). Together, these studies underscore that the relationship between sedentary behaviour and mental health is type-specific and may vary according to the context studied (60).

However, although such evidence highlights the importance of context, most systematic reviews on sedentary behaviour and mental health have continued to treat sedentary behaviour as a single, undifferentiated construct. For instance, a systematic review and meta-analysis that synthesised evidence from 13 cross-sectional studies and 11 longitudinal studies concluded that sedentary behaviour is associated with an increased risk of depression (53). However, the studies included largely focused on total or leisure-time sitting, such as television viewing, internet use, or overall sitting duration. Similarly, systematic reviews and meta-analyses investigating anxiety and stress have also primarily examined total sedentary time or leisure-based sedentary activities (54, 61). The conclusions of these reviews therefore generalise the impact of sedentary behaviour on mental health as a whole, which risks extrapolating findings from leisure-time sedentary activities to sedentary behaviour in general. Such an approach may obscure important contextual differences and hinder the development of targeted and context-specific interventions.

Sedentary behaviour in the workplace, in particular, may exhibit a differential relationship with mental health outcomes (62), suggesting the need for domain-specific investigations. Nevertheless, evidence that specifically summarises the

relationship between occupational sedentary behaviour and mental health outcomes, particularly depression, anxiety, and stress, remains limited.

1.3.2 The Behaviour Change Wheel for Changing Sedentary Behaviour

The need to reduce prolonged occupational sedentary behaviour among Software and IT professionals in China has been established in the preceding sections. Developing intervention strategies, however, requires more than simply identifying the problem; it also necessitates a structured approach to understanding the target behaviour and designing strategies that are evidence-informed and theoretically grounded. The Behaviour Change Wheel provides such a framework, offering a comprehensive and systematic method for characterising behaviours and selecting intervention strategies (63, 64).

The Behaviour Change Wheel was developed in response to limitations in existing approaches to characterising and designing behaviour change interventions. A systematic review and expert consultation identified 19 behaviour change frameworks, which were evaluated against three criteria: comprehensiveness, coherence, and their linkage to an overarching model of behaviour. As none of the existing frameworks fully satisfied these criteria, the Behaviour Change Wheel was constructed to fill this gap. Its validity has been demonstrated in various health-related behaviour change interventions, including those targeting eating behaviour (65), smoking (66), and alcohol consumption (67). The most renowned application of the Behaviour Change Wheel in sedentary behaviour reduction is the Stand More AT (SMArT) Work intervention in the UK. This programme was explicitly developed using the Behaviour Change Wheel to address prolonged sitting in office workers (68). Participants in the intervention group reduced their sitting time by an average of 83.28 minutes per workday compared with controls after a 12 month intervention (69), providing strong evidence for the robustness of Behaviour Change Wheel-informed intervention development in reducing sedentary behaviour.

At the core of the Behaviour Change Wheel is the Capability, Opportunity, Motivation-Behaviour (COM-B) model (Figure 1.1) (70), which was created to

facilitate understanding of the behaviour targeted for change. The COM-B model conceptualises behaviour as part of a complex system arising from the interaction of three components: Capability, Opportunity, and Motivation. Capability refers to an individual's psychological and physical capacity to engage in the activity, including the necessary knowledge and skills. Opportunity encompasses external physical and social factors that make the behaviour possible or prompt it. Motivation refers to cognitive processes that energise and direct behaviour, extending beyond goals and conscious decision-making to include both reflective and automatic processes, such as habits, emotional responses, and analytical reasoning.

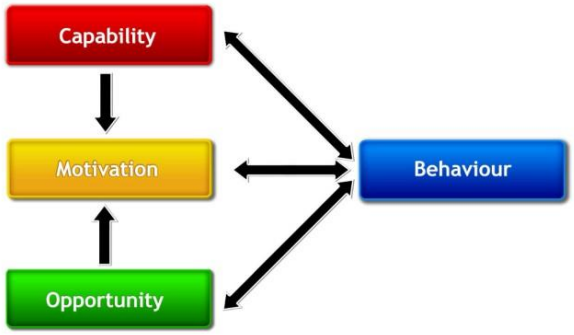

Figure 1. 1 The COM-B Model, Reproduced from (70).

To move from the broad components of the COM-B model to a more precise, theory-driven understanding of the barriers and facilitators to behaviour, the Theoretical Domains Framework (TDF) is often employed as a theoretically rich and detailed diagnostic tool. The TDF is an integrative framework that draws on 33 organisational and psychological theories and encompasses 128 key theoretical constructs related to behaviour change (71). It comprises 14 domains influencing behaviour (72). Importantly, the TDF and COM-B have been integrated in subsequent work (73), with each of the TDF's 14 domains mapped onto the COM-B model to provide a more detailed understanding of each factor. Surrounding the COM-B core and the TDF are nine intervention functions identified as influential to the behavioural determinants, and seven policy categories that enable implementation. (Figure 1.2)

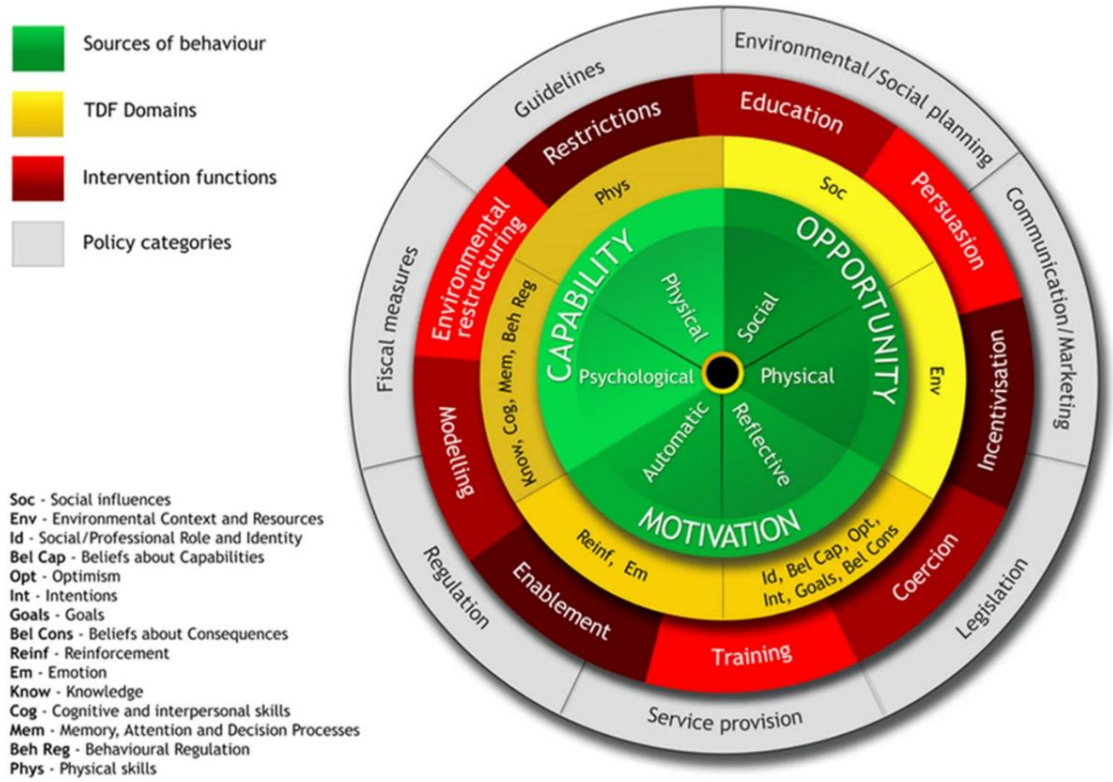

Figure 1. 2 Behaviour Change Wheel, Reproduced from (73).

The Behaviour Change Wheel therefore offers a comprehensive and coherent framework that links theory to practice through the systematic design of interventions, following a standardised approach comprising three main stages (Figure 1.3): (i) understanding the target behaviour; (ii) identifying intervention functions; and (iii) selecting content and implementation options. The first stage, understanding the behaviour, involves precisely defining the target action and identifying its drivers and barriers using the COM-B model. By recognising which components are absent or contributing to the problem, it becomes possible to determine what needs to change. This leads to the second stage: selecting Intervention Functions and Policy Categories. Based on the COM-B analysis, the Behaviour Change Wheel framework guides the choice of the most appropriate Intervention Functions (e.g., Education, Persuasion, Restriction) to address the identified barriers. Policy Categories (e.g., Service Provision, Legislation, Environmental Planning) are then selected to specify the mechanisms by which these functions will be delivered to the target population. The final stage involves selecting behaviour change techniques and the Mode of Delivery. At this point, the

chosen functions are translated into concrete, actionable components of the intervention, the specific behaviour change techniques (e.g., “Goal setting,” “Prompting practice”), which are both observable and replicable. Finally, the Mode of Delivery (e.g., app, face-to-face consultation, leaflet) is determined to finalise the design of a coherent, evidence-informed behaviour change intervention.

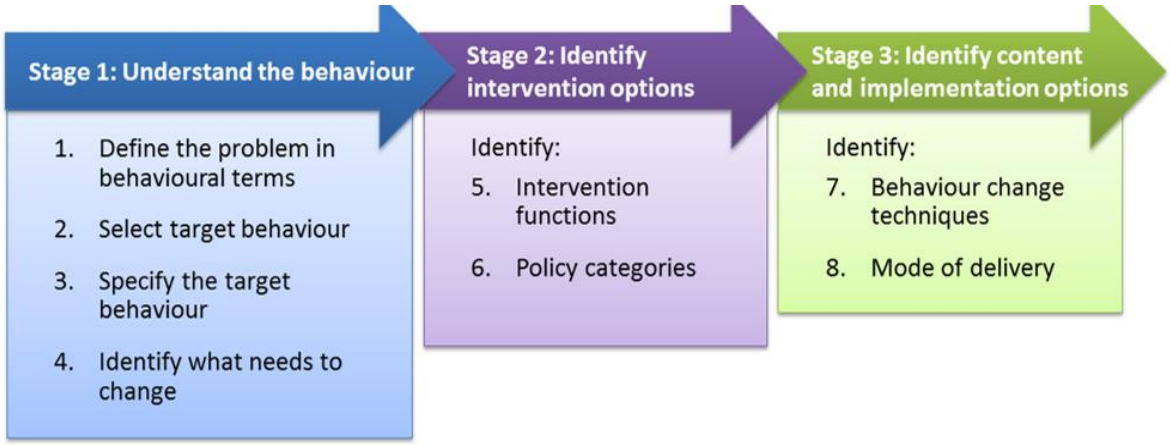

Figure 1. 3 The Behaviour Change Wheel Intervention Design Process, Reproduced from (63).

Overall, the Behaviour Change Wheel was selected for this thesis over other prominent behavioural or motivational theories initially considered, such as the Theory of Planned Behaviour (TPB) (74). While other models are effective in predicting behavioural intention, they primarily focus on individual-level determinants, including attitudes, beliefs, and self-efficacy. In the specific context of the Chinese software and IT industry, however, sedentary behaviour is likely to be shaped not only by individual motivation but also by wider contextual constraints. The Behaviour Change Wheel, together with its core COM-B model, explicitly incorporates Opportunity, encompassing both the physical and social environment, alongside Capability and Motivation. This structure enables a more holistic analysis of the complex interplay between workers and their social environments.

Furthermore, in contrast to theoretical frameworks that are primarily explanatory, the Behaviour Change Wheel was selected for its pragmatic utility in translational research (64). It provides a systematic framework linking diagnostic analysis using

COM-B and the Theoretical Domains Framework directly to evidence-based intervention functions, thereby addressing the specific aim of this thesis to inform the design of targeted intervention strategies.

1.3.3 Multi-Level Factors Influencing Sedentary Behaviour

While the Behaviour Change Wheel provides a robust and systematic framework for developing strategies to address drivers of behaviour, recent evidence suggests the importance of also considering broader contextual influences. For example, a recent scoping review highlighted the need for systemic and complementary interventions that address barriers across the micro-, meso- and macro-levels, and recommended integrating behavioural theories and techniques that capture this systemic nature of behavioural change (75). In this regard, the socio-ecological model provides a valuable complementary framework, offering a multi-level perspective particularly relevant to sedentary behaviour in workplace settings (76).

Specifically, the socio-ecological model was selected to complement the Behaviour Change Wheel by providing a structural framework. While the Behaviour Change Wheel establishes the importance of social and environmental influences on behaviour, the socio-ecological model offers a systematic means of identifying where these influences operate. In the context of this thesis, occupational sedentary behaviour maybe determined by immediate physical constraints, such as desk-based work, as well as embedded within a nested hierarchy of influences ranging from the macro-level of national health policy to the meso-level of organisational culture. Integrating the socio-ecological model in this way enables a structured stratification of these environmental determinants. This ensures that subsequent intervention design extends beyond the individual level to target the organisational and policy contexts that shape occupational sedentary behaviour.

Originally derived from Bronfenbrenner's ecological systems theory (77, 78), and subsequently refined for public health research (79), the socio-ecological model posits that health behaviours are the product of interactions among factors at the individual, organisational, community, and policy levels. In this thesis, the socio-

ecological model is crucial for ensuring that the analysis captures the full spectrum of determinants of occupational sedentary behaviour, which are systematically mapped to the following interacting levels:

1. Individual level: Factors residing within the employee, such as employees' knowledge (80), motivation (81), and self-regulation (82) are relevant.
2. Organisational level: The Software and IT workplace setting, such as workplace culture (83) and office design (84).
3. Community level: Broader social and industry systems, such as professional norms (85) and local infrastructures that shape behavioural expectations (86).
4. Policy level: Global and national regulation or guidelines on physical activity and sedentary behaviour, such as the WHO Global Action Plan on Physical Activity (GAPPA) 2018-2030 (87) and the Physical Activity Guidelines for Chinese (2021)(6), provide a macro-context within which workplace behaviours occur.

This multi-level framing serves as the guiding theoretical lens, highlighting the complexity of sedentary behaviour in the workplace. It underscores the need to consider not only the barriers to reducing sedentary behaviour, but also to identify where those barriers lie within the socio-ecological levels and provide insights into informing intervention strategies.

1.4 Research Gaps

Despite the growing literature on sedentary behaviour, the current body of knowledge is characterised by several significant gaps, particularly concerning specific populations and the relationship with mental health. These unresolved issues necessitate further investigation, which are outlined below across two key areas addressed in this thesis.

1. The Empirical Gap

Considering the nature of their work and inherent occupational demands, Software and IT workers in China are hypothesised to constitute a high-risk population for prolonged sedentary behaviour. However, there is a dearth of

research that has measured or collected data on their duration of occupational sitting. Concurrently, the absence of corresponding intervention development tailored for this population means both the scale of the problem and potential solutions remain unknown. Therefore, this thesis explicitly targets Software and IT workers in China to generate initial evidence, thereby addressing a crucial empirical gap.

2. The Knowledge and Contextual Gap

While the prevailing consensus suggests a detrimental association between daily total sedentary behaviour and mental health, a growing body of inconsistent findings challenges this generalised view, indicating that not all forms of sedentary behaviour are equally harmful. A critical knowledge gap arises from the way current systematic reviews and meta-analyses operate, as they frequently synthesise all types of sedentary behaviour data together, with the majority of studies included in published reviews focusing on leisure-time sedentary behaviour. This approach risks overstating the relevance of leisure-time sedentary behaviour by generalising its association with mental health to sedentary behaviour as a whole, thereby overlooking the importance of context. The relationship between occupational sedentary behaviour and mental health remains largely unexamined and unknown. This thesis therefore focuses on the occupational domain of sedentary behaviour to provide a more nuanced and context-specific understanding of its psychological effects.

1.5 Research Aim, Objectives, and Questions

The overarching aim of this PhD research was to develop evidence-based and theory-informed intervention strategies for Software and IT workers in China, with a primary focus on reducing occupational sedentary behaviour, while giving particular attention to the implications for mental health during the development of intervention strategies.

Research Objectives:

1. To examine whether occupational sedentary behaviour is associated with common mental health symptoms among Software and IT workers in China.
2. To identify barriers and facilitators influencing occupational sedentary behaviour among Software and IT workers in China.
3. To integrate empirical findings to inform the development of evidence-based and theory-informed intervention strategies.

Research Questions:

1. Is occupational sedentary behaviour related to common mental health symptoms (i.e., depression, anxiety and stress) among Software and IT workers in China?
2. What factors influence occupational sedentary behaviour among Software and IT workers in China?
3. How can the integrated findings from empirical studies in this PhD research inform the development of evidence-based and theory-informed intervention strategies for Software and IT workers in China?

1.6 Thesis Overview

This thesis comprises six main chapters following the introduction.

Chapter 2 presents a systematic literature review that synthesises existing evidence on the relationship between the occupational domain of sedentary behaviour and common mental health symptoms, specifically focusing on depression, anxiety, and stress. By critically appraising and integrating findings from previous studies, this chapter identifies key research gaps and provides the conceptual foundation necessary for the empirical components of the thesis.

Chapter 3 outlines the methodological framework, detailing the underpinning philosophical assumptions and the overall explanatory sequential mixed-methods design. It explains the rationale for adopting this integrated approach and describes the procedures undertaken to ensure methodological rigour and coherence across the research phases (Phase 1: quantitative; Phase 2: qualitative).

Chapter 4 presents the cross-sectional survey study (Phase 1) conducted among Software and IT workers in China. This quantitative study examines the patterns and prevalence of occupational sedentary time and common mental health symptoms within this occupational group, and explores the associations and potential underlying pathways linking these two constructs.

Chapter 5 presents the qualitative study (Phase 2), which involved focus groups and individual interviews with Chinese Software and IT workers. It aimed to identify the perceived barriers and facilitators to reducing prolonged occupational sedentary behaviour, and to explore how participants conceptually understand and perceive the relationship between sedentary work and their mental health.

Chapter 6 integrates and synthesises the empirical findings from the quantitative (Chapter 4) and qualitative (Chapter 5) studies using a weaving and joint display method. Drawing upon the Behaviour Change Wheel framework and socio-ecological model, this chapter combines these integrated insights to propose potential evidence-based and theory informed intervention strategies specifically tailored to reducing occupational sedentary behaviour and promoting mental wellbeing among Chinese Software and IT workers.

Chapter 7 discusses the overall findings of the thesis in relation to existing literature, theoretical perspectives, and the identified research gaps. It also reflects on the research design, methodological considerations, and the thesis's strengths, limitations, and key implications for future research and practice.

Chapter 2: Exploring Associations Between Occupational Sedentary Behaviour and Mental Health Symptoms among Adults: A Systematic Review

Publication:

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Communication:

- Jin M, Swainson M, Wang C, Morris A. Exploring associations between occupational sedentary behaviour and mental health symptoms among adults: A systematic review [Oral presentation]. In: International Society for Physical Activity and Health (ISPAH) Congress; 2024 Oct 28–31; Paris, France.

2.1 Introduction

The prevalence of common mental health disorders such as depression, anxiety and stress among working-age adults poses a critical public health concern, which significantly impacts individual well-being and productivity (88). In addition, poor mental health can adversely affect individuals' work performance, resulting in reduced pace, increased errors and elevated absenteeism (89). Globally, approximately 1 billion individuals suffer from mental health disorders, and it is estimated that the global economy incurs an annual loss of $1 trillion as a direct result of reduced productivity stemming from common mental health disorders, specifically depression and anxiety (90). Consequently, understanding the factors influencing mental health disorders is of significance to public health.

Daily sedentary behaviour in adults has been shown to be deleteriously associated with common mental health disorders with the risk of depression increasing by 5% for each hour accumulated of daily television watching (91). It is estimated that

adults spend about 8.2 h/day (ranging from 4.9 to 11.9 h/day) being sedentary (92). This might expose adults to a high risk of negative mental health outcomes.

Although previous research has consistently demonstrated a negative association between daily sedentary behaviour and mental health, recent studies have suggested a more nuanced perspective, indicating that not all forms of sedentary behaviour are linked to adverse mental health outcomes. Based on the social-ecological model of sedentary behaviour, there are different domains that have been identified, which include leisure and occupational sedentary behaviour (4). Current evidence predominantly shows positive associations between leisure-related sedentary behaviour and mental disorders, such as watching TV (91). However, there is evidence suggesting that office work–related sedentary behaviour is linked to lower hazards of mental disorders (93).

Considering that the workplace is an important setting where high volumes of daily sedentary behaviour are accumulated (94), and depending on the job role, desk-based work accounts for 60–90% of an individual's daily sitting time (34, 95). It is essential to determine whether there is an association between occupational sedentary behaviour and common mental health symptoms. Therefore, the aim of this review was to explore the potential associations between occupational sedentary behaviour and common mental health symptoms, including depression, anxiety and stress.

2.2 Method

The systematic review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (96). Data synthesis was conducted using a best-evidence synthesis approach (97), prioritising higher-quality studies in the analysis. The protocol was registered with PROSPERO (registration number: CRD42024517946).

2.2.1 Search Strategy

An initial systematic literature search was conducted in April 2023, and a further search was conducted in January 2024 to check for additional studies. The

following databases were used: PsycINFO, CINAHL, MEDLINE Complete, SPORTDiscus and Web of Science. The selection of databases was based on previous studies and advice from Lancaster University librarians. There were no restrictions on publication dates and language.

The key terms used were “sedentary behaviour”, “work”, and “mental health”. The MeSH terms (Medical Subject Headings) were used. Full search strings are included in the Appendix 1.

2.2.2 Study Eligibility Criteria

The inclusion criteria are as follows:

(i) The study included working-age adults (≥18 years old) who were employed in desk-based jobs (in person, not remote).
(ii) Participants had no chronic physical conditions, e.g. cancer or diabetes.
(iii) Any measurement of occupational sedentary behaviour was included, such as self-reported logs, questionnaires, standardised scales, pedometer and/or accelerometer device–based measurements.
(iv) Any measurement of mental health was included, such as standardised psychological scales, questionnaires and clinical diagnoses of mental health disorders.
(v) The study design included observational studies or experimental studies, such as cross-sectional studies, cohort (longitudinal) studies and randomised or non-randomised controlled trial interventions.
(vi) Intervention studies focused on the direct association between sedentary behaviour and mental health.

Exclusion criteria are as follows:

(i) Papers written in languages other than English.
(ii) No measurement or report of germane mental health issues (i.e. measuring well-being rather than depression, anxiety and stress);
(iii) Leisure or non-occupational sedentary behaviour.
(iv) Work from home.
(v) Study protocols.

(vi) Child, adolescent, or older adult participants.

(vii) Intervention studies that primarily aimed at promoting physical activity; and

(viii) Studies reported the effects of an intervention on either mental health or sedentary behaviour, but not their association.

Retrieved papers were initially input into EndNote for deduplication. All papers were then uploaded into the online systematic review tool, Rayyan (https://www.rayyan.ai/), for screening. The first and third authors independently conducted the screening process, including title, abstract and full text. Disagreements were resolved by discussion.

2.2.3 Data Extraction

A customised data extraction form was developed. Key elements extracted included general study information (authors, publication time, country) and methodological characteristics including the study design, participant characteristics (sample size, age, sex), occupational sedentary behaviour and its measurement, indicators and measurements of mental health and outcomes on the association between occupational sedentary behaviour and mental health.

2.2.4 Quality Assessment

The Joanna Briggs Institute (JBI) checklist for cross-sectional studies (98) was utilised for the methodological quality evaluation. It comprises eight items that assess the included studies based on sample selection, the validity and reliability of measurement, confounding factors and statistical analysis. This review adopted cut-offs from previous research while adhering to the JBI checklist authors' recommendation by presenting the results of the critical appraisal in a tabulated format for each question (99, 100). To assess the risk of bias, the studies' scores were categorised into three levels: a low risk of bias for studies with 70% or more of the items scored "Yes"; a moderate risk for those with 50%–69% "Yes" scores; and a high risk for studies scoring below 50% "Yes".

2.2.5 Main Outcomes

This systematic review investigated outcomes identifying a direct statistical association between occupational sedentary behaviour and mental health symptoms, including depression, anxiety and stress.

2.2.6 Strategy for Data Synthesis

This review used a best-evidence synthesis approach (97) to investigate the association between occupational sedentary behaviour and mental health. This is an alternative to meta-analysis and traditional narrative review, aiming to incorporate the 'best evidence' available (i.e. studies of the highest quality) to comprehensively analyse the included literature. The rationale for adopting this approach stemmed from the limited number of studies included and the heterogeneity in measures of effect across findings (i.e. odds ratio, risk ratio, correlation and prevalence), which made quantitative meta-analysis unsuitable. Meanwhile, the traditional narrative synthesis might face challenges of lacking transparency and replicability (101). The best-evidence method, however, has been widely used in previous systematic reviews examining the association between sedentary behaviour and health outcomes (61, 102, 103).

In this review, three levels of evidence strength were utilised. Strong evidence is defined as consistent findings derived from two or more high-quality studies. Moderate evidence encompasses two scenarios: either consistent result observed in one high-quality study alongside at least one lower quality study or consistent findings observed across two or more lower quality studies. Finally, insufficient evidence indicates either the availability of only one study or inconsistent results reported in two or more studies.

Consistent findings referred to at least 75% of the studies showing results in the same direction (103). Studies with weak quality were disregarded in the evidence synthesis if two or more studies were of strong or moderate methodological quality (61).

2.3 Results

2.3.1 Study Selection

The study selection procedure involved five steps, as illustrated in the PRISMA flow diagram (Figure 1). Of the 2401 identified records, five studies met the eligibility criteria and were included in the review. The majority of studies were excluded during the title (n = 1655) and abstract (n = 21) screening phase primarily for the following reasons: (i) focused on populations other than working-age adults, (ii) focused on physical activity, and (iii) focused on leisure sedentary behaviour. During the full-text screening stage, an additional 20 studies were excluded. Details of the procedure and exclusion reasons are shown in Figure 2.1.

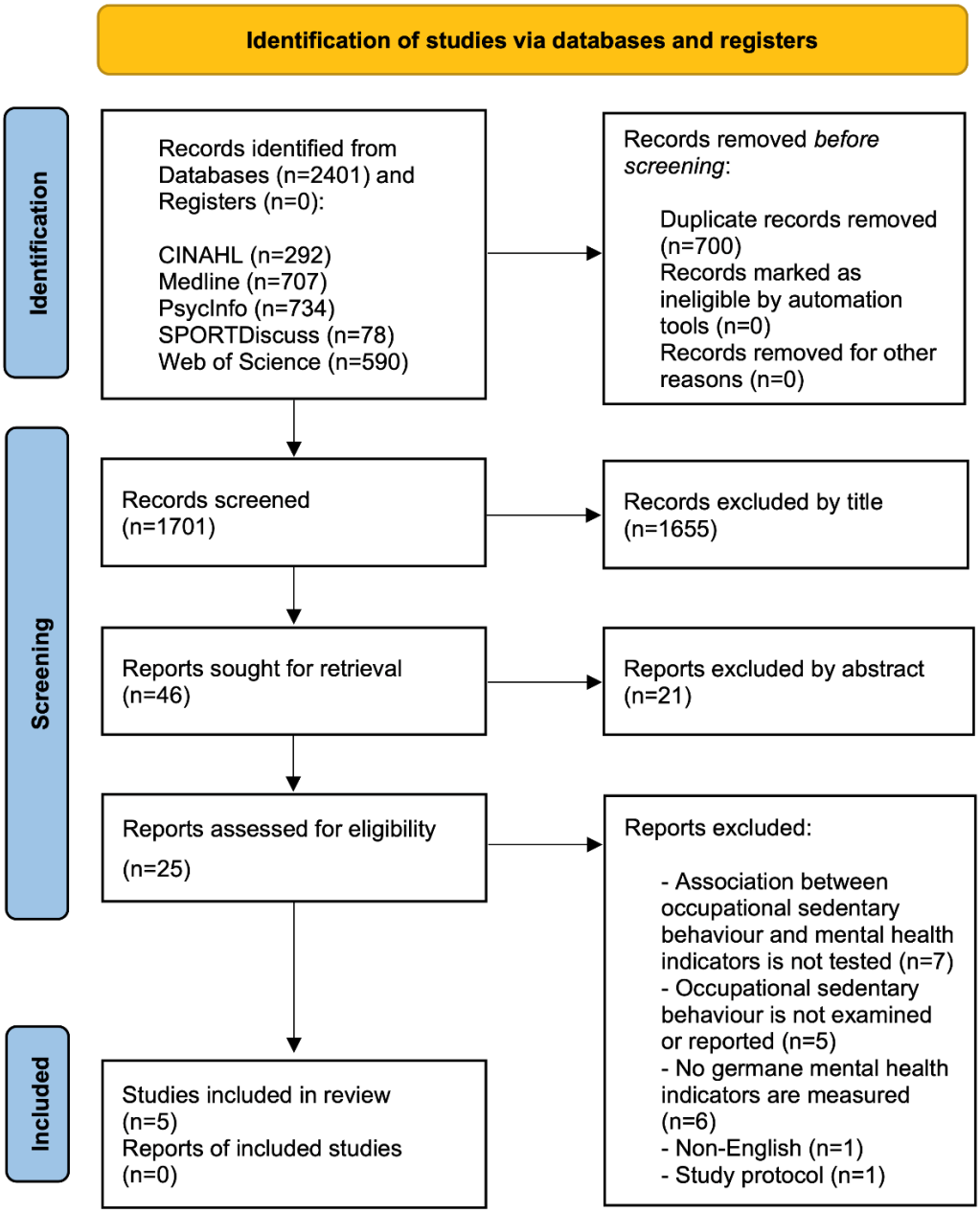

Figure 2. 1The PRISMA flowchart of the study.

2.3.2 Study Characteristics

The five studies involved a total of 29045 participants (ranging from 77 to 23644). Contributions were published between 2013 and 2021, originating from Australia (n = 2) (104, 105), Sweden (n = 1) (106), UK (n = 1) (107), and USA (n = 1) (108). All five articles were cross-sectional designs, with no longitudinal, interventional or experimental studies meeting the inclusion criteria. Detailed descriptions of each study are provided in Table 2.1.

Table 2. 1 Studies Investigating the Association Between Occupational Sedentary Behaviour and Common Mental Health Disorders.

Study	Study design and sample	OSB and Measurement	MH indicator(s) and Measurement	Outcomes
Kilpatrick, et al. (2013) (105) Australia	Cross-sectional study N=3367 Age=47 72% Female **Sector:** Public sector **Occupations:** State government employees	**Indicator:** Sitting at work **OSB levels:** Mean 287.5 min/day (~4.8 h/day) for men; Mean 252.4 min/day (~4.2 h/day) for women **Self-report measures:** First estimate time spent at the workplace, then estimate time spent sitting at the workplace.	**Components:** A state of emotional suffering characterised by symptoms of depression and anxiety **Self-report measures:** 10-item Kessler Psychological Distress Scale	In adjusted model: Men Moderate distress = + High distress = 0 Very high = 0 Women Moderate distress = + High distress = + Very high = 0
Rebar, et al. (2014) (104) Australia	Cross-sectional study N=1843 Age=58 55% Female **Sector:** Various sectors **Occupations:** General employed adults across 13 job levels (e.g., manager/administrator, professional, and labourer/related worker).	**Indicator:** Work sitting **OSB levels:** Median 2.0 h/day **Self-report measures:** 10-item Workforce Sitting Questionnaire	**Components:** Symptoms of depression, anxiety, and stress **Self-report measures:** 21-item Depression, Anxiety, and Stress Scale	Depression = 0 Anxiety = 0 Stress = 0
Ryde, et al. (2019) (107) The UK	Cross-sectional study N=77 Age=40.8 78% Female	**Indicator:** Occupational sedentary behaviour **OSB levels:** Mean 5.3 h/day	**Components:** Stress Biomarker: Hair cortisol	Biomarker = 0 Self-report stress = 0

Study	Study design and sample	OSB and Measurement	MH indicator(s) and Measurement	Outcomes
	Sector: Various (Office-based) **Occupations:** Desk-based employees	**Device-based measures:** Sitting pad	**Self-report measures:** 10-item Cohen Perceived Stress Scale	
Hallgren, et al. (2020) (106) Sweden	Cross-sectional study N=23644 Age=42 57% Female **Sector:** Various sectors **Occupation:** General employed adults	**Indicator:** Occupational sedentary behaviour **OSB levels:** 11% sat "almost always"; 21.3% sat "75% of time"; 18.9% sat "50% of time"; 18.2% sat "25% of time"; 30.7% sat "almost never". **Self-report measures:** Assessed with the question 'I sit still at work…' with five proportion responses.	**Components:** Symptoms of depression and anxiety Self-report measures: Assessed with the question 'I experience worry, depressed mood or anxiety…' with five frequency responses.	In adjusted model: Almost always = + 75% of time = 0 50% of time = 0 25% of time = 0 Almost never = 0
Gallagher, et al. (2021) (108) The USA	Cross-sectional study N=114 Age= 39 74.5% Female **Sector:** Various sectors **Occupations:** 14 common US occupations (e.g., retail sales, cashiers, food preparations, registered nurses, administrative assistants, office clerks, customer service, freight movers, waiters,	**Indicator:** Occupational sedentary behaviour **OSB levels:** Mean 29 min/hr (approx. 48% of work time). **Device-based measures:** Accelerometer	**Components:** Stress Self-report measures: Ecological Momentary Assessment (assess stress by a single item Likert scale from 1 to 10).	Average stress = 0

Study	Study design and sample	OSB and Measurement	MH indicator(s) and Measurement	Outcomes
	general operation managers, janitorial services, medical assistants, pharmacy technicians, and accountants).			

Note. OSB = occupational sedentary behaviour, MH = mental health; '+' = occupational sedentary behaviour is associated with worse mental health conditions/higher risk of mental health issues, '0' = no association is found or reported.

Occupational sedentary behaviour was assessed using both self-reported and device-based measurements across the included articles. Three studies utilised self-reported measurements, which included estimations of sitting time (105, 106) and validated questionnaires, i.e. the Workforce Sitting Questionnaire (104). Two studies employed device-based measurements, including sitting pads (107) and accelerometers, ActivPAL3 (108).

Mental health indicators were evaluated using self-reported measurements and biological indicators across the five articles. Two of the five studies examined the combined symptoms of depression and anxiety, including one study assessed by asking participants to rate their mental experience on a five-point scale (106), while the other used a standardised Kessler Psychological Distress scale (105). Another two of the five studies focused solely on assessing stress, with one utilising both a biological indicator (Hair Cortisol) and a standardized stress scale (Cohen Self Perceived Stress Scale) (107); one employing a self-reported ecological momentary assessment (108). The remaining study assessed all symptoms of depression, anxiety and stress individually using a standardised scale, i.e. Depression Anxiety Stress Scale (104).

Confounding variables were identified and measured by questionnaire or scale, including sex and gender (104-107), age (104-107), ethnic background (107, 108), income (104, 107, 108), education (104-106, 108), smoking status (106), marital or relationship status (105, 108), physical functioning (105), weight status (105), BMI (105, 106, 108), pain (106), presence of chronic conditions (104), self-reported perceived health (107), exercise frequency (106), light physical activity (105), moderate-to-vigorous physical activity (107), effort reward imbalance (work-related stress) (105), job level (104), employment status and work condition (105, 107), work category (105), average workday length (107), hours worked in the last 7 days (107), and qualification (107).

2.3.3 Risk of Bias in Studies

Overall, the included articles showed a moderate to low risk of bias. Four studies were rated as high-quality (low risk of bias) and one study was rated as moderate.

Consistent with the best-evidence synthesis approach, greater weight was given to the findings from the four high-quality studies when determining the strength of evidence. Rating details of each article are presented in Table 2.2.

Table 2. 2 JBI Checklist for Analytical Cross-Sectional Studies

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	%Yes	Risk of bias	Quality
Kilpatrick, et al. (2013)	N	Y	N	Y	Y	Y	Y	Y	75%	low	high
Rebar, et al. (2014)	N	Y	Y	Y	Y	Y	Y	Y	87.5%	low	high
Ryde, et al. (2019)	Y	Y	Y	Y	Y	Y	Y	Y	100%	low	high
Hallgren, et al. (2020)	N	Y	N	N	Y	Y	N	Y	50%	moderate	moderate
Gallagher, et al. (2021)	Y	Y	Y	Y	Y	Y	Y	N	87.5%	low	high

Note. Risk of bias was classified as high (0–49% affirmative responses), moderate (50–69%), or low (⩾70%). Abbreviations: Y = affirmative; N = negative; ? = unclear; N/A = not applicable. Checklist items: Q1 = Were the criteria for inclusion in the sample clearly defined?; Q2 = Were the study subjects and the setting described in detail?; Q3 = Was the exposure measured in a valid and reliable way?; Q4 = Were objective, standard criteria used for measurement of the condition?; Q5 = Were confounding factors identified?; Q6 = Were strategies to deal with confounding factors stated?; Q7 = Were the outcomes measured in a valid and reliable way?; Q8 = Was appropriate statistical analysis used?

2.3.4 Best Evidence Synthesis

In line with the predefined best-evidence synthesis criteria, only studies rated as high or moderate methodological quality were considered when determining the strength of evidence. Evidence strength was assigned based on both study quality and consistency of findings across studies. Table 2.3 summarises the resulting evidence classifications and the studies contributing to each synthesis outcome.

Of the five studies, three high-quality studies (60%) found null associations between occupational sedentary behaviour and mental health components (104, 107, 108). One high-quality study (20%) found positive associations between the two variables (105), and one moderate-quality study (20%) found mixed findings

(i.e. positive and null) (106). Based on the best evidence synthesis, there was insufficient evidence to determine the association between occupational sedentary behaviour and common mental health symptoms, due to the mixed results (i.e. positive and null associations) across the included studies.

Table 2. 3 Synthesis Results and Supporting Evidence

Synthesis groups and results		Supporting article (Quality)
Combined symptoms of depression and anxiety: Positive and no association (insufficient evidence)	×	(Kilpatrick et al., 2013) (high)
		(Rebar et al., 2014) (high)
		(Ryde et al., 2019) (high)
	×	(Hallgren et al., 2020) (moderate)
		(Gallagher et al., 2021) (high)
Depression: No association (insufficient evidence)		(Kilpatrick et al., 2013) (high)
	×	(Rebar et al., 2014) (high)
		(Ryde et al., 2019) (high)
		(Hallgren et al., 2020) (moderate)
		(Gallagher et al., 2021) (high)
Anxiety: No association (insufficient evidence)		(Kilpatrick et al., 2013) (high)
	×	(Rebar et al., 2014) (high)
		(Ryde et al., 2019) (high)
		(Hallgren et al., 2020) (moderate)
		(Gallagher et al., 2021) (high)
Stress: No association (strong evidence)		(Kilpatrick et al., 2013) (high)
	×	(Rebar et al., 2014) (high)
	×	(Ryde et al., 2019) (high)
		(Hallgren et al., 2020) (moderate)
	×	(Gallagher et al., 2021) (high)

Note. Crosses (x) indicate that the specific measurement was assessed or reported in the study. Only studies rated as high or moderate quality contributed to the best-evidence synthesis, in accordance with predefined criteria.

Regarding combined symptoms of depression and anxiety, a high-quality study demonstrated positive associations, whereas a moderate-quality study reported mixed results (positive and null associations). Given the inconsistency across studies and the limited number of high-quality studies, the evidence was therefore classified as insufficient. Specifically, one high-quality study investigated the association between work sedentary behaviour and psychological distress among employees (105). The study found that men who sit for more than 6h a day show a

higher prevalence of moderate psychological distress compared to those who sit for less than 3h a day. Similarly, women sitting for more than 6h a day experience a higher prevalence of both moderate and high psychological distress. One moderate-quality study found mixed results in examining the association between occupational sedentary behaviour and the frequency of combined depression and anxiety (106).

Regarding depression, only one high-quality study assessed this outcome and reported a null association. According to the predefined best-evidence synthesis criteria, the presence of a single study (despite high methodological quality) was insufficient to establish the strength of evidence, and therefore the evidence was classified as insufficient (104).

Similarly, for anxiety, evidence was derived from a single high-quality study reporting no association (104). As consistency across multiple studies could not be assessed, the evidence was classified as insufficient despite the high methodological quality of the available study.

Regarding stress, all three studies assessing this outcome were rated as high quality and consistently reported null associations. Based on the predefined best-evidence synthesis criteria, this was classified as strong evidence indicating a lack of observed association between occupational sedentary behaviour and stress. Specifically, one study used a standardised workforce sedentary behaviour scale and a mental health scale to explore the association, and no significant result was found (104). One study used device-based measurement to capture occupational sedentary behaviour and self-reported stress and found no association (108). The final one used objective measurement of both occupational sedentary behaviour and stress, and no association was found (107).

