OCCUPATIONAL STRESS AND ITS IMPACT ON SLEEP QUALITY AND WORK-RELATED MUSCULOSKELETAL DISORDERS (WRMSDS) AMONG INDUSTRIAL DESIGNERS IN SHENZHEN, CHINA

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by

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LIST OF ABBREVIATIONS

WRMSDS	Work-Related Musculoskeletal Disorders
OSH	Occupational Safety and Health
WHO	World Health Organization
CAID	Computer-Aided Industrial Design
GDP	Gross Domestic Product
JD-R	Job Demands-Resources
ILO	International Labour Organization
COSHA	China Occupational Safety and Health Association
NIOSH	National Institute for Occupational Safety & Health
KOSS	Korean Occupational Stress Scale
REM	Rapid Eye Movement
NREM	Non-Rapid Eye Movement
NIHLBI	National Heart, Lung, and Blood Institute
CBT	Cognitive-Behavioural therapy
rTMS	Repetitive Transcranial Magnetic Stimulation
PSQI	Pittsburgh Sleep Quality Index
BLS	Bureau of Labor Statistics
PSRFs	Psychosocial risk factors
GBD	Global Burden of Disease
NMQ	Nordic Musculoskeletal Questionnaire
UNESCO	United Nations Educational, Scientific and Cultural Organization
KOSS-SF	Korean Occupational Stress Scale-Short Form
RMR	Root Mean Square Residual
RMSEA	Root-Mean-Square Error of Approximation

GFI	Goodness of Fit Index
AGFI	Adjusted Goodness of Fit Index
CFI	Comparative Fit Index
NFI	Normed Fit Index
AVE	Average Variance Extracted
M	Mean
SD	Standard Deviation
CR	Composite Reliability
H	Hypothesis
DALY	Disability Adjusted Life Year

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STRES PEKERJAAN DAN KESANNYA TERHADAP KUALITI TIDUR DAN GANGGUAN MUSKULOSKELETAL BERKAITAN KERJA (WRMSDS) DALAM KALANGAN PEREKA INDUSTRI DI SHENZHEN, CHINA

ABSTRAK

Sebagai satu sektor yang berkembang pesat dalam bidang perindustrian di China, reka bentuk industri memainkan peranan penting dalam meningkatkan inovasi dan daya saing pasaran global. Walau bagaimanapun, sifat kerja reka bentuk—tuntutan kerja yang tinggi, waktu bekerja yang panjang, dan beban kognitif yang berat—telah menimbulkan kebimbangan yang semakin meningkat terhadap kesihatan pekerjaan dan kesejahteraan pereka industri. Kajian ini meneroka stres pekerjaan dalam kalangan pereka industri di Shenzhen, China serta kesannya terhadap kualiti tidur dan gangguan muskuloskeletal berkaitan kerja (WRMSDs). Kajian ini menilai stres pekerjaan dalam kalangan 411 orang pereka industri dan kesannya terhadap kualiti tidur dan WRMSDs. Data telah dikumpul menggunakan soal selidik KOSS-SF, PSQI, dan NMQ. Keputusan menunjukkan tahap stres yang tinggi (Min = 58.94), kualiti tidur yang rendah (70.3% melaporkan skor PSQI > 5), dan kadar WRMSDs yang tinggi di bahagian leher, bahu, belakang dan pergelangan tangan. Faktor utama stres termasuk kekurangan ganjaran, tuntutan kerja yang tinggi, dan kawalan kerja yang rendah. Stres pekerjaan didapati mempunyai kaitan yang signifikan dengan kualiti tidur yang buruk dan kadar WRMSDs yang lebih tinggi. Kajian ini menekankan keperluan mendesak untuk penambahbaikan di tempat kerja dan sokongan dasar bagi meningkatkan kesejahteraan serta produktiviti pereka industri.

OCCUPATIONAL STRESS AND ITS IMPACT ON SLEEP QUALITY AND WORK-RELATED MUSCULOSKELETAL DISORDERS (WRMSDS) AMONG INDUSTRIAL DESIGNERS IN SHENZHEN, CHINA

ABSTRACT

As a rapidly growing sector in China's industrial field, industrial design plays a key role in enhancing innovation and global market competitiveness. However, the nature of design work—high-intensity job demands, long working hours, and high cognitive load—has raised growing concerns about the occupational health and well-being of industrial designers. This study explores the occupational stress of industrial designers in Shenzhen, China, and its impact on sleep quality and work-related musculoskeletal disorders (WRMSDs). This study investigated the occupational stress of 411 industrial designers and its impact on sleep quality and work-related musculoskeletal disorders (WRMSDs). Data were collected using KOSS-SF, PSQI, and NMQ questionnaires. Results showed high stress levels (M = 58.94), poor sleep quality (70.3% reporting PSQI > 5), and high WRMSDs prevalence in the neck, shoulders, back, and wrists. Key stressors included lack of reward, job demand, and low job control. Occupational stress was significantly associated with poorer sleep and higher WRMSDs rates. This study highlights the urgent need for workplace improvements and policy support to enhance the well-being and productivity of industrial designers.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter provides an overview of the research background, including occupational safety and health, industrial design and industrial designers, Chinese industrial designers, and the Occupational Health of Chinese industrial designers. It follows with a problem statement, research objectives, research questions, and the significance of the study. Finally, it defines the important concepts within the research.