2.4 Discussion

From an occupational domain-centred perspective, this review found insufficient evidence to establish an association between occupational sedentary behaviour and common mental health symptoms. Specifically, for combined symptoms of depression and anxiety, mixed results were found, including positive and no

associations. For depression, anxiety and stress, individually, insufficient evidence indicates an association. However, with only five studies published specifically focusing on the work environment, it is clear that evidence is scarce in this area of research. To the authors' knowledge, this is the first systematic review to synthesise the evidence of associations between occupational sedentary behaviour and common mental health symptoms.

This review's insufficient evidence regarding an association between depression or anxiety and occupational sedentary behaviour contrasts with prior systematic reviews that have demonstrated total sedentary behaviour to be associated with an increased risk of these symptoms (53, 54, 109).

The primary factor contributing to this discrepancy is the scarcity of studies specifically focusing on sedentary behaviour within occupational contexts. This focus is crucial, however, given that a significant proportion of modern employment is predominantly sedentary with low physical demands (e.g. office work, vehicle operation, call centres). Although some autonomy regarding movement may exist, opportunities for physical activity during work hours are often constrained by the inherent nature of the work (27). Investigating the proportion of time spent sedentary during work and whether this differs from non-working hours can help inform workplace health and well-being strategies. Understanding sedentary patterns across diverse occupations is also beneficial for tailored intervention development, as occupations exhibit different regularities. For example, call-centre employees exhibited longer sedentary bouts than office workers (28).

Second, the nature of occupational sedentary behaviour may offer some protection for mental health, which could explain the discrepancy. This is because occupational sedentary behaviour inherently involves greater cognitive engagement, encompassing tasks that require working memory and logical reasoning. Cognitive engagement is associated with better mental health (110), and is a major component of "mentally active sedentary behaviour" (111). A recent meta-analysis suggests that "mentally active sedentary behaviour" is not associated with depression risk (111), a finding consistent with the null

association observed in this review. Depression and anxiety are common comorbid mood disorders (112), and research shows that both symptoms exhibit similar responses to risk and protective factors (113). This may explain why total sedentary behaviour is associated with an increased risk of both conditions, while cognitively engaging occupational sedentary behaviour does not.

Moreover, understanding the job characteristics is crucial when exploring the relationship between occupational sedentary behaviour and mental health. While occupational sedentary behaviour generally involves cognitive engagement, the varying levels of mental activity across occupations may have different impacts on mental health. Repetitive tasks in some job roles could be detrimental for mental health (114), such as assembly line. Future research should focus on specific occupations to identify their distinct characteristics that influence workplace behaviour and mental health outcomes. Meanwhile, employers are expected to take responsibility for preventing or managing these outcomes. For instance, the UK Health and Safety Executive advises stress risk assessments to help resolve related issues (115), whether stemming from overwork or boredom.

Regarding stress, all included studies found no association with occupational sedentary behaviour, aligning with a previous review on total sedentary behaviour that found insufficient evidence (61). However, current findings should be interpreted cautiously due to the limited number of studies. Unlike depression and anxiety, which are chronic mental disorders, stress is an immediate response to external pressures (51). Given this, a stronger association with occupational sedentary behaviour was anticipated, but none was found in this review. It is possible that unmeasured workplace stressors, such as job demands and workloads (116), may diminish sedentary behaviour's influence on stress. Therefore, further investigation is needed to explore the complex interplay between occupational sedentary behaviour, workplace stressors and stress, especially since unmanaged stress can escalate into chronic mental health disorders (117).

The included studies examined several confounding variables that could mediate or moderate the relationship between total sedentary behaviour and mental health. Sex and gender are important factors; one study showed sex contributes to

depression risk but not anxiety (104), while another found differential responses to occupational sedentary behaviour between males and females (105). Additionally, physical activity, known to benefit mental health, was found in three studies to attenuate certain effects of sedentary behaviour (104, 108). The cause and effect between occupational sedentary behaviour and mental health is challenging to define because it is multifaceted, dynamic and potentially bidirectional (118). Nevertheless, despite this complexity, current World Health Organisation (WHO) guidelines emphasise that reducing sedentary behaviour is important for health (119).

While this review followed rigorous, replicable methods, its findings should be interpreted cautiously due to limitations in the evidence. First, with only five studies included, the conclusions are inherently limited in generalisability and should be viewed as preliminary. However, the small sample size reflects the early stage of research into the nuanced impact of sedentary behaviour on mental health. Second, all included studies were cross-sectional, preventing causal inferences between occupational sedentary behaviour and mental health to be drawn. Nonetheless, attention was primarily given to sedentary behaviour's potential influence on mental health, as it is modifiable and aligns with public health recommendations [39]. Another limitation of this review is the heterogeneity in how occupational sedentary behaviour was measured across studies. This warrants cautious interpretation but also highlights the need for future reviews to include more consistent and objective measures, which aligns with the WHO's recommendation to incorporate device-based measurements (87).

In conclusion, this review examined existing cross-sectional literature on the association between occupational sedentary behaviour and common mental health symptoms. Although insufficient evidence was found to establish clear associations, the scarcity of research highlights several gaps for future studies, including (i) investigate the specific domain of occupational sedentary behaviour, (ii) use device-based measurements to understand sedentary behaviour patterns across different occupations and (iii) understand how job characteristics influence

the relationship between occupational sedentary behaviour and mental health. These efforts will contribute to developing targeted workplace interventions for reducing sedentary behaviour and promoting mental health

Chapter 3: Methodology and Methods

3.1 Introduction

The overarching aim of this PhD research project was to develop evidence-based and theoretically driven intervention strategies for Software and IT workers in China, with a primary focus on reducing occupational sedentary behaviour, while giving particular attention to the implications for mental health during the development of intervention strategies. To address this aim, an explanatory sequential mixed-methods design comprising two independent yet interconnected empirical studies was employed to investigate the following research objectives and research questions.

Research Objectives:

1. To examine whether occupational sedentary behaviour is associated with common mental health symptoms among Software and IT workers in China.
2. To identify barriers and facilitators influencing occupational sedentary behaviour among Software and IT workers in China.
3. To integrate empirical findings to inform the development of evidence-based and theory-informed intervention strategies.

Research Questions:

1. Is occupational sedentary behaviour related to common mental health symptoms (i.e., depression, anxiety and stress) among Software and IT workers in China?
2. What factors influence occupational sedentary behaviour among Software and IT workers in China?
3. How can the integrated findings from empirical studies in this PhD research inform the development of evidence-based and theory-informed intervention strategies for Software and IT workers in China?

This chapter outlines the overall methodology and methods employed across the subsequent studies within this PhD research. To begin, the philosophical stance

underpinning the study, namely critical realism, is presented alongside an explanation of its key concepts. The ontological and epistemological position informed the subsequent decision to pursue a sequential mixed methods design, which integrates both quantitative and qualitative approaches to address the research questions. This chapter then provides an overview of the two empirical phases, including the rationale and procedures for the two-phase data collection and analysis. Consideration is also given to ethical issues that arose throughout the research process, particularly in relation to sensitive topics, anonymity, and the potential for power imbalances. Finally, the chapter addresses the rigour of the study, discussing how validity, reliability, and trustworthiness were ensured across both quantitative and qualitative components respectively.

3.2 Critical Realist Research Philosophy

Critical realism is a philosophical paradigm that explains how knowledge develops, arguing that social science should explore not only patterns and regularities but also the underlying mechanisms that generate them (120, 121).

3.2.1 Ontological realism

Critical realism holds a position of ontological realism, affirming the existence of a reality that is independent of human awareness, perception, and knowledge (120). This reality has three overlapping domains as illustrated in Figure 3.1: the empirical, actual, and real (122). The empirical domain consists of experiences, that are events as they are observed or perceived. However, what could be observed is only a subset of what happened (120). The actual domain includes all events that occur, regardless of whether they are or can be observed. Critical realism posits that humans can never fully access the actual domain, as people's empirical observations are only partial and mediated by existing knowledge or theoretical frameworks (123). Finally, the real domain refers to the underlying structures and causal mechanisms that generate events. In critical realism, causal mechanisms are understood as the capacities or powers to produce outcomes (120). These mechanisms may not be directly observable, but their existence can be inferred from the outcomes they generate, which are observable in the

empirical domain. By examining patterns in these observed outcomes and considering the contexts in which they occur, researchers can reason about and infer the underlying causal mechanisms (124).

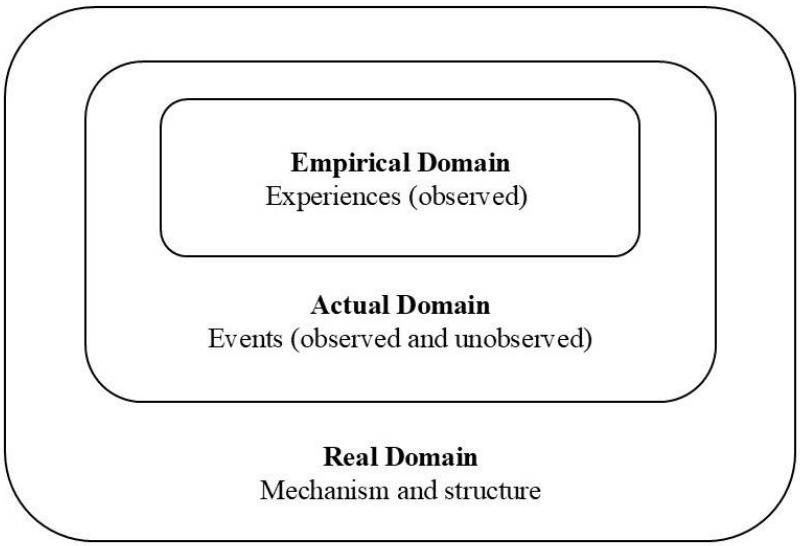

Figure 3. 1 Three Overlapping Dimensions of Reality in the Critical Realism, Adapted from (122).

In relation to this PhD:

A) The empirical domain includes self-reported occupational sedentary behaviour time and symptoms of depression, anxiety, and stress obtained directly from participants through surveys, as well as lived experiences of prolonged sedentary behaviour and mental health gathered through interviews, without addressing the underlying explanations of how prolonged sedentary time develops or the factors influencing mental health outcomes.
B) The actual domain includes employees' occupational sedentary behaviour and mental health as they exist in reality, independent of observation. While surveys or even more technologically advanced approaches (such as device-based measurements) can provide increasingly refined approximations, they still do not grant full access to the actual domain. This is because human behaviour is inherently complex and mental health is constantly changing,

meaning that the actual domain always exceeds what can be empirically captured.

C) The real domain related to the causes of occupational sedentary behaviour and mental health symptoms in the workplace. This includes exploring the barriers and facilitators to reducing occupational sedentary behaviour, as well as assessing whether there is a relationship between occupational sedentary behaviour and mental health.

3.2.2 Epistemological Relativism and Judgmental Rationality

The stratified reality of critical realism entails an epistemological relativism (123), which recognises that the human understanding of reality can be limited, partial, fallible, theory-laden, and socially produced (125). Though this fallibilism is widely acknowledged and accepted (126), critical realism maintains judgmental rationality, which posits the necessity of making judgments and decisions among diverse and often conflicting theories and evidence about reality (127), to reach the most plausible and accurate explanation of it.

An example of fallibility in sedentary behaviour research can be linked to previous explorations of the relationship between sedentary behaviour and mental health. While a previous meta-analysis indicated that total sedentary behaviour time increased the risk of mental health disorder (53), subsequent studies produced inconsistent and conflicting evidence. For example, a longitudinal study revealed that mentally active (i.e., cognitively engaging) sedentary behaviours, such as office work, may actually benefit adults' well-being (93). Another meta-analysis supported this direction by revealing that such mentally active sedentary behaviour did not associate with the risk of depression (111). The systematic review in the present PhD thesis further focused on the specific occupational domain of sedentary behaviour (Chapter 2) and found insufficient evidence for an association with mental health. Guided by epistemological relativism and judgmental rationality, it is important to note that studies exploring the relationship between occupational sedentary behaviour and mental health should acknowledge and prioritise exploring specific domains or context of sedentary behaviour (60, 61).

3.2.3 Rationale for Adopting Critical Realism

Critical realism is adopted as the underpinning philosophical paradigm for this PhD research because it aligns closely with the PhD project's aim. Critical realism emphasises that research should not only identify patterns and regularities but also uncover the underlying mechanisms that generate observable phenomena (120). In this PhD, outcomes such as occupational sitting time and common mental health symptoms can be measured directly. However, the causes of these phenomena, including why people engage in prolonged sitting and how sedentary behaviour relates to mental health, are not directly measurable through empirical indicators such as sitting time or mental health symptoms. The underpinning philosophical critical realist lens highlights the importance of systematically exploring these underlying mechanisms (128).

Critical realism is also focused on context. Social phenomena are shaped by specific settings in which causal mechanisms operate (129). Workplaces operate in real-world settings in which outcomes such as sedentary behaviour and mental health are likely shaped by the interaction of multiple causal mechanisms and contextual factors (120). These outcomes could not be controlled as they would be under experimental conditions. As emphasised in the Medical Research Council's guidance, effective intervention development requires an understanding of theories, contexts, and the underlying mechanisms of change (130, 131). The critical realist world view is therefore aligned well with the aim of the research on developing complex interventions in real-world workplace settings (132).

3.3 Mixed Methods Design

A mixed-methods design is adopted for this research because it can best address the research questions in this study. According to Creswell and Plano Clark's definition, several core characteristics define mixed-methods research (133). These include:

- Collecting and analysing both qualitative and quantitative data in response to research questions.
- Integrating or mixing the two forms of data and their results.

- Organising these procedures into specific research designs that provide the logic and procedures for conducting the study.
- Framing these procedures within theory and philosophy.

This section demonstrates how the characteristics of a mixed-methods approach supports the research design in this study.

3.3.1 Philosophical Foundation of Mixed Methods Design

The ontological depth of critical realism requires a methodological pluralism, which posits that the choice of method should be driven by the research aims, and a combination of methods can be beneficial to uncover the mechanisms of events (121, 124, 134). This position aligns well with mixed-method research, which embraces both quantitative and qualitative methods as diverse but compatible techniques for research (135).

Specifically, critical realism adopts not only deductive and inductive reasoning, but also emphasises abductive and retroductive inference (136). Abduction involves using existing theoretical frameworks and concepts to interpret phenomena, leading to new insights about those phenomena and the development of hypotheses that extended or refined existing theory (136). Retroduction aims to uncover the underlying mechanisms that produce the observed patterns, regularities, or new insights and hypotheses (136, 137). The use of multiple logical reasoning enables an iterative exploration between theory and data, allowing both qualitative and quantitative insights to inform a more comprehensive understanding of reality. This makes critical realism particularly well-suited for in this mixed methods research that sought not only to describe but also to explain complex social phenomena. Specifically in this research, this relates to understanding the prevalence of sedentary behaviour and mental health symptoms among Software and IT workers in China (Chapter 4), how occupational sedentary behaviour may relate to mental health symptoms (Chapter 4) and using qualitative findings to explain what factors influence individuals' occupational sedentary behaviour and mental health (Chapter 5).

The choice of critical realism, rather than pragmatism, across the studies included in this thesis was primarily driven by their differing foci in ontology and epistemology. Pragmatism views reality as dynamic and shaped through ongoing interactions between people and their environment, adopting a "what works" epistemological stance (133). This ontology and epistemology are indeed suitable and have been widely adopted as a philosophical foundation for mixed methods research. However, while pragmatism prioritises practical effectiveness by asking "what works", it often focuses on observable outcomes, which can be insufficient if the aim is to understand unobservable mechanisms (121, 138). Unlike pragmatism, critical realism explores causal mechanisms that underpin observable events, thereby providing the philosophical basis for the realist methodology's core question regarding "what works, for whom, in what circumstances, and why?" (132). This approach is grounded in the assumption that different methods are necessary to access different aspects of a complex reality (139). The present research questions, which include exploring the underlying mechanisms of occupational sedentary behaviour and its relationship with mental health, are particularly suitable to be addressed by the three-stratified ontology of critical realism, as it acknowledges the underlying "real" domain that generates observable events and patterns.

3.3.2 Rationale for Sequential Mixed Method Design

An explanatory sequential mixed-methods design was adopted because addressing the research questions required fulfilling two critical characteristics of a mixed-methods approach. First, quantitative data, such as self-reported occupational sitting time and mental health symptoms captured through surveys, offer a broad understanding of patterns within the target population. Subsequently, qualitative data on the lived experiences of barriers and facilitators to reducing occupational sedentary behaviour were collected to provide deeper insights and help explain the quantitative findings, offering contextual understanding that surveys alone cannot capture. To examine the relationship between occupational sedentary behaviour and mental health symptoms, it was deemed necessary to establish statistical associations as well as identify influencing factors. These

influencing factors also required investigation through quantitatively examining potential mediators and moderators and qualitatively exploring participants' perceptions of how occupational sedentary behaviour may influence mental health.

Second, the integration of both data types is essential to address the research questions comprehensively. Quantitative findings alone reveal statistical associations between occupational sedentary behaviour and mental health, but they cannot explain the potential reasons or contextual factors underlying these associations. Conversely, qualitative findings alone provide insights into lived experiences and perceived influences of occupational sedentary behaviour on mental health, but they cannot establish the generalisability or strength of the relationship (140). Integrating both strands allowed the study to link measurable patterns with explanatory insights, thereby informing the development of evidence-based and theory informed intervention strategies. While evaluating the effectiveness of such strategies lies beyond the scope of this thesis and warrants future investigation, the integrated findings provide a critical foundation for future intervention design in the Software and IT sector, an arear which is currently understudied.

3.3.3 Study Design and Approach

This thesis employed a case-selection variant of an explanatory sequential design, which began with quantitative research and was followed by qualitative interviews. This variant is employed when a researcher's primary aim was the qualitative examination of a phenomenon, but initial quantitative findings were necessary to identify and intentionally choose the most suitable participants (133). In the ordinary explanatory sequential design, the subsequent qualitative phase typically aims to explain the quantitative results (133). However, in the case-selection variant, the qualitative phase was prioritised over the initial quantitative phase (133). In this thesis, the qualitative phase explored an independent research aim while also explaining and expanding the quantitative findings.

Following the establishment of the research background and theoretical framework (Chapter 1) and a systematic review of existing evidence (Chapter 2), important gaps were identified. Phase 1 of the quantitative study aimed to partially fill these gaps through a cross-sectional survey. Subsequently, in Phase 2, a qualitative study further addressed these gaps using focus groups and individual interviews.

3.4 Overview of Empirical Phases

Gaps from the research background and systematic review identified insufficient evidence regarding the association between occupational sedentary behaviour and mental health; a scarcity of focus on the occupational domain of sedentary behaviour; and a limited focus on specific occupations' behaviour patterns and job characteristics. This lack of evidence highlighted the need for primary empirical research to further explore this relationship within a specific occupational context.

Building on these identified gaps, this thesis examined an occupational group within a clearly defined demographic context. Software and IT workers who were chosen because sedentary work posed a substantially higher occupational exposure risk for them compared to all other occupations (141). Moreover, the Chinese context was the focus of this research, because China hosts the world's largest Software and IT workforce, comprising over 9.4 million professionals in this sector (37).

3.4.1 Phase 1: A Quantitative Cross-Sectional Survey Exploring the Pathway Between Occupational Sedentary Behaviour and Mental Health Symptoms Among Software and Information Technology Workers in China

This empirical study involved a cross-sectional survey study among 4 Software and IT companies in China. Detailed information regarding recruitment, data collection, and data analysis can be found in Chapter 4. This study phase provided an overview of the Software and IT population, including their sociodemographic

characteristics, occupational sedentary time, and prevalence of common mental health symptoms. Phase 1 aimed to:

1) describe the patterns and prevalence of sedentary behaviour and common mental health symptoms among the Software and IT workers,

2) determine whether there is an association between occupational sedentary behaviour and common mental health symptoms, and

3) identify variables that may influence the association between occupational sedentary behaviour and common mental health symptoms.

Phase 1 was directly informed by the findings of the systematic review, which highlighted both the inconsistency of existing evidence and the lack of quantitative data focusing specifically on occupational sedentary behaviour. As such, the cross-sectional design was selected as an exploratory approach to establish baseline patterns of occupational sedentary behaviour, test associations, and identify potential influencing factors within a specific occupational group.

Guided by critical realism, the underlying drive of this research was to explore the association between occupational sedentary behaviour and mental health. Path analysis, a statistical technique used to explore causal relationships between variables, was chosen to help explain the relationships among occupational sedentary behaviour, mental health, and identify potential covariates (142).

As presented in Table 3.1 and Figure 3.2, Phase 1 addressed Research Question 1.

3.4.2 Phase 2: A Qualitative Exploration on the Barriers, Facilitators, and Lived Experience of Workplace Sedentary Behaviour and Mental Health Among Software and Information Technology Workers in China

This phase involved a qualitative study conducted through focus groups and individual interviews at one of the Software and IT companies that participated in Phase 1. The company was selected following their involvement in Phase 1 and because its employees reported the longest hours of occupational sedentary behaviour in the Phase 1 cross-sectional survey. This purposive selection was

informed by quantitative findings and aimed to maximise the relevance and depth of qualitative insights.

Given the thesis's primary focus on developing evidence-based intervention strategies to reduce sedentary behaviour; an occupational setting where Software and IT employees reported spending high volumes being sedentary was deemed appropriate for revealing barriers and mechanisms which would be helpful for understanding mechanisms and causality (143). Detailed information regarding recruitment, data collection, and data analysis of Phase 2 can be found in Chapter 5.

In line with critical realism's emphasis on uncovering causal mechanisms, Phase 2 sought to understand the factors contributing to employees' prolonged sedentary behaviour, mental health and the underlying mechanisms of this relationship. Specifically, this phase explored

1) the barriers and facilitators of occupational sedentary behaviour in the workplace;

2) participants' perceptions of how occupational sedentary behaviour may influence their mental health.

Phase 2 was directly informed by the findings of the cross-sectional study in Phase 1. Findings from Phase 1 indicated that occupational sedentary behaviour was highly prevalent among software and IT workers, yet no direct association with overall mental health outcomes was observed. Several potential influencing factors were identified, suggesting that the relationship between occupational sedentary behaviour and mental health is complex and shaped by contextual mechanisms.

By exploring participants' interpretations, Phase 2 sought to provide explanatory insights into why prolonged and prevalent self-reported occupational sedentary behaviour was observed, why a direct quantitative association was not identified in Phase 1, and how contextual, organisational, and individual-level mechanisms may shape the relationship between occupational sedentary behaviour and mental health.

As presented in Table 3.1 and Figure 3.2, Phase 2 addresses Research Question 2 and provided insights relevant to Research Question 1.

3.4.3 Data Integration

In line with the mixed methods approach adopted, data integration occurred at both the design and interpretation stages. At the design stage, quantitative results guided the qualitative phase by informing the selection of the most suitable sample. At the interpretation stage, qualitative findings were used to explain and expand upon the quantitative patterns, providing triangulation and offering insights into the relationships from participants' experiential perspectives (144). Both weaving and joint display approaches were employed to integrate the two strands of this explanatory sequential mixed-methods study. Weaving is a narrative integration approach in which qualitative and quantitative findings are presented together on a theme-by-theme or concept-by-concept basis (145). A joint display, in contrast, provides a structured visual juxtaposition of quantitative and qualitative findings within a single framework, thereby making the process of integration explicit and transparent (145). As presented in Table 3.1, findings from both studies were subsequently integrated to inform the development of intervention techniques guided by the Behaviour Change Wheel (64). This process directly addressed Research Question 3, which concerns how the integrated findings from this PhD project can inform the development of evidence-based theory informed intervention strategies.

Table 3. 1 Research Questions and Corresponding Study Methods

Research questions	Study method
1. Is occupational sedentary behaviour related to common mental health symptoms among Software and IT workers in China (i.e., depression, anxiety and stress)?	Phase 1: Quantitative survey study ● Conducted a survey to examine the association between occupational sedentary behaviour and mental health. ● Examined potential mediators and moderators of this association using path analysis. Phase 2: Qualitative study ● Conducted interviews to explore individuals' perceptions of how occupational sedentary behaviour may influence their mental health, providing insights for future exploration of possible mechanisms underlying the relationship.
2. What factors influence occupational sedentary behaviour among Software and IT workers in China?	Phase 2: Qualitative study ● Conducted interviews to capture individuals' perceptions regarding barriers and facilitators to reducing occupational sedentary behaviour.
3. How can the integrated findings from empirical studies in this PhD research inform the development of evidence-based and theory informed intervention strategies for Software and IT workers in China?	Integration and intervention strategies development: ● Explained and expanded upon key quantitative findings using qualitative results through both weaving and joint display integration. ● Identified appropriate behaviour change techniques using the Behaviour Change Wheel.

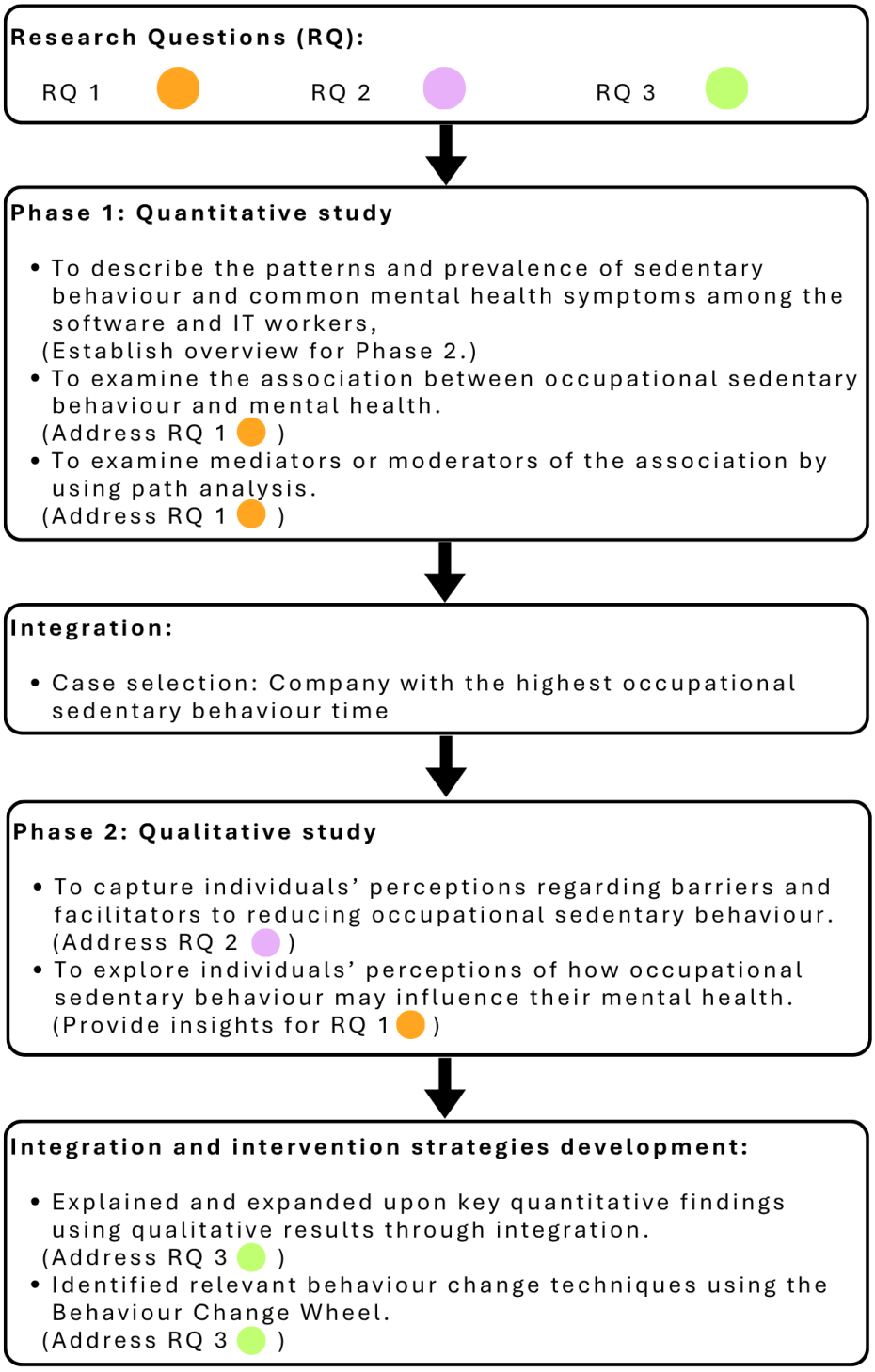

Figure 3. 2 Study Flow.

3.5 Ethical Considerations

Ethical approval for the Phase 1 quantitative study (FHM-2024-4276-RECR-3) was gained in May 2024, and for the Phase 2 qualitative study (FHM-2024-4859-RECR-2) in October 2024. The following section identifies the main ethical issues addressed in the research design.

3.5.1 Sensitive Topic and Participant Well-Being

Both studies included socio-demographic data collection, such as age, sex, income, and number of dependants to describe the sample. To mitigate any potential discomfort, participants were provided with the option to select "I prefer not to answer" for these items.

The topic of mental health was considered potentially sensitive to some participants because seemingly innocuous questions could unexpectedly evoke traumatic experiences or upset participants. To protect participants, first, participant information sheets in both studies explicitly stated that participation was entirely voluntary. In the survey study, participants retained the right to withdraw at any point, while in the qualitative study, withdrawal was possible up to two weeks following data collection, without facing any adverse consequences. For the survey, a statement was presented at the start in case participants experienced any discomfort, stating they could skip that section. For the focus group and individual interviews, participants were informed before the interview that they could pause or opt out at any time, were not required to answer every question, and were able to skip any questions they found uncomfortable. A distress protocol was prepared in case participants appeared distressed for any reason during the interviews (Appendix 2).

3.5.2 Anonymity and Confidentiality

The name and contact email were collected for individuals who participated in the focus group and individual interviews. This information was only used to communicate the details of the focus group and individual interviews, including software, online meeting link, and time arrangement. All participants were

assigned pseudonyms in the form of alphanumeric codes, e.g., P1, P2, P3 etc., to ensure anonymity in the transcriptions. A password-protected document linking participants to their pseudonyms was stored separately from the transcribed data on the university's encrypted Microsoft OneDrive server and was accessible only to me as the primary researcher. This process ensured the anonymity of the data, and participants in individual interviews could request to withdraw their data after pseudonymisation within two weeks of participation if they wished to do so.

3.5.3 Addressing Potential Power Imbalances

Gatekeepers were involved in participant recruitment in two empirical studies to facilitate the process. Because of this, there was a potential risk of power imbalance, particularly in workplace contexts where participation could be perceived as implicitly encouraged or expected.

In the Phase 1 quantitative study, this risk was mitigated by ensuring that gatekeepers were solely responsible for distributing participant information sheets and survey links. They had no access to any identifying information about who took part in the study. Participants completed the online survey anonymously and voluntarily, independent of managerial oversight.

In the Phase 2 qualitative study, interviews were conducted during working hours. A human resource manager acted as the gatekeeper to coordinate online interviews between employees and the primary researcher, who were separated by a seven-hour time difference (UK vs. China-based company). To minimise power dynamics, interviews only commenced after the gatekeeper had assisted with the technical setup and left the room.

3.6 Study Rigour

This research employed various strategies to ensure methodological robustness by maintaining quantitative validity and reliability alongside qualitative trustworthiness.

3.6.1 Validity and Reliability in the Quantitative Study (Phase 1)

All instruments used in the Phase 1 quantitative study were standardised and previously validated in Chinese populations, ensuring construct validity. The reliability of the scales used was confirmed by Cronbach's alpha values exceeding 0.70 across the current samples (146). To ensure analytical rigour and model parsimony, covariates were conceptually grouped and entered in a structured, stepwise manner in hierarchical regression to assess their influence on the primary relationship between occupational sedentary behaviour and mental health (147, 148). This approach informed the final selection of variables for subsequent path analysis, ensuring appropriate covariate control without overadjustment, and contributing to overall analytical rigour (147, 148). In both hierarchical regression and path analysis, model diagnostics and fit criteria such as multicollinearity, residual distribution, and model fit indices were considered to ensure the robustness of the findings.

3.6.2 Trustworthiness in the Qualitative Study (Phase 2)

In the Phase 2 qualitative study, steps were taken to address credibility, transferability, dependability, and confirmability (149). Credibility was enhanced by developing interview questions grounded in the COM-B model and refined through iterative feedback from two supervisors, ensuring alignment with theoretical constructs. Data collection, transcription, and analysis were conducted in Chinese, maintaining linguistic and cultural authenticity. For translation accuracy, a back-translation procedure was employed where codes and themes were first translated from Chinese into English for supervisory review and discussion, then translated back into Chinese to check for inconsistencies or loss of meaning (150). This process was conducted by the primary researcher who is proficient in both languages. Reflexive thematic analysis was used, with the analytic approach and emerging themes regularly discussed with supervisors to foster reflexivity and reduce researcher bias. Additionally, methodological triangulation was achieved by conducting a quantitative study prior to the qualitative phase and subsequently integrating findings from both strands. This strengthened the credibility of

interpretations by allowing convergence and complementarity between different data sources (151).

Transferability was supported through detailed descriptions of the research context and participant characteristics, enabling readers to assess applicability to other settings. Dependability was ensured by maintaining comprehensive records of the coding and analysis processes, assisted by NVivo, thereby providing transparency and consistency. Confirmability was strengthened through peer scrutiny via supervisory review, which helped to minimise subjective influence, and by writing a positionality statement to reflexively consider how my perspectives may have shaped the findings.

3.7 Positionality Statement

I am the primary researcher and hold an MSc in Performance Psychology and a BSc in Applied Psychology. I am a native Chinese speaker and have prior experience as a research assistant in a university-affiliated laboratory located in a commercial office building in China. This background provides a foundation for understanding psychological factors relevant to Chinese workplace behaviour.

I occupy a partial insider position due to my previous experience in office environments similar to those of the study's participants. I have personally experienced the impacts of prolonged sitting, including low back pain and sleep difficulties during a previous office-based research role, which shaped my interest in occupational sedentary behaviour and mental health and cultivates empathy for participants facing similar challenges. At the same time, I maintain an outsider perspective, as I do not have direct experience as a software or technology information worker, and I may be less familiar with the specific occupational culture and practices of participants.

I am aware that my sensitivity to environmental influences could risk over-emphasising social context and underestimating individual agency. To enhance the trustworthiness of qualitative data collection and analysis, I adopt multiple strategies. I maintained reflexive memos throughout the coding and analysis process, and regularly discussed emerging themes with my supervisors. I also

employed methodological triangulation, integrating findings from prior quantitative research with qualitative data. By continuously reflecting on how my perspectives may influence interpretation, I aim to minimise subjective bias and accurately represent participants' experiences.

In summary, my personal experiences with sedentary behaviour in the workplace inform my interest in this research. I remain attentive to these influences to ensure that I accurately represent participants' perspectives without over-generalising from my own experiences.

Chapter 4: Phase 1: Exploring the Pathway Between Occupational Sedentary Behaviour and Mental Health Symptoms Among Software and Information Technology Workers in China: A Cross-Sectional Study with Path Analysis

Publication:

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Communication:

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4.1 Introduction

Excessive (≥6 hours) daily sedentary behaviour (including leisure and occupational time) is associated with a range of adverse health outcomes, including increased incidence of type 2 diabetes, cardiovascular disease and cancer mortality (13). Moreover, recent studies show that prolonged daily sedentary behaviour is also deleterious to common mental health conditions, including depression and anxiety (53, 54). However, current evidence is largely based on leisure-time sedentary behaviour, while the association between occupational sedentary behaviour and common mental health symptoms is less understood (152).

Given that the workplace is an important setting where high volumes of daily sedentary behaviour are accumulated (94), it is essential to understand whether there is an association between occupational sedentary behaviour and mental health symptoms. Depending on job role, work typically accounts for 60%-90% of an individual's daily sitting time (27, 34). Additionally, poor mental health can detrimentally affect work performance and productivity, resulting in a reduced pace, an increase in errors, and increased absenteeism (88, 89). These consequences not only affect individual employees' well-being but also have economic implications for organisations, manifesting in decreased productivity (153).

The Software and IT workforce, characterised by desk-based and computer-led tasks, is prone to a high prevalence of occupational sedentary behaviour (30, 85). China hosts the world's largest Software and IT workforce, comprising over 9.4 million professionals in this sector (37). Notably, China has experienced a noticeable increase in the prevalence of mental health disorders over the past three decades, coinciding with swift economic development (154). It is estimated that the prevalence of mental health disorders has reached as high as 16.6% (155), suggesting that approximately one in six individuals in the Chinese population may experience mental health disorders during their lifetime.

However, to date, there is currently no data about the occupational time spent sedentary in this population of Software and IT workers in China. Moreover, the association between occupational sedentary behaviour and common mental health symptoms has not been explored among this significant workforce. Therefore, the aims of this study were:

1) To examine the duration of total and occupational sedentary behaviour and the level of mental health symptoms among Software and IT workers in China.
2) To determine whether there is an association between occupational sedentary behaviour and common mental health symptoms.

3) To identify variables that may influence the association between occupational sedentary behaviour and common mental health symptoms.

4.2 Methods

4.2.1 Research Design and Setting

A cross-sectional study targeting employees in the Software and IT industry in Wuhan, China, was conducted between May-August 2024. Ethical approval was obtained from Lancaster University's Faculty of Health and Medicine Ethics Committee in accordance with the Declaration of Helsinki (reference: FHM-2024-4276-RECR-3).

4.2.2 Organisational Recruitment

Four companies within the Software and IT industry in Wuhan, China, were recruited to participate in the study using a convenience sampling approach. The recruitment involved a multi-pronged approach to secure organisational consent. The primary researcher initially utilised existing professional and social networks to identify potential target companies, which included:

1. Direct Professional Contacts: Approaching personal contacts within target companies, providing them with a research introductory document (which detailed the research aim, procedure, and participant benefits), and requesting they forward it to their respective human resources department or business owners.
2. Indirect Network Referrals: Seeking referrals from peers and colleagues to identify individuals working in or owning target companies. Upon identification, the introductory document was shared, and an introduction to the relevant human resource personnel or business owner was requested.
3. Direct Outreach: Conducting online searches for Software and IT companies in Wuhan and following up with cold calls to introduce the research aims, explain the benefits, and request participation.

Following the positive interest received, the primary researcher travelled to China to arrange a follow-up in-person meeting. The participant information sheet and consent form were formally presented to the organisational gatekeepers (human resource managers or department managers). Organisational consent was officially obtained when the gatekeepers from all four companies reviewed and signed a paper consent form.

4.2.3 Participant and Procedure

Following the formal organisational consent, gatekeepers in each company circulated the study information and survey invitation to all Software and IT workers in their respective organisations. This invitation comprised the research information package, including the research introduction, eligibility criteria, and participant information sheet, and the link to the online survey. The invitation was distributed using email or WeChat. WeChat is a widely used social media platform in China that provides messaging, calling, and a variety of social features, and it is commonly used in workplace settings for both individual communication and group discussions (156). Anyone in the company who was 18 years old or above, worked full-time in a Software and IT role, and worked in an office setting was eligible for this study. The exclusion criteria were applied to individuals employed on a part-time or intern basis, as well as those whose primary work arrangement was a home-based or remote setting.

The minimum sample size was calculated by the formula: n=$Z^2P(1-P)/d^2$ (157), using the constants, Z=1.96 (for 95% confidence) and the margin of error, d=0.05. P represents the prevalence of common mental health disorders and the value will be P=16.6% in this study, which was based on the latest statistics from China (155). Therefore, 213 participants will be needed to meet the minimum sample size requirement for the self-reported survey.

Participants accessed the survey by clicking on the Qualtrics link and were required to complete a digital consent form before proceeding. The full survey questionnaire is presented in Appendix 3.

4.2.4 Total and Occupational Sedentary Behaviour on Workdays

The short-form International Physical Activity Questionnaire (IPAQ) was used to estimate total sedentary behaviour (158). The IPAQ has been validated as a reliable and valid tool among the Chinese population (159, 160). Participants were asked to recall their sitting time on weekdays during the past 7 days, including work, home, coursework, and leisure time, and to report it in hours and minutes. Subsequently, for occupational sedentary behaviour, participants were asked to recall their sitting time specifically for work on weekdays during the past 7 days, and again to report it in hours and minutes. The responses were then converted to minutes per day for data analysis.

4.2.5 Depression and Anxiety

Sensations of depression and anxiety were measured using the Hospital Anxiety and Depression Scale (HADS) (161). While initially developed to detect anxiety and depression in hospital medical outpatient clinics, this scale has been widely adopted as a screening tool rather than a diagnostic instrument (162, 163). It has been validated in the general population, and recent studies also support its use in workplace settings (164, 165). Moreover, it is widely used and validated among the Chinese population (166, 167).

HADS contained 14 items, with 7 measuring symptoms of anxiety and 7 measuring symptoms of depression (161), which were scored separately. Each item was assigned a value from 0 to 3, resulting in a total score that ranges from 0 to 21 for each scale. A score of 0–7 represents no symptoms of depression or anxiety, 8–10 could indicate potential signs of anxiety or depression feelings, while a score of 11 or higher may indicate a higher likelihood of experiencing depression or anxiety symptoms (161). This scale demonstrated acceptable reliability in this study, with Cronbach's α values of 0.839 for the overall scale, 0.811 for the anxiety subscale, and 0.704 for the depression subscale.

4.2.6 Stress

Psychological stress was assessed using a single-item measure (168), rated by a 5-point Likert scale. Participants were provided with the following definition: "Stress

means a situation in which a person feels tense, restless, nervous, or anxious or is unable to sleep at night because his/her mind is troubled all the time" and asked, "Do you feel this kind of stress these days?" The scale ranged from 1 (not at all) to 5 (very much), where a higher score indicates greater levels of stress that individuals are experiencing. This method is associated with cortisol secretion (169), a key biomarker used for assessing psychological stress levels, demonstrating its sensitivity in stress assessment. Its applicability and robustness have been further evidenced in the Chinese workplace setting (170, 171).

4.2.7 Demographic, Lifestyle, and Occupational Characteristics

Based on previous empirical studies and systematic reviews (172-174), potential covariates were identified when examining the association between sedentary behaviour and mental health outcomes, including sociodemographic and lifestyle factors.

4.2.7.1 Sociodemographic Characteristics

To mitigate potential participant discomfort regarding sensitive information, an "I prefer not to answer" option was provided for all demographic questions.

Age group: Age was divided into six groups, i.e., "18–24", "25–34", "35–44", "45–54", "55–64", and "65 and over". Since no participants chose the "55–64" and "65 and over" options, these two groups were merged into "55 and over" for data analysis and reporting.

Sex: Measured as "male" and "female".

Marital status: Measured using five options: "single," "married," "separated," "divorced," and "widowed." This variable was subsequently converted into a dummy variable for data analysis and reported as "married" and "non-married."

Educational level: Education was measured using the following categories: "primary school or below," "middle school," "senior high school/secondary vocational school," "undergraduate degree/higher vocational school," and "master's degree or above." The first three categories were merged into "education at or below secondary school" for data analysis and reporting.

Body mass index (BMI): BMI was calculated by self-reported weight and height, using the formula body mass divided by height squared (kg/m^2).

4.2.7.2 Lifestyle Characteristics

Smoking status: “Never smoked,” “former smoker,” “current occasional smoker,” and “current daily smoker.” This variable was converted into dummy variables: “never smoked” and “former or current smoker.”

Alcohol consumption: The Alcohol Use Disorders Identification Test for Consumption (AUDIT-C) was used (175). The AUDIT-C consists of the first three questions of the 10-item AUDIT (176) and primarily asks participants about alcohol consumption, including the frequency and amount. The AUDIT-C has been validated as an efficient drinking screening tool among the Chinese population (174, 177). Cronbach's α for the AUDIT-C was 0.839 in this study.

Poor sleep quality: The Athens Insomnia Scale (AIS) was employed to examine sleep quality. The AIS is a brief instrument used to evaluate insomnia severity using eight items, each rated from 0 to 3 (178). A higher AIS score indicates poorer sleep quality. Cronbach's α for the AIS was 0.839 in this study.

Physical activity: Participants complete the short-form IPAQ to estimate physical activity (158). The IPAQ measures the intensity and duration of physical activity within the past week. It has been used in the Chinese population and has shown acceptable reliability and validity (159, 174, 179).

4.2.7.3 Occupational Characteristics

Job position: “Ordinary employee,” “frontline manager,” “middle manager,” “senior manager,” and “other.” This variable was converted into a dummy variable: “ordinary employees” and “managerial employees and others.”

Duration in the current company (Tenure): “Less than 1 year,” “1–3 years,” “4–6 years,” “7–9 years,” and “more than 10 years.”

Duration in the current industry: “Less than 1 year,” “1–3 years,” “4–6 years,” “7–9 years,” and “more than 10 years.”

Workdays per week: 5 days, 6 days, or a “big/small week working scheme” (meaning that for two weeks each month, employees work 6 days a week).

Daily working minutes: Participants were asked to report their arrival and departure times at the company on a typical workday. These times were then converted into working minutes per day.

Job satisfaction: The 6-item job satisfaction index was utilised to assess job satisfaction (180). The scale demonstrated good internal consistency in this study (Cronbach’s α = 0.933).

4.2.8 Statistical Analysis

For descriptive statistics, Shapiro-Wilk tests were first performed, revealing that all continuous variables were non-normally distributed. Based on this, mean and standard deviation (SD) were used to describe variables with skewness less than 1, while median and interquartile ranges (IQRs) were used for variables with skewness greater than 1. Categorical variables and missing data were described using frequencies and percentages.

For inferential analysis, analysis was conducted in two phases, namely hierarchical ordinal logistic regression and path analysis. These phases were implemented to control for the influence of sociodemographic, lifestyle, and occupational factors and to more comprehensively explore the association between sedentary behaviour and mental health.

It is important to note that the analytical strategy adopted in this study was predominantly data-driven rather than guided by an explicit theoretical or causal framework. Although previous empirical evidence informed the selection and sequencing of covariates, no formal causal model was specified a priori. Consequently, the inclusion of variables in the regression models should not be interpreted as implying definitive causal assumptions regarding their roles as confounders, mediators, or outcomes. Instead, the modelling strategy was intended to examine the robustness and sensitivity of observed associations under varying degrees of statistical adjustment.

All analyses were conducted using the MICE (181), dplyr (182), purrr (183), and MASS (184) packages in R (version 4.4.0), and SPSS AMOS 28.0.

4.2.8.1 Hierarchical Ordinal Regression

Separate analyses were conducted for occupational and total sedentary behaviour. Associations and robustness of the association between sedentary behaviour (both total and occupational) and mental health symptoms (i.e., depression, anxiety, and stress) were examined using hierarchical ordinal regressions (185). This hierarchical regression approach involved the stepwise inclusion of demographic, lifestyle, and occupational variables in separate models, allowing for the examination of whether the association between sedentary behaviour (both total and occupational) and mental health remained significant after adjusting for each group of covariates (185).

Five models of analysis were applied separately for occupational and total sedentary behaviour. This approach aimed to systematically examine the robustness of the core association between sedentary behaviour (total and occupational) and mental health symptoms (depression, anxiety, and stress) while testing the impact of sequential statistical adjustment. The order and rationale for the hierarchical modelling were primarily informed by empirical precedent and statistical considerations, with reference to existing literature, rather than by a clearly specified theoretical or causal framework.

Crude Model & Model A:

The analysis began with the Crude Model, followed by Model A, which represented the initial adjustment, accounting for key sociodemographic and lifestyle variables (sex, age, education, marital status, income, number of dependents, BMI, smoking status, and alcohol consumption). This modelling strategy is consistent with established analytic approach in studies investigating the associations between sedentary behaviour and mental health (93, 106).

Model B:

This model then included physical activity (Model A plus physical activity). Physical activity was treated separately rather than as part of the initial lifestyle adjustment, as previous research has identified physical activity as a potential attenuating factor in the association between sedentary behaviour and mental health and was therefore examined separately (186). However, substantial empirical evidence indicates that sedentary behaviour has mental health effects independent of physical activity (55, 187, 188). Based on this evidence, this study hypothesised that the association between sedentary behaviour and mental health would also remain independent of physical activity. Accordingly, physical activity was included separately but early in the model hierarchy (Model B) as an important covariate.

Model C:

This model incorporated variables reflecting the occupational context (Model B plus job satisfaction, job position, duration in the current industry, tenure, workdays per week, and daily working minutes). Prior research has suggested that the domain or context of sedentary behaviour (e.g., work-related vs. leisure-time) may influence its psychological impact (59, 108). These occupational variables were included to assess whether the association between sedentary behaviour and mental health was robust to adjustment for work-related characteristics; however, their inclusion does not assume that these factors function solely as confounders. In particular, job satisfaction may also represent an outcome of mental health or a variable located on the causal pathway (189).

Model D (fully adjusted model):

The final model added poor sleep quality (Model C plus poor sleep quality), which, although classified as a lifestyle variable in the survey, was examined separately. This decision was informed by previous evidence from physical activity studies which identified sleep as a mediator in the relationship with mental health (190, 191). Moreover, as poor sleep has been consistently recognised as a strong determinant of mental health, it was hypothesised to play a major influencing role (192, 193). However, it was entered in the final step as an exploratory adjustment

rather than as a variable with an assumed unidirectional causal role. Poor sleep quality may act as a mediator, an outcome, or a variable bidirectionally related to mental health. Therefore, adjustment for sleep quality was intended to assess the sensitivity of the association rather than to assert a specific causal mechanism. Multicollinearity was assessed using the variance inflation factor (VIF), with VIF values of 5.0 or greater indicating a potential multicollinearity problem.

4.2.8.2 Path Analysis

Following hierarchical regressions to identify potential influencing variables on the relationship between occupational sedentary behaviour and mental health, path analysis was employed to overcome the limitations of regression in handling complex relationships. Path analysis allows for the exploration of multiple variables and their complex interrelationships in a single model (194), thus enabling the exploration of potential direct and indirect associations among occupational sedentary behaviour, occupational characteristics, sleep quality, and mental health outcomes. However, it is not a confirmatory test of a predefined causal model.

The conceptual model (see Figure 4.1) was informed by existing evidence and exploratory regression analysis (195) on occupational characteristics. To be specific, previous studies revealed that poor sleep quality mediates the effect of physical activity on mental health (190, 191). This study, therefore, hypothesised that occupational sedentary behaviour indirectly influences stress through poor sleep quality. Given the cross-sectional nature of the data, this hypothesis was examined cautiously and was not intended to imply definitive causal mediation.

To initially evaluate the potential mediating effect of poor sleep quality, Baron and Kenny's 4-step approach was performed (196). This procedure was used as a preliminary heuristic to assess whether the data were consistent with a potential mediating role of poor sleep quality, recognising the limitations of causal inference in cross-sectional studies.

For occupational characteristics, given the lack of existing evidence regarding their role in the relationship between occupational sedentary behaviour and stress,

exploratory regression analysis was performed as an abductive process to generate a theory with explanatory merit (195). Two complementary exploratory regression approaches were employed. First, single-factor regression models were used to examine the association between each occupational variable (i.e., job position, duration in the current industry, tenure, working days per week, daily working minutes, and job satisfaction) and both stress and occupational sedentary behaviour. Second, a series of regression models with sequential adjustment were performed to investigate whether the association between occupational sedentary behaviour and stress remained robust after controlling for each occupational variable in turn. In each sequentially adjusted model, occupational sedentary behaviour served as the primary independent variable, with one occupational variable added as a control factor. Based on the findings from these analyses (Appendix 4), a path analysis model is proposed (Figure 4.1).

Spearman's rank correlation was conducted among all variables that were included in the model. The path analysis was performed using Maximum Likelihood Estimation (MLE) in Amos to estimate the model's parameters (i.e., path coefficients). The bootstrapping method with 5000 iterations was used to estimate indirect effects and confidence intervals. Meanwhile, the bootstrap method was used as a remedy for non-normally distributed data in this study (197). Model fit was assessed using the following indices and cutoffs (198): Chi-square to degrees of freedom ratio ($1 \leq \chi^2/df \leq 3$), goodness-of-fit index (GFI) ≥0.90, Comparative Fit Index (CFI) ≥0.95, Tucker-Lewis Index (TLI) ≥0.95, and Root Mean Square Error of Approximation (RMSEA) ≤0.06.

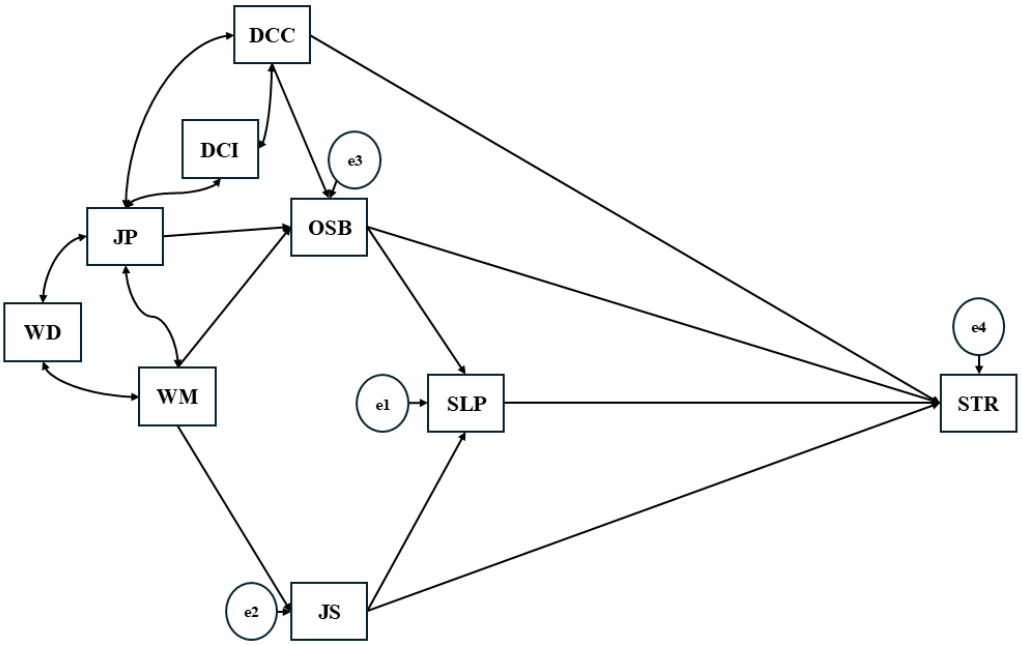

Figure 4. 1 Proposed Path Analysis Model.

Note. OSB=occupational sedentary behaviour, SLP=poor sleep quality, STR= stress, DCC=tenure, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction. A single-headed arrow represents a predictive relationship (regression), showing that one variable influence another. A double-headed arrow represents a correlation.

4.2.8.3 Missing Data and Sensitivity Analysis

Prior to analysis, missing data were imputed using multiple imputation with the random forest algorithm via RStudio. Five imputed datasets were generated and subsequently used as parallel datasets in regression and correlation analyses. The final results of regression and correlation analyses were pooled across the five imputed datasets according to Rubin's rules (199). Path analysis was conducted on the first imputed dataset, with sensitivity analyses across all imputed datasets yielding consistent results (Appendix 5).

4.3 Results

4.3.1 Participants

Four organisations participated in this study, all of which were technology-driven private enterprises located in Wuhan, China. One organisation employed fewer than 500 staff, while the remaining three had between 500 and 1,000 employees. Across all participating organisations, the workforce was primarily office-based, with Software and IT professionals constituting approximately 50–70% of employees.

The survey received 322 responses from employees across four companies, resulting in a response rate of approximately 27%. Among these, 235 participants fully completed the survey, with no missing data on occupational sedentary behaviour or mental health symptoms.

4.3.2 Descriptive Data

Descriptive statistics, as well as missing data for the sample, are presented in Table 4.1, Table 4.2 and Table 4.3. Most participants were male (68.1%), aged 25–34 (60.9%), had received tertiary education (92.3%), and were non-married (56.2%). The largest proportion of the sample (31.5%) reported an annual income of CNY 80,000–140,000, and 41.7% reported having no dependents.

This demographic distribution closely mirrors the characteristics of the broader Software and IT workforce in China, which is widely documented as predominantly male and youthful (a survey of over 10,000 participants found that 71% were under 30) (200). Furthermore, the high prevalence of tertiary education aligns with the industry's standard entry requirements, suggesting that the sample provides a reasonable representation of the target population (200).

Participants reported an average actual working time of 590.8 (±68.7) minutes per workday. Within this time, the mean occupational sedentary behaviour was 427.9 (±133.2) minutes, and the total daily sedentary behaviour was 499.9 (±161) minutes. According to these self-reported measures, occupational sedentary time

accounted for 72.4% of working hours, which equated to 347.52 minutes in a standard 8-hour working day.

Participants reported moderate mean scores for both depression and anxiety symptoms, as assessed by the Hospital Anxiety and Depression Scale (HADS). The average scores for depression and anxiety were 7.5 (±3.8) and 7.6 (±3.9), respectively. Further analysis using the established HADS cut-offs (0–7: No/Low symptom scores; 8–10: Mild symptom scores; ≥11: Moderate to Severe symptom scores) indicated that a considerable proportion of participants exhibited elevated symptom levels. Specifically, 20.4% (n = 48) had depression scores and 21.7% (n = 51) had anxiety scores falling within the range corresponding to moderate to severe symptom levels. The mean stress score was 2.3 (±0.9) on a 1–5 scale. This value lies below the scale's mid-point of 3.

Table 4. 1 Demographic Characteristics (n=235)

Variables	Frequency
Sex, n (%)	
Male	160 (68.1)
Female	73 (31.1)
Data not reported	2 (0.9)
Age, n (%)	
18–24	56 (23.8)
25–34	143 (60.9)
35–44	31 (13.2)
45–54	2 (0.9)
55 and over	0 (0)
Data not reported	3 (1.3)
Educational level, n (%)	
At or below secondary school	2 (0.9)
Undergraduate degree/Higher vocational school	217 (92.3)
Master's degree or above	12 (5.1)
Data not reported	4 (1.7)
Annual income, n (%)	
Less than 80000 CNY	66 (28.1)
80000–140000 CNY	74 (31.5)
140000–190000 CNY	25 (10.5)
200000–250000 CNY	11 (4.7)
More than 250000 CNY	12 (5.1)
Data not reported	47 (20.0)
Marital status, n (%)	
Married	80 (34)
Non-married	132 (56.2)
Data not reported	23 (9.8)
Number of dependents, n (%)	
0	98 (41.7)
1	28 (11.9)
2	34 (14.5)
3	18 (7.7)
More than 4	21 (8.9)
Data not reported	36 (15.3)

Table 4. 2 Sedentary Behaviour and Mental Health (n=235)

Variables	Frequency	Mean/Median
Physical activity (METs), median (25%-75%)		612 (109.5-1923.8)
Occupational sedentary behaviour (min), mean (SD)		427.9 (±133.2)
Total sedentary behaviour (min), mean (SD)		499.9 (±161.0)
Depression, mean (SD)		7.5 (±3.8)
No/Low symptom scores	111 (47.2)	
Mild symptom scores	76 (32.3)	
Moderate to Severe symptom scores	48 (20.4)	
Anxiety, mean (SD)		7.6 (±3.9)
No/Low symptom scores	114 (48.5)	
Mild symptom scores	70 (29.8)	
Moderate to Severe symptom scores	51 (21.7)	
Stress, mean (SD)		2.3 (±0.9)

Note. Missing data of continuous variables: physical activity (6.8%), and self-reported total sedentary behaviour (7.7%)

Table 4. 3 Lifestyle and Occupational Characteristics (n=235)

Variables	Frequency	Mean/Median
Smoking status, n (%)		
Never smoked	151 (64.3)	
Former or current smoker	84 (35.7)	
AUDIT-C, median (25%-75%)		1 (1-3)
BMI, median (25%-75%)		23.5 (21.1-28.0)
Sleep, mean (SD)		6.0 (±4.0)
Job position, n (%)		
Ordinary employees	194 (82.6)	
Managerial employees and other	41 (17.4)	
Daily working minutes, mean (SD)		590.8 (±68.7)
Workdays per week, n (%)		
5	199 (84.7)	
6	16 (6.8)	
Big/small week scheme (employees work a six-day week every second week)	20 (8.5)	
Duration in the current industry (year), n (%)		
Less than 1	28 (11.9)	
1–3	81 (34.5)	
4–6	54 (23.0)	
7–9	38 (16.2)	
More than 10	34 (14.5)	
Tenure (year), n (%)		
Less than 1	55 (23.4)	
1–3	117 (49.8)	
4–6	38 (16.2)	
7–9	12 (5.1)	
More than 10	13 (5.5)	
Job satisfaction, mean (SD)		22.3 (±5.9)

Note. Missing data of continuous variables: alcohol (20%), BMI (3.8%), sleep quality (0.4%), and daily working minutes (0.4%).

4.3.3 Association of Sedentary Behaviour and Mental Health

The association of total and occupational sedentary behaviour and symptoms of depression, anxiety, and stress are presented separately in Table 4.4. The variance inflation factor (VIF) analysis revealed that all VIF values were below 3, indicating no multicollinearity in this study.

Table 4. 4 Association of Sedentary Behaviour and Mental Health Symptoms Indicators

	Depression	Anxiety	Stress
	β (95% CI)	β (95% CI)	β (95% CI)
Association of occupational sedentary behaviour and mental health symptoms indicator			
Crude	0.001 (-0.000, 0.003)	0.002 (-0.000, 0.004)	0.002* (0.000, 0.004)
A	0.001 (-0.000, 0.003)	0.002 (-0.000, 0.004)	0.002* (0.000, 0.004)
B	0.001 (-0.000, 0.003)	0.002 (-0.000, 0.004)	0.002* (0.000, 0.004)
C	0.001 (-0.000, 0.003)	0.002 (-0.000, 0.004)	0.001 (-0.000, 0.003)
D	0.001 (-0.002, 0.003)	0.002 (-0.000, 0.004)	0.001 (-0.001, 0.003)
Association of total sedentary behaviour and mental health symptoms indicator			
Crude	0.001 (-0.001, 0.003)	0.001 (-0.000, 0.003)	0.003** (0.001, 0.005)
A	0.001 (-0.001, 0.003)	0.001 (-0.001, 0.003)	0.003** (0.001, 0.005)
B	0.001 (-0.001, 0.003)	0.001 (-0.001, 0.003)	0.003** (0.001, 0.005)
C	0.001 (-0.001, 0.003)	0.001 (-0.001, 0.004)	0.003** (0.001, 0.005)
D	0 (-0.002, 0.002)	0.001 (-0.001, 0.003)	0.002* (0.000, 0.004)

Note. *p ⩽ 0.05, **p ⩽ 0.01, ***p ⩽ 0.001
OSB=occupational sedentary behaviour, TSB=total sedentary behaviour, DEP=depression, ANX=anxiety, STR=stress. Model A=Crude model plus sex, age, education, marital status, income, number of dependents, BMI, smoking status, and alcohol consumption. Model B= Model A plus physical activity. Model C=Model B plus job satisfaction, job position, duration in the current industry, tenure, workdays per week, and daily working minutes. Model D=Model C plus sleep.

4.3.3.1 Total Sedentary Behaviour and Symptoms of Depression, Anxiety, and Stress

No significant association was observed between total sedentary behaviour and symptoms of depression (β = 0, *p* = 0.830) or anxiety (β = 0.001, *p* = 0.332) across all models. A consistent association between longer total sitting time and higher stress was observed in the fully adjusted models (β = 0.001, *p* = 0.010).

4.3.3.2 Occupational Sedentary Behaviour and Symptoms of Depression, Anxiety, and Stress

No significant associations were found between occupational sedentary behaviour and symptoms of depression (β = 0, *p* = 0.868) or anxiety (β = 0.00, *p* = 0.800) across all models. In models adjusted for sociodemographic and lifestyle factors (sex, age, education, marital status, income, number of dependents, BMI, smoking status, alcohol consumption, and physical activity), a small but consistent association was found between occupational sedentary behaviour and stress in

the crude model (β = 0.001, *p* = 0.033), model A (β = 0.001, *p* = 0.041), and model B (β = 0.001, *p* = 0.039). However, this association was attenuated and no longer statistically significant in model C (β = 0.001, *p* = 0.180) and model D (β = 0.001, *p* = 0.381), which included occupational characteristics (job satisfaction, job position, duration in the current industry, tenure, workdays per week, daily working minutes) and sleep.

4.3.4 Correlations

Prior to conducting path analysis, pairwise correlations among included variables were assessed to detect potential multicollinearity (see Table 4.5) (201). Occupational sedentary behaviour was positively correlated with the daily working minutes (r = 0.255, *p* ≤ 0.001) and stress (r = 0.185, *p* = 0.005). A longer tenure was associated with a reduction in occupational sedentary time (r = -0.195, *p* = 0.003). Poor sleep quality was positively correlated with stress (r = 0.374, *p* ≤ 0.001). Tenure was positively correlated with duration in the current industry (r = 0.620, *p* ≤ 0.001). Managerial jobs showed fewer working minutes per day (r = -0.131, *p* = 0.046), less time in occupational sedentary behaviour (r = 0.237, *p* ≤ 0.001), fewer working days per week (r = -0.210, *p* ≤ 0.001), longer duration in their current company (r = -0.410, *p* ≤ 0.001) and industry (r = -0.396, *p* ≤ 0.001) than ordinary job positions. The number of working days per week was positively correlated with daily working minutes (r = 0.186, *p* = 0.004). Daily working minutes were positively correlated with job satisfaction (r = 0.138, *p* = 0.034). Finally, job satisfaction was negatively correlated with poor sleep quality (r = -0.210, *p* ≤ 0.001).

Although many of the correlations were statistically significant, the coefficients were relatively small (e.g., r = 0.1–0.3). This pattern suggests that multicollinearity is not a major concern, supporting the use of path analysis to explore their underlying latent structure (202).

Table 4. 5 Correlations between Variables Included in the Path Analysis

Variables	1	2	3	4	5	6	7	8	9
1. OSB	-								
2. SLP	0.089	-							
3. STR	0.185**	0.374***	-						
4. TEN	-0.195**	-0.046	-0.119	-					
5. DCI	-0.136*	-0.047	-0.024	0.620***	-				
6. JP	0.237***	0.073	0.073	-0.410***	-0.396***	-			
7. WD	-0.006	0.073	0.097	0.084	0.113	-0.210***	-		
8. WM	0.255***	-0.023	0.068	0.083	-0.002	-0.131*	0.186**	-	
9. JS	0.005	-0.210***	-0.117	0.034	0.157*	-0.083	0.013	0.138*	-

Note. *$p \leqslant 0.05$, **$p \leqslant 0.01$, ***$p \leqslant 0.001$

OSB=occupational sedentary behaviour, SLP=poor sleep quality, STR= stress, TEN=tenure, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction

4.3.5 Path Analysis

The proposed model demonstrated good fit: χ^2/df = 1.234, GFI = 0.978, CFI = 0.984, TLI = 0.972, and RMSEA = 0.032. As presented in Figure 4.2 and Table 4.6, the path analysis revealed that occupational sedentary behaviour was not associated with stress (β = 0.001, p = 0.231). Occupational sedentary behaviour was positively associated with poor sleep quality (i.e., longer sedentary time at work was linked to worse sleep quality) (β = 0.004, p = 0.035). Lower job satisfaction was associated with poorer sleep quality (i.e., higher job satisfaction was associated to better sleep quality) (β = -0.119, p = 0.006). Poor sleep quality, in turn, was positively associated with higher levels of stress (β = 0.074, p < 0.001). Higher daily working time was associated with higher levels of job satisfaction (β = 0.012, p = 0.025). Daily working time, job position, and tenure were antecedent variables of occupational sedentary behaviour, indicating that: 1) longer working time were associated with higher occupational sedentary behaviour (β = 0.462, p < 0.001); 2) non-managerial employees spent more time on occupational sedentary behaviour than managerial employees (β = 68.364, p = 0.005); and 3) employees with longer tenure in the company tended to spend less time in occupational sedentary behaviour (β = -24.456, p = 0.005).

The VIF analysis confirmed the absence of multicollinearity between tenure and occupational sedentary behaviour.

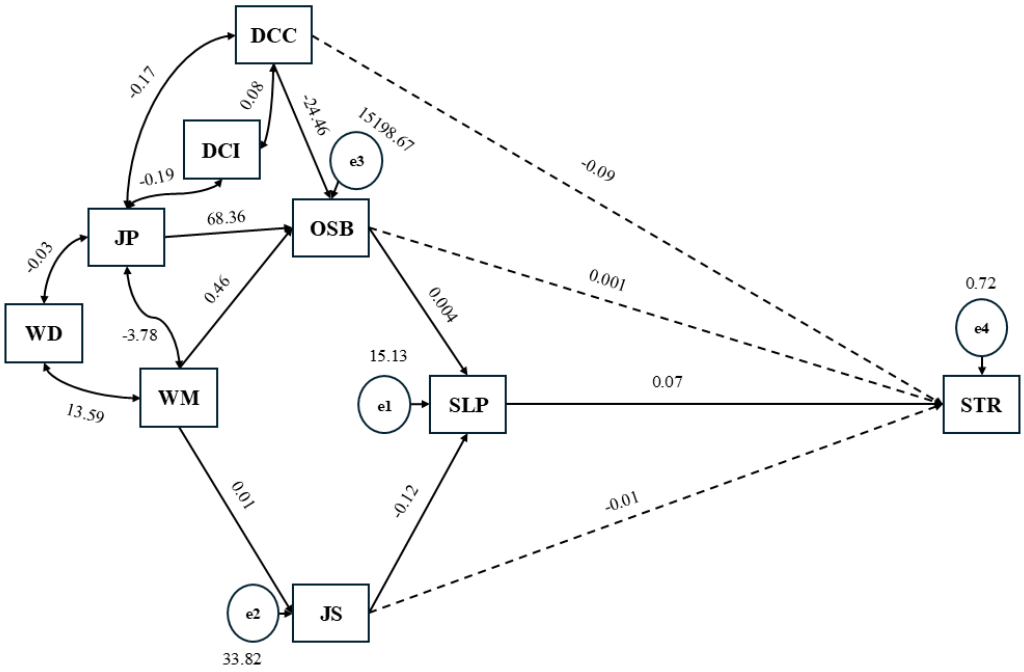

Figure 4. 2 Path Analysis Results.

Note. OSB=occupational sedentary behaviour, SLP=poor sleep quality, STR= stress, DCC=tenure, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction. A single-headed arrow represents a predictive relationship (regression), showing that one variable influence another. A double-headed arrow represents a correlation.

Table 4. 6 Unstandardised and Standardised Regression Coefficients for the Path Model

Estimator	Unstandardised β	SE	Standardised β
Outcome: Occupational sedentary behaviour			
Daily working minutes	0.462***	0.119	0.237
Job position	68.364**	24.370	0.192
Tenure	-24.456**	8.795	-0.188
Outcome: Sleep quality			
Occupational sedentary behaviour	0.004*	0.002	0.135
Job satisfaction	-0.119**	0.043	-0.175
Outcome: Stress			
Occupational sedentary behaviour	0.001	0.000	0.076
Job satisfaction	-0.015	0.010	-0.095
Sleep quality	0.074***	0.014	0.319
Tenure	-0.086	0.056	-0.097
Outcome: Job satisfaction			
Daily working minutes	0.012*	0.006	0.145

Note. *$p \leqslant 0.05$, **$p \leqslant 0.01$, ***$p \leqslant 0.001$

Mediation analysis of poor sleep quality between occupational sedentary behaviour and stress showed that occupational sedentary behaviour was not directly (β = 0.119, *p* = 0.278) or indirectly (β = 0.043, *p* = 0.059) associated with stress (Table 4.7). Direct and indirect effects of other variables on stress were examined. Job satisfaction was found to be negatively associated with stress levels when mediated by sleep quality (β = -0.056, *p* = 0.015).

Table 4. 7 Standardised direct, Indirect, and Total Effects of Included Variables on Stress

Path	Direct Effects	Indirect Effects	Total Effects
Effects of occupational sedentary behaviour on stress via sleep quality			
OSB→SLP→STR	0.076	0.043	0.119
Effects of other variables on stress			
SLP→STR	0.319***	-	0.319***
JS→STR	-0.095	-0.056*	-0.151*
TEN→STR	-0.097	-0.022	-0.119
JP→STR	-	0.023	0.023
WM→STR	-	0.006	0.006

Note. *$p \leqslant 0.05$, **$p \leqslant 0.01$, ***$p \leqslant 0.001$
OSB=occupational sedentary behaviour, SLP=sleep quality, STR= stress, TEN=tenure, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction

4.4 Discussion

This study provided an overview of occupational sedentary behaviour and mental health symptoms among Software and IT employees in China through an online survey. It aimed to 1) examine the duration of sedentary behaviour and the level of mental health symptoms among Software and IT workers in China, 2) determine whether there is an association between occupational sedentary behaviour and common mental health symptoms, and 3) identify variables that may influence the association between occupational sedentary behaviour and common mental health symptoms.

4.4.1 Duration of Sedentary Behaviour and the Level of Mental Health Symptoms

The Software and IT workers in this study engaged in a high volume of occupational sedentary behaviour. The mean occupational sedentary behaviour was 427.9 (±133.2) minutes, and total daily sedentary behaviour was 499.9 (±161) minutes during the workday. Occupational sedentary time accounted for 72.4% of working hours, which equated to 347.52 minutes in a standard 8-hour working day. This self-reported proportion is comparable to device-based observations among employees in the UK (72.6%) (69). Although slightly lower than device-measured sedentary time in some office, customer service, and call centre settings (77–81.8%) (28-30), it unsurprisingly remains substantially higher than in physically active occupations such as construction work, where sedentary time accounts for less than 50% of working hours (203).

The average score for depression, anxiety, and stress among Software and IT workers was 7.5 (±3.8), 7.6 (±3.9), and 2.3 (±0.9), respectively. While both mean scores for depression and anxiety fall below the clinical cutoff of 8 (scores are considered normal) (164), the proximity of these mean scores to the threshold is critical, as it indicates that some participants likely exhibit subclinical symptoms. Conversely, participants reported a low average stress score of 2.3 on the 1–5 scale, indicating participants generally experienced low to moderate levels of stress compared to the scale's mid-point of 3. This discrepancy may be partly due to the single-item stress measure, which might underestimate stress levels by capturing only a general impression rather than the multidimensional aspects of stress. Alternatively, this pattern may potentially be explained by a state of emotional exhaustion or burnout, where individuals no longer perceive acute stress but still experience significant emotional symptoms (204, 205). However, further evaluation is needed for this explanation.

The observed proportion of participants with moderate to severe levels of depression and anxiety symptoms (20.4% and 21.7%, respectively) was higher than the estimated prevalence of clinically diagnosed mental health disorders in

the general population in China (16.6%) (155). This difference should not be interpreted as a higher clinical incidence among the current population, as the measure in this study reflects self-reported symptoms at the time of data collection rather than confirmed diagnoses. However, this finding suggests that employees in the Software and IT sector may be at elevated risk of mental distress.

Overall, the occurrence of high occupational sedentary behaviour and pre-clinical mental health scores is a critical finding, indicating that Software and IT workers in China require targeted interventions to reduce occupational sedentary behaviour and promote mental health.

4.4.2 Association Between Occupational Sedentary Behaviour and Mental Health Symptoms

Hierarchical regressions revealed that neither total or occupational sedentary behaviour showed a statistically significant association with depression or anxiety across all models. These findings are inconsistent with previous systematic reviews, which have indicated that a higher volume of sedentary behaviour is associated with a higher risk of depression and anxiety (53, 109). This inconsistency may be explained by sample characteristics and the context of the sedentary behaviour. While previous reviews included studies encompassing broader age groups and contexts, such as older adults where TV watching was the most frequent context (84% of total sedentary time) (206), this study focused specifically on Software and IT office workers, primarily aged 25–34 years, for whom work-related sedentary behaviour was the dominant context (86% of sedentary sitting time). This interpretation aligns with previous studies reporting null associations between workplace sedentary behaviour and common mental health symptoms in other occupations (104, 107, 108).

A difference emerged between total sedentary behaviour and occupational sedentary behaviour in their relationship with stress. While total sedentary behaviour remained consistently significantly associated with stress from the Crude Model through the fully adjusted Model D, the association between occupational sedentary behaviour and stress vanished in Model C and D.

Generally, it was not surprising that stress was more statistically significantly associated with both total and occupational sedentary behaviour than were depression and anxiety because stress is an immediate response to external pressures, in this case, sedentary behaviour, whereas depression and anxiety symptoms are chronic emotional states (51). Crucially, previous research has revealed that sedentary behaviour is associated with a series of psycho-biological responses to stress, such as diastolic blood pressure and cortisol (55), which could be one explanation for the presence of significant associations in these findings.

However, the disappearance of a significant association between occupational sedentary behaviour and stress indicated that occupational variables (Model C) and poor sleep quality (Model D) may influence the relationship between occupational sedentary behaviour and stress, which will be detailed in the next section.

It should be noted that the inclusion of job satisfaction and sleep quality in the adjusted regression models requires cautious interpretation. Both variables are known to have complex and potentially bidirectional relationships with mental health and may also act as mediators on (or serve as intermediate variables in) the causal pathway linking occupational sedentary behaviour and psychological outcomes (189, 207). Consequently, adjusting for these factors risks introducing overadjustment bias, potentially skewing the results towards the null (underestimation). Therefore, the fully adjusted models should be interpreted as conservative estimates, while findings from partially adjusted models remain informative in capturing the broader association.

4.4.3 Influencing Factors on the Association

Occupational sedentary behaviour initially demonstrated a statistically significant association with stress, but the observed relationship between occupational sedentary behaviour and stress disappeared following adjustment for occupational variables (Model C) and poor sleep quality (Model D). This indicated that variables within these two aspects confounded or mediated the relationship.

Path analysis was conducted to further explore the mechanism underpinning this relationship by examining both direct and indirect pathways between occupational sedentary behaviour and stress. Poor sleep quality was hypothesised to be the mediator, and the result showed that this is a plausible pathway but was not statistically significant (β = 0.043, p = 0.059). Specifically, longer occupational sedentary time was associated with poorer sleep quality, which, in turn, led to higher stress levels. Previous studies revealed the mediator role of sleep between physical activity and mental health (190, 191), and this study provides one of the first pieces of evidence for a similar relationship involving sedentary behaviour. Notably, the limited sample size of the current investigation may have constrained its statistical power. Future research should employ a larger sample size to delineate the complex causal pathway linking occupational sedentary behaviour to stress.

Tenure was identified as a potential confounder, influencing both occupational sedentary behaviour and stress. In single-factor exploratory regressions, tenure showed negative associations with both occupational sedentary behaviour and stress, while occupational sedentary behaviour was positively associated with stress. However, when both variables were included concurrently in a path model, neither tenure nor occupational sedentary behaviour was significantly associated with stress. The loss of significance may be attributable to the small effect sizes of both tenure and occupational sedentary behaviour on stress, and to the reduced statistical power resulting from including both variables (208). The opposing directions of the effects of tenure and occupational sedentary behaviour on stress may have also contributed to this result by partially offsetting each other (185). Though the association between tenure and stress disappeared, longer tenure was found to be associated with less sedentary time, which is consistent with previous study (29). This finding has practical implications for workplaces, suggesting that support for new employees' adaptation could be essential for their healthy behaviour in the workplace.

These potential influencing factors suggest that the relationship may be shaped by contextual mechanisms that are not fully captured through quantitative measures

alone. Consequently, these results informed the subsequent qualitative Phase 2 of the thesis, which sought to explore explanations of observed patterns in greater depth, based on employees' lived experiences and interpretations.

4.4.4 Strengths and Limitations

This study provides important evidence of the relationship between sedentary behaviour and mental health and attempts to reveal the underlying mechanisms. The rigorous methodology and innovative use of path analysis are key strengths of this study, enabling a holistic exploration of the interactions between all variables. Furthermore, the study provides theoretical evidence by revealing a potential mechanism (i.e., sleep) underlying the relationship between occupational sedentary behaviour and mental health. This study also offers practical implications for employers, as findings in this study show that employees with shorter tenure exhibit longer occupational sedentary time and higher stress levels.