1.2 Background

1.2.1 Occupational Safety and Health

The International Labour Organization (ILO) defines Occupational Safety and Health (OSH) as a discipline dealing with the prevention of work-related injuries and diseases, as well as the protection and promotion of the health of workers(United Nations Global Compact, 2023). Researching OSH aims to improve working conditions and environments for workers, ensuring their safety and health while at work and providing compensation in case of work-related injuries.

In China, Labor Law of the People's Republic of China (National People’s Congress, 2019) and Law of the People's Republic of China on the Prevention and Control of Occupational Diseases (National People’s Congress, 2017) state that OSH is the study and prevention of diseases caused by work and the prevention of the deterioration of existing diseases. It is mainly manifested in the changes in human physiological functions caused by the environment and exposure to harmful factors at work.

The study of OSH can contribute to a better understanding of the health status and related risk factors for employees in various professions, benefiting both the workers and society. The research outcomes can offer valuable information for the design of intervention plans and policies, aiming to reduce risks in the workplace and enhance the overall health levels of employees (Lissah *et al.*, 2022). Analysing the incidence rates of diseases and injuries relevant to specific occupations can guide measures and regulations aimed at lowering risks (Rikhotso *et al.*, 2022).

The core objectives of OSH are: (1) to protect workers' health and safety: by reducing occupational hazards such as long working hours, poor posture, repetitive tasks, and work-related stress, OSH aims to safeguard both the physical health and psychological well-being of employees. (2) To improve work efficiency and productivity: a healthy work environment helps boost employees' motivation and productivity, while reducing absenteeism, work burnout, and accidents caused by health issues. (3) To achieve social and economic sustainability: occupational health issues impose significant burdens on individuals, businesses, and society. For example, the medical costs, compensation expenses, and labor loss caused by occupational diseases and work-related injuries can hinder economic development. Therefore, improving occupational health is not only a corporate responsibility but also a key to achieving sustainable economic growth. (4) To address the new challenges of modern work environments: with the global economy's development and rapid technological progress, many new professions and work modes, such as remote work and automation, have emerged, bringing about new health issues and risks. This is especially true in creative and high-tech professions, where prolonged computer use, mental stress, and increasing work demands pose more complex challenges for occupational health.

OSH encompasses a multitude of issues, some of which are universal across all types of workers. Occupational stress is a prevalent concern, evidenced by extensive research in professions such as healthcare (M. Zhang *et al.*, 2021), college staff (Luis Rojas-Solis *et al.*, 2021), firefighters s(Mohamad *et al.*, 2021), and police officers (Queiros *et al.*, 2020). Sleep-related problems are frequently reported by workers (Gusman *et al.*, 2023; Y. Liu *et al.*, 2022; Mucci *et al.*, 2020). Moreover, some issues are more occupation-specific due to variations in work environments, tasks, requirements, and durations. Therefore, the safety or health problems associated with their work differ, and the research focus varies accordingly. A review of OSH in the construction industry between 2002 and 2016 identified falls and airborne silica exposure as the two most prominent topics of concern (Sinyai & Choi, 2020). For workers exposed to significant noise levels, such as thrillers and casters, there is a substantial risk of hearing loss (Shi *et al.*, 2021). In studies focusing on computer workers, Work-Related Musculoskeletal Disorders have been recurrently addressed as a significant topic (Vinothini *et al.*, 2018).

With the development of the global economy, the acceleration of industrialization, and changes in the nature of work, occupational health issues have become an important and widely recognized global concern. According to the International Labour Organization (ILO), more than 2.8 million people die each year from work-related diseases and accidents, while 340 million workers are injured or fall ill due to health risks in the workplace (ILO, 2021). Occupational health issues not only severely impact workers' physical health and quality of life, but also bring significant economic losses to the global economy, including decreased productivity, increased medical costs, and workforce attrition.

In 1970, the United States enacted "the Occupational Safety and Health Act," marking the beginning of the industrial sector's specification of various policies and strategies to minimize factors impacting OSH (Rosner & Markowitz, 2020). In comparison, legislation related to occupational safety and health in China came into effect later. As one of the largest manufacturing and industrial production countries in the world, China's OSH system has undergone significant development and transformation over the past few decades. With rapid economic growth and urbanization, occupational health and safety issues have gradually attracted the attention of the government, businesses, and academia. Especially since the beginning of the 21st century, the Chinese government has made efforts to improve workers' working environments and health conditions through improved legislation, strengthened regulation, and enhanced corporate responsibility.