However, several limitations exist. Firstly, to minimise questionnaire fatigue and improve survey completion rates, the study prioritised brevity, leading to the use of a single-item measure for stress assessment. This may limit the breadth of assessment compared to multi-item scales. However, the current single-item measure has strengths in its focused definition and direct query. Moreover, this method has been associated with key stress biomarker cortisol (169), as well as showing robustness in previous studies (170, 171). Secondly, while acknowledging that the relationship between sedentary behaviour and mental health may be bidirectional, this study adopted a theoretically informed, hypothesis-driven approach to examine the direction from occupational sedentary behaviour to mental health outcomes. Given that occupational sedentary behaviour is a potentially modifiable workplace factor, this analytical focus was intended to inform future intervention studies rather than to infer causality. Thirdly, the observed effect sizes were relatively small. While the current sample size of 235 participants presents a limitation regarding statistical power and the precision of the effect size estimation, a previous cross-sectional study involving 1,843 participants reported a similar small effect size (104). This similarity suggests that the current sample size accurately reflects the modest association between

occupational sedentary behaviour and mental health. Another limitation is that part of the proposed path model was informed by data-driven exploration. Given the lack of established theoretical frameworks on how occupational characteristics influence sedentary behaviour, this approach was necessary to identify potential associations. Nonetheless, it may increase the risk of overfitting. As such, the findings should be interpreted as exploratory and hypothesis-generating. Future research should employ pre-specified models to validate these pathways. Finally, future research should incorporate objective, device-based assessments of total and occupational sedentary time may offer more objective and sensitive data to validate these findings.

4.5 Conclusion

This study identified high levels of occupational sedentary behaviour and pre-clinical mental health scores among Software and IT workers in China. No direct association was found between occupational sedentary behaviour and depression, anxiety, or stress after controlling for all potential confounding variables. However, an indirect effect of occupational sedentary behaviour on stress was observed, mediated by poor sleep quality. Overall, the findings of this study highlight the need for tailored interventions to promote healthy behaviours and mental health for employees.

Chapter 5: Phase 2: Understanding the Barriers, Facilitators and Experience of Sedentary Behaviour and Perceived Mental Health in the Software and Information Technology Workplace in China: A Qualitative Study

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5.1 Introduction

Sedentary behaviour refers to any waking behaviour characterised by an energy expenditure of ≤1.5 METs while in a sitting or reclining posture (1). Excessive (≥6 hours) volumes of daily sedentary behaviour have been associated with a range of adverse health outcomes, including increased risk of poor mental health conditions (54, 111), major cardiovascular events (209), and all-cause mortality (210). It is recommended to reduce sedentary behaviour or replace it with light physical activity every 30 minutes to help prevent mental health issues and non-communicable diseases including cardiovascular disease, diabetes, and cancer (119, 211).

Software and IT workers are a population exposed to high volumes of sedentary behaviour (141), as their primary work tool is the computer, so largely desk-based with lower physical demands (94). Work typically accounts for 60% to 90% of an individual's daily sitting time (27, 30), and the workplace has also been identified as a key setting for public health interventions to promote and maintain the highest degree of physical, mental and social well-being of workers (212). A cross-

sectional study used accelerometers to measure general workers' movement behaviours at work and found that office workers in China spend a daily average of 9.19 (±1.38) hours sedentary (213). China has the world's largest Software and IT workforce, comprising over 9.4 million professionals in this sector (37), potentially signifying future public health challenges for a large population exposed to the risks of sedentary behaviour. Therefore, developing evidence informed and theoretically driven tailored interventions to reduce sedentary behaviour in the Software and IT workplace could be meaningful, especially in China.

Understanding the nature of behaviour is fundamental to developing a behaviour change intervention (64). The Capability, Opportunity, Motivation, Behaviour (COM-B) model and the Theoretical Domains Framework (TDF) are established tools that provide systematic and comprehensive approaches to identifying the factors that need to be modified to support behaviour change (64, 72). These frameworks have been widely used among desk-based occupational groups (68, 214-217); however, to date, the COM-B and TDF frameworks have not been applied among Software and IT workers in the Chinese workplace. Moreover, to fully understand the complexity of sedentary behaviour and effectively inform the intervention design, it is beneficial to consider the social and environmental factors that influence it (218). These contextual influences can be captured using the Social-Ecological Model (79), which complements COM-B by situating individual behaviour within multiple interacting or interconnected levels of influence, thereby supporting the development of a comprehensive intervention strategy for sedentary behaviour reduction.

Existing evidence offers valuable insights into the positive association between prolonged sedentary behaviour and an elevated risk of mental health issues (53). For instance, a dose response relationship exists where the risk of depression increased by 20% among individuals with a total sedentary time of 8 hours a day compared to those with less than 4 hours a day (91). Poor mental health can adversely affect individuals' work performance and productivity, resulting in increased errors and absenteeism (89). However, despite the statistical associations, the specific factors by which sedentary behaviour influences mental

health conditions remain unknown. Furthermore, the process of quantification alone may risk oversimplifying contextual and personalised nuances by reducing them to numbers (219), such as whether an individual chooses to be sedentary or is obliged to do so, and whether it occurs in isolation or within social interactions. Therefore, relying solely on statistical patterns may misrepresent the complexity of sedentary patterns and accumulation in workplace settings.

This qualitative phase was directly informed by the findings of the cross-sectional study in Phase 1. Findings from Phase 1 indicated that occupational sedentary behaviour was highly prevalent among software and IT workers, yet no direct association with overall mental health outcomes was observed. Several potential influencing factors were identified, suggesting that the relationship between occupational sedentary behaviour and mental health is complex and shaped by contextual mechanisms. By exploring participants' interpretations, Phase 2 sought to provide explanatory insights into why prolonged and prevalent self-reported occupational sedentary behaviour was observed, why a direct quantitative association was not identified in Phase 1, and how contextual, organisational, and individual-level mechanisms may shape the relationship between occupational sedentary behaviour and mental health.

To date, no study has explored the lived experience of Software and IT workers in relation to their perspectives on occupational sedentary behaviour and how this may influence their mental health.

Thus, this qualitative phase aims to:

1) Explore the barriers and facilitators of reducing occupational sedentary behaviour among Chinese Software and IT workers.
2) Understand Software and IT workers' perspectives on how occupational sedentary behaviour may influence their mental health.

5.2 Method

5.2.1 Research Design

A cross-sectional qualitative study was conducted using online focus groups with employees and individual one-to-one interviews with managers in a Software and IT company in China. The Consolidated Criteria for Reporting Qualitative Research (CORE-Q) guided the reporting of this research (220), which is presented in Appendix 6. Ethical approval was obtained from Lancaster University's Faculty of Health and Medicine Ethics Committee in accordance with the Declaration of Helsinki (reference: FHM-2024-4859-RECR-2).

5.2.2 Recruitment and Settings

A purposive sampling strategy, followed by convenience sampling, was employed to recruit participants. One technology company in Wuhan, China, was purposively selected from four companies that had participated in the previous cross-sectional survey study (Chapter 4). The company was purposively selected because its Software and IT employees reported a high amount of sedentary time, averaging 498 (±104) minutes per day. Contacts with this company were made through existing social networks. After an online meeting to introduce the study aims and requirements with the Human Resources department, the company provided gatekeeper consent to recruit workers within their organisation. Convenience sampling was then used to recruit Software and IT employees and managers between December 2024 and April 2025.

The recruitment message, eligibility criteria, participant information sheet, link to the consent form, and sociodemographic questionnaire were first sent to the gatekeeper, who then circulated them to all Software and IT employees and managers via the company's WeChat group. WeChat is a widely used social media platform in China that provides messaging, calling, and a variety of social features, and it is commonly used in workplace settings for both individual communication and group discussions (156).

Inclusion criteria for Software and IT employees included:

(i) Eighteen years old and above.
(ii) Working in the Software and IT industry for at least one year (The Software and IT industry encompasses a wide range of job positions and is evolving. Examples of key job positions include software engineer/developer, game developer, e-learning developer, IT support, and data scientist).
(iii) Individuals who are contracted, full-time employees in the current company.
(iv) Work in the workplace in person.

Inclusion criteria for Software and IT managers included:

(i) Eighteen years old and above.
(ii) Working as Software and IT managerial role (this includes any managerial roles, such as technology manager, project manager, and human resources manager).
(iii) Individuals who are contracted, full-time employees.
(iv) Work in the workplace in person.

Exclusion criteria included (for Software and IT employees and managers):

(i) Individuals who are employed on a part-time basis or as interns.
(ii) Individuals whose primary workplace is a home-based or remote setting.

The initial recruitment plan was informed by the recommended range from a systematic review, which suggested that 4–8 focus groups or 9–17 individual interviews are typically sufficient for exploring common experiences in qualitative research (221). However, this range was used only as a practical guideline for recruitment; the sample size was not determined by, nor described in terms of, data saturation. Instead, the focus was on ensuring that the sample was sufficiently rich and diverse to support a meaningful and nuanced analysis of the research questions (222), capturing both shared patterns and individual perspectives.

5.2.3 Focus Group and One-to-One Interviews

To minimise potential power imbalance and enhance homogeneity (223), all consenting Software and IT employees participated in focus groups, while all consenting Software and IT managers took part in individual interviews. Participants who confirmed their eligibility and availability were invited to a designated meeting room within their company for either a focus group or a one-to-one interview. Each focus group or individual interview was conducted and recorded via an online Microsoft Teams meeting displayed on a large screen in the designated meeting room. Each participant completed the online consent form and sociodemographic questionnaire before they took part in the interviews. The gatekeeper assisted the equipment and technology setup for each focus group and individual interview and left the meeting room before the commencement of interview.

All interviews and focus groups were conducted in Chinese by the primary author (MJ), a native female Chinese speaker fluent in English. MJ holds a BSc in Applied Psychology and an MSc in Performance Psychology. This combination of linguistic and professional expertise facilitated qualitative data collection through skills such as active listening and ensured effective communication with participants. Interviews and focus groups were not piloted prior with the target Software and IT workforce. However, to ensure rigour and relevance, the interview questions were carefully constructed to align with the study's aims and theoretical framework. They were rigorously reviewed and refined by co-author with extensive expertise in qualitative research (AM). MJ began each focus group session by outlining ground rules to create a comfortable and inclusive environment, emphasising respectful communication, openness, and confidentiality. To ensure equitable participation, the facilitator (MJ) avoided extended dialogue with individuals and actively encouraged contributions from quieter members (223, 224). Informal notes were taken immediately after each interview, focusing on the researcher's immediate reflections on the interaction dynamics and emotional tone, as part of the reflexivity process. The primary author (MJ) performed verbatim transcription and

cross-checked the transcripts against the original audio recordings. Transcripts were not returned to participants for verification.

The first section of the interviews addressed study aim 1 through questions informed by the TDF framework and the COM-B model. The second section of the interviews explored employees' perceptions of mental health in relation to their occupational sedentary behaviour, beginning by asking how they generally feel about work. All focus groups and interviews commenced with a standardised ice-breaking question that asked participants to describe a typical working day in terms of the patterns of physical activity or inactivity of employees. To ensure anonymity, all participants' identifying information was removed and replaced by an alphanumeric code. This coding system comprises two elements: a capital letter "P" (Participant) followed by a number to denote the order of participation, and a subsequent abbreviation (FG: Focus Group; Int.: Individual Interview) to specify the source of the data. Thus, quotations are cited using the format (P10 FG) or (P20 Int.). A full interview schedule is provided within the Appendix 7.

5.2.4 Data Analysis

Data were analysed using a hybrid analytical approach combining reflexive thematic analysis (225) and framework analysis, underpinned by a critical realist epistemological position. Critical realism posits that an independent reality exists, while our access to this reality is influenced by theoretical, social, and individual interpretations (125). This position legitimises the use of theory as an analytic lens while acknowledging the interpretive role of the researcher.

Reflexive thematic analysis was adopted as the overarching analytic logic, recognising the researcher's subjectivity and theoretical positioning as integral to knowledge production, and viewing themes as actively generated rather than passively discovered (225). This aligns with the critical realist view that understanding reality requires interpretive engagement with data and the use of theory to uncover the deeper structures and generative mechanisms of events (125). In parallel, framework analysis techniques were employed to structure and organise the analysis, particularly through the use of established theoretical

frameworks (i.e., COM-B and TDF) to support systematic comparison and interpretation across cases and aims.

The analysis followed six iterative and recursive phases consistent with reflexive thematic analysis: 1) familiarisation, 2) coding, 3) initial theme generation, 4) reviewing and developing themes, 5) refining, defining and naming themes, and 6) writing up the report. These phases were conducted iteratively and recursively, involving repeatedly moving back and forth among the entire dataset, the generated codes, and the proposed themes (226, 227). A step-by-step overview of the analytic process is presented in Figure 5.1.

The analysis was conducted separately for Aim 1 and Aim 2 by MJ under the supervision of AM and MS. MJ regularly met with AM and MS to discuss the analysis progress, including coding and emergent themes. These discussions were intended to enhance reflexivity and deepen interpretation rather than to reach analytic consensus, consistent with the reflexive thematic analysis approach (226).

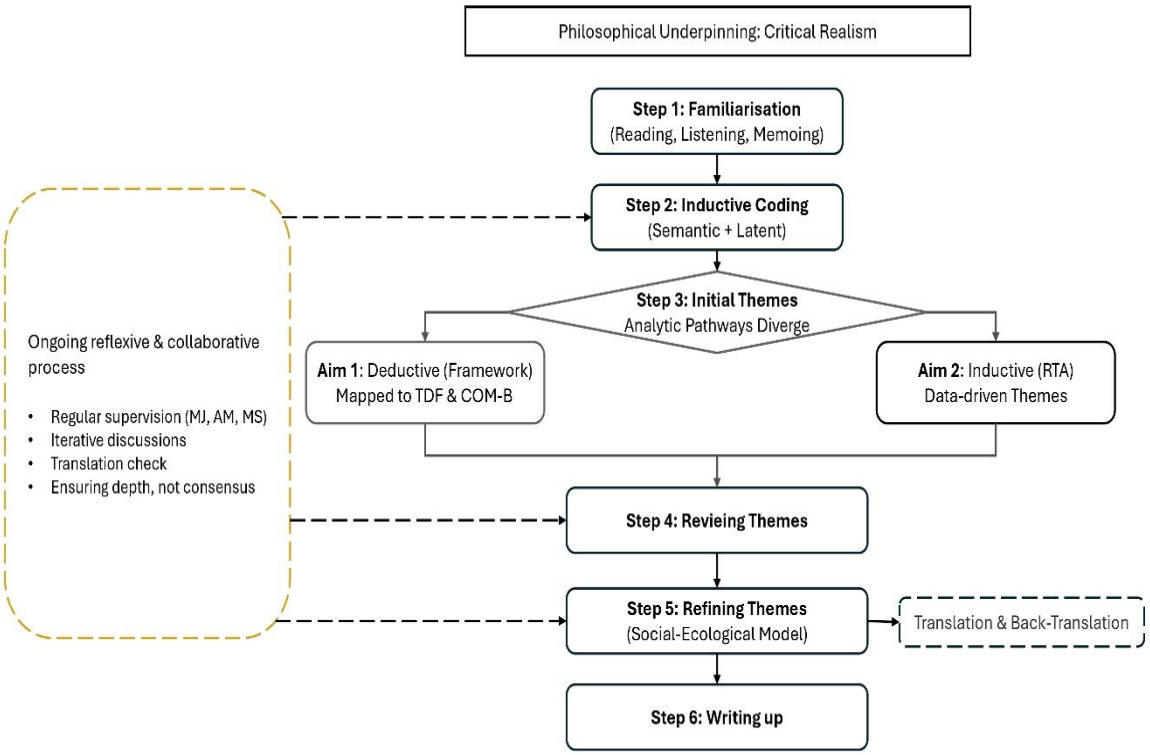

Figure 5. 1 Step-by-Step Analytic Process

Step 1: Familiarisation.

In the familiarisation phase, MJ listened to the recording, read and re-read the transcription, and took notes to immerse in the data.

Step 2: Coding.

NVivo 14 software (Lumivero, USA) was used in the second phase to assist with developing codes potentially relevant to the two research aims. The coding phase was conducted inductively in Chinese, identifying both semantic (i.e., descriptive) and latent (i.e., interpretive) levels of codes (225).

Step 3: Generating Initial Themes (Hybrid Approach).

During the initial theme generation phase, codes were deductively grouped into the items of the TDF, which underpins the COM-B model domains for Aim 1, and inductively for Aim 2. The COM-B domains components served as the initial themes for aim 1. While the COM-B model was the deductive frameworks used, this study remained open to emergent themes that did not neatly fit into their components, ensuring a comprehensive data representation.

Step 4: Reviewing Themes.

In the subsequent reviewing and theme development phase, the codes grouped under the COM-B model of Aim 1 and proposed themes of Aim 2 were inductively synthesised into broader themes. These themes encompassed patterns observed within each model and those that spanned across both models.

Step 5: Refining, Defining, and Naming Themes.

In the refining, defining and naming themes phase, the themes generated in earlier phases were reviewed and adjusted through the lens of social-ecological model to enhance conceptual clarity and theoretical alignment. All codes and themes were translated from Chinese to English by the first author and underwent a collaborative review and discussion with all authors. Back translation was used to

check that the meaning and nuances of the original text were not lost in this process (228).

Step 6: Writing Up.

In the final phase, MJ drafted and refined the theme interpretation based on feedback from and discussions with AM and MS.

This study adopts a specific terminology convention for participant quotations. While the formal term “Software and IT workers” is used throughout the analysis, the interviewees consistently referred to their occupation as “programmer,” reflecting common local usage. To ensure clarity and maintain consistency with the study's formal terminology, the interviewee's original term “programmer” will be replaced with the formal term “Software and IT workers” in square brackets in all direct quotations.

5.3 Results

5.3.1 Participants Demographics

A total of 23 participants took part with the sample primarily consisting of males (87%) aged 25-34 years who had attained a tertiary level of education. There were 5 focus groups (n=17, mean duration 47.8±18.86 min; range 33–85 min), each comprising 2–4 participants, and 6 individual interviews (mean duration 31±7.54 min; range 24–47 min). Among the 6 managerial participants, 5 were Software and IT project managers, while the remaining participant was a human resources manager. Table 5.1 shows detailed participant characteristics information.

Table 5. 1 Sociodemographic Characteristics (n=23)

Variables	Employees (n=17)	Managers (n=6)
Sex, n (%)		
Male	14 (82.3%)	6 (100%)
Female	2 (11.8%)	-
Data not reported	1 (5.9%)	-
Age, n (%)		
18–24	2 (11.8%)	1 (16.7%)
25–34	15 (88.2%)	5 (83.3%)
Educational level, n (%)		
Undergraduate degree/Higher vocational school	17 (100%)	6 (100%)
Annual income, n (%)		
Less than 80000 CNY	2 (11.8%)	-
80000–130000 CNY	12 (70.6%)	1 (16.7%)
140000–190000 CNY	-	2 (33.3%)
Data not reported	3 (17.6%)	3 (50%)
Marital status, n (%)		
Single	14 (82.3%)	-
Married	2 (11.8%)	5 (83.3%)
Data not reported	1 (5.9%)	1 (16.7%)
Number of dependents, n (%)		
0-1	10 (58.8%)	2 (33.3%)
2-3	6 (35.3%)	3 (50%)
Data not reported	1 (5.9%)	1 (16.7%)
Duration in the current company (year), n (%)		
Less than 1	1 (5.9%)	-
1–3	11(64.7%)	-

4–6	5 (29.4%)	5 (83.3%)
7–9	-	1 (16.7%)
Duration in the current industry (year), n (%)		
1–3	8 (47.1%)	-
4–6	9 (52.9%)	4 (66.7%)
7–9	-	2 (33.3%)
Workdays per week, n (%)		
5	17 (100%)	5 (83.3%)
Big/small week scheme	-	1 (16.7%)

Note. Big/small week scheme means workers work a six-day week every second week.

5.3.2 Aim 1: Barriers and Facilitators of Reducing Sedentary Behaviour

For Aim 1, four key themes (comprising eight subthemes) were identified, which explored the barriers to and facilitators of reducing occupational sedentary behaviour in the workplace. Table 5.2 summarises these themes, detailing their subthemes, dimensions of each sub-theme, corresponding barriers and/or facilitators, the source of these subthemes (i.e., from employees, managers, or both), and how each maps to the COM-B model and social-ecological model.

Table 5. 2 Themes Related to Barriers and Facilitators to Address Aim 1

Themes	Sub-themes	Dimensions of sub-themes	B/F	Source	COM-B	SEM Level
Industry-Driven	Nature of the industry	Productivity	B	Both	Motivation-R	Community
		Responsibility	B	Mgr	Motivation-R	
	Pressure from the industry		B	Mgr	Motivation-R	
Company Influence	Staff-centred concept	Pro-movement environment	F	Both	Opportunity-P	Organisational
		Encouragement	F	Both	Opportunity-S	
		Outcome-driven leadership	F	Mgr	Opportunity-S	
	Managerial constraints	Unfamiliarity	B	Emp	Opportunity-S	
		Workload	B	Both	Opportunity-S	
		Cost control	B	Both	Opportunity-P	
Automatic & Reflective Motivation	Knowledge and habits	Insufficient knowledge	B	Both	Capability-P	Individual
		Scheduled or spontaneous breaks	F	Both	Motivation-A Opportunity-P	
		Preference	B	Both	Motivation-A	
	Beliefs and attitudes	Receptive to reduce OSB	F	Both	Motivation-R	
		Downplaying the harm of SB	B	Both	Capability-P	
		Concentration	B	Both	Motivation-R Capability-P	
Socialisation	Education	Education fostered sitting	B	Emp	Motivation-A	Community& Policy
		News and social media	F	Emp	Motivation-A	
	Social norms		B	Emp	Opportunity-S	

Note. B/F=Barriers or Facilitators; Mgr=Manager; Emp=Employee; COM-B=Capability, Opportunity, Motivation, and Behaviour; SB=Sedentary Behaviour; OSB=Occupational Sedentary Behaviour; Capability-P=Psychological Capability; Opportunity-P=Physical Opportunity; Opportunity-S=Social Opportunity; Motivation-A=Automatic Motivation; Motivation-R=Reflective Motivation; SEM=Social-Ecological Model.

5.3.2.1 Theme 1: Industry-Driven Prolonged Sedentary Behaviour

This theme illustrates how the work characteristics of the Software and IT industry contribute to prolonged sitting. The participant accounts highlighted two main factors: the inherent nature of the work, described by both employees and managers, and the age-related pressures of the industry, emphasised particularly by managers.

Subtheme 1.1: Nature of the Industry

Both employees and managers in the Software and IT industry believed that occupational sedentary behaviour was linked to productivity. As one employee noted, *"Well, the work is mainly software development, so comparatively speaking, it just means sitting for longer."* (P5 FG2) Similarly, a manager explained, *"What does sitting mean for a [Software and IT worker]? When they're sitting here, it definitely means they're working."* (P23 Int.6)

Moreover, participants, especially managers, also recognised sitting as a responsibility of being client centred. For example, one manager said, *"If I'm not at my workstation and don't have my computer, and a client suddenly needs urgent help but can't reach us, they will be stressed out. And if this cannot be resolved in time, it might cause some loss to the company or to the client themselves."* (P20 Int.3)

Subtheme 1.2: Pressure from the Industry

Participants, particularly managers in the Software and IT industry described experiencing considerable pressure related to their age and the sustainability of their careers. This pressure was perceived to drive them to make full use of their prime years for work, while downplaying the importance of health behaviours such as reducing occupational sedentary time. As one manager reflected: *"You can think of being a [Software and IT worker] as something tied to a certain period of time. In simple terms, it's like a 'youth-dependent job.' Within your prime years, you*

can generate and gain the greatest value. For example, between the ages of 25 and 35, that's my golden period, right? At that stage, my physical functions are at their best, so I don't really need much exercise." (P19 Int.2)

5.3.2.2 Theme 2: Company Influence on Occupational Sedentary Behaviour

This theme illustrates how the occupational sedentary behaviour of Software and IT workers was influenced by the company. Two subthemes were identified: the staff-centred concept, described by both employees and managers, and managerial constraints, primarily reported by employees, though not exclusively.

Subtheme 2.1: Staff-Centred Concept

A pro-movement environment, physically and socially, was identified by participants. Both employees and managers stated that the company intended to provide them with a pro-movement environment. They mentioned that there were flowers and a table tennis table on the rooftop terrace, providing opportunities for relaxation during work hours. *"The company's boss often encouraged us to take breaks. For example, they planted many flowers and other plants on the rooftop, and suggested that when we felt tired, we could go upstairs, have a look, and walk around."* (P12 FG4) They also reported that a nearby sports hall for badminton and basketball was rented for them to use after work, and that employees would organise activities on their own initiative. As a manager explained: *"In our company we have badminton, table tennis, basketball and so on. Different groups are formed, and we can arrange a time together to play basketball, table tennis, or badminton."* (P21 Int.4) One manager who had worked there since the company's establishment noted the company's willingness to pay higher rent in order to provide employees with a better, movement-friendly workplace environment: *"The boss had mentioned moving to another building nearby to save on rent, but we never ended up moving because our current location is right by the lake in this business park. The reason we sometimes walk for so long after work is that the scenery here is quite beautiful."* (P22 Int.5)

Moreover, both employees and managers reported that business owners directly encouraged them to move more during working hours. For example, one employee

noted: *"The bosses encouraged us to communicate with each other in person. This makes things more efficient and enables us to get up and move around more often."* (P12 FG4) Interviews with managers echoed this, as one explained: *"The boss sometimes asks in the group chat if anyone wants to play table tennis, and then we (managers) would lead employees in some exercise."* (P20 Int.3)

Additionally, managers described themselves as adopting an outcome-driven leadership style, enabling employee's flexibility in arranging their tasks and breaks. When asked whether employees reducing occupational sedentary behaviour would influence a project's progress from a manager's perspective, the manager said: *"I don't think it would at all. For our projects, we set specific deadlines for each task. As long as they deliver the required results on time, there's absolutely no problem. It's completely normal for everyone to want to relax."* (P19 Int.2)

Subtheme 2.2: Managerial constraints

Participants identified several aspects of the management system that they felt limited their ability to reduce occupational sedentary behaviour, despite the company's supportive intentions.

Several employees described feeling unfamiliar with their job responsibilities during the early stages of employment. This lack of familiarity required them to spend additional time learning their tasks, which often resulted in prolonged periods of sitting without realising it. For instance, one employee stated: *"When I had just joined the company, I wasn't familiar with the overall business and workflow. So, I had to spend a lot of time thinking about that, and I would often forget to intentionally exercise."* (P3 FG1)

Both employees and managers identified heavy workloads as a major barrier to reducing occupational sedentary time, *"If the workload is heavy, it inevitably leads to longer periods of sitting."* (P2 FG1) When asked what factors might hinder reducing occupational sedentary behaviour, one employee remarked: *"I think sometimes, working on multiple projects simultaneously might have some impact. It can just get quite busy."* (P11 FG3) A manager explained this from a client-driven perspective: *"After communicating with the client many times, for various reasons*

they often compress the timeline. Once the timeline is shortened, it inevitably means that for software development work we need to work as quickly as possible. This requires either improving efficiency or, alternatively, spending more hours to complete the related tasks as quickly as we can." (P20 Int.3)

Employees identified height-adjustable desks as a potential facilitator: *"If there's a desk that can be adjusted up and down, I feel that standing to work is actually a way to break up long periods of sitting."* (P15 FG5) However, both employees and managers recognised that cost was a major barrier to implementation. Fully equipping the company with sit-stand desks would be expensive and likely unattainable given the company's current resources. As one employee explained: *"The cost of purchasing this kind of equipment is quite high, and since a desk is a fairly personal item, you can't really have multiple people sharing one. So, you have to buy equipment for every single person. I think that's the most fundamental and core challenge."* (P14 FG5)

5.3.2.3 Theme 3: Automatic and Reflective Motivation for Reducing Occupational Sedentary Behaviour

Two subthemes were identified: knowledge and habits, and beliefs and attitudes. Both subthemes, described by employees and managers, encompassed factors that acted as both barriers and facilitators.

Subtheme 3.1: Knowledge and Habits

When discussing ways to reduce occupational sedentary behaviour, participants mostly mentioned increasing physical activity, such as walking or exercising. For example, when asked about the inconvenience of reducing occupational sedentary behaviour in the workplace, one manager stated, *"I feel that it's unreasonable to make everyone exercise during work hours."* (P21 Int.4)

Both employees and managers described reductions in sedentary time as occurring automatically, prompted by either scheduled or spontaneous breaks, such as attending to basic physiological needs, impromptu work tasks, lunch or snack times, or discomfort and fatigue from prolonged sitting. One employee

stated: *"I feel that most of the time I act unintentionally; for example, if there is an activity happening, I might just move around spontaneously."* (P4 FG1)

Moreover, both employees and managers believed that remaining seated was a matter of personal preference, as one participant stated, *"I generally just sit, nothing more. I'm not fond of being active."* (P1 FG1)

Subtheme 3.2: Beliefs and Attitudes

Participants reported varying attitudes towards sedentary behaviour. Most described beliefs in the negative effects of prolonged sitting and the benefits of taking breaks for both physical and mental well-being, particularly when experiencing fatigue, reflecting a generally receptive attitude toward reducing occupational sedentary behaviour. As one participant noted, *"I feel that whether it is sitting for long periods in general or sitting for work, reducing sedentary time is beneficial for both the mind and body. It helps improve mood and physical health, making oneself feel more comfortable."* (P4 FG1)

Some employees and managers, however, reported experiencing little immediate impact from prolonged sitting. As one participant noted, *"Anyway, we don't feel anything when we sit."* (P7 FG2) A participant from the same focus group also described a belief that engaging in exercise could offset the negative health effects associated with sedentary behaviour: *"Let's say you sit for 8 to 10 hours during the day. At that point, exercising after work can provide a certain amount of offset."* (P5 FG2) The same participant further expressed scepticism about the health risks of sedentary behaviour, even while acknowledging the evidence: *"I know that journals like Nature or certain SCI medical papers tend to suggest that prolonged sitting might increase your risk of cardiovascular disease or liver cirrhosis. But the reality is that for every single individual, the correlation isn't necessarily very strong."* (P5 FG2)

Both employees and managers stated that a high level of concentration could lead to losing track of time, resulting in prolonged sedentary periods at work. As one participant stated, *"When I'm working, I might just forget about the time."* (P13 FG4) More importantly, participants expressed reluctance to break this state:

"When I'm really focused on writing code and finally come up with an idea, if I get interrupted, it takes me a long time to get back into the flow." (P22 Int.5)

5.3.2.4 Theme 4: Influence of Socialisation on Occupational Sedentary Behaviour

This theme illustrates how socialisation shapes occupational sedentary behaviour through two key aspects: education and social norms. Here, education encompasses both formal schooling and informal sources of information, such as news and social media. Both subthemes were primarily reported by employees.

Subtheme 4.1: Education Fosters Sedentary Behaviour

While the initial interview guide did not explicitly include questions about educational experiences, one participant mentioned becoming accustomed to sitting from a young age, *"we might have been used to sitting since we were little."* (P7 FG2) This prompted further exploration of the potential influence of education, given its prominent role in shaping early behaviours.

Several employees reported becoming accustomed to prolonged sitting since their school years, with early elementary stages explicitly mentioned as formative periods, *"When I was a child, adults, including teachers, would always say, 'Habits are something you build from a young age.' The teachers would constantly tell us, 'Cultivate your habits. If you can't even sit still, how can you learn? It's about developing your concentration.'"* (P14 FG5)

Apart from formal schooling, participants considered news and information on social media as a form of informal education. When asked whether they had heard about the Physical Activity Guidelines for Chinese (2021), one employee said, *"I came across it on short videos."* (P12 FG4).

Subtheme 4.2: Social Norms

Several employees stated that the workplace was primarily seen as a setting reserved for work, and thus not an appropriate environment for physical activity. As one employee described, *"Work time is for working, and time for exercise can be reserved for after work."* (P4 FG1) The working environment also made them

hesitant to move. As one employee stated, *"It just feels kind of strange to walk around at work."* (P7 FG2)

5.3.3 Aim 2: How Occupational Sedentary Behaviour May Affect Mental Health

For Aim 2, three key themes (comprising four subthemes) were identified, which examined Software and IT employees' perspectives on how occupational sedentary behaviour may influence their mental health. Table 5.3 summarises how each theme is mapped to the levels of the socio-ecological model (SEM).

Table 5. 3 Themes Related to Perceived Mental Health Impacts for Aim 2

Themes	Sub-themes	SEM Level
Physical Discomfort		Individual
Work Pace	Workload and pressure	Organisational & Community
	Loss of autonomy	
Beliefs and Attitudes		Individual

5.3.3.1 Theme 1a: Physical Discomfort from Sedentary Work and Its Impact on Mental Health

Both employees and managers expressed that prolonged occupational sedentary behaviour led to physical and mental fatigue. One employee identified occupational sedentary behaviour as the foundational factor that initiates a cycle of physical discomfort and subsequent mental health struggles: *"It could be considered a foundational factor. For example, prolonged sitting might lead to neck pain, which then causes dizziness, making you feel irritable and frustrated when doing anything. This creates a vicious cycle. While it may not be a decisive factor that completely determines your mood or physical state, it is certainly a fundamental, underlying influence that creates this kind of progressive, layered cycle."* (P14 FG5)

5.3.3.2 Theme 2a: Work Pace of Software and IT Work

This theme, mentioned by both employees and managers, reflects how workload, pressure, and loss of autonomy influenced their mental health.

Subtheme 2a.1: Workload and Pressure

Both employees and managers indicated that workload, including high work intensity and long working hours, directly influenced their mood. For example, when asked about factors affecting mental health, one manager noted: *"If our work hours are shorter and the intensity is lower, we'll naturally be in a better mood"* (P22, Int.5)

Meanwhile, participants, mainly managers, also indicated that in the Software and IT industry within computer science, they felt pressure from the perceived threat of being replaced by artificial intelligence technology. To be specific, the manager stated, *"I think what makes me anxious is this technological development, because it makes me wonder how I'll survive in society. What level can I take my own skills to? What kind of contribution can I make at work or for my company?"* (P21 Int.4)

Subtheme 2a.2: Loss of Autonomy

Participants, primarily managers, expressed that a loss of control over physical movement due to occupational sedentary behaviour can negatively affect mental health. When asked about the potential effects of prolonged sitting on mental health, a manager described the experience of feeling compelled to sit due to the nature of their industry, *"My immediate thought is that it feels somewhat like a restriction of personal freedom, because at least while working, you're required to be at your workstation. Of course, it's not that the company or anyone is stopping you from moving around, but it's the nature of the job that dictates you must be in that work position during work time."* (P20 Int.3)

5.3.3.3 Theme 3a: Beliefs and Attitudes about Occupational Sedentary Behaviour

This theme, reported by both employees and managers, illustrates how occupational sedentary behaviour may influence mental health through factors such as beliefs and attitudes toward sitting.

Some participants, both employees and managers, expressed their beliefs that it was not the act of occupational sedentary behaviour itself, but rather the activities they engaged in while being sedentary, that influenced their mental health. For example, when asked about their mental state after a whole day of prolonged sitting at work, an employee said, *"I don't have any particular feelings about sitting—whether it's good or bad. It mainly depends on what you're doing while sitting. Sitting at work and sitting while playing video games are two completely different states."* (P7 FG2)

Some participants expressed satisfaction and enjoyment with their job and felt that sitting enabled them to complete their working tasks *"Typing codes is enjoyable [...] I find that prolonged sitting helps me think better."* (P2 FG1) Meanwhile, some employees and managers described prolonged occupational sitting as negatively impacting their mental health because it led to feelings of monotony. One employee explained, *"When it comes to work, I think sitting for a long time is quite boring because you're just sitting there continuously. For people who like to be active, it can be a rather dull experience."* (P10 FG3)

5.4 Discussion

This is the first study to focus on perceptions of occupational sedentary behaviour and mental health among Software and IT workers in China. Firstly, the study identified the barriers and facilitators to reducing occupational sedentary behaviour among Chinese Software and IT employees. Four themes were identified, representing key aspects influencing sedentary behaviour, encompassing barriers, facilitators, or both: 1) Industry-Driven Prolonged Sedentary Behaviour, 2) Company Influence on Occupational Sedentary Behaviour, 3) Automatic and Reflective Motivation to Reduce Occupational Sedentary Behaviour, and 4) Influence of Socialisation on Occupational Sedentary Behaviour.

Secondly, the study explored employees' views on how occupational sedentary behaviour might affect their mental health. Three themes emerged in relation to

this aim: 1) Physical Discomfort from Sedentary Work, 2) Work Pace of Software and IT Work, and 3) Beliefs about Occupational Sedentary Behaviour.

It is worth noting that the Software and IT industry is male dominated. In the context of China, reports indicate that males constitute a range from 79% to over 90% of employees in this sector (39). The current study aligns with this demographic, featuring a high proportion of male participants (87%), which suggests that the present sample reflects the typical demographic profile of the industry.

5.4.1 Exploring Barriers and Facilitators of Reducing Sedentary Behaviour

5.4.1.1 Industry-Driven Prolonged Sedentary Behaviour

Findings from this study highlight how work characteristics of the industry can shape prolonged sitting. Occupational sedentary behaviour was rationalised as professionally necessary by the Software and IT participants. Previous research has shown that perceptions of productivity and responsibility are a common barrier to interrupting sitting in office settings (229). This study extends this evidence by showing how such perceptions manifest differently across occupational roles within the same industry. For Software and IT employees, sitting was closely linked to productivity through its perceived benefits for concentration, as their work primarily involved writing code, which required sustained focus. For managers, however, sitting was also associated with responsibility. Their tasks involved fewer technological demands but frequent communication with clients, including resolving urgent problems with the software. Not being at their workstation was considered irresponsible to clients. This distinction underscores the need for role-specific approaches when designing workplace interventions. It also highlights the importance of ensuring that strategies to encourage breaks or movement do not conflict with workers' perceived obligations of productivity and responsibility.

In addition, managers' unique concerns about career sustainability illustrate how perceived pressures from the industry may reinforce occupational sedentary

behaviour. The career sustainability pressure was reflected in their belief of being less competitive as they grew older. This led them to believe it would be difficult to secure employment that matched their salary expectations. This drove them to prioritise work when available, even at the expense of health-related behaviours such as reducing sedentary time. Their concern may be rooted in some evidence. For example, according to a 2021 survey of nearly 550,000 Software and IT workers conducted by Proginn, a professional platform that provides work for freelance and part-time software developers in China, only 1.7% were over the age of 40 (230). Similar concerns documented among Software and IT workers in the US suggest that this is not a unique phenomenon in the Chinese context (231). Although the validity of this fear has been debated in recent years, with some commentators suggesting that media narratives exaggerate the pressure (231), the fact that this perceived pressure shapes work priorities indicates that it functions as a powerful barrier to reducing occupational sedentary behaviour. Intervention development aimed at reducing occupational sedentary behaviour therefore needs to consider how industry structures influence workers' perceptions and explore the potential role organisations can play in addressing this challenge. Crucially, while this pressure exists, the belief among workers that their current good health negates the need for physical activity underscores the need for an educational strand to raise awareness of the long-term risks associated with prolonged sedentary behaviour.

Taken together, these findings suggest that prolonged occupational sedentary behaviour in Software and IT work is reinforced by both the intrinsic nature of tasks and the context of the industry. These influences from the community level suggest that individual-level behaviour change strategies alone may be insufficient (232).

5.4.1.2 Company Influence

Though participants experienced health concern and supported efforts from their company to reduce sedentary time, some managerial constraints were identified which appear to unintentionally sustain occupational sedentary behaviour. From

the perspective of the COM-B framework, barriers were expressed in terms of both social and physical opportunities.

Issues of unfamiliarity and workload were identified by participants. Employees mentioned that in the early stages of joining the company, their lack of familiarity with job content led them to spend more time sedentary to better understand their tasks. More generally, both Software and IT employees and managers emphasised workload as the most significant barrier to reducing sedentary time at work. They noted that multiple concurrent projects often made them either increase productivity or extend working hours, with the latter inevitably prolonging sedentary time. While part of the challenge may lie in individual adaptation and skill development, the findings from this research also imply insufficient support from management, whether stemming from resource constraints or a lack of awareness of employee needs.