China's relevant regulations started implementation in 2002 with the introduction of "The People’s Republic of China Production Safety Law" and "The People’s Republic of China Law on the Prevention and Control of Occupational Diseases" (X. Chen *et al.*, 2025). In China, the "Occupational Health and Safety Management System Requirements" (GB/T 28001) and the "Occupational Health and Safety Management System Implementation Guidelines" (GB/T 28002) have been implemented for nearly two decades and have undergone two revisions (Biao Zhun Ji Shu Si, 2020). The occupational health and safety management system has now become one of China's three major management systems. The Chinese government promotes OSH work through cooperation among various departments. These include the National Health Commission (NHC), which is responsible for managing and supervising occupational disease prevention and control; the Ministry of Emergency Management, which oversees safety production supervision and ensures that enterprises implement safety production responsibilities; and local governments, which strengthen occupational health inspections for regional enterprises, especially for small and medium-sized enterprises and labor-intensive industries. In addition, occupational health research institutions and social organizations play an important role in promoting the OSH concept, training enterprises, and conducting occupational health surveys.

In China, the National Health Commission (NHC) plays a central role in the governance of OSH, particularly in the prevention and control of occupational diseases(Li Y. *et al.*, 2023). As a national-level administrative body, the NHC is responsible for developing laws, policies, and technical standards related to occupational health (Association, 2023; Chao *et al.*, 2021). It also oversees national surveillance systems for occupational diseases and supervises occupational health services such as workplace hazard assessments and health examinations. One of its key affiliates, the National Institute of Occupational Health and Poison Control under the Chinese Center for Disease Control and Prevention (China CDC), provides scientific and technical support for national occupational health strategies (Y.-J. Wang *et al.*, 2022). The NHC's coordination with local health commissions and disease control institutions ensures a multilevel implementation of OSH policies across the country.

Despite the positive progress China has made in the field of occupational safety and health, several prominent issues remain, especially against the backdrop of modernization, urbanization, and the development of emerging professions:

1. Prevalence of Occupational Diseases

China continues to face serious occupational health issues, particularly in high-risk industries such as manufacturing, construction, and mining. For example, a meta-analysis found that the average PSQI score in the general Chinese population was 4.32 (95% CI = 3.82–4.81), and approximately 20% were likely to experience poor sleep quality (P. Chen *et al.*, 2024). Survey results from 2018 to 2020 indicated that the prevalence of WRMSDs in various key occupational groups in China—such as manufacturing, healthcare, and aviation—ranged from 41.2% to 58.8%, with the neck, shoulders, and lower back being the most commonly affected regions (Jia *et al.*, 2021). Furthermore, with the rise of the information technology and service sectors, musculoskeletal disorders and vision impairments caused by prolonged computer use have gradually increased.

2. Health Risks for Creative and High-Pressure Professions

As China's economy shifts toward high value-added and knowledge-intensive industries, occupational health concerns have expanded from traditional physical laborers to emerging professional groups. For example, creative professions like industrial designers require long hours of intense mental and detailed work, which often leads to increased occupational stress, poor sleep quality, and WRMSDs. IT engineers and design professionals, characterized by prolonged sitting, irregular working hours, and high-intensity tasks, face new health risks in their work environments.

3. Inadequate OSH Management in Small and Medium-Sized Enterprises

Many small and medium-sized enterprises in China face significant shortcomings in OSH management. These include a lack of occupational health knowledge, avoidance of health-related investments, and neglecting employee health checks. As a result, workers are exposed to unsafe and unhealthy working environments, further exacerbating the risks of occupational diseases.

4. Lack of Occupational Health Awareness

Despite efforts by the government and relevant agencies to promote OSH concepts, many enterprises and workers still do not give sufficient attention to occupational health. Some enterprises only meet the basic requirements for safety training without implementing substantial health intervention measures.

5. New Challenges Posed by Rapid Technological Development

The widespread use of automation and smart devices has introduced new occupational health problems for workers. For example, prolonged use of touch devices, virtual reality (VR) technology, and other new tools increases the risk of musculoskeletal disorders in the wrists, neck, and shoulders. Additionally, new technologies may bring psychological stress and adaptation issues, further affecting workers' overall health.

China's OSH system is gradually improving, but it still faces significant challenges among emerging professional groups.Research on OSH in China has been unable to cover all professions, with many workers' work environments and health conditions left unexplored. Due to insufficient research and a lack of emphasis in the industrial sector, many workers struggle to access OSH-related information, consequently impeding their ability to ensure personal safety and health in the workplace (Shankar *et al.*, 2022).

1.2.2 Occupational Stress, Sleep Quality and WRMSDs

Occupational stress refers to the physical and mental tension experienced by an individual in the work environment due to demands that exceed their abilities, resources, or coping strategies. More than 58% of workers worldwide report being affected by occupational stress to varying degrees, especially in high-pressure occupations such as healthcare, education, technology, and creative industries, where the incidence of stress is higher (ILO, 2021). Occupational stress is not only a natural response to challenges but also a long-standing and difficult-to-address health issue. In modern society, with the acceleration of economic globalization, technological innovation, and increasing job competition, occupational stress has become a universal health threat worldwide. Occupational stress increasingly affects workers' physical health, mental well-being, and job performance. Chronic occupational stress triggers the body's stress response, causing overactivation of the sympathetic nervous system, which can lead to a series of health problems such as hypertension, cardiovascular diseases, ulcers, and weakened immune systems (Crandall, 2020). Occupational stress is also closely related to WRMSDs, manifesting as muscle pain, joint wear, and spinal issues. It is a significant cause of psychological problems such as anxiety, depression, and burnout. Individuals in high-pressure environments for extended periods may experience mood swings, poor concentration, sleep disorders, and, in severe cases, mental health disorders (Assis *et al.*, 2022). In response to occupational stress, individuals may adopt unhealthy coping strategies, such as smoking, alcohol abuse, overeating, or lack of exercise, further exacerbating their health risks.