Cost control emerged as a distinct constraint, specifically concerning the procurement of environmental adaptations. Employees identified that while height-adjustable desks could provide a potential solution to reducing occupational sedentary behaviour, their companies were unlikely to invest in such equipment due to financial constraints. This reflects a common challenge in workplace sedentary behaviour reduction, where financial considerations often overshadow potential long-term benefits (233-235). Evidence from the SMArT Work trial in the UK National Health Service suggests that the provision of height-adjustable desks, alongside behavioural support, not only reduced occupational sedentary time but also increased productivity, with cost savings outweighing the investment (236). Specifically, the intervention demonstrated a strong return on investment of 256%, which was estimated to result in a substantial net saving of £1,770.32 per intervention group employee over the 12-month period (236). However, translating such evidence to the Software and IT industry requires caution, as outcomes are likely to vary depending on employee engagement, industry context, and the nature of tasks. Employees also suggested that shared fixed-height standing high desks could serve as a more affordable alternative to the individual height-adjustable workstations. However, the effectiveness of this

kind of hot desk system is questionable, as evidence shows that it does not contribute to an overall reduction in sitting time (237). In the Software and IT workplace context, the hot desk system may be hindered by ergonomic considerations, as some employees would connect their laptops to workstation monitors. Further research is needed to examine both the effectiveness and the cost-effectiveness of occupational sedentary behaviour interventions in Software and IT organisations.

Taken together, these findings highlight the critical role of organisations in shaping employees' sedentary behaviour. On one hand, companies are expected to take a proactive role, such as with onboarding training for new employees and workload allocation. On the other hand, financial constraints represent a valid concern. This suggests that while organisational support is essential, research should also explore more cost-effective approaches that make promoting healthier working practices more feasible by avoiding unmanageable costs. For instance, the BeUpstanding intervention in Australia (238), which empowers workplace champions to promote standing and movement through participatory, low-cost strategies rather than equipment-based solutions, has demonstrated both feasibility and effectiveness in reducing occupational sitting time (239).

5.4.1.3 Automatic and Reflective Motivation to Reduce Sedentary Behaviour

Similar to previous studies in workplaces outside China, many participants demonstrated limited knowledge about how to reduce sedentary behaviour, often equating being less sedentary with doing more physical activity such as walking or exercising. Since these behaviours were perceived as incompatible with the workplace context, employees and managers tended to regard sitting reduction as impractical. This knowledge gap thus constrained their motivation to change. In addition, a subset of participants expressed scepticism regarding the harms of occupational sedentary behaviour, suggesting a misalignment between scientific evidence and personal beliefs. Such scepticism appears to stem from a reactive health mindset that views discomfort or symptoms as a prerequisite for behavioural modification. Consequently, this mindset may contribute to underestimating the severity of occupational sedentary behaviour and reduce

willingness to engage in change. Educational intervention techniques may therefore be useful (240), not only to clarify that reducing sedentary time is distinct from exercising, but also to highlight the independent health risks of prolonged sitting that cannot be fully offset by physical activity (e.g., cardiovascular and metabolic disease outcomes) (241). Raising awareness of these risks, even when no immediate discomfort is felt, may strengthen both automatic and reflective motivation to reduce occupational sedentary time. This preventative focus is particularly crucial, as evidence shows that adopting a preventive approach to health interventions is significantly more cost-efficient than relying on secondary or tertiary strategies that focus on treating or managing existing health problems (242, 243).

Concentration also emerged as a salient factor, spanning both psychological capability and reflective motivation within the COM-B model. Many participants reported being unaware of how long they had been sitting once they were absorbed in their work, indicating a lack of psychological capability to monitor sitting. Meanwhile, some Software and IT workers described deep concentration as a valued state of mental flow, which is indeed supported by current research (244, 245), and were reluctant to interrupt it. Here, reflective motivation to maintain productivity reinforced prolonged sitting. Addressing this challenge may require reframing short interruptions. Rather than being seen as disruptions, brief breaks could be promoted as opportunities to alleviate fatigue and enhance subsequent cognitive performance (246).

Collectively, these findings indicate that at the individual level, motivation to reduce occupational sedentary behaviour is influenced by a combination of knowledge, beliefs, and habits. Effective strategies may therefore need to operate on both automatic and reflective levels (247). This requires complementary approaches, such as providing education to address misconceptions and scepticism (a reflective approach) (240), and introducing supportive cues to raise awareness and reframe breaks as productivity-enhancing practices (an automatic or nudge-based approach) (248).

5.4.1.4 Socialisation

Findings from this study suggest the essential role of early socialisation in shaping adult sedentary behaviour, consistent with evidence that sedentary behaviour in childhood is associated with sedentary behaviour in adulthood (249). Within both family and school contexts, the ability to sit still was often framed as a marker of concentration and academic success. While these practices may cultivate discipline, they also risk legitimising prolonged sitting as a valued skill, neglecting its long-term behavioural consequences and health risks (250). Moreover, educators have sometimes encouraged sitting or restricted movement as a classroom management strategy (250, 251), further embedding inactivity within the learning environment. The persistence of such early influences was apparent in the perspectives of participants in this study, who recognised their formative impact. From a public health standpoint, this highlights a tension between educational goals and health promotion. Specifically, prioritising stillness for academic performance may inadvertently hinder the development of healthy, lifelong movement habits. Such early-life prioritised values may subsequently transfer and manifest in occupational performance during adulthood.

Crucially, however, the same socialisation processes that once reinforced sitting can be redirected positively within organisational contexts. By leveraging social influence, such as cultivating an organisational culture for frequent breaks (32, 83), organisations may "re-socialise" employees toward more active workplace norms. Future research should examine how early life experiences of sedentary behaviour intersect with workplace culture, particularly in a Chinese context, and how interventions might harness socialisation mechanisms across the life course to cultivate healthier behavioural patterns.

5.4.2 Exploring How Occupational Sedentary Behaviour May Influence Mental Health

Participants reported how prolonged occupational sedentary behaviour contributed to their physical discomfort, which in turn influenced their mental states and created what participants referred to as a "vicious cycle" of behaviour

and affect. This aligns with existing evidence showing that physical and mental health are closely intertwined (252). The survey study in Chapter 4 revealed that Software and IT workers in China engaged in occupational sedentary behaviour for an average of 427.9 (±133.2) minutes, which constituted 72.4% of their working hours. Such prolonged sedentary behaviour may contribute to poorer sleep quality, a physiological state that can, in turn, negatively affect mental health. Future research could further examine whether the impact of occupational sedentary behaviour on mental health is mediated by physical health conditions. These insights also suggest that interventions targeting only sedentary behaviour or only mental health may be insufficient to disrupt this potential "vicious cycle"; instead, a dual focus may be more effective.

Work pace, including heavy workload and industry-related pressures, was described as overarching factors shaping both occupational sedentary behaviour and mental health. Participants emphasised that the nature of their jobs often required prolonged sitting, which was experienced not only as physical stillness but also as a restriction on personal freedom. In this sense, sedentary behaviour was perceived less as a voluntary choice and more as a job-related constraint undermining autonomy, a factor known to contribute to negative mental health outcomes (253). These findings suggest that high workload and pressure influenced participants occupational sedentary behaviour and mental health.

How occupational sedentary behaviour influences mental health may vary depending on individuals' beliefs and attitudes toward occupational sedentary behaviour. Participants expressed some beliefs and attitudes consistent with existing evidence. For example, they noted that the impact of sitting stemmed not from sedentary behaviour per se, but from the work-related stressors embedded within occupational sedentary behaviour. This aligns with evidence suggesting that the environmental and social contexts in which sedentary behaviour occurs can shape its mental health consequences (59, 61). At the same time, participants reported that when sedentary tasks were creative or personally enjoyable, sitting was experienced as pleasant. This view resonates with research distinguishing between mentally passive and mentally active sedentary behaviours, where only

passive sedentary behaviours are associated with adverse mental health outcomes (5, 93).

However, participants also held beliefs that contrast with research findings. For example, they considered occupational sedentary behaviour, rather than leisure sitting, as detrimental to mental health, and believed that sitting helped thinking. These perceptions contrast with existing evidence, which generally shows that leisure, but not occupational, sedentary behaviour is detrimental to health (108), and a negative association between sedentary behaviour and cognitive function (254). Such discrepancies may arise from differences between how variables are measured in research and how individuals experience them in their own contexts. For example, job tasks may differ between Software and IT workers and those included in previous research. The *"I find that prolonged sitting helps me think better"* referred to by Software and IT workers in this study meant sustained attention in real-life job tasks. In contrast, previous research on sedentary behaviour and cognitive functions typically defines cognitive function more narrowly, using measures such as digit span forward and backward (255).

These findings highlight the need for future research to clarify how occupational sedentary behaviour across different professions, job tasks, and industries relates to specific dimensions of mental health, and how beliefs and attitudes may mediate or moderate these effects. From a public health perspective, they also suggest that employees may hold misconceptions about the impact of sitting on mental health, indicating a need for targeted educational interventions.

5.4.3 Strengths, Limitations, and Implications

This study has several strengths. First, the use of focus groups with employees and individual interviews with managers minimised potential power imbalances, thereby encouraging participants to share their views freely. Moreover, the reflexive thematic analysis combined inductive and deductive reasoning iteratively, drawing on the COM-B model and refined through a social-ecological lens. This approach enhanced both the depth and theoretical grounding of the findings.

Nevertheless, focus group interviews carry the risk of conformity. To mitigate this, ground rules were introduced at the outset, individual exchanges were kept brief, and quieter participants were actively encouraged to contribute to ensure balanced participation.

Future interventions aimed at reducing occupational sedentary behaviour in the workplace should be tailored to specific occupations, job roles, tasks, and industry characteristics. Research examining the relationship between occupational sedentary behaviour and mental health would benefit from exploring the influencing factors, including the potential mediating, moderating, and confounding roles of physical condition, work pace, and individual beliefs and attitudes regarding occupational sedentary behaviour.

5.5 Conclusion

Findings from this study demonstrate that occupational sedentary behaviour among Software IT workers in China is shaped by a complex interplay of factors across the individual, organisational, social, and policy levels. These insights underscore the need for tailored approaches in future health promotion interventions in the workplace. The study also revealed factors that influence both occupational sedentary behaviour and mental health, as well as identifying elements that may help explain how occupational sedentary behaviour relates to employees' mental health. Ultimately, conducting further quantitative studies to validate these factors would be crucial for developing a robust theoretical model that explains the intricate relationship between occupational sedentary behaviour and mental health outcomes.

Chapter 6: Evidence Integration and Intervention Strategies Development

6.1 Introduction

This chapter presents the final phase of the explanatory sequential mixed-methods study, in which the quantitative and qualitative findings are brought together and used to inform the development of intervention strategies. The chapter is organised into two parts. The first focuses on integration, where the weaving approach is employed to narratively combine quantitative and qualitative findings within a single storyline (145), and the joint display approach is used to visually juxtapose quantitative results with relevant qualitative evidence (145). The second, moves from evidence to practice by applying the Behaviour Change Wheel to systematically translate both qualitative findings and integrated findings into evidence informed and theoretically driven intervention strategies. By combining rigorous data integration with a structured intervention development framework, this chapter demonstrates how mixed-methods research can generate both explanatory insights and practical implications.

6.2 Integration

To integrate the two strands of this explanatory sequential mixed-methods study, both weaving and joint display approaches were employed. Weaving is a narrative integration approach in which qualitative and quantitative findings are presented together on a theme-by-theme or concept-by-concept basis (145). This allows the researcher to combine numerical patterns with participants' experiences within the same narrative flow, facilitating a more holistic interpretation of the findings. Weaving was chosen because it enables a deeper interpretive connection between the two datasets (Chapter 4 and Chapter 5), allowing qualitative insights to explain, expand, or nuance quantitative results beyond what can be shown numerically (133). The quantitative findings from Phase 1 were interpreted narratively and then integrated with the qualitative findings in Phase 2 (256). A joint

display, in contrast, provides a structured visual juxtaposition of quantitative and qualitative findings within a single framework, thereby making the process of integration explicit and transparent (145). Together, the two approaches strengthen both the interpretive richness and the procedural clarity of the integration.

As this thesis followed an explanatory sequential mixed methods design, the integration logic was primarily driven by the need for the qualitative findings to explain the prior quantitative results. Accordingly, the narrative structure was anchored in the quantitative constructs, while the qualitative findings provided the depth and context necessary for meaningful explanation. The following three integration themes emerged from revisiting the overarching aim of this thesis, as well as the specific aims and findings of both strands, ensuring that the qualitative component directly fulfilled its explanatory role within the overall mixed methods design.

1. Prevalence of total and occupational sedentary behaviour and mental health among Chinese Software and IT employees
2. Sedentary behaviour and mental health: association and potential mechanisms
3. Using the integrated findings to develop evidence informed and theoretically driven intervention strategies for Software and IT employees

Four types of data integration fit were used to describe how qualitative data fit with the quantitative data, including confirmation, complementarity, expansion, and discordance (145). Confirmation occurs when both sets of findings lead to the same conclusion. Complementarity is when the data, while different, present non-conflicting stories. For instance, qualitative interpretations might reveal one aspect of a phenomenon, and quantitative data, another side of that same issue. Expansion means that combining both qualitative and quantitative data offers a broader yet overlapping understanding. Finally, discordance is the situation where the two types of data conflict with each other.

6.2.1 Prevalence of Total and Occupational Sedentary Behaviour and Mental Health among Chinese Software and IT Employees

The Phase 1 quantitative study (Chapter 4) demonstrated that Software and IT workers in China represent a population engaged in a high level of occupational sedentary behaviour, averaging 427.9 (±133.2) minutes per day, which accounted for 72.4% of their working hours (approximately 347.52 minutes during an 8-hour workday). Meanwhile, participants also showed a potentially high prevalence of pre-clinical mental health symptoms, with 20.4% (n = 48) scoring within the moderate to severe range for depression, and 21.7% (n = 51) scoring within the moderate to severe range for anxiety. The Phase 2 qualitative data were integrated with the quantitative findings through a combination of confirmation and complementarity, as well as a critical finding of discordance. The four interrelated themes that emerged in the Phase 2 qualitative study mostly detailed barriers, confirming the high level of sedentary behaviour (72.4%). For instance, the industry's characteristics inherently promote sitting, as participants have internalised sedentary behaviour as a synonym for productivity and responsibility, making leaving the workstation an interruption to work. Additionally, the industry's high competitiveness and the rapid evolution of technological development led workers to feel anxious and choose to spend more time working to remain competitive. This finding complements the mental health scores by providing potential explanations of the perceived mental pressure.

However, a critical discordance emerged regarding participants' self-reported mental health. Although the quantitative results indicated that some participants may have experienced elevated levels of anxiety or depression, no accounts of psychological distress emerged in the qualitative focus groups and interviews. This inconsistency between quantitative symptom scores and qualitative self-reports could be due to several reasons. For example, the self-selective convenience sampling may have excluded individuals with mental health symptoms (257). In addition, the online focus group facilitated by a researcher unfamiliar to the participants and attended by colleagues, may have lacked the necessary trust and

confidentiality required for participants to disclose personal mental health struggles (258).

Moreover, it is possible that some Software and IT workers may lack mental health literacy, potentially misunderstanding symptoms as personality traits. For example, when asked what mental health is and what it means to Software and IT workers, one participant said: *"Mental health… I don't think I have any particular issues in that regard. I find it a bit hard to come up with anything specific. To me, everyone seems more or less the same. Some people might be quieter, others more outgoing. But I don't really notice much difference. Personally, I don't feel that mental health is something that poses any kind of barrier for me. I also don't tend to judge or think much about these things. I haven't really had any exposure to them, no experience or cases that I know of, so I'm not quite sure how to answer this question."* (P21 Int.4). A recent scoping review revealed that this lack of mental health knowledge and associated stigma is a persistent issue in China (259), which can hinder individuals from recognising symptoms and even seeking help. In this case, the integration of quantitative findings (suggestive of subclinical symptoms) and qualitative findings (symptoms unrecognised) suggests that some Software and IT workers may be experiencing, or at risk of, symptoms of depression or anxiety, but lack the awareness to acknowledge the potential impact of these symptoms on their well-being.

Overall, the findings regarding both the long hours of occupational sedentary behaviour and the prevalence of mental health symptoms suggest that health promotion initiatives would be valuable among Software and IT workers in China.

6.2.2 Occupational Sedentary Behaviour and Mental Health: Association and Potential Mechanism

The Phase 1 (Chapter 4) quantitative analysis demonstrated that neither total or occupational sedentary behaviour was directly or statistically significantly associated with depression, anxiety, or stress. An association between occupational sedentary behaviour and stress, which emerged in the crude model (and persisted in Models A and B, adjusting for sociodemographic, lifestyle, and

physical activity variables), was attenuated to non-significance after the sequential inclusion of occupational contextual variables (Model C) and poor sleep quality (Model D) in the hierarchical regression. Path analysis suggested two plausible theoretical explanations for the absence of a direct association: confounding by upstream occupational factors (i.e., tenure) that influence both sedentary behaviour and mental health, and mediation via poorer sleep quality.

Phase 2 (Chapter 5) qualitative data were integrated with the quantitative results using an expansion fit of integration, with two primary aims: to elucidate the mechanisms underlying the absence of a direct statistical association, and to identify empirical candidates for the potential upstream factors and mediators. The loss of significance after controlling for occupational variables in the Phase 1 quantitative study suggests that work-related factors may account for, or potentially modify, the relationship between occupational sedentary behaviour and mental health. There might also be some unmeasured occupational variables. Qualitative findings echoed this interpretation, as participants emphasised that it was not sedentary behaviour per se but the activities, responsibilities, and contexts while engaging in sedentary behaviour that were salient to their mental health. They described distal occupational stressors, including heavy workload and industry pressure, that plausibly influence both patterns of occupational sedentary behaviour and mental health concurrently. Together, the attenuation of the quantitative association after controlling for occupational context and the qualitative emphasis on contextual pressures are consistent with the hypothesis that observed associations between sedentary behaviour and mental health may be context-driven rather than exclusively driven by the behaviour itself (59, 108).

The Phase 2 qualitative study further expanded the Phase 1 quantitative findings by identifying novel candidate mediators for future investigation. The quantitative path analysis suggested that poor sleep quality could plausibly mediate the association between occupational sedentary behaviour and stress. Although participants did not explicitly discuss sleep quality during the Phase 2 qualitative study, they described perceived consequences of prolonged occupational sedentary behaviour, such as physical discomfort and a perceived loss of

autonomy, that could reasonably precede and affect mental health outcomes. Given that the evidence supports poor sleep and physical ill-health as well-established correlates of worse mental health (192, 260, 261), future research should empirically assess whether these physical health conditions and sleep quality indeed mediate the relationships between occupational sedentary behaviour and mental health. Participants also prominently highlighted perceived loss of autonomy associated with prolonged sedentary behaviour. While studies on job autonomy (control over work tasks and methods) consistently show protective mental health associations (253, 262, 263), the specific concept of "physical autonomy" (i.e., control over when and whether employees may take movement breaks during the workday) remains an underexplored mechanism. Investigating whether this limited physical autonomy mediates the relationship between occupational sedentary behaviour and mental health would be a valuable next step.

Finally, participants identified personal beliefs and attitudes (for example, whether sedentary behaviour is perceived as voluntary or desirable) as crucial potential influencing factors of the occupational sedentary behaviour-mental health relationship. This qualitative insight aligns with evidence from non-work populations suggesting that voluntary sedentary time relates to better well-being, whereas involuntary sedentary time relates to poorer health (264). From this perspective, perceived agency appears to be as important as the objective sedentary behaviour context itself. This focus on subjective appraisal is further supported by inconsistent findings in the wider literature on work behaviours. For instance, while physical activity is generally viewed as beneficial for mental health (265), a recent systematic review revealed a positive association between work-related physical activity and mental ill-health (266). This inconsistency indicates that future research should move beyond solely focusing on domains and contexts. It would be also valuable to assess individual subjective appraisals, such as desirability, voluntariness, and perceived intensity of work-related physical activity, when evaluating their complex relationships with mental health.

It is important to acknowledge that the hypothesised pathways proposed in this section must be empirically tested in future longitudinal and experimental designs, as the current cross-sectional research design limits the ability to draw causal inferences.

6.2.3 Using the Integrated Findings to Develop Evidence-Informed and Theory-Driven Intervention Strategies for Software and IT Employees

Path analysis in the Phase 1 quantitative study identified several factors significantly associated with higher levels of occupational sedentary behaviour, including longer working hours (β=0.462, $p<0.001$), non-managerial role (β=68.364, $p=0.005$), and shorter tenure (β=−24.456, $p=0.005$). Among the participants, managerial employees spent on average 58.2% of their working time in occupational sedentary behaviour, whereas non-managerial employees spent 76.0% of their working time being sedentary. Regarding tenure, employees who had worked for less than one year reported that occupational sedentary behaviour accounted for 76.8% of their working time. Those with one to three years of tenure showed a similar proportion (76.5%), followed by a decrease among employees with four to six years (69.5%), seven to nine years (53.5%), and ten years or more (51.2%).

However, since these variables represent characteristics of the job role and work context, they are not readily amenable to direct modification at the individual level. The Phase 2 qualitative findings were integrated with the quantitative results using both confirmation and complementarity fit to provide contextual explanations and to pinpoint modifiable aspects embedded within these non-modifiable characteristics through mapping them onto the COM-B domains.

Regarding long working hours, participants consistently reported that extended hours were often driven by heavy workloads and tight deadlines. These extended hours directly increased total time spent sitting. Crucially, they noted that extended working hours provided fewer opportunities for colleague interactions compared to normal hours, thus fewer opportunities for taking breaks from their workstation. This combination of extended duration and reduced activity during

extended working hours provides the contextual explanation for the quantitative finding linking longer working hours to higher occupational sedentary behaviour. Given that overwork is viewed as a mutual obligation in the Software and IT sector (267, 268), and is the result of organisational pressure and internalised career necessity (269), direct modification at the individual level is likely unfeasible. Thus, there is a strong rationale for requiring modification at the policy, industry, and organisational levels.

Specifically, although China has laws regulating overtime hours (270), long working hours are still prevalent in the Software and IT sectors (271). The economic premise of overwork has been challenged by recent evidence, as a study reveals that policy leniency towards an organisation's overtime culture does not significantly boost company competitiveness (272). Moreover, the health costs may outweigh the potential benefits to society. Specifically, the overtime culture significantly impairs the health of both employees and their spouses, with a 1% increase in overtime rate estimated to reduce a composite health index by 0.198 and 0.142 standard deviations for employees and their spouses, respectively (273). Furthermore, sedentary behaviour itself is associated with an increase in annual out-of-pocket health care expenditures by approximately $37 USD for each additional sedentary hour (274). Taking this information together, the persistence of overtime and its resulting occupational sedentary behaviour could become a significant economic and health burden for society. However, there is currently a lack of guidelines in the occupational regulation of the office workplace, including Software and IT industry. Through the lens of the COM-B model, Software and IT workers currently lack a social opportunity to counteract the influence of overtime on reducing sedentary behaviour in the workplace.

The quantitative finding that non-managerial employees exhibited higher sedentary time can be contextualised through role-dependent differences identified in the qualitative data. Managerial roles typically involve greater mobility within the workplace, such as attending or leading meetings, moving between departments, and engaging in “management by walking around” practices (275). As job roles themselves are relatively non-modifiable, this underscores the

importance of designing workplace interventions that are tailored to the specific demands of different job types. The concept of “movement for work purposes”, which naturally benefits managers, could be adapted to non-managerial contexts through structured micro-breaks or task-embedded movement opportunities (276), such as standing meetings (277, 278), presented not as leisure but as potentially beneficial for both productivity and employee wellbeing. From the lens of COM-B, this could cultivate a reflexive motivation among Software and IT workers by integrating light physical activity into their professional role and identity, leading them to view such activity as a natural part of their job.

Finally, the quantitative finding that shorter tenure was associated with higher occupational sedentary behaviour can be explained by the qualitative data. Specifically, employees reported remaining sedentary for long periods during the initial stage of their careers because they needed additional time for work familiarisation and were less mindful of taking breaks. This explanation suggests that heightened sedentary behaviour is a natural consequence of the initial “onboarding” phase. As new employees strive to rapidly understand their roles and responsibilities (279), they tend to prioritise concentrated effort over taking breaks, possibly because they lack the clarity or confidence to interrupt their familiarisation with work by engaging in movement. This helps explain the quantitative association. This integrated finding implies that organisations can leverage their formal training and induction programmes to address this issue. Specifically, by explicitly embedding a healthy culture, such as providing clear guidance and permission for movement breaks, into the components of training that define work expectations, organisations can accelerate new employees’ successful adjustment to both their roles and healthier work patterns. Such an approach is likely to contribute to more positive health outcomes (280). In terms of the COM-B model, this integrated finding addresses both the employees' internal state (i.e., automatic motivation) and the external environment (i.e., social opportunity). Specifically, the need for new employees to build habits (e.g., taking breaks) relates to automatic motivation, while the organisation's obligation to

provide a supportive onboarding process and explicit break guidance directly constitutes a social opportunity.

6.2.4 Joint Display

Table 6.1 presents a joint display integrating the quantitative and qualitative findings of this study. From left to right, the table displays the integration themes derived from the earlier weaving process, the corresponding quantitative findings, exemplar qualitative quotes, and the integration fit. Four types of data integration fit were used to describe how the qualitative data aligned with or elaborated upon the quantitative results, namely confirmation, complementarity, expansion, and discordance (145). This format facilitates a clear visualisation of the relationships between the two strands of data.

Table 6. 1 Joint Display Illustrating Integration Themes, Quantitative Findings, Qualitative Exemplar Quote(s), and Integration Fit

Integration Themes	Quantitative Findings	Qualitative Exemplar Quote(s)	Integration Fit
Prevalence of total and occupational sedentary behaviour and mental health among Chinese Software and IT employees	The quantitative study revealed that Software and IT workers in China engaged in occupational sedentary behaviour for an average of 427.9 (±133.2) minutes per day, which accounted for 72.4% of their working hours (approximately 347.52 minutes during an 8-hour workday).	*"Sitting for long periods… this isn't something you can decide for yourself, it's tied to the nature of your work. IT work means sitting, there's no way around it."* (P1 FG1)	Confirmation and complementarity
		"If I'm not at my workstation and don't have my computer, and a client suddenly needs urgent help but can't reach us, they will be stressed out. And if this cannot be resolved in time, it might cause some loss to the company or to the client themselves." (P20 Int.3)	
		"When I'm working, I might just forget about the time." (P13 FG4)	
	Participants showed a potentially high prevalence of pre-clinical mental health symptoms, with 20.4% (n = 48) scoring within the moderate to severe range for depression, and 21.7% (n = 51) scoring	Although the quantitative results indicated that some participants may have experienced elevated levels of anxiety or depression, no accounts of psychological distress emerged in the qualitative focus groups and interviews.	Discordance

	within the moderate to severe range for anxiety.	*"Mental health…I don't think I have any particular issues in that regard. I find it a bit hard to come up with anything specific. To me, everyone seems more or less the same. Some people might be quieter, others more outgoing. But I don't really notice much difference. Personally, I don't feel that mental health is something that poses any kind of barrier for me. I also don't tend to judge or think much about these things. I haven't really had any exposure to them, no experience or cases that I know of, so I'm not quite sure how to answer this question."* (P21 Int.4)	Complementarity
Sedentary behaviour and mental health: association and potential mechanism	Occupational sedentary behaviour was not directly associated with depression (β = 0, *p* = 0.868), anxiety (β = 0.001, *p* = 0.800), or stress (β = 0, *p* = 0.381) after adjusting for potential covariates.	*"I think prolonged sedentary behaviour is fine; it doesn't really affect my mental health"* (P16 FG5)	Confirmation
	Poor sleep quality may mediate the indirect effect of occupational sedentary behaviour on stress, although this pathway did not reach statistical significance (β = 0.043, *p* = 0.059).	No descriptions of poor sleep quality were reported that could support the potential mediation.	N/A
		"It could be considered a foundational factor. For example, prolonged sitting might lead to neck pain, which then causes dizziness, making you feel	Complementarity

		irritable and frustrated when doing anything. This creates a vicious cycle. While it may not be a decisive factor that completely determines your mood or physical state, it is certainly a fundamental, underlying influence that creates this kind of progressive, layered cycle." (P14 FG5)	
		"My immediate thought is that it feels somewhat like a restriction of personal freedom, because at least while working, you're required to be at your workstation. Of course, it's not that the company or anyone is stopping you from moving around, but it's the nature of the job that dictates you must be in that work position during work time." (P20 Int.3)	
Using the integrated findings to develop evidence informed and theoretically driven intervention strategies for Software and IT employees	Path analysis revealed that longer working hours were associated with higher levels of occupational sedentary behaviour ($\beta = 0.462$, $p < 0.001$).	*"Once the timeline is shortened, it inevitably means that for software development work we need to work as quickly as possible. This requires either improving efficiency or, alternatively, spending more hours to complete the related tasks as quickly as we can."* (P20 Int.3)	Confirmation and complementarity

		"Basically, during overtime, people barely talk to each other; communication is minimal, and everyone is focused on their own tasks" (P20 Int.3)	
	Path analysis revealed that non-managerial employees spent more time engaged in occupational sedentary behaviour than their managerial counterparts (β = 68.364, *p* = 0.005). Managerial employees spent on average 58.2% of their working time in occupational sedentary behaviour, whereas non-managerial employees spent 76.0% of their working time being sedentary.	*"Some employees, for example, those who take on more important roles or work on busier projects, may need to attend meetings more frequently. As a result, they tend to move around more often. However, general workers usually don't have that many meetings. They spend most of their time quietly sitting at their desks, coding, and only get up occasionally, such as, to get a drink or go to the restroom. So, overall, the amount of movement can vary depending on each employee's project and position."* (P18 Int.1)	Complementarity
	Path analysis revealed that longer tenure in the company was associated with reduced occupational sedentary behaviour (β = -24.456, *p* = 0.005). Employees who had worked for less than one year reported that occupational sedentary behaviour accounted for 76.8%	*"When I had just joined the company, I wasn't familiar with the overall business and workflow. So I had to spend a lot of time thinking about that, and I would often forget to intentionally exercise."* (P3 FG1)	Complementarity

	of their working time. Those with one to three years of tenure showed a similar proportion (76.5%), followed by a decrease among employees with four to six years (69.5%), seven to nine years (53.5%), and ten years or more (51.2%).		

6.3 Implications for Intervention Strategies

Building on the Phase 2 qualitative study and integrated findings, the second part of this chapter focuses on how the collective findings have been used to inform evidence-based intervention strategies specifically for Software and IT workers. The underpinning framework adopted was the Behaviour Change Wheel, which provides a theory-driven process for designing interventions by linking behavioural analysis to intervention strategies (63). While other intervention design frameworks are available, the Behaviour Change Wheel was developed following a systematic review of 19 existing frameworks. It provides a coherent, multi-layered structure that explicitly maps the process from comprehensive behavioural change identification to specific behaviour change techniques. This makes the Behaviour Change Wheel sufficiently broad and systematic to cover the full range of factors that potentially affect behaviour (64).

The process of using the Behaviour Change Wheel to inform intervention development begins with identifying the target behaviour using the COM-B model. This identification was accomplished in two steps: first, by drawing on the Phase 2 qualitative study to identify barriers to reducing sedentary behaviour among Software and IT workers in China, and second, by translating quantitative findings into modifiable intervention strategies that were mapped onto the COM-B domains during the integration phase. The next step involved selecting appropriate intervention functions, broad categories representing how an intervention can change behaviour, including education, training, persuasion, incentivisation, coercion, restriction, modelling, environmental restructuring, and enablement (63). This was followed by selecting appropriate policy categories, which represent the types of authoritative decisions that support and enact behaviour change, including communication/marketing, guidelines, fiscal measures, regulation, legislation, environmental/social planning, and service provision (63). Finally, the behaviour change techniques were selected. A behaviour change technique is defined as an “observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behaviour” (63). The Behaviour Change Technique

Taxonomy version 1 includes 93 techniques and provides a detailed framework for describing behaviour change interventions (64).

In this thesis, the intervention development was primarily aimed at reducing occupational sedentary behaviour. At the same time, particular attention was given to mental health symptoms during intervention design. The intention was not to assume or imply a direct causal pathway from occupational sedentary behaviour to mental health symptoms. Indeed, the quantitative evidence suggested only weak potential associations, and qualitative accounts highlighted nuanced, context-dependent perceptions. Instead, the focus was on ensuring that strategies for reducing occupational sedentary behaviour were considered not only in terms of behavioural outcomes but also with particular attention to their potential relevance for psychological well-being.

To address the goal of reducing occupational sedentary behaviour, the COM-B model was employed in the qualitative study to categorise the identified barriers and facilitators into the domains of capability, opportunity, or motivation. Each barrier was then mapped onto the corresponding intervention functions, from which policy categories and behaviour change techniques were derived in line with Behaviour Change Wheel guidance (63).

To achieve the goal of considering mental health, some of the factors identified were not purely behavioural determinants and therefore could not be fully accommodated within the strict mapping of the COM-B model. In these cases, an evidence-informed adaptation of the Behaviour Change Wheel was applied, whereby behaviour change techniques were selected directly based on empirical findings and their theoretical relevance. This approach is justified by the established function of the Behaviour Change Technique Taxonomy version 1 as an independent content-coding system, designed to identify and describe the active ingredients of behaviour change interventions irrespective of their underlying theoretical model (281). While the COM-B model guides the theoretical selection of behaviour change techniques through the identification of specific behavioural deficits, the Behaviour Change Technique Taxonomy version 1 provides “specificity of content beyond what is given by broader

intervention labels" (282). Specifically, previous research has demonstrated that the Behaviour Change Technique Taxonomy version 1 can effectively be used to "characterise the active ingredients" of behavioural interventions by identifying their granular content, even when the interventions were not originally designed within a specific theoretical framework (282).

Table 6.2 provides a comprehensive overview of the proposed evidence informed and theoretically driven intervention design, integrating evidence from this thesis with Behaviour Change Wheel. The first column, "What Needs to Change", identifies the specific behaviours or contextual factors targeted for modification. The second column, "Evidence in This Thesis", summarises relevant quantitative and qualitative findings, including the corresponding COM-B domain, to justify the selection of intervention targets. The third and fourth columns, "Intervention Functions" and "Policy Categories", map each target behaviour to broad strategies and supportive policy mechanisms as outlined in the Behaviour Change Wheel framework.

The fifth column, "Behaviour Change Techniques" (Version 1) and Rationale, specifies the concrete behaviour change techniques used in each intervention and provides a rationale linking them to wider empirical evidence. Specifically, the selected Behaviour Change Techniques were identified through systematic mapping from the relevant COM-B components via the Behaviour Change Wheel, and their inclusion was justified by prior intervention studies demonstrating the effectiveness of these techniques in comparable occupational or organisational settings.

Finally, the sixth column, "Strategies and Target Social-Ecological Level", describes concrete implementation approaches and specifies the level of the social-ecological system (e.g., individual, organisational, community, policy) at which each strategy is aimed toward. The proposed strategies in this column represent the operationalisation of the selected Behaviour Change Techniques into practical actions. These strategies were informed by how the same or similar techniques have been implemented in previous workplace-based interventions (68, 165, 238), and were adapted to ensure contextual relevance to Software and

IT workplaces in China. Together, the Table 6.2 synthesises theory, evidence, and practical considerations to guide the design of contextually appropriate interventions in Software and IT workplaces in China.

Table 6. 2 Intervention Strategies

What Needs to Change	Evidence in This Thesis	Intervention Functions[a]	Policy Categories[b]	Behaviour Change Techniques (Version 1) and Rationale[c]	Strategies and Target SEM Level
Workload redistribution and organisational practices are needed to reduce excessive overtime, while also embedding strategies that promote opportunities for regular movement and support wellbeing during unavoidable extended working hours.	Phase 1 quantitative findings from this study indicated that longer working time was associated with higher levels of occupational sedentary behaviour. Phase 2 qualitative findings further supported this relationship, particularly under Subtheme 2.2, Managerial constraints–workload, which highlighted that heavy workloads can led to overtime work. Within the COM-B framework, these findings reflect the influence of social opportunity.	Environmental restructuring, Enablement	Environmental and social planning, Service provision	**5.3 Information about social and environmental consequences** **12.2 Restructuring the social environment** **Rationale:** The selection of these two techniques is grounded in evidence indicating that heavy workloads and an overtime culture contribute to increased occupational sedentary behaviour and poorer psychological well-being (283), while failing to significantly enhance company competitiveness (272). Providing information about the negative organisational consequences of excessive overtime, such as diminished employee wellbeing and reduced productivity, may encourage companies to reassess their workload management practices. In addition, restructuring the social environment, for instance through more balanced task distribution and adequate	**Organisational level:** 1.Provide information to organisations that overtime culture does not significantly boost company competitiveness. 2.Allocate adequate staff and resources to urgent projects to minimise excessive overtime and associated sedentary behaviour. Convert a meeting room into a restoration space where employees can rest, meditate, or

				staffing, can help reduce the need for overtime and promote a healthier and more sustainable working culture.	listen to music during overtime.
Strategies need to be developed that enable postural variation and provide opportunities for movement while maintaining engagement with core tasks and responsibilities.	Evidence from the Phase 2 qualitative findings (Subtheme 1.1: Nature of the Industry–Productivity and Responsibility; Subtheme 2a.2: Loss of Autonomy) indicates that the nature of the industry reinforces prolonged sedentary behaviour, as sitting is perceived as an integral part of work, interruptions are viewed as costly, and constant availability to clients is considered a professional responsibility. Within the COM-B framework, these findings reflect the influence of reflexive motivation.	Education, Enablement, Environmental restructuring	Guidelines, Social planning	**5.3 Information about social and environmental consequences** **12.2 Restructuring the social environment** **Rationale:** Evidence from "Stand More AT (SMArT) Work" suggests that interventions targeting reductions in sedentary behaviour have also resulted in secondary outcomes such as alleviation of occupational fatigue and enhancement of work engagement (69). Providing employees with information about these beneficial consequences may help alleviate their concerns regarding productivity loss from interrupting sedentary behaviour. Meanwhile, restructuring the social environment was selected because it has been identified as a promising component in reducing sedentary behaviour (240). For instance, it was applied in the "Stand Up, Sit Less, Move More" intervention through	**Individual level:** 1. Provide information to Software and IT employees that interrupting prolonged sitting does not delay work progress but can enhance productivity. **Organisational level:** 1. Establish a team agreement to designate a backup who can temporarily cover responsibilities when the primary person takes a short movement break.

				management consultation, team-based strategy planning, and ongoing liaison support (284). Restructuring the organisational and peer support can potentially help alleviate Software and IT employees' concerns about being perceived as irresponsible when leaving their workstations.	
Organisational support systems are needed to help employees manage work pressures while protecting opportunities for reducing sedentary behaviour and promoting mental well-being.	Evidence from the Phase 2 qualitative findings (Subtheme 1.2: Pressure from the Industry & Subtheme 2a.1: Workload and pressure) indicates that perceived competitive pressures and career insecurity drive employees, particularly managerial staff, to maximise time at their workstations, reinforcing prolonged sitting and contributing to heightened psychological stress.	Environmental restructuring, Training	Social planning, Service provision	**12.2 Restructuring the social environment** **11.2 Reduce negative emotions** **Rationale:** As restructuring the social environment involves modifying organisational structures and norms that discourage taking breaks, it is considered capable of targeting employees' perceived industry-related pressures that hinder Software and IT workers' motivation to reduce sedentary behaviour. Reducing negative emotions is a technique that eases psychological concerns (such as perceived pressure), which often serves as a barrier to reducing sedentary behaviour. A previous intervention successfully incorporated	**Organisational level:** 1.Provide an anonymous feedback channel for employees to express work-related concerns (e.g., career sustainability) to employers, and develop organisational responses (e.g., timely clarification of promotion pathways). 2.Offer stress management workshops and

	Within the COM-B framework, these findings reflect the influence of reflexive motivation.			cognitive behavioural therapy and motivational interviewing to support sedentary behaviour reduction. Although no significant effects were observed for depression and anxiety symptoms, or stress, improvements in mental well-being were reported among participants in the sedentary behaviour reduction group (165). This approach is potentially transferable to Software and IT employees, who often experience industry-related pressure that influences both their sedentary behaviour and mental health.	provide access to mental health resources, linking them to strategies for active recovery (e.g., short movement breaks to relieve tension and improve focus).
Onboarding processes need to be enhanced to include guidance on healthy work practices and organisational adjustments that reduce prolonged sitting.	Evidence from the Phase 1 quantitative findings indicated that employees with longer company tenure tended to engage in less sedentary behaviour at work. Complementary evidence from the Phase 2 qualitative findings (Subtheme 2.2: Managerial Constraints–	Enablement, Education, Training	Guidelines, Social planning	**12.2 Restructuring the social environment** **Rationale:** As new Software and IT employees tend to engage in longer sedentary time, restructuring the organisational system is considered capable of targeting this specific adaptation period for them.	**Organisational level:** 1.Adjust performance requirements (e.g., easing KPIs) for new employees during their initial months to reduce pressure to remain seated continuously.

	Unfamiliarity) suggested that insufficient onboarding support may lead to prolonged sitting, as employees require additional time to familiarise themselves with new work tasks. Addressing this issue therefore requires not only individual awareness but also organisational support. Within the COM-B framework, these findings reflect the influence of social opportunity.				
Workplace strategies are needed to support postural variation by providing ergonomic	Evidence from the Phase 2 qualitative findings (Theme 2.2: Managerial Constraints–Cost Control) suggests that a lack of opportunities to work while standing	Environmental restructuring, Education, Persuasion	Environmental planning, Guidelines	**12.1 Restructuring the physical environment** **12.5 Adding objects to the environment** **7.1 Prompts and cues** **1.1 Goal setting (behaviour)** **Rationale:**	**Organisational level:** 1.Provide standing desk setups (where feasible), create standing meeting rooms, or relocate shared facilities

options, encouraging movement breaks, and raising awareness of the benefits of reducing sedentary behaviour.	leads employees to perceive sitting as the only feasible way to work. The use of height-adjustable desks provides a tangible means of demonstrating that work tasks can be performed in various positions. However, when financial constraints are a concern, organisations may need to explore low-cost alternatives to promote more dynamic working postures. Within the COM-B framework, these findings reflect the influence of physical opportunity.			Providing standing desks may represent the most direct way to restructure the physical environment to reduce prolonged sitting (285). However, when cost is a constraint, alternative low-cost approaches can be adopted. For example, the BeUpstanding intervention incorporated several inexpensive strategies, such as creating standing areas, relocating shared facilities away from workstations, introducing prompt breaks, and setting team-based physical activity goals (238).	(e.g., printers) away from individual workstations. 2.Offer simple fitness equipment and accessible stretching guides to encourage movement during the workday. 3.Display posters prominently in each department to remind employees to stand up and move around. **Individual level:** 1. Agree a daily walking goal within the team or department.
Participants need a clearer understanding of sedentary	Evidence from the Phase 2 qualitative findings (Subtheme 3.1: Knowledge and	Education, Training	Guidelines	**5.1 Information about health consequences** **4.1 Instruction on how to perform the behaviour**	**Organisational level:** 1.Workshops provide evidence

behaviour as distinct from physical activity, along with practical strategies for reducing prolonged sitting in daily routines.	Habits–Insufficient Knowledge; Subtheme 3.2: Beliefs and Attitudes–Downplaying the Harm) indicates that participants often underestimate the long-term consequences of prolonged sedentary behaviour. Some also hold the misconception that only structured exercise qualifies as non-sedentary activity, reflecting limited awareness of the benefits of incorporating light physical movement into daily routines. Within the COM-B framework, these findings reflect the influence of			**Rationale:** Providing information on the health consequences of behaviour acts as a foundational element for enhancing motivation in workplace sedentary behaviour interventions (286). It is a critical behaviour change technique included in effective multi-component interventions. For example, in a randomised controlled trial, information outlining sedentary behaviour as a health risk was explicitly provided in the intervention material as essential background (287). Providing this information to employees potentially benefits the intervention by raising awareness. As Software and IT workers may misunderstand the distinction between reducing sedentary behaviour and engaging in formal exercise, specific guidance on how to interrupt sitting during work hours may be beneficial. However, it is worth noting that educational approaches alone have shown limited effects on reducing sedentary time (288), and a	on the independent health risks of prolonged sedentary behaviour, highlighting that these risks persist even when individuals meet physical activity guidelines. **Individual level:** 1.Demonstrate ways to replace sedentary behaviour, such as standing up during phone calls, stretching between tasks, or walking short distances within the office.

	psychological capability.			combination with other techniques is needed.	
Broaden attitudes so that breaking up sitting is also seen as a beneficial and restorative activity, not only prolonged sitting.	Evidence from the Phase 2 qualitative findings (Subtheme 3.1: Knowledge and Habits–Preference) revealed that some participants expressed a positive attitude towards sitting. The aim of the intervention strategies should not challenge these favourable perceptions, but rather to broaden attitudes so that breaking up sitting is also regarded as a beneficial and restorative activity. In this way, interruptions to sitting can be viewed not as disruptions to productivity, but as opportunities for	Education, Persuasion, Enablement	Guidelines, Communication	**5.1 Information about health consequences** **1.2 Problem solving** **Rationale:** Information about health consequences is selected to establish the necessity for change, informing employees of the objective health risks associated with prolonged sitting and the benefits of regular movement. To ensure effective implementation, problem solving is also considered. This technique has been identified as a highly promising component frequently included in effective multi-component sedentary behaviour interventions (240), as it collaboratively supports employees in identifying and overcoming specific workplace barriers, thereby translating their health intentions into feasible daily actions. For example, the "Stand Up, Sit Less, Move More" intervention included brainstorming and selecting organisation-specific strategies (284).	**Individual level:** 1.Provide information detailing how prolonged sitting significantly increases the risk of chronic diseases. 2.Collaboratively identify minimally disruptive ways to interrupt sitting (e.g., standing to stretch for 30 seconds).

	recovery and well-being. Within the COM-B framework, these findings reflect the influence of automatic motivation.				
Participants need support to maintain concentration in healthier ways, including greater awareness of time, reframing beliefs about breaks, and practical strategies for integrating movement without disrupting productivity.	Evidence from the Phase 2 qualitative findings (Subtheme 3.2: Beliefs and Attitudes–Concentration) indicates that when participants are deeply focused on their work, they tend to lose track of time and remain seated for prolonged periods. Some participants also expressed a desire to maintain this state of concentration, which may inadvertently reinforce sedentary behaviour. Within the COM-B framework,	Education, Environmental restructuring	Guidelines, Service provision	**7.1 Prompts/cues** **5.3 Information about social and environmental consequences** **Rationale:** To address the cognitive barrier of forgetting to move, prompts/cues are considered to provide scheduled, automated reminders that serve as external triggers to interrupt prolonged sitting. This approach has been applied in a workplace intervention in China and was found not to adversely affect perceived work performance (289). Simultaneously, information about social and environmental consequences targets reflexive motivation associated with concerns about productivity loss. By communicating evidence of reduced occupational fatigue and enhanced work engagement (69), this technique	**Organisational level:** 1.Digital prompts (e.g., pop-up reminders or email notifications) remind individuals to take regular breaks.

	these findings reflect the influence of both reflexive motivation and psychological capability.			reframes taking breaks not as a disruption, but as a behaviour that actively supports both productivity and well-being.	
Workplace social norms and organisational culture need to be cultivated to support and normalise posture variation and regular movement during work.	Evidence from the Phase 2 qualitative findings (Subtheme 4.1: Education–Education Fostered Sitting; Subtheme 4.2: Social Norms) suggests that social norms and codes of conduct, ingrained through socialisation and formal education, discourage movement in the workplace. Employees often perceive standing or moving while others remain seated as inappropriate or inconsistent with professional expectations, thereby reinforcing a culture of	Environmental restructuring, Persuasion, Enablement	Social planning, Communication/ marketing	**12.2 Restructuring the social environment** **3.2 Social support (practical)** **Rationale:** Restructuring the social environment directly tackles social norms by altering the codes of conduct. Strategies such as establishing formal organisational policies validate the behaviour, showing employees that movement is expected. This restructuring can be strengthened by practical social support because it provides collective opportunities to move, transforming the individual act of taking a break into a shared, appropriate, and routine group activity. This collaborative approach ensures peer-level support for the new norm. For example, in the SMArT Work intervention, restructuring the social environment through management	**Organisational level:** 1.Establishing formal organisational policies regarding movement breaks, or appointing "movement champions" to model the behaviour. 2.Organise scheduled team breaks, for example short gatherings in the pantry at 10 a.m. and 3 p.m.

	prolonged sitting. Within the COM-B framework, these findings reflect the influence of automatic motivation.			buy-in, team-based support, and policy changes has been shown to successfully shift workplace behaviours to be more active (69).	
Foster a workplace culture in which physical activity is integrated into the professional identity of non-managerial employees.	Phase 1 quantitative findings showed that non-managerial employees spent more time engaged in occupational sedentary behaviour compared with managerial staff. Within the COM-B framework, this behaviour appears to be influenced by reflective motivation.	Enablement	Guidelines, Social planning	**12.1 Restructuring the physical/social environment** **Rationale:** Non-managerial employees often spend long periods seated due to routine work and duty structures. Changing the duty format, for example, implementing standing meetings or walking meetings during small group or one-to-one discussions (277), directly modifies the environment to facilitate movement without affecting productivity (277, 278).	**Organisational level:** 1.Initiate standing meetings and encourage walking meetings during discussions to integrate movement into routine work activities.
Reduce prolonged sitting to minimise physical discomfort and improve physical	Evidence from the Phase 1 quantitative findings suggests that poor sleep quality may mediate the indirect effect of occupational sedentary behaviour on stress, although	Education, Persuasion, Enablement	Guidelines, Service provision	**2.3 Self-monitoring of behaviour** **2.4 Self-monitoring of outcome(s) of behaviour** **11.2 Reduce negative emotions** **Rationale:** These three Behaviour Change Techniques were selected to	**Individual level:** 1. Encourage employees to monitor their daily sitting time and associated physical feedback

health, which may indirectly support mental wellbeing.	this pathway did not reach statistical significance. Complementary insights from the Phase 2 qualitative findings (Theme 1a: Physical Discomfort from Sedentary Work and Its Impact on Mental Health; Subtheme 2a.2: Loss of Autonomy) revealed that, although participants did not explicitly report sleep problems, they described several experiences associated with occupational sedentary behaviour, such as physical discomfort and perceived lack of control, that may, in turn, affect mental health. These factors			systematically disrupt the potential vicious cycle between sedentary behaviour, physical health, and mental well-being by enhancing self-awareness and alleviating negative psychological states. Self-monitoring of behaviour enables employees to obtain empirical feedback on their sedentary time, thereby increasing awareness of their own activity patterns. When combined with self-monitoring of outcomes, such as tracking perceived physical discomfort or sleep quality, this approach creates a feedback loop that helps employees connect their movement patterns (behaviour) with immediate well-being indicators (outcomes). In parallel, incorporating strategies to reduce negative emotions can further support behavioural regulation by addressing stress and frustration that may arise during the change process. This systematic approach empowers employees to regain a sense of control, countering the loss of autonomy reported in qualitative findings, and ultimately promoting both physical and	2.Encourage employees to track their mood and emotional state in relation to their sitting patterns. **Organisational level:** 1.Provide stress management guidance.

	appear to be interconnected and mutually reinforcing, indicating that a systematic approach is essential to promote both behavioural change and psychological well-being.			psychological well-being. Self-monitoring techniques have been widely used in mobile health interventions to promote physical activity and reduce sedentary behaviour in workplace settings, demonstrating feasibility, acceptability, and effectiveness (290).	

Note. SEM=Social Ecological Model

a: The Behaviour Change Wheel outlines nine potential intervention functions, representing broad categories through which an intervention can influence behaviour. These include education, training, persuasion, incentivization, coercion, restriction, modelling, environmental restructuring, and enablement (63).

b: The Behaviour Change Wheel also specifies seven policy categories that are likely to support the implementation of intervention functions. These categories reflect types of decisions made by authorities to facilitate and sustain behaviour change, including communication/marketing, guidelines, fiscal measures, regulation, legislation, environmental/social planning, and service provision (63).

c: A Behaviour Change Technique is considered the “active ingredient” of behaviour change, defined as an observable, replicable, and irreducible component of an intervention designed to alter or redirect the causal processes that regulate behaviour (63). The Behaviour Change Technique Taxonomy (version 1) comprises 93 Behaviour Change Technique grouped into 16 categories.

6.4 Conclusion

This chapter integrates quantitative and qualitative findings to pool the results together, aiming to identify key areas for intervention in Software and IT workplaces in China. Using weaving and joint display approaches, the study highlighted how participants' perspectives complemented and contextualised quantitative patterns. Building on this synthesis, intervention strategies were developed with a primary focus on reducing occupational sedentary behaviour, while giving particular attention to mental health as a related outcome. The process combined COM-B-informed mapping with an evidence-informed application of the Behaviour Change Wheel framework, ensuring that the interventions were both theory-driven and grounded in empirical findings. Overall, the chapter demonstrates how mixed-methods evidence can inform practical, targeted, and contextually relevant intervention strategies for improving workplace health.

Chapter 7: Discussion and Conclusion

7.1 Introduction

The overarching aim of this PhD research was to develop evidence-based and theory-informed intervention strategies for Software and IT workers in China, with a primary focus on reducing occupational sedentary behaviour, while giving particular attention to the implications for mental health during the development of intervention strategies.

This chapter first discusses the results in relation to the three central research questions, then offers methodological reflections, including reflexive appraisals of the explanatory sequential mixed-method design and its case selection variant. Following this, it outlines the strengths and limitations of this PhD project, before turning to its contributions and implications for research, practice, and policy.

7.2 Discussion of Key Findings in Relation to the Research Questions

While each empirical study in this thesis includes its own discussion, this chapter synthesises the evidence across studies to reflect on the research questions of this PhD project:

1. Is occupational sedentary behaviour related to common mental health symptoms (i.e., depression, anxiety and stress) among Software and IT workers in China?
2. What factors influence occupational sedentary behaviour among Software and IT workers in China?
3. How can the integrated findings from empirical studies in this PhD research inform the development of evidence-based and theory-informed intervention strategies for Software and IT workers in China?

7.2.1 Is Occupational Sedentary Behaviour Related to Common Mental Health Symptoms (i.e., Depression, Anxiety and Stress) among Software and IT Workers in China?

The Phase 1 quantitative findings revealed no direct association between occupational sedentary behaviour and mental health symptoms after controlling for all potential confounders. However, the absence of statistically significant associations should not be interpreted as evidence that reducing sedentary behaviour has no value for mental health promotion. Rather, when integrating evidence from both Phase 1 quantitative findings and Phase 2 qualitative results, it becomes clear that the relationship between occupational sedentary behaviour and mental health cannot be adequately understood through statistical associations alone; contextual factors must also be considered.

For instance, although the quantitative results of Phase 1, together with previous studies (107, 108), found no significant association, evidence from intervention studies has consistently shown that reducing sedentary behaviour in the workplace can improve employees' mental wellbeing (165, 291, 292). This suggests that while there may not be a straightforward direct association, modifying occupational sedentary behaviour could potentially influence or interact with contextual factors that positively affect mental health.

The value of statistical findings, therefore, lies not only in identifying whether an association exists, but also in serving as a starting point for exploring how and under what circumstances such relationship occur, and how they can be leveraged for mental health promotion. Recognising this crucial shift, from focusing solely on static associations to understanding contextual dynamics, is essential for the design of real-world health interventions. Otherwise, conclusions risk becoming overly reductive.

For example, studies have distinguished between "mentally passive" and "mentally active" sedentary behaviours, reporting that the former are associated with poorer mental health outcomes, whereas the latter are not (5, 93). On this basis, some studies have suggested reducing or replacing this specific "mentally

passive" sedentary behaviours for better mental health outcomes (111, 293). While this reasoning appears intuitive, it is insufficient to serve as an intervention recommendation in the workplace. Although occupational sedentary behaviour has been regarded as a form of "mentally active" sedentary behaviour in previous research owing to its cognitive engagement (93), such engagement varies substantially across job types. For instance, office administrative workers are occasionally engaged in repetitive tasks such as document management. In such cases, occupational sedentary behaviour may functionally align more closely with a "mentally passive" state, and the tasks themselves cannot be easily modified. Moreover, such interpretations may inadvertently imply that "mentally active" sedentary behaviour requires no modification. Instead, further exploration should delve into the evaluation of: What types of job tasks involve "mentally active" or "mentally passive" sedentary behaviour? Why could the reduction in occupational sedentary behaviour lead to an improvement in well-being? What behaviour change techniques can be applied to protect worker mental health if their job inevitably involves "mentally passive" components?

In summary, these findings suggest that understanding the relationship between occupational sedentary behaviour and mental health requires moving beyond static statistical models. Instead, it calls for a context-sensitive approach that recognises the diverse contexts of different job roles.

7.2.2 What Factors Influence Occupational Sedentary Behaviour among Software and IT Workers in China?

This thesis examined the factors influencing occupational sedentary behaviour in the Software and IT workplace in China. This was achieved by primarily conducting a qualitative study (Phase 2) to explore barriers to reducing sedentary behaviour and integrating its findings with the outcomes of a cross-sectional quantitative study (Phase 1).

The Phase 2 qualitative study revealed that several influential factors in this context align with those found in other occupational settings. For instance, concerns regarding productivity and job responsibility emerged as common

barriers to reducing time spent sitting, mirroring reports from diverse environments such as call centres, government sectors, and universities (215, 229, 294). However, some factors appear to be more distinct to the Software and IT industry and its cultural context, thus extending the evidence within this under-researched area. Specifically, while previous studies have identified general workload-related time pressure as a barrier (295), the intense competitiveness of this industry emerged as a unique, intensified pressure contributing significantly to prolonged occupational sedentary behaviour. Furthermore, the observed formation of sedentary habits during prior educational environments expands upon previous findings (296), offering a plausible explanation for the prevalence of sedentary habits in the workplace.

Integrating Phase 1 quantitative and Phase 2 qualitative findings was crucial for uncovering the underlying mechanisms behind statistical patterns and identifying future research directions. Consistent with previous research among telephone-based or clerical workers (29), the thesis found that longer job tenure was associated with greater occupational sedentary time. The qualitative insights suggested that this quantitative trend might stem from increasing familiarity with job tasks and adaptation to organisational routines. Moreover, quantitative data revealed differences in occupational sedentary time between managerial and non-managerial employees. Combining this finding with qualitative data on distinct job tasks across role positions underscored the value of this integrated analysis by suggesting the possible influence of professional identity on sedentary behaviour. While earlier studies in the university workplace highlighted differences across job roles (such as management, professional, and specialist roles having the highest sedentary time) (297), this thesis demonstrates the critical importance of considering positional differences within the same occupation when designing workplace sedentary behaviour intervention strategies.

In summary, occupational sedentary behaviour in the Software and IT workplace is shaped by multiple, interconnected factors. While some are common across occupations, others are specific to this high-pressure, competitive industry.

Therefore, a nuanced understanding of these occupational characteristics and cultural influences is essential for developing targeted and effective behaviour change interventions to reduce sedentary time.

7.2.3 How Can the Integrated Findings from Empirical Studies Inform the Development of Evidence-Based and Theory-Informed Intervention Strategies for Software and IT Workers in China?

The process of integration, operationalised through weaving and joint display approaches, was undertaken to examine how qualitative insights might explain and contextualise the quantitative results. These integrated insights highlighted both the factors associated with longer occupational sedentary behaviour and the potential mechanisms underlying its connection to mental health symptoms, which were subsequently mapped onto intervention strategies using the Behaviour Change Wheel.

The integration of quantitative and qualitative strands enabled statistical patterns to be interpreted with contextual mechanisms. Integrating the two strands of studies not only confirmed that occupational sedentary behaviour is not statistically associated with mental health symptoms (i.e., depression, anxiety, and stress) but also provided deeper insights. These insights include why this may be the case, how Software and IT employees perceive occupational sedentary behaviour, and which contextual issues need to be addressed for intervention development. Specifically, while regression analyses demonstrated no direct association between occupational sedentary behaviour and mental health, the qualitative data added nuance by revealing participants' diverse perceptions of prolonged sitting at work. Some participants did not regard occupational sedentary behaviour as detrimental to mental health, as they preferred to remain seated, whereas others expressed receptiveness to reducing occupational sedentary behaviour, believing that it could benefit both their physical health and mental health. Participants also highlighted how workload and industry-related pressures simultaneously leads to increases in their sitting time and contributed to poorer mental health. These insights provide rich

empirical evidence emphasising that occupational sedentary behaviour and mental health cannot be meaningfully disentangled from their contextual background and therefore can meaningfully inform intervention strategies development.

Integration of the two study strands enables a more theory-informed approach to developing intervention strategies. For example, the quantitative results indicated that employees with longer company tenure tended to engage in less sedentary behaviour at work. Complementary evidence from the Phase 2 qualitative findings, which highlighted employees' experiences of unfamiliarity at the beginning of employment, helps to clarify this pattern. Only through the integration of these two strands of evidence can the underlying mechanism be fully understood, revealing that addressing it requires not only individual awareness but also organisational support. From a theoretical standpoint, this integration strengthens the practical application of the COM-B model and the social-ecological framework. Specifically, the COM-B model can be used to classify this as a barrier related to social opportunity, while the social-ecological framework provides a lens for identifying organisational-level strategies to support employees in reducing sedentary behaviour.

Overall, adopting an evidence-based yet theory-supported approach ensured that the proposed intervention strategies remained grounded in observed realities while retaining alignment with behavioural science frameworks. The integration of evidence thus facilitated the development of strategies that are both contextually relevant and scientifically robust.

7.3 Methodological Reflections

This section critically reflects on the methodological choices that shaped the knowledge generated within this thesis, with particular consideration of two aspects. First, the adoption of an explanatory sequential mixed-methods design is appraised in terms of its appropriateness for the research aims; the integration it enabled across quantitative and qualitative strands; and the epistemological commitments it implied. Second, the decision to implement a case variant in the

qualitative phase is discussed. In the Phase2 qualitative study, an extreme case was selected, namely the company whose employees reported the highest duration of occupational sedentary behaviour in the Phase 1 cross-sectional survey. The implications of this decision are considered in terms of depth of explanation, contextualisation, and the balance between theoretical transferability and representativeness. Overall, the methodological choices made in this thesis both reflect and reinforce a critical realist philosophical stance to stratified explanations, while recognising the contingency of knowledge claims.

7.3.1 Reflections on the Conceptualisation and Measurement of Key Constructs

Sedentary Behaviour: Beyond Duration

To date, the current measurement of sedentary behaviour has predominantly centred on the temporal dimension (i.e., duration), utilising both subjective self-reports (e.g., questionnaires such as the IPAQ (158)) and objective monitors (e.g., accelerometers such as GENEActiv (298)). While objective measures are often considered the “gold standard” for capturing patterns of accumulation in real time, posture and energy expenditure (299), while questionnaires are often deemed practical for large-scale surveillance. However, both approaches share a common limitation: they primarily quantify how long an individual is sedentary, often neglecting the behavioural context (i.e., what individuals are doing) and the degree of cognitive engagement involved.

The findings of this thesis, specifically the absence of a statistically significant association between sedentary duration and mental health outcomes, highlight this important conceptual gap. Unlike metabolic health, where the physiological absence of movement (inactivity) constitutes the primary risk factor, mental health outcomes appear to be more strongly influenced by contextual characteristics of sedentary behaviour, such as cognitive demand and voluntariness. However, validated measurement tools capable of capturing and distinguishing these specific dimensions are currently lacking.

To partially address these complexities, this thesis adopted a mixed-methods approach to mitigate the limitations associated with reliance on a single measurement modality. While the quantitative phase depended on self-reported sedentary duration, which is subject to inherent limitations such as recall bias (300), the subsequent qualitative phase provided essential contextual depth. By exploring participants' lived experiences, the study unpacked the nature of their sedentary time, revealing it to be highly cognitively active and frequently undertaken under high-pressure, involuntary conditions.

This methodological triangulation enabled a more nuanced interpretation of the null quantitative findings, suggesting that the nature of sedentary behaviour may override the effects of duration alone in relation to mental health. A key strength of this approach was its capacity to explain why sedentary duration may not predict mental health outcomes in this specific workforce. Nevertheless, the reliance on retrospective self-reports means that the precise volume, pattern and accumulation of sedentary behaviour remain an estimate, underscoring the need for future measurement instruments that can simultaneously capture both objective patterns and subjective context (e.g., cognitive load).

Mental Health Constructs: From Acute Response to Chronic Strain

The conceptualisation of mental health in this thesis initially aligned with traditional psychometric distinctions, in which stress was categorised as a predominantly immediate, acute psychophysiological response to environmental demands, whereas depression and anxiety were conceptualised as more enduring and chronic emotional states (301). This distinction informed the initial interpretation of the null associations observed in the systematic review.

However, the integration of quantitative and qualitative findings prompted a critical re-evaluation of these constructs within the specific context of the Chinese Software and IT workplace. The quantitative analysis indicated that occupational sedentary behaviour was more consistently associated with stress symptoms than with depression or anxiety. The subsequent qualitative inquiry

provided an essential interpretive lens for understanding this pattern. Participants described their experiences of stress not as transient episodes of tension that resolve quickly, but as a sustained state of pressure driven by continuous cognitive demands and compressed project cycles. Consequently, the conceptualisation of stress in this thesis evolved from an acute definition to a cumulative one, explicitly extending the original quantitative conceptualisation. This suggests that what is categorised as stress may, in this workforce, represent a pervasive baseline condition of accumulated burden.

Conversely, the boundaries regarding depression and anxiety also required nuance. While these states are traditionally viewed as stable traits, the findings suggest that within this high-pressure environment, symptoms of anxiety and depressive mood may fluctuate occasionally in response to specific situational exposures, such as project deadlines, rather than solely reflecting chronic pathology. This situational variability implies that these symptoms are more sensitive to discrete work events than to the continuous nature of occupational sedentary behaviour. In contrast, stress, conceptualised here as a cumulative response to the ongoing high-pressure environment, aligns more closely with the persistent occupational exposure. This distinction provides a plausible explanation for why stress emerged as the most consistent and sensitive indicator of the risks associated with occupational sedentary behaviour in the quantitative analysis, whereas associations with depression and anxiety remained non-significant.

7.3.2 Reflexive Appraisal of the Explanatory Sequential Mixed-Method Design

The decision to adopt an explanatory sequential mixed-method design was suitable for the overarching aim of this thesis. Existing literature had already suggested, though somewhat inconsistently, that sedentary behaviour may be detrimental to mental health, with most previous studies focusing on total sedentary behaviour (53, 54). By narrowing the focus to occupational sedentary behaviour, this thesis sought to clarify whether and how this specific domain of

sedentary behaviour was implicated. The initial quantitative survey, conducted across four companies, not only examined associations in a previously unstudied demographic group but also modelled potential pathways using path analysis. The subsequent qualitative inquiry then extended this by probing the potential mechanisms underlying the observed patterns. For example, why employees with longer tenure or managerial roles tended to sit less. In this sense, there was clear complementarity between the phases, and the sequencing effectively supported the thesis aims.

It is also important to reflect on possible methodological alternatives. A single-method design would have been insufficient for the aim of this thesis. Specifically, A solely quantitative cross-sectional survey is insufficient for informing intervention development, as it cannot establish causal relationships, uncover behavioural dynamics, or account for the contextual factors essential to designing interventions strategies (131, 302). Similarly, a qualitative interview alone cannot establish associations between occupational sedentary behaviour and mental health because it yields non-numerical data and lacks the statistical power to test hypotheses or measure the strength and significance of a relationship. An exploratory sequential design might initially have yielded richer insights into contextual factors by a qualitative study, which could then be tested quantitatively. However, given the partial but suggestive evidence in the existing literature that sedentary behaviour is associated with mental health risk (53, 54), the explanatory sequential design was determined more suitable for this PhD research topic. This design allowed for the quantitative evaluation of the association between occupational sedentary behaviour and mental health symptoms.

This reflection highlights that methodological choices are not neutral, as they fundamentally shape the knowledge produced. Consequently, the explanatory sequential design utilised in this thesis privileged the elaboration of predefined patterns, which inherently constrained opportunities for unexpected insights to emerge.

7.3.3 Reflexive Appraisal of the Case Selection Variant Explanatory Sequential Mixed-Method Design

The qualitative phase of this thesis adopted a case selection variant of the explanatory sequential mixed-method design, focusing on one company selected from the four surveyed in the quantitative phase. The purpose of this selection was not to secure statistical representativeness but to maximise theoretical insight (303, 304). This was achieved by accentuating mechanisms that become most visible in contexts characterised by particularly high levels of occupational sedentary behaviour (303, 304), as exemplified by the company with the highest reported sitting duration.

However, the reliance on a single company inevitably raised the risk that dynamics specific to that organisational context may have been over-emphasised. This highlights the challenge of contextualisation; for example, variation exists in workplace infrastructures (e.g., the availability of height-adjustable desks) that could shape both behaviours and the relevance of intervention strategies. Thus, while the findings are contextually grounded, they are best understood as offering analytical rather than statistical generalisation, as they provide theoretically transferable insights into mechanisms that may resonate across similar settings, while still requiring local adaptation in practice.

7.4 Strengths and Limitations

7.4.1 Strengths

This research demonstrates several notable strengths. First, it is a pragmatic project addressing real-world issues, which enhances external validity (305), as the findings and implications can be directly applied and evaluated in Software and IT workplace health promotion initiatives in China.

Another important strength lies in the adoption of an evidence-led yet theory-informed approach to guide intervention development (306). By grounding the analysis in participants lived experiences and drawing on established

behavioural frameworks, the study enhanced ecological validity, conceptual robustness, and translational potential (77, 304).

Moreover, the thesis employed a range of methodological approaches to investigate the relationship between occupational sedentary behaviour and mental health. This methodological diversity enabled triangulation, thereby strengthening both the reliability and validity of the findings (133, 307). While the systematic review and cross-sectional survey helped to identify patterns and trends, providing breadth, qualitative focus groups and interviews allowed for a more nuanced exploration of contextual mechanisms, thereby providing depth.

In addition, a major strength of the project lies in its sequential, multi-stage design (308). The research unfolded in a logical manner, beginning with a systematic review of existing evidence, progressing to empirical testing of associations, and concluding with an in-depth exploration of workplace realities. This staged integration not only enhanced the coherence of the overall project but also established a strong foundation for intervention development, as the insights were derived from both broad epidemiological patterns and situated contextual understanding (309).

7.4.2 Limitations

Several limitations should also be acknowledged. First, this PhD project cannot make causal inferences. The quantitative study was cross-sectional, and while the qualitative component shed light on potential mechanisms linking occupational sedentary behaviour and mental health, neither strand could establish causality or directionality. Nevertheless, these findings provide preliminary insights for future research to examine causal relationships.

Second, methodological constraints arose from the sequential structure of the mixed-methods design. In explanatory sequential designs, beginning with quantitative analysis may risk narrowing the focus to issues represented in the survey data (133). To mitigate this, the qualitative study was guided by theoretical frameworks (COM-B and the TDF), rather than simply reproducing survey findings. Although this strategy shaped the boundaries of qualitative exploration,

it strengthened methodological rigour by ensuring that the exploration remained theoretically informed and relevant to the research questions (310).

Moreover, the in-depth focus on Software and IT workers in China may limit the generalisability of the findings to other occupational groups or cultural contexts. Nevertheless, concentrating on a target population is necessary for health intervention development, as it ensures that the findings are contextually relevant and applicable to the population of interest (309).

Finally, although the intervention strategies proposed in this thesis were theoretically grounded and supported by evidence, evaluating their effectiveness was beyond the scope of this PhD research. Future studies are needed to experimentally test these strategies in real-world settings, either as individual components or as parts of multicomponent interventions.

7.5 Contributions and Implications

This thesis makes several contributions across research, practice, and policy. At the research level, the systematic review (published) in Chapter 2 (152) empirically reiterates the importance of focusing on specific domains of sedentary behaviour when evaluating its mental health outcomes. The cross-sectional survey (currently under review) revealed that the relationship between occupational sedentary behaviour and stress may be mediated by sleep quality, and that both may be influenced by tenure in the company. The qualitative study (submitted) identified barriers and facilitators of occupational sedentary behaviour, and further elucidated factors that may influence occupational sedentary behaviour, mental health, and their interrelationship. Methodologically, the explanatory sequential design demonstrates how qualitative inquiry, grounded in the COM-B model and socio-ecological perspectives, can complement quantitative findings. Taken together, these contributions underscore the need for further research on the relationship between occupational sedentary behaviour and mental health outcomes, as well as on the potential pathways linking sedentary behaviour to health outcomes within specific occupational contexts.

At the practical level, interpreting the findings through the lens of the social-ecological model yields critical implications for designing future interventions. The first key implication arises from the interconnected nature of the model's levels, whereby factors across the individual, organisational, and community layers are not isolated categories but mutually shape one another (311). Consequently, interventions should adopt a multi-level approach that moves beyond addressing individual barriers (e.g., lack of personal motivation) in isolation, acknowledging that resistance to change at one level often originates from pressures exerted by another. For instance, what appears to be an individual choice to remain seated for task concentration is simultaneously reinforced by industry-wide expectations of hyper-productivity and rapid responsiveness. To address this complexity, interventions must couple individual cues for movement with robust organisational support mechanisms. The second implication draws on the concept that change initiated within micro-levels can create a feedback loop that influences meso- and macro-levels (312). When top-down industry pressures prove highly resistant to immediate change, a strategic leverage point can be found in a more manageable shift at the individual or interpersonal level. Accordingly, interventions should be designed to facilitate feasible changes that can initiate a "bottom-up" shift in social norms and organisational practices. For example, an employee's successful attempt to incorporate regular movement breaks, when visibly supported by management or team leaders, may trigger a feedback loop that normalises the behaviour for colleagues. By acknowledging the dynamic, bidirectional nature of the social-ecological model, practitioners can identify strategic points of an intervention to achieve a reduction of occupational sedentary behaviour within the workplace.

At the policy level, this thesis underscored the impact of long working hours on prolonged sedentary time in the Software and IT industry. The integration section discussed how this pattern could evolve into a significant economic and health burden for society. This outcome fundamentally contradicts the vision of the Healthy China 2030 National Strategy, which aims to place health as a fundamental priority (47). The principle of “integrating health into all sectoral

policies", a core tenet formalised by the Healthy China 2030 Strategy (47), offers a viable mechanism for systemic change. A compelling example is the 2021 Chinese Education Sector policy (the "Double Reduction" policy) (313), which aimed to reduce academic burden during the compulsory education stage (i.e., aged 6-15). This "Double Reduction" policy, coupled with physical activity guidelines (published in the same year) that recommended reducing children's sedentary behaviour and screen time (6), can be viewed as a remedy for the sedentary behaviour issues described by Phase 2 focus group participants. Specifically, some participants noted that sedentary habits were developed in children by the belief that sedentary behaviour means preparing well for future academic study. A similar, high-level policy intervention targeting the Software and IT industry could be instrumental in legitimising health-focused regulation regarding occupational sedentary behaviour and challenging the prevailing overtime culture.

7.6 Conclusion

The overarching aim of this PhD research project was to develop evidence-based and theory-informed intervention strategies for Software and IT workers in China. The primary focus was on reducing occupational sedentary behaviour, while paying particular attention to the implications for mental health during the intervention development process. By employing a systematic review and an explanatory sequential mixed-methods design, several objectives were achieved through this programme of study: a better understanding of the relationship between occupational sedentary behaviour and mental health; the identification of factors influencing occupational sedentary behaviour in the Software and IT workplace in China; and the proposal of potential intervention strategies based on empirical and integrated findings. These findings contribute to the growing body of sedentary behaviour research and highlights the need for future research and practice. The thesis proposes that this could include exploring the mechanism between reducing sedentary behaviour and mental health outcomes; tailoring the intervention development in the workplace setting by taking into account the specific occupational characteristics of the target

population; and discussing the potential for policy to mitigate the overtime culture that contributes to prolonged workplace sedentary behaviour. Future research and practice in Chinese workplaces can use the findings in this thesis as a basis for refining the intervention development.

Appendices

Appendix 1 Full Search Strategy for Each Database

CINAHL (n=292)

S1 ((MH "Life Style, Sedentary+") OR (MH "Screen Time")) OR TI (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based) OR AB (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based)

S2 ((MH "Work+") OR (MH "Stress, Occupational+")) OR TI (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*))) OR AB (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*)))

S3 ((MH "Mental Health") OR (MH "Depression+") OR (MH "Anxiety+") OR (MH "Stress+") OR (MH "Stress, Occupational+")) OR TI (((mental OR Psyc*) n3 health) OR depress* OR anxiety OR stress) OR AB (((mental OR Psyc*) n3 health) OR depress* OR anxiety OR stress)

S1 AND S2 AND S3

Medline Complete (n=707)

S1 (MH "Sedentary Behavior") OR TI (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based) OR AB (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based)

S2 ((MH "Work+") OR (MH "Workplace+")) OR TI (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*))) OR AB (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*)))

S3 ((MH "Population Health") OR (MH "Mental Health") OR (MH "Occupational Health")) OR TI (((mental OR Psyc*) n3 health) OR depress* OR anxiety OR stress) OR AB (((mental OR Psyc*) n3 health) OR depress* OR anxiety OR stress)

S1 AND S2 AND S3

APA PsycInfo (n=734)

S1 (DE "Sedentary Behavior" OR DE "Computer Usage" OR DE "Computer Searching" OR DE "Internet Usage" OR DE "Online Behavior" OR DE "Screen Time" OR DE "Smartphone Use" OR DE "Computers" OR DE "Screen Time") OR TI (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based) OR AB (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based)

S2 (DE "Occupations" OR DE "Employee Well Being" OR DE "Occupational Stress" OR DE "Personnel" OR DE "Workplace Intervention") OR TI (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*))) OR AB (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*)))

S3 (DE "Mental Health" OR DE "Occupational Stress" OR DE "Occupational Health Psychology" OR DE "Occupational Health" OR DE "Depression (Emotion)" OR DE "Stress" OR DE "Occupational Stress" OR DE "Anxiety") OR TI (((mental OR Psyc*) n3 health) OR depress* OR anxiety OR stress) OR AB (((mental OR Psyc*) n3 health) OR depress* OR anxiety OR stress)

S1 AND S2 AND S3

SPORTDiscus (n=78)

S1 (DE "SEDENTARY behavior" OR DE "SEDENTARY lifestyles" OR DE "SEDENTARY people") OR TI (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based) OR AB (((sedentary OR seated OR sitting) n3 (behav* OR time)) OR desk-based)

S2 (DE "OCCUPATIONAL diseases" OR DE "OCCUPATIONAL health services") OR TI (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*))) OR AB (employe* OR workplace OR occupation* OR context OR ((office) n3 (work*)))

S3 (DE "PUBLIC health" OR DE "PSYCHOLOGICAL stress" OR DE "MENTAL illness" OR DE "MENTAL health" OR DE "MENTAL depression" OR DE "PSYCHOLOGICAL stress" OR DE "ANXIETY") OR TI (((mental OR Psyc*) n3

health) OR depress* OR anxiety OR stress) OR AB (((mental OR Psyc*) n3 health) OR depress* OR anxiety OR stress)

S1 AND S2 AND S3

Web of Science (n=590)

Topic (((sedentary OR seated OR sitting) near/3 (behav* OR time)) OR desk-based) AND Topic (employe* OR workplace OR occupation* OR context OR ((office) near/3 (work*))) AND Topic (((mental OR Psyc*) near/3 health) OR depress* OR anxiety OR stress)

Appendix 2 Distress Protocol

Signs of distress:

- The participant verbalises they are distressed or upset.
- The participant exhibits behaviours suggesting that they are in distress. For example, uncontrolled crying, shaking, agitation, and anger.

Response:

- Stop the interview or focus group (stop recording).
- Offer support (ask participants how they're feeling, listen with empathy and give them time to recover).
- Ask the participant if they feel safe

Review:

- Ask the participant if they feel comfortable to continue.
- If the participant would like to pause before continuing, take a break or offer to reschedule the interview. If they are taking part in a focus group, offer them to take part in an interview at a different time.
- If the participant is unable to carry on, move on to the second response.

Second Response:

- With permission, withdraw the participant from the study.
- Signpost participant to further resources (e.g. wellbeing support at their organisation).

Follow up

- If the participant consents, follow up with a courtesy phone call. OR
- All participants are to be given debrief with relevant organisations' contact details and places for support (e.g. wellbeing support in their organization/ local mental health centre).

Appendix 3 Full Survey Questionnaire

Exploring the association between occupational sedentary behaviour and mental health symptoms among software and information technology employees in China

Thank you for taking part!

This questionnaire consists of five sections, namely, Basic Information, Lifestyle Survey, Work-related Details and Job Satisfaction Survey, Physical Activity Survey, and Psychological Health Survey. Sections two to five used validated scales, and answers are required for all questions to generate valid scores, but if you experience any discomfort, you may skip that section. You can reasonably expect your privacy to be protected, whether you choose to answer the more sensitive questions or not.