Moreover, occupational stress can have negative effects on organizations and society. Over 70% of Chinese workers report experiencing some degree of occupational stress, with more than half having experienced anxiety, insomnia, and other related issues (Mercer, 2022). High levels of occupational stress lead to decreased employee productivity, reflected in lower work quality, reduced efficiency, and frequent mistakes. If occupational stress is not effectively managed, it can result in employee dissatisfaction and intentions to leave, thereby increasing recruitment and training costs for organizations (Kachi *et al.*, 2020). Chronic occupational stress also tends to cause employees to take sick leave or require increased medical care, further driving up operational costs for businesses. The diseases and health problems caused by occupational stress contribute to significant economic losses globally each year, including medical expenses, productivity losses, and social welfare expenditures (Hassard *et al.*, 2018; Thomas *et al.*, 2022). The widespread nature of occupational stress has become a key factor impacting societal health, especially in knowledge-intensive and high-pressure industries.

Sleep quality refers to the degree of recovery and rest an individual gains during sleep, including the depth, continuity, duration, and smoothness of the sleep onset process. Unlike sleep duration, sleep quality focuses more on the overall effectiveness of sleep, reflecting an individual's physiological recovery and psychological relaxation during sleep. Good sleep quality is a key factor in maintaining physical health, mental well-being, and normal work performance. However, in modern high-pressure work environments, declining sleep quality has become a widespread health issue, particularly in high-stress professional groups. Sleep quality problems have become a global health challenge, especially in workgroups with high levels of occupational stress. According to the World Health Organization (WHO), approximately 30% of adults worldwide experience some form of sleep issues, includingnia, difficulty falling asleep, frequent night awakenings, and early morning waking (Smith *et al.*, 2022). In China, sleep quality problems are also increasingly prominent. The "China Sleep Research Report" shows that more than 60% of Chinese adults have sleep problems, including delayed sleep onset, frequent nighttime awakenings, and daytime fatigue. Work pressure, fast-paced lifestyles, and irregular sleep patterns are the main factors contributing to the decline in sleep quality (J. Wang *et al.*, 2023).

Long-term poor sleep quality not only has profound effects on an individual's physical and mental health but also poses potential risks to work performance and the socio-economic system. Poor sleep quality impacts physical health in various ways, increasing the risk of several chronic diseases, including weakened immune function, higher risk of cardiovascular diseases, metabolic disorders and obesity, chronic pain, and musculoskeletal issues (Barakat *et al.*, 2019; Umbro *et al.*, 2020; R. Wei *et al.*, 2022). Poor sleep quality significantly affects an individual's mood and cognitive function, and in severe cases, it can even lead to psychological disorders, including emotional instability, impaired cognitive abilities, and exacerbated stress and anxiety(Scott *et al.*, 2021)

In addition to harming personal health, poor sleep quality also negatively impacts work performance, particularly in professions that require high levels of focus and creativity. Sleep deprivation leads to daytime dysfunction, manifesting as attention deficits, delayed reactions, and weakened decision-making abilities (NIHLBI, 2022). This is especially critical for industrial designers, whose work directly relies on concentration, affecting the quality and efficiency of their design tasks. As a creative profession, industrial designers require high levels of creativity and inspiration (Cross, 2023). However, poor sleep quality affects the brain's divergent thinking and problem-solving abilities, stifling innovation potential. Studies have shown that sleep deprivation significantly increases the error rate and accident risk at work, especially in jobs that require precise operations and high accuracy (Paller *et al.*, 2021). This not only affects individual performance but also may lead to economic losses and safety hazards for businesses. Poor sleep quality is closely linked to occupational burnout, with individuals exhibiting emotional exhaustion, decreased work motivation, and dissatisfaction with their profession, leading to an increased tendency to leave their job.

Poor sleep quality is not only an individual issue; its long-term effects also place a significant burden on social and economic systems. Poor sleep quality is closely linked to the high prevalence of chronic diseases, which leads to increased medical expenditures, placing a huge burden on individuals, businesses, and the public healthcare system. One study showed that due to insufficient sleep, the U.S. lost 2.28% of its Gross Domestic Product (GDP), amounting to a loss of approximately $411 billion and 1.2 million workdays annually (Arshad *et al.*, 2021). Sleep deprivation increases the incidence of traffic accidents and workplace injuries, posing a threat to public safety (D. Dawson *et al.*, 2021). For instance, fatigued driving is one of the leading causes of traffic accidents globally.

Work-Related Musculoskeletal Disorders (WRMSDs) are chronic diseases of the muscles, bones, joints, and nerves that are caused or aggravated by occupational activities. These disorders are often closely related to poor work posture, repetitive movements, prolonged static loads, and high work pressure, making them a focal point in global occupational health. Commonly affected areas include the neck, shoulders, upper back, lower back, wrists/hands, and lower limbs (NSC, 2021). WRMSDs affect over 1.7 billion people worldwide, making them one of the leading causes of decreased work capacity and the burden of occupational diseases (Lim *et al.*, 2022).

WRMSDs have a severe impact on the health and professional performance of workers, especially in occupations that require prolonged computer use, maintaining fixed postures, or repetitive tasks. WRMSDs primarily manifest as pain, stiffness, swelling, and functional limitations, affecting individuals' daily activities and work abilities (Das *et al.*, 2021). For example, wrist pain can reduce the precision of mouse and keyboard operation (Fagarasanu & Kumar, 2003), while lower back pain can affect comfort and focus during prolonged sitting (Pattath & Webb, 2022). Long-term physical discomfort can lead to job burnout and reduced work motivation, and in severe cases, it may result in sick leave and absenteeism (Munk Killingmo *et al.*, 2021). This not only impacts an individual's career development but also leads to productivity loss for businesses. WRMSDs are often accompanied by occupational stress, with persistent pain and discomfort potentially triggering anxiety, depression, and emotional instability, creating a vicious cycle of physical and mental health issues (Heikkinen *et al.*, 2019). The medical costs, rehabilitation expenses, and productivity losses caused by WRMSDs place a heavy economic burden on individuals, companies, and society. According to statistics, WRMSDs are among the most economically costly occupational diseases globally (Lim *et al.*, 2022).

The complex and interrelated relationship between occupational stress, sleep quality, and work-related musculoskeletal disorders (WRMSDs) has become a key issue in occupational health research. High levels of occupational stress not only have negative effects on mental health but also affect sleep quality and musculoskeletal health through physiological mechanisms. These multidimensional health challenges not only impact individual job performance and quality of life but also pose a potential threat to business productivity and the sustainable development of industries.

1.2.3 Industrial Design and Industrial Designers

Industrial design is a process aimed at creating new products for consumers, which can then be mass-produced by the manufacturing industry (M. Li *et al.*, 2015; Muminovic *et al.*, 2019). In 2015, the World Design Organization provided a fresh definition for industrial design: "Industrial Design is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences" (World Design Organization, 2015). The field of industrial design does not target specific industrial sectors but rather serves the entire industrial realm. It is associated with all products produced on a large scale. Industrial design constitutes a pre-production process that provides plans for manufacturing, significantly influencing factors such as the form, materials, and processes of the product (M. Li *et al.*, 2015). Due to its role in the product manufacturing process, industrial design plays a crucial role in the development of the manufacturing industry.

Industrial designers are tasked with enhancing the appearance and interface of industrial products to improve user experiences (Ulrich *et al.*, 2019). Their knowledge is guided by aesthetics and ergonomics (Eder, 2012). Industrial designers need to have a keen eye and the ability to form subtle emotional connections with products. The field of industrial design is vast, encompassing various domains such as transportation, furniture, appliances, and home goods, distinguishing it from other design disciplines like graphic design, software design, architecture, fashion design, among other (Muminovic *et al.*, 2019). Once industrial designers complete their design proposals, other departments take charge of mass-producing the products. Ultimately, consumers purchase and use these products. Industrial designers play a crucial role in the product development process, exerting significant influence on aspects like product aesthetics, functionality, materials, and more, particularly in the initial stages of the product lifecycle (Sheweta *et al.*, 2023).

In the early days of the concept of industrial design when it was just emerging in the market, industrial designers played the role of creators, much like artists. Their work primarily involved sketching and drawing design proposals(Gunes, 2012). However, the role of industrial designers has evolved over time with the changing landscape. They transitioned from being artists to becoming resource integrators deeply involved in the entire product development process(Hu *et al.*, 2021). Nowadays, their work encompasses user research, product planning, conceptual innovation, aesthetic design, usability design, interface design, and collaboration with engineers to see the entire manufacturing process through (M. Li *et al.*, 2015). Due to advancements in information technology, industrial designers have increasingly relied on computers to carry out their work. Computer-Aided Industrial Design (CAID) has become an indispensable tool for industrial designers, and they use various computer software extensively in their design work (Hashem, 2015). Consequently, industrial designers spend a significant portion of their daily routine working with computers. They use various types of computers, including desktops, laptops, and tablets, for creating 2D and 3D sketches, as well as detailed rendering (Evans & Aldoy, 2016). Additionally, they utilize computers for document creation, data collection, analysis, email correspondence, and other tasks, significantly enhancing efficiency compared to traditional methods. Unlike some professions, creativity is an indispensable factor for designers in completing design projects, and it is not something easily obtained (Ask, 2016). In the field of industrial design, designers need to address complex, multidisciplinary problems with novel solutions (Dorst & Cross, 2001). Industrial designers must not only meet user requirements but also contend with pressures related to cost, marketing, and production (Cuenca & María, 2022). To satisfy various demands from different sources, industrial designers often find themselves revising or even redoing their original designs.