Section One: Basic Information

This section is designed to gather essential personal details, such as your sex and age.

Q1.1 Sex

a. Male
b. Female
c. I prefer not to say

I am aware that research should consider the difference between 'sex' and 'gender', and it would be better to use a 2-step approach by asking participants both. But I'll only ask about 'sex' in this study because there is no biological and social dichotomy of 'sex' and 'gender' in Chinese language. There is only one word. Asking participants twice might confuse them.

Q1.2 Age

a. 18-24
b. 25-34
c. 35-44
d. 45-54
e. 55-64
f. Over 65

g. I prefer not to say

Q1.3 Educational level

a. Primary school or below
b. Middle school
c. Senior high school/Secondary vocational school
d. Undergraduate degree/Higher vocational school
e. Master's degree or above
f. I prefer not to say

Q1.4 Marital status

a. Single
b. Married
c. Separated
d. Divorced
e. Widowed
f. I prefer not to say

Q1.5 Income (unit: CNY/year)

a. Less than 80000
b. 80000-140000
c. 140000-190000
d. 200000-250000
e. More than 250000
f. I prefer not to say

Q1.6 Number of dependents (Specifically, how many family members depend on you for financial support?)

a. 0
b. 1
c. 2
d. 3
e. More than 4
f. I prefer not to say

Section Two: Lifestyle Survey

This section consists of six questions designed to gather information about your physical characteristics and lifestyle habits, including height, weight, smoking history, sleep quality, and more. Please provide this information as accurately as possible.

Q2.1 Height

____cm

Q2.2 Weight

____kg

Q2.3 Smoking or vaping history

a. Never smoked
b. Former smoker
c. Current occasional smoker
d. Current daily smoker

The following 3 questions are the direct English translation of the validated and culturally adapted Chinese version of the alcohol use disorder identification test for consumption (AUDIT-C) (assess from: https://auditscreen.org/translations).

Q2.4 How often have you drunk alcohol in the past year?

a. Never
b. Monthly or less
c. 2-4 times a month
d. 2-3 times a week
e. 4 or more times a week

Alcohol unit reference

1 unit = 10 grams of pure alcohol

1 bottle of beer = 2 units

1 Liang (about 50g) of 52% Baijiu = 2 standard drinks

1 Liang of 45% Baijiu = 1.8 standard drinks

1 Liang of 38% Baijiu = 1.5 standard drinks

1 bottle of 500 ml Huangjiu (rice wine) = 6 standard drinks

1 bottle of 750 ml wine = 9 standard drinks

Q2.5 On average, how much alcohol did you drink per day over the past year?

a. 1 to 2 units: For example, half to one bottle of beer; 38-degree alcohol 1 Liang to 1 and a half Liang; 52-degree Baijiu 5 Qian to 1 Liang.
b. 3 to 4 units: For example, one and a half to two bottles of beer; 38-degree alcohol from 2 Liang to 2 and a half Liang; 52-degree Baijiu from 1 and a half Liang to 2 Liang.

c. 5 to 6 units: For example, two and a half to three bottles of beer; 38-degree alcohol 3 and a half Liang to 4 Liang; 52-degree Baijiu 2 and a half Liang to 3 Liang.
d. 7 to 9 units: For example, three and a half to four and a half bottles of beer; 38-degree alcohol 4 and a half Liang to 6 Liang; 52-degree Baijiu 3 and a half Liang to 4 and a half Liang.
e. 10 units or more: For example, five or more bottles of beer; 38-degree alcohol 7 Liang or more; 52-degree Baijiu half a Jin or more.

Q2.6 In the past year, how often have you consumed four or more bottles of beer or 3 Liang of 52-degree Baijiu in one occasion?

a. Never
b. Less than monthly
c. Monthly
d. Weekly
e. Daily or almost daily

The following scale is intended to record your own assessment of any sleep difficulty you might have experienced. Please, check (by choosing the appropriate number) the items below to indicate your estimate of any difficulty, provided that it occurred at least three times per week during the last month.

Q2.7 Sleep induction (time it takes you to fall asleep after turning-off the lights)

0: No problem

1: Slightly delayed

2: Markedly delayed

3: Very delayed or did not sleep at all

Q2.8 Awakening during the night

0: No problem

1: Minor problem

2: Considerable problem

3: Serious problem or did not sleep at all

Q2.9 Final awakening earlier than desired

0: Not earlier

1: A little earlier

2: Markedly earlier

3: Much earlier or did not sleep at all

Q2.10 Total sleep duration

0: Sufficient

1: Slightly insufficient

2: Markedly insufficient

3: Very insufficient or did not sleep at all

Q2.11 Overall quality of sleep (no matter how long you slept)

0: Satisfactory

1: Slightly unsatisfactory

2: Markedly unsatisfactory

3: Very unsatisfactory or did not sleep at all

Q2.12 Sense of well-being during the day

0: Normal

1: Slightly decreased

2: Markedly decreased

3: Very decreased

Q2.13 Functioning (physical and mental) during the day

0: Normal

1: Slightly decreased

2: Markedly decreased

3: Very decreased

Q2.14 Sleepiness during the day

0: None

1: Mild

2: Considerable

3: intense

Section Three: Work-related Information and Job Satisfaction Survey

This section is divided into two parts. The first part includes questions regarding your fundamental work details, such as job title, duration of employment, and related information. The second part involves your satisfaction with your current work. Please keep in mind that your responses will be treated with the utmost confidentiality, so we encourage you to provide candid feedback.

Q3.1 What's your job position?

a. Employee
b. Frontline manager
c. Middle manager
d. Senior manager
e. Other

Q3.2 How many years have you been working at your current company?

a. Less than 1
b. 1-3
c. 4-6
d. 7-9
e. More than 10

Q3.3 How many years have you been working in your current industry?

a. Less than 1
b. 1-3
c. 4-6
d. 7-9
e. More than 10

Q3.4 How many days a week do you work?

a. 5
b. 6
c. Big/small week scheme (employees work a six-day week every second week)

Q3.5 What time do you usually arrive at the office on a typical workday? (Please report in 24-hour format)

Arrival time _____

Q3.6 What time do you usually leave the office on a typical workday? (Please report in 24-hour format)

Leave time _____

Q3.7 Below, you will see statements related to your job. Responses are obtained on a 5-point Likert-type scale where 1 = strongly dissatisfied and 5 = strongly satisfied.

The scale used for measuring job satisfaction was the Job Satisfaction Index. Due to copyright constraints concerning the reproduction of the instrument, the items of this scale are not presented in this Appendix. For reference, the scale can be accessed/viewed by consulting the original publication (180).

Section Four: Physical Activity and Sedentary Behaviour Survey

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities you engaged in during the past 7 days. Vigorous physical activities are those that require a significant amount of effort and make your breathing much harder than usual. Only consider activities that were at least 10 minutes in duration each time.

Q4.1 During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____days per week

No vigorous physical activities— — Skip to question 3

Q4.2 How much time did you usually spend doing vigorous physical activities on one of those days?

_____hours per day

_____minutes per day

Don’t know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

Q4.3 During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____days per week

No moderate physical activities— — Skip to question 5

Q4.4 How much time did you usually spend doing moderate physical activities on one of those days?

_____hours per day

_____minutes per day

Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

Q4.5 During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____days per week

No walking— — Skip to question 7

Q4.6 How much time did you usually spend walking on one of those days?

_____hours per day

_____minutes per day

Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during

leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

Q4.7 During the last 7 days, how much time did you spend sitting on a week day?

_____hours per day

_____minutes per day

Don't know/Not sure

Occupational sedentary behaviour in the workplace

Q4.8 How much time do you usually spend sitting while working, including writing, using the computer, and answering the phone?

_____ hours_____ minutes per day

Section Five: Psychological Health Assessment

Well done! You are almost near to completion. This is the final part of the survey.

Please read the following items and choose the reply that is closest to how you have been feeling in the past week. Don't take too long over your replies; your immediate is best.

Note. The scale used for measuring depression and anxiety symptoms was the Hospital Anxiety and Depression Scale. Due to copyright constraints concerning the reproduction of the instrument, the original scale is not presented in this Appendix. For reference, the scale can be accessed/viewed by consulting the original publication (161).

Q5.15 Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because his/her mind is troubled all the time.

Do you feel this kind of stress these days?

a. Not at all
b. Only a little
c. To some extent
d. Rather much
e. Very much

This is the end of the questionnaire, thank you for participating

Appendix 4 Exploratory Regression for Path Analysis Model Proposal

1. Single-factor regressions

Table 1

Single-factor regression between occupational variables and stress

Variable	β (95% CI)	*p* value
Job position	0.35 (-0.27, 0.97)	0.27
Tenure	-0.26 (-0.49, -0.03)	0.03
Duration in the current industry	-0.05 (-0.24, 0.14)	0.60
Workdays per week	0.37 (-0.05, 0.80)	0.08
Daily working minutes	0.00 (0.00, 0.01)	0.36
Job satisfaction	-0.04 (-0.09, 0.00)	0.04

Table 2

Single-factor regression between occupational variables and occupational sedentary behaviour

Variable	β (95% CI)	*p* value
Job position	84.19 (40.53, 127.85)	0.00
Tenure	-33.46 (-49.48, -17.45)	0.00
Duration in the current industry	-14.85 (-28.45, -1.24)	0.03
Workdays per week	10.88 (-19.83, 41.58)	0.49
Daily working minutes	0.37 (0.12, 0.61)	0.00
Job satisfaction	0.67 (-2.23, 3.58)	0.65

2. Investigate whether the association between occupational sedentary behaviour and stress remained robust after controlling for each occupational variable

Table 1

Association between Occupational Sedentary Behaviour, Controlling for Job Position

Variable	β (95% CI)	*p* value
Occupational sedentary behaviour	0.002 (0.000, 0.004)	0.053
Job position	0.203 (-0.434, 0.840)	0.532

Table 2

Association between Occupational Sedentary Behaviour, Controlling for Tenure

Variable	β (95% CI)	*p* value
Occupational sedentary behaviour	0.002 (0.000, 0.003)	0.112
Tenure	-0.203 (-0.447, 0.041)	0.102

Table 3

Association between Occupational Sedentary Behaviour, Controlling for Duration in the Current Industry

Variable	β (95% CI)	*p* value
Occupational sedentary behaviour	0.002 (0.000, 0.004)	0.038
Duration in the current industry	-0.017 (-0.213, 0.179)	0.864

Table 4

Association between Occupational Sedentary Behaviour, Controlling for Workdays per Week

Variable	β (95% CI)	*p* value
Occupational sedentary behaviour	0.002 (0.000, 0.004)	0.045
Workdays per week	0.338 (-0.083, 0.758)	0.116

Table 5

Association between Occupational Sedentary Behaviour, Controlling for Daily Working Minutes

Variable	β (95% CI)	*p* value
Occupational sedentary behaviour	0.002 (0.000, 0.004)	0.050
Daily working minutes	0.001 (-0.003, 0.004)	0.709

Table 6

Association between Occupational Sedentary Behaviour, Controlling for Job Satisfaction

Variable	β (95% CI)	*p* value
Occupational sedentary behaviour	0.003 (0.001, 0.005)	0.011
Job satisfaction	-3.229 (-5.233, -1.224)	0.002

Appendix 5 Path Analysis Across All Imputed Datasets

Imputed data 2

Table 4.6 a

Unstandardised and standardised regression coefficients for the path analysis model

Estimator	Unstandardised β	SE	Standardised β
Outcome: Occupational sedentary behaviour			
Daily working minutes	0.473***	0.119	0.242
Job position	68.681**	24.334	0.193
Duration in the current company	-24.675**	8.780	-0.190
Outcome: Sleep quality			
Occupational sedentary behaviour	0.004*	0.002	0.135
Job satisfaction	-0.119**	0.043	-0.175
Outcome: Stress			
Occupational sedentary behaviour	0.001	0.000	0.076
Job satisfaction	-0.015	0.010	-0.095
Sleep quality	0.074***	0.014	0.319
Duration in the current company	-0.086	0.056	-0.097
Outcome: Job satisfaction			
Daily working minutes	0.012*	0.006	0.144

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 4.7 a

Standardised direct, indirect, and total effects of included variables on stress

Path	Direct Effects	Indirect Effects	Total Effects
Effects of occupational sedentary behaviour on stress via sleep quality			
OSB→SLP→STR	0.076	0.043	0.119
Effects of other variables on stress			
SLP→STR	0.319***	-	0.319***
JS→STR	-0.095	-0.056*	-0.151*
DCC→STR	-0.097	-0.023	-0.119
JP→STR	-	0.023	0.023
WM→STR	-	0.007	0.007

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

OSB=occupational sedentary behaviour, SLP=sleep quality, STR= stress, DCC=duration in current company, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction

Imputed data 3

Table 4.6 b

Unstandardised and standardised regression coefficients for the path analysis model

Estimator	Unstandardised β	SE	Standardised β
Outcome: Occupational sedentary behaviour			
Daily working minutes	0.475***	0.119	0.244
Job position	68.736**	24.324	0.193
Duration in the current company	-24.748**	8.776	-0.191
Outcome: Sleep quality			
Occupational sedentary behaviour	0.004*	0.002	0.135
Job satisfaction	-0.119**	0.043	-0.175
Outcome: Stress			
Occupational sedentary behaviour	0.001	0.000	0.076
Job satisfaction	-0.015	0.010	-0.095
Sleep quality	0.074***	0.014	0.319
Duration in the current company	-0.086	0.056	-0.097
Outcome: Job satisfaction			
Daily working minutes	0.012*	0.006	0.143

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 4.7 b

Standardised direct, indirect, and total effects of included variables on stress

Path	Direct Effects	Indirect Effects	Total Effects
Effects of occupational sedentary behaviour on stress via sleep quality			
OSB→SLP→STR	0.076	0.043	0.119
Effects of other variables on stress			
SLP→STR	0.319***	-	0.319***
JS→STR	-0.095	-0.056*	-0.151*
DCC→STR	-0.097	-0.023	-0.119
JP→STR	-	0.023	0.023
WM→STR	-	0.007	0.007

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

OSB=occupational sedentary behaviour, SLP=sleep quality, STR= stress, DCC=duration in current company, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction

Imputed data 4

Table 4.6 c

Unstandardised and standardised regression coefficients for the path analysis model

Estimator	Unstandardised β	SE	Standardised β
Outcome: Occupational sedentary behaviour			
Daily working minutes	0.477***	0.119	0.245
Job position	68.764**	24.314	0.193
Duration in the current company	-24.821**	8.776	-0.191
Outcome: Sleep quality			
Occupational sedentary behaviour	0.004*	0.002	0.136
Job satisfaction	-0.120**	0.043	-0.177
Outcome: Stress			
Occupational sedentary behaviour	0.001	0.000	0.075
Job satisfaction	-0.015	0.010	-0.094
Sleep quality	0.074***	0.014	0.319
Duration in the current company	-0.087	0.056	-0.097
Outcome: Job satisfaction			
Daily working minutes	0.012*	0.006	0.142

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 4.7 c

Standardised direct, indirect, and total effects of included variables on stress

Path	Direct Effects	Indirect Effects	Total Effects
Effects of occupational sedentary behaviour on stress via sleep quality			
OSB→SLP→STR	0.075	0.043	0.119
Effects of other variables on stress			
SLP→STR	0.319***	-	0.319***
JS→STR	-0.094	-0.056*	-0.151*
DCC→STR	-0.097	-0.023	-0.120
JP→STR	-	0.023	0.023
WM→STR	-	0.008	0.008

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

OSB=occupational sedentary behaviour, SLP=sleep quality, STR= stress, DCC=duration in current company, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction

Imputed data 5

Table 4.6 d

Unstandardised and standardised regression coefficients for the path analysis model

Estimator	Unstandardised β	SE	Standardised β
Outcome: Occupational sedentary behaviour			
Daily working minutes	0.476***	0.119	0.244
Job position	68.753**	24.319	0.193
Duration in the current company	-24.785**	8.774	-0.191
Outcome: Sleep quality			
Occupational sedentary behaviour	0.004*	0.002	0.136
Job satisfaction	-0.120**	0.043	-0.177
Outcome: Stress			
Occupational sedentary behaviour	0.001	0.000	0.075
Job satisfaction	-0.015	0.010	-0.094
Sleep quality	0.074***	0.014	0.319
Duration in the current company	-0.087	0.056	-0.097
Outcome: Job satisfaction			
Daily working minutes	0.012*	0.006	0.143

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

Table 4.7 d

Standardised direct, indirect, and total effects of included variables on stress

Path	Direct Effects	Indirect Effects	Total Effects
Effects of occupational sedentary behaviour on stress via sleep quality			
OSB→SLP→STR	0.075	0.043	0.119
Effects of other variables on stress			
SLP→STR	0.319***	-	0.319***
JS→STR	-0.094	-0.056*	-0.151*
DCC→STR	-0.097	-0.023	-0.120
JP→STR	-	0.023	0.023
WM→STR	-	0.007	0.007

Note. *$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$

OSB=occupational sedentary behaviour, SLP=sleep quality, STR= stress, DCC=duration in current company, DCI=duration in current industry, JP=job position, WD=workdays per week, WM=daily working minutes, JS=job satisfaction

Appendix 6 COREQ (COnsolidated criteria for REporting Qualitative research) Checklist

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	82
Credentials	2	What were the researcher's credentials? e.g. PhD, MD	82
Occupation	3	What was their occupation at the time of the study?	82
Gender	4	Was the researcher male or female?	82
Experience and training	5	What experience or training did the researcher have?	82-83
Relationship with participants			
Relationship established	6	Was a relationship established prior to study commencement?	80-81
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	81
Interviewer characteristics	8	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	48-49
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	83
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	80-82
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	82-83
Sample size	12	How many participants were in the study?	85
Non-participation	13	How many people refused to participate or dropped out? Reasons?	N/A
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	80-82
Presence of nonparticipants	15	Was anyone else present besides the participants and researchers?	82-83
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	86
Data collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	82-83
Repeat interviews	18	Were repeat interviews carried out? If yes, how many?	N/A

Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	82
Field notes	20	Were field notes made during and/or after the interview or focus group?	83
Duration	21	What was the duration of the interviews or focus group?	85
Data saturation	22	Was data saturation discussed?	82
Transcripts returned	23	Were transcripts returned to participants for comment and/or correction?	83
Domain 3: Analysis and findings			
Data analysis			
Number of data coders	24	How many data coders coded the data?	83
Description of the coding tree	25	Did authors provide a description of the coding tree?	87
Derivation of themes	26	Were themes identified in advance or derived from the data?	84
Software	27	What software, if applicable, was used to manage the data?	84
Participant checking	28	Did participants provide feedback on the findings?	N/A
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	86-96
Data and findings consistent	30	Was there consistency between the data presented and the findings?	86-96
Clarity of major themes	31	Were major themes clearly presented in the findings?	84
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	86-96

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Appendix 7 Full Interview Schedule

Thank you so much for taking the time to be here today, and a very warm welcome to you all! We're here for a focus group interview to discuss your experiences with daily sedentary behaviour and overall mental health.

Please feel free to relax interact with each other. This focus group encourages you to share your genuine experiences and thoughts, engaging in discussion rather than just answering my questions.

To ensure we have a productive and comfortable discussion environment, please allow me to outline the ground rules for this focus group:

- Respectful Communication: Please respect the opinions and viewpoints of every participant, even if you disagree. Maintain a polite and open-minded attitude.
- Open and Honest Sharing: Please feel free to share your thoughts and feelings openly and honestly, without worrying about right or wrong answers.
- Clear Speech: Please avoid talking over one another, as the focus group is being recorded and transcribed.
- Confidentiality: Please rest assured that the content of this interview will be kept strictly confidential. All personal information and statements will be anonymised and used solely for the purpose of this research. No personally identifiable information will be revealed in any public reports.

This focus group will last approximately 45-50 minutes. I will occasionally ask questions to guide the discussion throughout the interview. If you have any questions at any time, please feel free to ask.

Research Aim 1:

Explore the barriers and facilitators of reducing occupational sedentary behaviour among Chinese Software and IT workers.

COM-B	TDF Domain	Main Questions and Probes
Capability-Psychological	Knowledge	Can you describe a typical working day in terms of the patterns of physical activity or inactivity (of your employees)? (e.g., how you get to work, what are your main job tasks, how often do you have a break and how do you typically spend your break times) Identify 'How much control on activity do you have over your working day/tasks. ' Are you aware that China released the "Physical Activity Guidelines for Chinese Residents (2021)"? It recommends ● Engaging in 150-300 minutes of moderate-intensity aerobic activity or 75-150 minutes of vigorous-intensity aerobic activity per week, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. ● Performing muscle-strengthening activities on at least 2 days per week. ● Maintaining daily physical activity and increase the amount of activity.
Opportunity-Physical	Environmental Context and Resources	Are there any opportunities for you to break up your sitting time at work - What are they? What does your typical break schedule look like? Are these task dependent/ work related? or are these a conscious effort to break up sedentary time?

Opportunity-Social	Social influences	Can you identify any factors that you experience or perceive within the workplace (including your colleagues, company policy/activities) which encourage or prevent you (your employees) from breaking your sedentary time?
Motivation-Reflective	Intentions	Do you have the intention (conscious decision) to reduce your sitting time in the workplace? If so, what motivates you (e.g health, wellbeing, fatigue, stress) Specifically?
Capability-Psychological	Memory, Attention and Decision Processes	Have you tried to interrupt your sitting in the workplace? If yes- What movements have you tried? For how long? What motivates you take movements? (Prompt: awareness to health) If no- Why not? What hampers you? (Prompt: workload, efficiency)
Capability-Psychological	Behavioural regulation	(If yes) Can you think of systems or strategies that you use to break sitting?
Motivation-Reflective	Social / professional role and identity & Optimism	What does sedentary behaviour mean in the context of your (or your employees') job? As a Software and IT office worker, how feasible is it for you to consciously break up your sitting time during working ?

Motivation-Reflective	Goals	We all have different work goals. Have you ever consciously set any goals related to your health, like reducing the amount of time you spend sitting? If so, what were those goals? And do you find that achieving them conflicts with your work goals?
Motivation-Reflective	Beliefs about consequences Optimism	What would be the benefits of reducing your sitting time at work?
Motivation-Reflective	Beliefs about capabilities	What would be inconvenient/challenging about that?
Motivation-Automatic	Reinforcement	What could motivate or encourage you to take breaks when working?
Motivation-Automatic	Emotion	How do you feel if you have been sitting down for the majority of the day?

Note. The COM-B component "physical capability" was excluded from the interview schedule because previous research indicates it is not a relevant factor for engaging in the target behavior among non-clinical, healthy populations (e.g., MacDonald et al., 2018).

Research Aim 2:

Understand Software and IT workers' perspectives on how occupational sedentary behaviour may influence their mental health.

Main questions	**Probes**
How do you feel at work?	What does mental health mean to you? What types of behaviours and emotional states in the workplace do you associate with individuals who have good mental health?

What do you think influences this? How do you feel during and after a workday when you've been sedentary for the entire day?	What do you think influences these attitudes or behaviours? What types of behaviours and emotional states in the workplace do you associate with individuals who have poor mental health? What do you think influences these attitudes or behaviours? Sleep, stress, early year in the company vs now? Would you describe sitting for the entire day as having a positive or negative impact on mental health? In what ways do you experience occupational sedentary behaviour as positive? In what ways do you experience occupational sedentary behaviour as negative?

Abbreviations

Capability, Opportunity, Motivation-Behaviour (COM-B)

Confidence Interval (CI)

Information Technology (IT)

Social-Ecological Model (SEM)

Variance Inflation Factor (VIF)

Theoretical Domains Framework (TDF)

References

1. Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson V, Latimer-Cheung AE, et al. Sedentary behavior research network (SBRN)–terminology consensus project process and outcome. Int J Behav Nutr Phys Act. 2017;14:1-17.
2. Van der Ploeg HP, Hillsdon M. Is sedentary behaviour just physical inactivity by another name? Int J Behav Nutr Phys Act. 2017;14(1):142.
3. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126.
4. Owen N, Sugiyama T, Eakin EE, Gardiner PA, Tremblay MS, Sallis JF. Adults' sedentary behavior: determinants and interventions. Am J Prev Med. 2011;41(2):189-96.
5. Hallgren M, Dunstan DW, Owen N. Passive versus mentally active sedentary behaviors and depression. Exerc Sport Sci Rev. 2020;48(1):20-7.
6. Composing and Editorial Board of Physical Activity Guidelines for Chinese. Physical Activity Guidelines for Chinese (2021). Chinese Journal of Public Health. 2022;38(2):129-30.
7. Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: the population health science of sedentary behavior. Exerc Sport Sci Rev. 2010;38(3):105-13.
8. Cavallo FR, Golden C, Pearson-Stuttard J, Falconer C, Toumazou C. The association between sedentary behaviour, physical activity and type 2 diabetes markers: a systematic review of mixed analytic approaches. PLoS One. 2022;17(5):e0268289.
9. Chau JY, Grunseit A, Midthjell K, Holmen J, Holmen TL, Bauman AE, et al. Sedentary behaviour and risk of mortality from all-causes and cardiometabolic diseases in adults: evidence from the HUNT3 population cohort. Br J Sports Med. 2015;49(11):737-42.
10. Biller VS, Leitzmann MF, Sedlmeier AM, Berger FF, Ortmann O, Jochem C. Sedentary behaviour in relation to ovarian cancer risk: a systematic review and meta-analysis. Eur J Epidemiol. 2021;36(8):769-80.
11. Clarke AE, Janssen I. A compositional analysis of time spent in sleep, sedentary behaviour and physical activity with all-cause mortality risk. Int J Behav Nutr Phys Act. 2021;18(1):25.
12. Santos R, Mota J, Okely AD, Pratt M, Moreira C, Coelho-e-Silva MJ, et al. The independent associations of sedentary behaviour and physical activity on cardiorespiratory fitness. Br J Sports Med. 2014;48(20):1508-12.
13. Patterson R, McNamara E, Tainio M, De Sá TH, Smith AD, Sharp SJ, et al. Sedentary behaviour and risk of all-cause, cardiovascular and cancer mortality, and incident type 2 diabetes: a systematic review and dose response meta-analysis. Eur J Epidemiol. 2018;33(9):811-29.
14. Trinh L, Wong B, Faulkner GE. The independent and interactive associations of screen time and physical activity on mental health, school connectedness and academic achievement among a population-based sample

of youth. Journal of the Canadian Academy of Child and Adolescent Psychiatry. 2015;24(1):17.
15. Ekelund U, Steene-Johannessen J, Brown WJ, Fagerland MW, Owen N, Powell KE, et al. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. The lancet. 2016;388(10051):1302-10.
16. Ekelund U, Tarp J, Fagerland MW, Johannessen JS, Hansen BH, Jefferis BJ, et al. Joint associations of accelerometer-measured physical activity and sedentary time with all-cause mortality: a harmonised meta-analysis in more than 44 000 middle-aged and older individuals. Br J Sports Med. 2020;54(24):1499-506.
17. Ekelund U, Brown WJ, Steene-Johannessen J, Fagerland MW, Owen N, Powell KE, et al. Do the associations of sedentary behaviour with cardiovascular disease mortality and cancer mortality differ by physical activity level? A systematic review and harmonised meta-analysis of data from 850 060 participants. Br J Sports Med. 2019;53(14):886-94.
18. Li M, Fan C, Wang C, Feng Q, Wang J. Accelerometry-Based Physical Activity and Sedentary Behavior Among Chinese Adults—7 PLADs, China, 2023. China CDC Weekly. 2025;7(1):15.
19. Heron L, O'Neill C, McAneney H, Kee F, Tully MA. Direct healthcare costs of sedentary behaviour in the UK. J Epidemiol Community Health. 2019;73(7):625-9.
20. Kolu P, Kari JT, Raitanen J, Sievänen H, Tokola K, Havas E, et al. Economic burden of low physical activity and high sedentary behaviour in Finland. J Epidemiol Community Health. 2022;76(7):677-84.
21. Chaput J-P, Janssen I, Lang JJ, Sampasa-Kanyinga H. Economic burden of excessive sedentary behaviour in Canada. Canadian Journal of Public Health. 2023;114(2):165-74.
22. Zhang J, Chaaban J. The economic cost of physical inactivity in China. Prev Med. 2013;56(1):75-8.
23. Van Bakel B, Kroesen S, Bakker E, Van Miltenburg R, Günal A, Scheepmaker A, et al. Effectiveness of an intervention to reduce sedentary behaviour as a personalised secondary prevention strategy for patients with coronary artery disease: main outcomes of the SIT LESS randomised clinical trial. Int J Behav Nutr Phys Act. 2023;20(1):17.
24. Henson J, Dunstan DW, Davies MJ, Yates T. Sedentary behaviour as a new behavioural target in the prevention and treatment of type 2 diabetes. Diabetes Metab Res Rev. 2016;32:213-20.
25. Moore S, Gierach G, Schatzkin A, Matthews C. Physical activity, sedentary behaviours, and the prevention of endometrial cancer. Br J Cancer. 2010;103(7):933-8.
26. Castillo-Retamal M, Hinckson EA. Measuring physical activity and sedentary behaviour at work: a review. Work. 2011;40(4):345-57.
27. Kazi A, Haslam C, Duncan M, Clemes S, Twumasi R. Sedentary behaviour and health at work: an investigation of industrial sector, job role, gender and geographical differences. Ergonomics. 2019;62(1):21-30.

28. Thorp AA, Healy GN, Winkler E, Clark BK, Gardiner PA, Owen N, et al. Prolonged sedentary time and physical activity in workplace and non-work contexts: a cross-sectional study of office, customer service and call centre employees. Int J Behav Nutr Phys Act. 2012;9:1-9.
29. Hadgraft NT, Healy GN, Owen N, Winkler EA, Lynch BM, Sethi P, et al. Office workers' objectively assessed total and prolonged sitting time: individual-level correlates and worksite variations. Prev Med Rep. 2016;4:184-91.
30. Parry S, Straker L. The contribution of office work to sedentary behaviour associated risk. BMC Public Health. 2013;13:1-10.
31. Prince SA, Elliott CG, Scott K, Visintini S, Reed JL. Device-measured physical activity, sedentary behaviour and cardiometabolic health and fitness across occupational groups: a systematic review and meta-analysis. Int J Behav Nutr Phys Act. 2019;16(1):30.
32. Shrestha N, Kukkonen-Harjula KT, Verbeek JH, Ijaz S, Hermans V, Pedisic Z. Workplace interventions for reducing sitting at work. Cochrane Database Syst Rev. 2018(6).
33. Sui W, Smith ST, Fagan MJ, Rollo S, Prapavessis H. The effects of sedentary behaviour interventions on work-related productivity and performance outcomes in real and simulated office work: A systematic review. Appl Ergon. 2019;75:27-73.
34. Clemes SA, O'connell SE, Edwardson CL. Office workers' objectively measured sedentary behavior and physical activity during and outside working hours. J Occup Environ Med. 2014;56(3):298-303.
35. Ministry of Industry and Information Technology. The 14th Five-Year Plan for the Development of the Software and Information Technology Service Industry. Beijing: The Central People's Government of the People's Republic of China; 2021.
36. National Bureau of Statistics of China. Statistical Communiqué of the People's Republic of China on the 2024 National Economic and Social Development Beijing, China: The Central People's Government of the People's Republic of China; 2025 [updated March 1, 2025. Available from: https://english.www.gov.cn/archive/statistics/202503/01/content_WS67c2695cc6d0868f4e8f02ae.html.
37. National Data Administration. Digital China Development Report (2024). Beijing: National Data Administration; 2025.
38. Li X. (How) business context matters: understanding tech workers' occupational culture in China's Internet industry. Information Technology & People. 2025.
39. Dong R, Wu H, Ni S, Lu T. The nonlinear consequences of working hours for job satisfaction: The moderating role of job autonomy. Current Psychology. 2023;42(14):11849-70.
40. Lin W. Age discrimination causes Unemployment: Evidence from the "35-year-Old phenomenon" in China. China economic quarterly international. 2025;5(2):147-59.
41. Huang Y, Xiang Y, Zhou W, Li G, Zhao C, Zhang D, et al. Long working hours and all-cause mortality in China: A 26-year follow-up study. Scand J Work Environ Health. 2023;49(8):539.

42. Liu X, Wang C, Wang J, Ji Y, Li S. Effect of long working hours and insomnia on depressive symptoms among employees of Chinese internet companies. BMC Public Health. 2021;21(1):1408.
43. Wang B, Yang S, Huang Z, Li D, He J, Wang X. Data mining-based subhealth analysis of Chinese software programmers in 2017. Informatics in Medicine Unlocked. 2018;10:134-42.
44. Organization WH. WHO guidelines on mental health at work: World Health Organization; 2022.
45. HROne Team. Revolutionary New Employee Benefits Trends In China (2025 Edition): HROne; 2025 [Available from: https://hrone.com/blog/revolutionary-new-employee-benefits-trends-in-china-2025-edition/.
46. Qi X, Liu H, Li X, Liu H. The influence of flexible work arrangements on innovative employee behaviour in China: a perspective of person-job fit. Asia Pacific business review. 2023;29(3):479-500.
47. Central Committee of the Communist Party of China and State Council. "Healthy China 2030" Planning Outline Beijing, China: Central People's Government of the People's Republic of China; 2016 [Available from: https://www.gov.cn/zhengce/2016-10/25/content_5124174.htm.
48. World Health Organization. Mental health: Strengthening our response Geneva, Switzerland: World Health Organization; 2025 [updated 24 September, 2025. Available from: https://www.who.int/news-room/fact-sheets/detail/mental-health-strengthening-our-response.
49. Leka S, Nicholson PJ. Mental health in the workplace. Oxford University Press UK; 2019. p. 5-6.
50. World Health Organization. Prevention and promotion in mental health. Prevention and promotion in mental health2002.
51. VandenBos GR. APA dictionary of psychology: American Psychological Association; 2007.
52. Geurts SAE, Sonnentag S. Recovery as an explanatory mechanism in the relation between acute stress reactions and chronic health impairment: Work-related stress and health - risks, mechanisms and countermeasures. Scand J Work Environ Health. 2006;32(6):482-92.
53. Zhai L, Zhang Y, Zhang D. Sedentary behaviour and the risk of depression: a meta-analysis. Br J Sports Med. 2015;49(11):705-9.
54. Allen MS, Walter EE, Swann C. Sedentary behaviour and risk of anxiety: a systematic review and meta-analysis. J Affect Disord. 2019;242:5-13.
55. Chauntry AJ, Bishop NC, Hamer M, Kingsnorth AP, Chen Y-L, Paine NJ. Sedentary behaviour is associated with heightened cardiovascular, inflammatory and cortisol reactivity to acute psychological stress. Psychoneuroendocrinology. 2022;141:105756.
56. del Pozo Cruz B, Alfonso-Rosa RM, McGregor D, Chastin SF, Palarea-Albaladejo J, del Pozo Cruz J. Sedentary behaviour is associated with depression symptoms: compositional data analysis from a representative sample of 3233 US adults and older adults assessed with accelerometers. J Affect Disord. 2020;265:59-62.

57. Edwards MK, Loprinzi PD. Experimentally increasing sedentary behavior results in increased anxiety in an active young adult population. J Affect Disord. 2016;204:166-73.
58. Biddle SJ, Henson J, Davies MJ, Khunti K, Sutton S, Yates T, et al. Device-assessed total and prolonged sitting time: associations with anxiety, depression, and health-related quality of life in adults. J Affect Disord. 2021;287:107-14.
59. Hamer M, Stamatakis E. Prospective study of sedentary behavior, risk of depression, and cognitive impairment. Med Sci Sports Exerc. 2014;46(4):718.
60. Teno SC, Silva MN, Júdice PB. Physical activity and sedentary behaviour-specific domains and their associations with mental health in adults: a systematic review. Advances in Mental Health. 2024;22(3):738-65.
61. Teychenne M, Stephens LD, Costigan SA, Olstad DL, Stubbs B, Turner AI. The association between sedentary behaviour and indicators of stress: a systematic review. BMC Public Health. 2019;19(1):1357.
62. Teno SC, Silva MN, Júdice PB. Associations between domains of sedentary behavior, well-being, and quality of life–a cross-sectional study. BMC Public Health. 2024;24(1):1756.
63. Michie S, Atkins L, West R. The behaviour change wheel. A guide to designing interventions. 2014;1:1003-10.
64. Michie S, Van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implementation science. 2011;6:1-12.
65. Atkins L, Michie S. Designing interventions to change eating behaviours. Proc Nutr Soc. 2015;74(2):164-70.
66. Gould GS, Bar-Zeev Y, Bovill M, Atkins L, Gruppetta M, Clarke MJ, et al. Designing an implementation intervention with the Behaviour Change Wheel for health provider smoking cessation care for Australian Indigenous pregnant women. Implementation science. 2017;12(1):114.
67. Garnett C, Crane D, West R, Brown J, Michie S. The development of Drink Less: an alcohol reduction smartphone app for excessive drinkers. Transl Behav Med. 2019;9(2):296-307.
68. Munir F, Biddle SJ, Davies MJ, Dunstan D, Esliger D, Gray LJ, et al. Stand More AT Work (SMArT Work): using the behaviour change wheel to develop an intervention to reduce sitting time in the workplace. BMC Public Health. 2018;18:1-15.
69. Edwardson CL, Yates T, Biddle SJ, Davies MJ, Dunstan DW, Esliger DW, et al. Effectiveness of the Stand More AT (SMArT) Work intervention: cluster randomised controlled trial. BMJ. 2018;363.
70. West R, Michie S. A brief introduction to the COM-B Model of behaviour and the PRIME Theory of motivation [v1]. Qeios. 2020.
71. Michie S, Johnston M, Abraham C, Lawton R, Parker D, Walker A. Making psychological theory useful for implementing evidence based practice: a consensus approach. BMJ quality & safety. 2005;14(1):26-33.
72. Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. Implementation Science. 2012;7(1):37.

73. Atkins L, Sallis A, Chadborn T, Shaw K, Schneider A, Hopkins S, et al. Reducing catheter-associated urinary tract infections: a systematic review of barriers and facilitators and strategic behavioural analysis of interventions. Implementation science. 2020;15(1):44.
74. Hardeman W, Johnston M, Johnston D, Bonetti D, Wareham N, Kinmonth AL. Application of the Theory of Planned Behaviour in Behaviour Change Interventions: A Systematic Review. Psychol Health. 2002;17(2):123-58.
75. El Kirat H, van Belle S, Khattabi A, Belrhiti Z. Behavioral change interventions, theories, and techniques to reduce physical inactivity and sedentary behavior in the general population: a scoping review. BMC Public Health. 2024;24(1):2099.
76. Van Kasteren YF, Lewis LK, Maeder A. Office-based physical activity: Mapping a social ecological model approach against COM-B. BMC Public Health. 2020;20(1):163.
77. Bronfenbrenner U. Toward an experimental ecology of human development. Am Psychol. 1977;32(7):513.
78. Bronfenbrenner U. Ecological models of human development. International encyclopedia of education. 1994;3(2):37-43.
79. Sallis JF, Owen N, Fisher E. Ecological models of health behavior. Health behavior: Theory, research, and practice. 2015;5(43-64).
80. LeBlanc AG, Berry T, Deshpande S, Duggan M, Faulkner G, Latimer-Cheung AE, et al. Knowledge and awareness of Canadian Physical Activity and Sedentary Behaviour Guidelines: a synthesis of existing evidence. Applied physiology, nutrition, and metabolism. 2015;40(7):716-24.
81. Rollo S, Gaston A, Prapavessis H. Cognitive and motivational factors associated with sedentary behavior: A systematic review. AIMS Public Health. 2016;3(4):956.
82. Fanning J, Porter G, Awick E, Ehlers D, Roberts S, Cooke G, et al. Replacing sedentary time with sleep, light, or moderate-to-vigorous physical activity: effects on self-regulation and executive functioning. J Behav Med. 2017;40(2):332-42.
83. Taylor WC, Suminski RR, Das BM, Paxton RJ, Craig DW. Organizational culture and implications for workplace interventions to reduce sitting time among office-based workers: a systematic review. Front Public Health. 2018;6:263.
84. Jancey JM, McGann S, Creagh R, Blackford KD, Howat P, Tye M. Workplace building design and office-based workers' activity: a study of a natural experiment. Aust N Z J Public Health. 2016;40(1):78-82.
85. Cole JA, Tully MA, Cupples ME. “They should stay at their desk until the work’s done”: a qualitative study examining perceptions of sedentary behaviour in a desk-based occupational setting. BMC Res Notes. 2015;8:1-9.
86. Lin C-Y, Koohsari MJ, Liao Y, Ishii K, Shibata A, Nakaya T, et al. Workplace neighbourhood built environment and workers’ physically-active and sedentary behaviour: a systematic review of observational studies. Int J Behav Nutr Phys Act. 2020;17(1):148.
87. World Health Organization. Global action plan on physical activity 2018-2030: more active people for a healthier world: World Health Organization; 2019.