1.2.4 Chinese Industrial Designer

The manufacturing industry serves as a vital pillar for China's development and holds a significant position within the country's economic framework (H. Deng *et al.*, 2022). According to data from the National Bureau of Statistics of China (Rogoff & Yang, 2024), the output value of China's manufacturing industry accounted for over a quarter of China's total GDP between 2017 and 2022 (Figure 1.1). By 2022, the scale of China's manufacturing industry had reached $4.35 trillion, maintaining its position as the world's leader for 13 consecutive years. The rapid advancement of the manufacturing sector is greatly supported by industrial design (M. Li *et al.*, 2015). Chinese industrial designers have made substantial contributions to this growth.

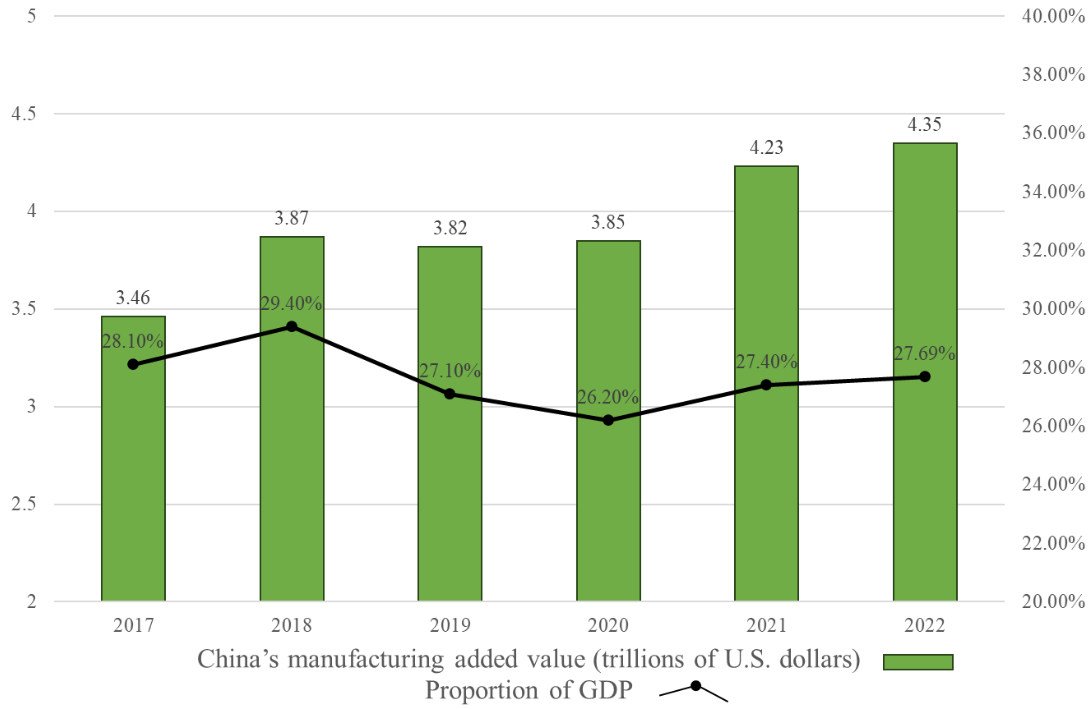

Figure 1.1 China’s Manufacturing Added Value and Proportion of GDP from 2107 to 2022 (Rogoff & Yang, 2024)

China's industrial design industry started relatively late but has developed rapidly. Since the reform and opening-up, along with the rise of manufacturing and the formation of global supply chains, industrial design has gradually gained attention as an important means to drive product innovation and enhance market competitiveness. The emergence of industrial design in China began in the 1970s, coinciding with China's economic reforms and its transition into comprehensive industrialization (M. Li *et al.*, 2015). Since the 1990s, China has established industrial design programs in higher education institutions to cultivate specialized design talents. In 2015, the State Council of the People's Republic of China issued the notice on "Made in China 2025," which outlined the development plan for Chinese manufacturing by 2025 (G. Li & Branstetter, 2024). The notice emphasized the central role of innovation in the overall development of the manufacturing industry. Industrial design played a pivotal role in the transformation from "Made in China" to "Created in China" (M. Li *et al.*, 2015). With China's manufacturing industry shifting towards "smart manufacturing" and high added value, the professional status and industry demand for industrial designers have significantly increased.

Industrial designers, as essential contributors to product innovation, have a significant impact on the development of China's manufacturing industry. In many cases, industrial design is also referred to by another name, product design (Muminovic *et al.*, 2019). In China, more than 500 higher education institutions offer industrial design (or product design) programs (X. Huang *et al.*, 2021), resulting in approximately 36,000 to 40,000 graduates annually (Yangguang Gaokao, 2023a, 2023b). According to information released by the China Industrial Design Association, as of February 28, 2022, there were 11,211 industrial design companies in China, marking an increase of 5,000 companies within just one year (China Industrial Design Association, 2022). Therefore, the number of designers in China is also quite substantial. China boasts approximately 17 million designers, among whom 5.61 million are specifically involved in industrial design (DouFuNao, 2021).

1.2.5 Working Process and Environment of Industrial Designers in China

The working environment of industrial designers is defined by high levels of specialization, technological integration, and creative intensity. This profession sits at the intersection of engineering, art, and user-centered problem solving, demanding both analytical and aesthetic capabilities (Turtola & Määttä, 2023). Designers are often expected to continuously deliver innovative solutions that not only meet technical standards but also appeal to users and align with business goals.

Industrial designers are typically employed in design consultancies, manufacturing enterprises, R&D departments, start-up incubators, or university-based design centers. Their work spans various stages of the product development process, from initial user research to final design validation (Cuenca & María, 2022). These stages include market analysis, user interviews, competitive benchmarking, and the identification of user needs, which serve as the foundation for ideation and concept development.

During the concept generation phase, designers engage in brainstorming sessions, create mood boards, and develop preliminary sketches by hand or digitally. This is followed by detailed product modeling using software tools such as AutoCAD, SolidWorks, Rhino, and Alias. For visual rendering and presentation, tools like KeyShot and Adobe Creative Suite are widely used (Evans & Aldoy, 2016; Hashem, 2015). The iterative process of 3D modeling, rendering, and design refinement is essential for balancing form, function, and manufacturability (Verganti *et al.*, 2020).

As the project advances, industrial designers move into prototyping and user testing. They often produce physical prototypes using 3D printing, CNC machining, or manual fabrication techniques (Cuffaro & Zaksenberg, 2013). These prototypes are evaluated through ergonomic testing, aesthetic critique, and functional analysis. Designers must also collaborate with engineers, marketers, and production teams to ensure the proposed design can be successfully implemented at scale (Ulrich *et al.*, 2019; D. Zhang *et al.*, 2011).

In daily practice, designers work extensively with digital devices such as desktop computers, laptops, drawing tablets, and interactive touchscreen displays.

Prolonged screen time, static seated postures, and repetitive input using keyboards, mice, or styluses are common (Bi & Wang, 2020; Hashem, 2015; Kudrowitz *et al.*, 2012). The combination of high mental workload and physical immobility creates a distinct occupational pattern that is both cognitively and physically demanding.

Moreover, industrial designers often operate under project-based work schedules with fixed milestones and frequent revisions. The nature of design iteration and client feedback loops means that last-minute changes are frequent, especially in fast-paced commercial settings (Bai & Peng, 2014; Cuenca & María, 2022; Sheweta *et al.*, 2023). This imposes additional pressure to meet deadlines without compromising creativity or quality.

Consequently, the profession exposes individuals to a wide range of occupational stressors—including time pressure, job ambiguity, and high performance expectations—while also increasing the risk of physical ailments such as WRMSDs, particularly in the neck, shoulders, back, and wrists. These conditions are exacerbated by the dual demands of sustained mental concentration and repetitive manual activity.

Several critical challenges exist in the working environments of industrial designers:

1. Prolonged desk work and poor posture: Designers often remain in fixed positions for hours, especially leaning forward, craning the neck, or bending the wrists. These postures contribute to the risk of WRMSDs, particularly in the neck, shoulders, back, and wrists (Diana, 2021).

2. Lack of ergonomic workstation support: While some companies provide ergonomic furniture, many small or mid-sized design firms and studios are equipped with basic desks and chairs. Improper screen height, desk dimensions, and lighting conditions frequently fail to meet ergonomic standards, resulting in

widespread discomfort and visual fatigue (Evans & Aldoy, 2016; Guduru, Domeika, Obcarskas, *et al.*, 2022).

3. Fast-paced work and widespread overtime: Performance in the design industry is often evaluated by outcome, leading to a strong culture of overwork. Designers commonly work over 50 hours per week, especially in cities like Shenzhen, where competition and workload are high. Extended working hours severely disrupt work-life balance and negatively affect health (Si, 2018).

4. Creativity-driven emotional fluctuation: Creativity is central to industrial design, yet the creative process is inherently unpredictable. When ideas are rejected or progress is hindered, designers may experience frustration, anxiety, and even emotional burnout (Indrašienė *et al.*, 2019; Valentine *et al.*, 2021).

5. Shared workspace and distraction: In open office environments, designers frequently collaborate with marketing, engineering, and production departments. However, background noise, interruptions, and lack of privacy can hinder focus and reduce productivity (United Nations Global Compact, 2023).

6. Limited occupational health support: Unlike traditional manufacturing workers, industrial designers are often perceived as performing "light work," leading employers to overlook their occupational health risks. In China, health management systems for creative industries remain underdeveloped, with few designers undergoing regular health checks or receiving professional physical or psychological support (Mercer, 2022).

In summary, while the working environment of industrial designers is intellectually stimulating and creatively rich, it also harbors substantial health risks. Their professional profile—marked by prolonged sitting, high pressure, multitasking, and precision work—demands greater attention in occupational health research. A comprehensive understanding of their working conditions provides critical context for interpreting the unique patterns of occupational stress, sleep disturbances, and WRMSDs observed in this group, and lays the foundation for subsequent research.