88. de Oliveira C, Saka M, Bone L, Jacobs R. The role of mental health on workplace productivity: a critical review of the literature. Appl Health Econ Health Policy. 2023;21(2):167-93.
89. Hennekam S, Richard S, Grima F. Coping with mental health conditions at work and its impact on self-perceived job performance. Empl Relat. 2020;42(3):626-45.
90. The Lancet Global Health. Mental health matters. The Lancet Global Health. 2020;8(11):e1352.
91. Zhou Q, Guo C, Yang X, He N. Dose–response association of total sedentary behaviour and television watching with risk of depression in adults: A systematic review and meta-analysis. J Affect Disord. 2023;324:652-9.
92. Bauman AE, Petersen CB, Blond K, Rangul V, Hardy LL. The descriptive epidemiology of sedentary behaviour. Sedentary behaviour epidemiology. 2018:73-106.
93. Hallgren M, Owen N, Stubbs B, Zeebari Z, Vancampfort D, Schuch F, et al. Passive and mentally-active sedentary behaviors and incident major depressive disorder: a 13-year cohort study. J Affect Disord. 2018;241:579-85.
94. Straker L, Mathiassen SE. Increased physical work loads in modern work–a necessity for better health and performance? Ergonomics. 2009;52(10):1215-25.
95. Morris AS, Murphy RC, Shepherd SO, Healy GN, Edwardson CL, Graves LE. A multi-component intervention to sit less and move more in a contact centre setting: a feasibility study. BMC Public Health. 2019;19(1):292.
96. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372.
97. Slavin RE. Best-evidence synthesis: An alternative to meta-analytic and traditional reviews. Educational researcher. 1986;15(9):5-11.
98. Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, et al. Systematic reviews of etiology and risk. JBI manual for evidence synthesis. 2020;1:217-69.
99. Munn Z, Barker TH, Moola S, Tufanaru C, Stern C, McArthur A, et al. Methodological quality of case series studies: an introduction to the JBI critical appraisal tool. JBI evidence synthesis. 2020;18(10):2127-33.
100. Goplen CM, Verbeek W, Kang SH, Jones CA, Voaklander DC, Churchill TA, et al. Preoperative opioid use is associated with worse patient outcomes after total joint arthroplasty: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2019;20(1):234.
101. Campbell M, Katikireddi SV, Sowden A, Thomson H. Lack of transparency in reporting narrative synthesis of quantitative data: a methodological assessment of systematic reviews. J Clin Epidemiol. 2019;105:1-9.
102. Teychenne M, Costigan SA, Parker K. The association between sedentary behaviour and risk of anxiety: a systematic review. BMC Public Health. 2015;15(1):513.
103. Proper KI, Singh AS, Van Mechelen W, Chinapaw MJ. Sedentary behaviors and health outcomes among adults: a systematic review of prospective studies. Am J Prev Med. 2011;40(2):174-82.

104. Rebar AL, Vandelanotte C, Van Uffelen J, Short C, Duncan MJ. Associations of overall sitting time and sitting time in different contexts with depression, anxiety, and stress symptoms. Ment Health Phys Act. 2014;7(2):105-10.
105. Kilpatrick M, Sanderson K, Blizzard L, Teale B, Venn A. Cross-sectional associations between sitting at work and psychological distress: reducing sitting time may benefit mental health. Ment Health Phys Act. 2013;6(2):103-9.
106. Hallgren M, Owen N, Vancampfort D, Dunstan DW, Wallin P, Andersson G, et al. Associations of sedentary behavior in leisure and occupational contexts with symptoms of depression and anxiety. Prev Med. 2020;133:106021.
107. Ryde GC, Dreczkowski G, Gallagher I, Chesham R, Gorely T. Device-measured desk-based occupational sitting patterns and stress (hair cortisol and perceived stress). Int J Environ Res Public Health. 2019;16(11):1906.
108. Gallagher J, Carr LJ. Leisure but not occupational physical activity and sedentary behavior associated with better health. J Occup Environ Med. 2021;63(11):e774-e82.
109. Stanczykiewicz B, Banik A, Knoll N, Keller J, Hohl DH, Rosińczuk J, et al. Sedentary behaviors and anxiety among children, adolescents and adults: a systematic review and meta-analysis. BMC Public Health. 2019;19:1-22.
110. Jokela M. Why is cognitive ability associated with psychological distress and wellbeing? Exploring psychological, biological, and social mechanisms. Pers Individ Dif. 2022;192:111592.
111. Huang Y, Li L, Gan Y, Wang C, Jiang H, Cao S, et al. Sedentary behaviors and risk of depression: a meta-analysis of prospective studies. Translational psychiatry. 2020;10(1):26.
112. American Psychiatric Association D. Diagnostic and statistical manual of mental disorders: DSM-5: American psychiatric association Washington, DC; 2013.
113. Konac D, Young KS, Lau J, Barker ED. Comorbidity between depression and anxiety in adolescents: Bridge symptoms and relevance of risk and protective factors. Journal of psychopathology and behavioral assessment. 2021;43:583-96.
114. Häusser JA, Schulz-Hardt S, Schultze T, Tomaschek A, Mojzisch A. Experimental evidence for the effects of task repetitiveness on mental strain and objective work performance. Journal of Organizational Behavior. 2014;35(5):705-21.
115. Health and Safety Executive. Work-related stress and how to manage it: Health and Safety Executive; 2024 [cited 2025 Jun 10]. Available from: https://www.hse.gov.uk/stress/risk-assessment.htm.
116. MacDonald W. The impact of job demands and workload on stress and fatigue. Aust Psychol. 2003;38(2):102-17.
117. Hammen CL. Stress and depression: old questions, new approaches. Curr Opin Psychol. 2015;4:80-5.
118. Siwa M, Kulis E, Banik A, Szczuka Z, Boberska M, Wietrzykowska D, et al. Associations between depressive symptoms and sedentary behaviors in dyads: Longitudinal crossover effects. Ment Health Phys Act. 2023;24:100501.

119. World Health Organization. WHO guidelines on physical activity and sedentary behaviour. World Health Organization. 2020.
120. Bhaskar R. A realist theory of science: Routledge; 2013.
121. Danermark B, Ekström M, Karlsson JC. Explaining society: Critical realism in the social sciences: Routledge; 2019.
122. Mingers J. Real-izing information systems: critical realism as an underpinning philosophy for information systems. Information and organization. 2004;14(2):87-103.
123. Sayer A. Realism and social science. 1999.
124. Bhaskar R. The possibility of naturalism: A philosophical critique of the contemporary human sciences: Routledge; 2014.
125. Alderson P. Critical realism for health and illness research: a practical introduction: Policy Press; 2021.
126. Downward P, Finch JH, Ramsay J. Critical realism, empirical methods and inference: a critical discussion. Cambridge journal of economics. 2002;26(4):481-500.
127. Bhaskar R. Scientific realism and human emancipation: Routledge; 2009.
128. Archer M, Bhaskar R, Collier A, Lawson T, Norrie A. Critical realism: Essential readings: Routledge; 2013.
129. Archer MS. Realist social theory: The morphogenetic approach: Cambridge university press; 1995.
130. Moore GF, Audrey S, Barker M, Bond L, Bonell C, Hardeman W, et al. Process evaluation of complex interventions: Medical Research Council guidance. BMJ. 2015;350.
131. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ. 2021;374.
132. Pawson R, Tilley N. Realistic evaluation. 1997.
133. Creswell JW, Clark VLP. Designing and conducting mixed methods research: Sage publications; 2017.
134. Sayer RA. Method in social science: A realist approach: Psychology Press; 1992.
135. Ågerfalk PJ. Embracing diversity through mixed methods research. Taylor & Francis; 2013. p. 251-6.
136. Fletcher AJ. The reality of gender (ideology): Using abduction and retroduction in applied critical realist research. Critical realism, feminism, and gender: A reader: Routledge; 2020. p. 205-24.
137. Lewis-Beck M, Bryman AE, Liao TF. The Sage encyclopedia of social science research methods: Sage publications; 2003.
138. Maxwell JA. A realist approach for qualitative research: Sage; 2012.
139. Tashakkori A. Sage handbook of mixed methods in social & behavioral research: Sage; 2010.
140. Schonfeld IS, Mazzola JJ. Strengths and limitations of qualitative approaches to research in occupational health psychology1. Research methods in occupational health psychology: Routledge; 2012. p. 268-89.

141. Lalloo D, Lewsey J, Katikireddi S, Macdonald E, Demou E. Health, lifestyle and occupational risks in Information Technology workers. Occup Med. 2021;71(2):68-74.
142. Garson GD. Path analysis: Statistical Associates Publishing Asheboro, NC; 2013.
143. Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N, Hoagwood K. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and policy in mental health and mental health services research. 2015;42(5):533-44.
144. Teddlie C, Tashakkori A. Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences: Sage; 2009.
145. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs—principles and practices. Health Serv Res. 2013;48(6pt2):2134-56.
146. Taber KS. The use of Cronbach's alpha when developing and reporting research instruments in science education. Research in science education. 2018;48(6):1273-96.
147. Burnham KP, Anderson DR. Model selection and multimodel inference: a practical information-theoretic approach: Springer; 2002.
148. Tabachnick BG, Fidell LS, Ullman JB. Using multivariate statistics: pearson Boston, MA; 2007.
149. Shenton AK. Strategies for ensuring trustworthiness in qualitative research projects. Education for information. 2004;22(2):63-75.
150. Brislin RW. Back-translation for cross-cultural research. J Cross Cult Psychol. 1970;1(3):185-216.
151. Jick TD. Mixing qualitative and quantitative methods: Triangulation in action. Adm Sci Q. 1979;24(4):602-11.
152. Jin M, Swainson M, Wang C, Morris A. Systematic review: occupational sedentary behaviour and common mental health symptoms. Occup Med. 2025;75(6):275-81.
153. Pinheiro M, Ivandic I, Razzouk D. The economic impact of mental disorders and mental health problems in the workplace. Mental health economics: the costs and benefits of psychiatric care: Springer; 2017. p. 415-30.
154. Xiang Y-T, Zhang Q, Wang G, Zeng L-N, Ungvari GS. Prevalence of mental disorders in China. Lancet Psychiatry. 2019;6(6):467-8.
155. Huang Y, Wang Y, Wang H, Liu Z, Yu X, Yan J, et al. Prevalence of mental disorders in China: a cross-sectional epidemiological study. Lancet Psychiatry. 2019;6(3):211-24.
156. Tu F. WeChat and civil society in China. Commun Public. 2016;1(3):343-50.
157. Pourhoseingholi MA, Vahedi M, Rahimzadeh M. Sample size calculation in medical studies. Gastroenterology and hepatology from bed to bench. 2013;6(1):14-7.
158. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381-95.

159. Macfarlane DJ, Lee CC, Ho EY, Chan KL, Chan DT. Reliability and validity of the Chinese version of IPAQ (short, last 7 days). J Sci Med Sport. 2007;10(1):45-51.
160. Deng HB, Macfarlane DJ, Thomas GN, Lao XQ, Jiang CQ, Cheng KK, et al. Reliability and validity of the IPAQ-Chinese: the Guangzhou Biobank Cohort study. Med Sci Sports Exerc. 2008;40(2):303-7.
161. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983;67(6):361-70.
162. Stern AF. The hospital anxiety and depression scale. Occup Med. 2014;64(5):393-4.
163. Axford J, Butt A, Heron C, Hammond J, Morgan J, Alavi A, et al. Prevalence of anxiety and depression in osteoarthritis: use of the Hospital Anxiety and Depression Scale as a screening tool. Clin Rheumatol. 2010;29(11):1277-83.
164. Bocéréan C, Dupret E. A validation study of the Hospital Anxiety and Depression Scale (HADS) in a large sample of French employees. BMC Psychiatry. 2014;14(1):1-11.
165. Larisch L-M, Blom V, Hagströmer M, Ekblom M, Ekblom Ö, Nilsson J, et al. Improving movement behavior in office workers: effects of two multi-level cluster-RCT interventions on mental health. BMC Public Health. 2024;24(1):127.
166. Yang Y, Ding R, Hu D, Zhang F, Sheng L. Reliability and validity of a Chinese version of the HADS for screening depression and anxiety in psycho-cardiological outpatients. Compr Psychiatry. 2014;55(1):215-20.
167. Li Q, Lin Y, Hu C, Xu Y, Zhou H, Yang L, et al. The Chinese version of hospital anxiety and depression scale: psychometric properties in Chinese cancer patients and their family caregivers. Eur J Oncol Nurs. 2016;25:16-23.
168. Elo A-L, Leppänen A, Jahkola A. Validity of a single-item measure of stress symptoms. Scandinavian journal of work, environment & health. 2003:444-51.
169. Metzenthin P, Helfricht S, Loerbroks A, Terris DD, Haug HJ, Subramanian S, et al. A one-item subjective work stress assessment tool is associated with cortisol secretion levels in critical care nurses. Prev Med. 2009;48(5):462-6.
170. Sun T, Gao L, Li F, Shi Y, Xie F, Wang J, et al. Workplace violence, psychological stress, sleep quality and subjective health in Chinese doctors: a large cross-sectional study. BMJ Open. 2017;7(12):e017182.
171. Zhang S-e, Yang L-b, Zhao C-x, Shi Y, Wang H-n, Zhao X, et al. Contribution of character strengths to psychology stress, sleep quality, and subjective health status in a sample of Chinese nurses. Front Psychol. 2021;12:631459.
172. Smith L, McCourt O, Sawyer A, Ucci M, Marmot A, Wardle J, et al. A review of occupational physical activity and sedentary behaviour correlates. Occup Med. 2016;66(3):185-92.
173. O'donoghue G, Perchoux C, Mensah K, Lakerveld J, van Der Ploeg H, Bernaards C, et al. A systematic review of correlates of sedentary behaviour in adults aged 18–65 years: a socio-ecological approach. BMC Public Health. 2016;16:1-25.
174. Lau JH, Nair A, Abdin E, Kumarasan R, Wang P, Devi F, et al. Prevalence and patterns of physical activity, sedentary behaviour, and their association with health-related quality of life within a multi-ethnic Asian population. BMC Public Health. 2021;21:1-13.

175. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA, Project ACQI. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Arch Intern Med. 1998;158(16):1789-95.
176. Saunders JB, Aasland OG, Babor TF, De la Fuente JR, Grant M. Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. Addiction. 1993;88(6):791-804.
177. Yip BH, Chung RY, Chung VC, Kim J, Chan IW, Wong MC, et al. Is Alcohol Use Disorder Identification Test (AUDIT) or its shorter versions more useful to identify risky drinkers in a Chinese population? A diagnostic study. PLoS One. 2015;10(3):e0117721.
178. Soldatos CR, Dikeos DG, Paparrigopoulos TJ. Athens Insomnia Scale: validation of an instrument based on ICD-10 criteria. J Psychosom Res. 2000;48(6):555-60.
179. Liu Y-H, Yun Q-P, Zhang L-C, Zhang X-Y, Lin Y-T, Liu F-J, et al. Joint association of sedentary behavior and physical activity on anxiety tendency among occupational population in China. J Peking Univ Health Sci. 2022;54(3):490-7.
180. Tsui AS, Egan TD, O'Reilly III CA. Being different: Relational demography and organizational attachment. Adm Sci Q. 1992:549-79.
181. Van Buuren S, Groothuis-Oudshoorn K. mice: Multivariate imputation by chained equations in R. J Stat Softw. 2011;45:1-67.
182. Wickham H, François R, Henry L, Müller K, Vaughan D. dplyr: A Grammar of Data Manipulation. 1.1.4 ed. Vienna, Austria: R Foundation for Statistical Computing; 2023.
183. Wickham H, Henry L. purrr: Functional Programming Tools. 1.0.2 ed. Vienna, Austria: R Foundation for Statistical Computing; 2023.
184. Venables WN, Ripley BD. Modern applied statistics with S: Springer Science & Business Media; 2013.
185. Cohen J, Cohen P, West SG, Aiken LS. Applied multiple regression/correlation analysis for the behavioral sciences: Routledge; 2013.
186. Wang K, Li Y, Liu H, Zhang T, Luo J. Can physical activity counteract the negative effects of sedentary behavior on the physical and mental health of children and adolescents? A narrative review. Front Public Health. 2024;12:1412389.
187. Guo Y, Li K, Zhao Y, Wang C, Mo H, Li Y. Association between long-term sedentary behavior and depressive symptoms in US adults. Sci Rep. 2024;14(1):5247.
188. Jiang L, Cao Y, Ni S, Chen X, Shen M, Lv H, et al. Association of sedentary behavior with anxiety, depression, and suicide ideation in college students. Front Psychiatry. 2020;11:566098.
189. Cao X, Zhang H, Li P, Huang X. The Influence of Mental Health on Job Satisfaction: Mediating Effect of Psychological Capital and Social Capital. Frontiers in public health. 2022;10:797274.
190. Barham WT, Buysse DJ, Kline CE, Kubala AG, Brindle RC. Sleep health mediates the relationship between physical activity and depression symptoms. Sleep Breath. 2022:1-9.

191. Werneck AO, Silva DR, Malta DC, Lima MG, Souza-Júnior PR, Azevedo LO, et al. The mediation role of sleep quality in the association between the incidence of unhealthy movement behaviors during the COVID-19 quarantine and mental health. Sleep Med. 2020;76:10-5.
192. Vargas I, Perlis ML. Insomnia and depression: clinical associations and possible mechanistic links. Curr Opin Psychol. 2020;34:95-9.
193. Johnson EO, Roth T, Breslau N. The association of insomnia with anxiety disorders and depression: exploration of the direction of risk. J Psychiatr Res. 2006;40(8):700-8.
194. Duncan OD. Path analysis: Sociological examples. Am J Sociol. 1966;72(1):1-16.
195. Haig BD. Exploratory factor analysis, theory generation, and scientific method. Multivariate Behav Res. 2005;40(3):303-29.
196. Baron RM, Kenny DA. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. J Pers Soc Psychol. 1986;51(6):1173.
197. West SG, Finch JF, Curran PJ. Structural equation models with nonnormal variables: Problems and remedies. In: Hoyle RH, editor. Structural equation modeling: Concepts, issues, and applications. Thousand Oaks (CA): Sage Publications; 1995. p. 56-75.
198. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct Equ Modeling. 1999;6(1):1-55.
199. Rubin DB. Multiple imputation for nonresponse in surveys: John Wiley & Sons; 2004.
200. CSDN. 2022-2023 Survey Report on Developers in China Beijing2023 [Available from: https://img-bss.csdnimg.cn/2023_CSDN_REPORT.pdf.
201. Kline RB. Principles and practice of structural equation modeling: Guilford publications; 2023.
202. Weston R, Gore Jr PA. A brief guide to structural equation modeling. Couns Psychol. 2006;34(5):719-51.
203. van Dommelen P, Coffeng JK, van der Ploeg HP, van der Beek AJ, Boot CRL, Hendriksen IJM. Objectively Measured Total and Occupational Sedentary Time in Three Work Settings. PLoS One. 2016;11(3):e0149951.
204. Wiegner L, Hange D, Björkelund C, Ahlborg G. Prevalence of perceived stress and associations to symptoms of exhaustion, depression and anxiety in a working age population seeking primary care - an observational study. BMC Fam Pract. 2015;16(1):38.
205. Sardella A, Musetti A, Franceschini C, Quattropani MC, Lenzo V. Longitudinal associations of depression, anxiety, and stress among healthcare workers assisting patients with end-stage cancer during the COVID-19 pandemic: the moderator role of emotional exhaustion. BMC Psychol. 2024;12(1):359-10.
206. Leask CF, Harvey JA, Skelton DA, Chastin SF. Exploring the context of sedentary behaviour in older adults (what, where, why, when and with whom). Eur Rev Aging Phys Act. 2015;12:1-8.

207. João KADR, Jesus SNd, Carmo C, Pinto P. The impact of sleep quality on the mental health of a non-clinical population. Sleep Med. 2018;46:69-73.
208. Aberson C, Rodriguez J, Siegel D. Power analysis for regression coefficients: the role of multiple predictors and power to detect all coefficients simultaneously. Quant Methods Psychol. 2022;18:142-51.
209. Lan L, Lang X, McKee M, Tse LA, Rangarajan S, Qiang D, et al. Association of sitting time with cardiovascular events among manual and non-manual workers: a prospective cohort study (PURE-China). BMC Public Health. 2025;25(1):750.
210. Wu J, Fu Y, Chen D, Zhang H, Xue E, Shao J, et al. Sedentary behavior patterns and the risk of non-communicable diseases and all-cause mortality: A systematic review and meta-analysis. Int J Nurs Stud. 2023;146:104563.
211. Ross R, Chaput J-P, Giangregorio LM, Janssen I, Saunders TJ, Kho ME, et al. Canadian 24-Hour Movement Guidelines for Adults aged 18–64 years and Adults aged 65 years or older: an integration of physical activity, sedentary behaviour, and sleep. Applied physiology, nutrition, and metabolism. 2020;45(10):S57-S102.
212. World Health Organization. Achieving well-being: a global framework for integrating well-being into public health utilizing a health promotion approach: World Health Organization; 2024.
213. Zhou Z, Xi Y, Zhang F, Lu Q, Zhang F, Huang D, et al. Sedentary behavior predicts changes in cardiometabolic risk in professional workers: a one-year prospective study. J Occup Environ Med. 2016;58(4):e117-e23.
214. MacDonald B, Fitzsimons C, Niven A. Using the COM-B model of behaviour to understand sitting behaviour in UK office workers. Sport and Exercise Psychology Review. 2018;14:23-32.
215. Ojo SO, Bailey DP, Hewson DJ, Chater AM. Perceived barriers and facilitators to breaking up sitting time among desk-based office workers: a qualitative investigation using the TDF and COM-B. Int J Environ Res Public Health. 2019;16(16):2903.
216. Morton S, Fitzsimons C, Sivaramakrishnan D, Jepson R, Niven A. “Are we working (too) comfortably?”: a focus group study to understand sedentary behaviour when working at home and identify intervention strategies. BMC Public Health. 2024;24(1):1516.
217. Coffey A, Parés-Salomón I, Bort-Roig J, Proper KI, Walsh D, Reckman P, et al. Breaking the chain from the chair: a manager’s perspective on reducing employees sedentary time in a home-office context. BMC Public Health. 2025;25(1):1079.
218. Kwasnicka D, Dombrowski SU, White M, Sniehotta F. Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories. Health Psychol Rev. 2016;10(3):277-96.
219. Bryman A. Social research methods: Oxford university press; 2016.
220. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care. 2007;19(6):349-57.
221. Hennink M, Kaiser BN. Sample sizes for saturation in qualitative research: A systematic review of empirical tests. Soc Sci Med. 2022;292:114523.

222. Braun V, Clarke V. To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. Qualitative research in sport, exercise and health. 2021;13(2):201-16.
223. Krueger RA. Focus groups: A practical guide for applied research: Sage publications; 2014.
224. Stewart DW, Shamdasani PN, Rook DW. Focus groups : theory and practice. 2 ed. Thousand Oaks, Calif: Sage Publications; 2007.
225. Braun V, Clarke V, Hayfield N, Davey L, Jenkinson E. Doing reflexive thematic analysis. Supporting research in counselling and psychotherapy: Qualitative, quantitative, and mixed methods research: Springer; 2023. p. 19-38.
226. Braun V, Clarke V. Reflecting on reflexive thematic analysis. Qualitative research in sport, exercise and health. 2019;11(4):589-97.
227. Braun V, Clarke V. Thematic analysis: a practical guide. 2021.
228. Kowal M. Translation practices in cross-cultural social research and guidelines for the most popular approach: Back-translation. Anthropological Review. 2024;87(3):19-32.
229. Morris A, Murphy R, Shepherd S, Graves L. Multi-stakeholder perspectives of factors that influence contact centre call agents' workplace physical activity and sedentary behaviour. Int J Environ Res Public Health. 2018;15(7):1484.
230. Proginn. 2021 Survey Report on Chinese Programmers' Salaries and Living Conditions Zhihu2021 [Available from: https://zhuanlan.zhihu.com/p/355695490.
231. Baltes S, Park G, Serebrenik A. Is 40 the new 60? How popular media portrays the employability of older software developers. IEEE Software. 2020;37(6):26-31.
232. Mullane SL, Toledo MJ, Rydell SA, Feltes LH, Vuong B, Crespo NC, et al. Social ecological correlates of workplace sedentary behavior. Int J Behav Nutr Phys Act. 2017;14(1):117.
233. Chau JY, Daley M, Srinivasan A, Dunn S, Bauman AE, van der Ploeg HP. Desk-based workers' perspectives on using sit-stand workstations: a qualitative analysis of the Stand@Work study. BMC Public Health. 2014;14(1):752.
234. Zerguine H, Goode AD, Abbott A, Johnston V, Healy GN. Factors impacting workplace investment in sit-stand workstations from the perspective of purchasing decision-makers. Appl Ergon. 2022;98:103558.
235. Hall J, Kay T, McConnell AK, Mansfield L. Implementation of sit-stand desks as a workplace health initiative: stakeholder views. International journal of workplace health management. 2019;12(5):369-86.
236. Munir F, Miller P, Biddle SJ, Davies MJ, Dunstan DW, Esliger DW, et al. A cost and cost-benefit analysis of the stand more at work (SMArT work) intervention. Int J Environ Res Public Health. 2020;17(4):1214.
237. Gilson ND, Suppini A, Ryde GC, Brown HE, Brown WJ. Does the use of standing 'hot'desks change sedentary work time in an open plan office? Prev Med. 2012;54(1):65-7.
238. Healy GN, Goode A, Schultz D, Lee D, Leahy B, Dunstan DW, et al. The BeUpstanding Program™: Scaling up the Stand Up Australia workplace intervention for translation into practice. AIMS Public Health. 2016;3(2):341.

239. Healy GN, Goode AD, Ulyate L, Abbott A, Dunstan DW, Eakin EG, et al. National implementation trial of BeUpstanding™: an online initiative for workers to sit less and move more. Int J Behav Nutr Phys Act. 2024;21(1):111.
240. Gardner B, Smith L, Lorencatto F, Hamer M, Biddle SJ. How to reduce sitting time? A review of behaviour change strategies used in sedentary behaviour reduction interventions among adults. Health Psychol Rev. 2016;10(1):89-112.
241. Xu C, Furuya-Kanamori L, Liu Y, Færch K, Aadahl M, Seguin RA, et al. Sedentary behavior, physical activity, and all-cause mortality: dose-response and intensity weighted time-use meta-analysis. J Am Med Dir Assoc. 2019;20(10):1206-12. e3.
242. Masters R, Anwar E, Collins B, Cookson R, Capewell S. Return on investment of public health interventions: a systematic review. Journal of epidemiology and community health (1979). 2017;71(8):827-34.
243. Khushalani JS, Song S, Calhoun BH, Puddy RW, Kucik JE. Preventing Leading Causes of Death: Systematic Review of Cost-Utility Literature. Am J Prev Med. 2022;62(2):275-84.
244. Nakamura J, Csikszentmihalyi M. The concept of flow. Handbook of positive psychology. 2002;89:105.
245. Janssens S, Zaytsev V, editors. Go with the flow: software engineers and distractions. Proceedings of the 25th International Conference on Model Driven Engineering Languages and Systems: Companion Proceedings; 2022.
246. Radwan A, Barnes L, DeResh R, Englund C, Gribanoff S. Effects of active microbreaks on the physical and mental well-being of office workers: A systematic review. Cogent Engineering. 2022;9(1):2026206.
247. Presseau J, Johnston M, Heponiemi T, Elovainio M, Francis JJ, Eccles MP, et al. Reflective and automatic processes in health care professional behaviour: a dual process model tested across multiple behaviours. Ann Behav Med. 2014;48(3):347-58.
248. Thaler RH, Sunstein CR. Nudge : improving decisions about health, wealth and happiness. Updated edition. ed. London: Penguin Books; 2022.
249. Thivel D, Chaput J, Duclos M. Integrating sedentary behavior in the theoretical model linking childhood to adulthood activity and health? An updated framework. Physiol Behav. 2018;196:33-5.
250. Rosenkranz RR, Neuendorf CM, Rosenkranz SK, Sauer KL. Just sit still and pay attention?—A commentary. The Journal of School Health. 2020;90(5):345.
251. Turner L, Chriqui JF, Chaloupka FJ. Withholding recess from elementary school students: Policies matter. J Sch Health. 2013;83(8):533-41.
252. Ohrnberger J, Fichera E, Sutton M. The relationship between physical and mental health: A mediation analysis. Soc Sci Med. 2017;195:42-9.
253. Wheatley D. Autonomy in paid work and employee subjective well-being. Work and occupations. 2017;44(3):296-328.
254. Falck RS, Davis JC, Liu-Ambrose T. What is the association between sedentary behaviour and cognitive function? A systematic review. Br J Sports Med. 2017;51(10):800-11.

255. Kesse-Guyot E, Andreeva VA, Lassale C, Hercberg S, Galan P. Clustering of midlife lifestyle behaviors and subsequent cognitive function: a longitudinal study. Am J Public Health. 2014;104(11):e170-e7.
256. Onwuegbuzie AJ, Leech NL. Qualitizing data. The Routledge reviewer's guide to mixed methods analysis: Routledge; 2021. p. 141-50.
257. Etikan I, Musa SA, Alkassim RS. Comparison of convenience sampling and purposive sampling. American journal of theoretical and applied statistics. 2016;5(1):1-4.
258. Corrigan PW, Rao D. On the self-stigma of mental illness: Stages, disclosure, and strategies for change. The Canadian Journal of Psychiatry. 2012;57(8):464-9.
259. Zhang Y, Zhou M, Liang R, Chen J, Shi P, Zheng Y, et al. Mental health literacy and the stigmatisation and discrimination of individuals affected by mental illnesses in China: a scoping review. The Lancet Regional Health–Western Pacific. 2025.
260. Lin EH, Von Korff M, consortium WWs. Mental disorders among persons with diabetes—results from the World Mental Health Surveys. J Psychosom Res. 2008;65(6):571-80.
261. Baglioni C, Battagliese G, Feige B, Spiegelhalder K, Nissen C, Voderholzer U, et al. Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. J Affect Disord. 2011;135(1-3):10-9.
262. Spearing J. Workplace autonomy and mental health. Econ Hum Biol. 2025;56:101469.
263. Li LMW. Can job autonomy attenuate the effect of depression on employees' well-being? It may depend on culture. Journal of Mental Health. 2019;28(2):181-8.
264. Eklund C, Elfström ML, von Heideken Wågert P, Söderlund A, Gustavsson C, Cederbom S, et al. The meaning of sedentary behavior as experienced by people in the transition from working life to retirement: An empirical phenomenological study. Phys Ther. 2021;101(8):pzab117.
265. Biddle S. Physical activity and mental health: evidence is growing. World Psychiatry. 2016;15(2):176.
266. Teychenne M, Sousa GM, Baker T, Liddelow C, Babic M, Chauntry AJ, et al. Domain-specific physical activity and mental health: an updated systematic review and multilevel meta-analysis in a combined sample of 3.3 million people. Br J Sports Med. 2025.
267. King RC, Bu N. Perceptions of the mutual obligations between employees and employers: a comparative study of new generation IT professionals in China and the United States. The International Journal of Human Resource Management. 2005;16(1):46-64.
268. Peng X. The 6pm struggle: the changing meaning of work, a culture of overtime work, and corporate governmentality in urban China. Asian Anthropology. 2020;19(1):39-52.
269. Li X. Managerial technique and worker subjectivity in dialogue: Understanding overwork in China's internet industry. Work, Employment and Society. 2023;37(6):1699-716.

270. National People's Congress of the People's Republic of China. Labor Law of the People's Republic of China. Beijing: China NPC Website; 2019.
271. Xiao C, Silva EA, Zhang C. Nine-nine-six work system and people's movement patterns: using big data sets to analyse overtime working in Shanghai. Land Use Policy. 2020;90:104340.
272. Yang J, Fan D, Li C. Employee Overtime and Innovation Dilemma. Journal of Business Ethics. 2025:1-25.
273. Zhang Q, Zhao B. Hidden health costs of overtime culture: evidence from China. China Economic Journal. 2025:1-22.
274. Yu H, Schwingel A. Associations between sedentary behavior, physical activity, and out-of-pocket health care expenditure: Evidence from Chinese older adults. J Aging Phys Act. 2019;27(1):108-15.
275. Tucker AL, Singer SJ. The effectiveness of management-by-walking-around: A randomized field study. Production and Operations Management. 2015;24(2):253-71.
276. Zacher H, Brailsford HA, Parker SL. Micro-breaks matter: A diary study on the effects of energy management strategies on occupational well-being. J Vocat Behav. 2014;85(3):287-97.
277. Hadgraft NT, Brakenridge CL, LaMontagne AD, Fjeldsoe BS, Lynch BM, Dunstan DW, et al. Feasibility and acceptability of reducing workplace sitting time: a qualitative study with Australian office workers. BMC Public Health. 2016;16(1):933.
278. Danquah IH, Tolstrup JS. Standing meetings are feasible and effective in reducing sitting time among office workers—walking meetings are not: Mixed-methods results on the feasibility and effectiveness of active meetings based on data from the "take a stand!" study. Int J Environ Res Public Health. 2020;17(5):1713.
279. Bauer TN, Erdogan B. Organizational socialization: The effective onboarding of new employees. 2011.
280. Jia Y, Fu H, Gao J, Dai J, Zheng P. The roles of health culture and physical environment in workplace health promotion: a two-year prospective intervention study in China. BMC Public Health. 2018;18(1):457.
281. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Ann Behav Med. 2013;46(1):81-95.
282. Presseau J, Ivers NM, Newham JJ, Knittle K, Danko KJ, Grimshaw JM. Using a behaviour change techniques taxonomy to identify active ingredients within trials of implementation interventions for diabetes care. Implementation Science. 2015;10(1):55.
283. Houdmont J, Zhou J, Hassard J. Overtime and psychological well-being among Chinese office workers. Occup Med. 2011;61(4):270-3.
284. Healy GN, Eakin EG, LaMontagne AD, Owen N, Winkler EA, Wiesner G, et al. Reducing sitting time in office workers: short-term efficacy of a multicomponent intervention. Prev Med. 2013;57(1):43-8.

285. Grunseit AC, Chau JY-Y, Van der Ploeg HP, Bauman A. "Thinking on your feet": A qualitative evaluation of sit-stand desks in an Australian workplace. BMC Public Health. 2013;13(1):365.
286. Morton S, Fitzsimons C, Jepson R, Saunders DH, Sivaramakrishnan D, Niven A. What works to reduce sedentary behavior in the office, and could these intervention components transfer to the home working environment?: A rapid review and transferability appraisal. Frontiers in sports and active living. 2022;4:954639.
287. Rollo S, Prapavessis H. A combined health action process approach and mHealth intervention to increase Non-Sedentary behaviours in Office-Working Adults—A randomised controlled trial. Applied Psychology: Health and Well-Being. 2020;12(3):660-86.
288. Patel AK, Banga C, Chandrasekaran B. Effect of an education-based workplace intervention (move in office with education) on sedentary behaviour and well-being in desk-based workers: a cluster randomized controlled trial. Int J Occup Saf Ergon. 2022;28(3):1655-63.
289. Blake H, Lai B, Coman E, Houdmont J, Griffiths A. Move-It: a cluster-randomised digital worksite exercise intervention in China: outcome and process evaluation. Int J Environ Res Public Health. 2019;16(18):3451.
290. Buckingham SA, Williams AJ, Morrissey K, Price L, Harrison J. Mobile health interventions to promote physical activity and reduce sedentary behaviour in the workplace: a systematic review. Digital health. 2019;5:2055207619839883.
291. Konradt U, Heblich F, Krys S, Garbers Y, Otte K-P. Beneficial, adverse, and spiraling health-promotion effects: Evidence from a longitudinal randomized controlled trial of working at sit–stand desks. J Occup Health Psychol. 2020;25(1):68.
292. Daneshmandi H, Choobineh A, Ghaem H, Hejazi N. Proper sit–stand work schedule to reduce the negative outcomes of sedentary behavior: a randomized clinical trial. Int J Occup Saf Ergon. 2021;27(4):1039-55.
293. Jiang Y, Zhang M, Cui J. The relationship between sedentary behavior and depression in older adults: A systematic review and meta-analysis. J Affect Disord. 2024.
294. Mackenzie K, Such E, Norman P, Goyder E. Sitting less at work: a qualitative study of barriers and enablers in organisations of different size and sector. BMC Public Health. 2019;19:1-13.
295. Hadgraft NT, Brakenridge CL, Dunstan DW, Owen N, Healy GN, Lawler SP. Perceptions of the acceptability and feasibility of reducing occupational sitting: review and thematic synthesis. Int J Behav Nutr Phys Act. 2018;15(1):90.
296. Nooijen CF, Kallings LV, Blom V, Ekblom Ö, Forsell Y, Ekblom MM. Common perceived barriers and facilitators for reducing sedentary behaviour among office workers. Int J Environ Res Public Health. 2018;15(4):792.
297. Faghy M, Duncan M, Pringle A, Meharry JB, Roscoe C. UK university staff experience high levels of sedentary behaviour during work and leisure time. Int J Occup Saf Ergon. 2022;28(2):1104-11.

298. Pavey TG, Gomersall SR, Clark BK, Brown WJ. The validity of the GENEActiv wrist-worn accelerometer for measuring adult sedentary time in free living. J Sci Med Sport. 2016;19(5):395-9.
299. Aunger J, Wagnild J. Objective and subjective measurement of sedentary behavior in human adults: A toolkit. Am J Hum Biol. 2022;34(1):e23546-n/a.
300. Prince SA, Cardilli L, Reed JL, Saunders TJ, Kite C, Douillette K, et al. A comparison of self-reported and device measured sedentary behaviour in adults: a systematic review and meta-analysis. Int J Behav Nutr Phys Act. 2020;17:1-17.
301. Stress, Appraisal and Coping. By R. S. Lazarus and S. Folkman. (Pp. 445; illustrated;$31.95.) Springer Publishing: New York. 1984. - Stress (2 volumes). Edited by E. Usdin, R. Kvetnansky and J. Axelrod. (Pp. 605; illustrated; $ 275.00.) Gordon and Breach: New York. 1985. - Stress in Health and Disease. Edited by M. R. Zales. (Pp. 262; illustrated; $27.50.) Brunner/Mazel: New York. 1985. Psychol Med. 1985;15(3):705-.
302. Wang X, Cheng Z. Cross-sectional studies: strengths, weaknesses, and recommendations. Chest. 2020;158(1):S65-S71.
303. Yin RK. Case study research: Design and methods: sage; 2009.
304. Patton MQ. Qualitative research & evaluation methods: Integrating theory and practice: Sage publications; 2014.
305. Woolcock M. Using case studies to explore the external validity of 'complex'development interventions. Evaluation. 2013;19(3):229-48.
306. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. BMJ. 2008;337.
307. Johnson RB, Onwuegbuzie AJ. Mixed methods research: A research paradigm whose time has come. Educational researcher. 2004;33(7):14-26.
308. Ivankova NV, Creswell JW, Stick SL. Using mixed-methods sequential explanatory design: From theory to practice. Field methods. 2006;18(1):3-20.
309. O'Cathain A, Croot L, Sworn K, Duncan E, Rousseau N, Turner K, et al. Taxonomy of approaches to developing interventions to improve health: a systematic methods overview. Pilot and feasibility studies. 2019;5(1):41.
310. Maxwell JA. Qualitative research design: An interactive approach: An interactive approach: sage; 2013.
311. Walker VL, Carpenter ME, Reilly A. Social-Ecological Model. Handbook of Research-Based Practices for Educating Students with Intellectual Disability. 2024.
312. Golden SD, McLeroy KR, Green LW, Earp JAL, Lieberman LD. Upending the social ecological model to guide health promotion efforts toward policy and environmental change. Sage Publications Sage CA: Los Angeles, CA; 2015. p. 8S-14S.
313. Xue E, Li J. What is the value essence of "double reduction"(Shuang Jian) policy in China? A policy narrative perspective. Educational Philosophy and Theory. 2023;55(7):787-96.