1.2.6 OSH of Chinese Industrial Designer

With the rapid development of China's economy and the transformation and upgrading of its manufacturing industry, industrial designers, as an important occupational group driving product innovation and enhancing market competitiveness, have gradually attracted attention regarding their occupational health and safety issues. The working environment for Chinese industrial designers is not ideal. A survey of 285 respondents in China found that many industrial designers express some level of dissatisfaction or extreme dissatisfaction with their work (Si, 2018).. However, at present, the status of occupational health and safety among Chinese industrial designers still faces many shortcomings.

The work cycle of industrial designers is often highly tied to market demand and project timelines, and the urgency of projects leads them to work long hours under pressure. According to research, many industrial designers work over 50 hours per week, with some even exceeding 60 hours (China Industrial Design Association, 2022). Overtime work is prevalent among Chinese industrial designers, with designers in Shenzhen having the most extended working hours (Si, 2018). Nearly half of the industrial designers in Shenzhen work over 10 hours of overtime per week, and approximately one-fourth of them work more than 15 hours of overtime. Prolonged working hours not only lead to physical fatigue but also significantly increase occupational health risks. Chinese industrial designers face significant work-related stress, including creative pressure, bidding pressure, and the pressure to innovate (Bai & Peng, 2014). Occupational stress not only affects their mental health but may also lead to anxiety, burnout, and even depression. Mental health issues are often neglected, and there is a lack of effective psychological support mechanisms and intervention measures. More importantly, increased occupational stress also increases the risk of other health and safety problems (Bai & Peng, 2014).

In China, the concept of OSH primarily focuses on heavy industries and the manufacturing sector, with less attention paid to creative professions like industrial design. Although industrial designers do not engage in physical labor, their work—characterized by prolonged static sitting, repetitive tasks, and intense visual focus—poses significant occupational health risks (DouFuNao, 2021). However, many companies lack awareness of the health issues faced by designers and fail to provide the necessary health support and protective measures.

Industrial designers' work heavily relies on computer equipment, including mice, keyboards, drawing tablets, and monitors (Bi & Wang, 2020). If these devices are not properly optimized for ergonomics, they can lead to musculoskeletal strain in areas such as the neck, shoulders, wrists, and lower back (Guduru, Domeika, & Domeikienė, 2022). In addition, improper seating, desk height, and monitor positioning further exacerbate the risk of WRMSDs. Industrial designers often maintain poor posture for extended periods and perform repetitive tasks, placing continuous stress on their musculoskeletal systems (Petersen *et al.*, 2022). Occupational stress exacerbates these issues, with high job demands reducing rest time, and psychological stress causing muscle tension, thereby increasing the risk of health problems.

Due to long hours of intense work, tight project timelines, and the pressure of creative tasks, industrial designers often face sleep quality issues (Bai & Peng, 2014; J. Wang *et al.*, 2023). Sleep problems typically manifest as difficulty falling asleep, shallow sleep, frequent awakenings during the night, and daytime drowsiness or fatigue. These issues not only affect the designers' physical health but can also reduce their work efficiency, creative capacity, and overall job satisfaction. High job demands, tight deadlines, and frequent changes in client requirements make it difficult for designers to relax even in the evening (X. Deng *et al.*, 2020). Additionally, when designers face creative bottlenecks, the mental strain may prevent them from falling asleep, and they may continue to think about unfinished work even while in bed.

The occupational health and safety problems of Chinese industrial designers are increasingly prominent. Long working hours, high occupational stress, and unhealthy working environments lead to a dual challenge of declining sleep quality and WRMSDs. Ensuring the occupational health of designers is not only an enterprise responsibility but also a key to enhancing their work efficiency and creativity.

1.3 Problem Statement

Many enterprises prioritize economic interests, often overlooking the occupational health of their employees, leading to an increase in occupational morbidity(Q. Chen *et al.*, 2022). Additionally, numerous employees themselves lack clarity regarding their health status and how to address health issues arising from their occupations (Güner & Ekmekci, 2019). These issues can subject employees to psychological or physiological discomfort, ultimately diminishing their sense of well-being (Campbell & Gunning, 2020). Moreover, these problems can adversely impact employee productivity (Umugwaneza *et al.*, 2019), increase the healthcare and compensation expenses for both companies and society (Fan *et al.*, 2020), thus hindering economic development.

Occupational safety and health problems not only undermine employee well-being but also impose substantial obstacles to economic development. A recent report shows that East Asia has the world's highest workplace-stress rate, with 55 % of employees affected by occupational stress (GALLUP, 2024). In a large survey of work stress in China, 62.3 % of 3,553 respondents reported high job strain (Shen Y. et al., 2018). The economic burden is enormous: in the United States, untreated workplace mental illness costs an estimated USD 3.7 trillion per year (HealthCancal, 2023). Given China's higher stress prevalence and larger workforce, the associated costs are likely even greater. Sleep problems are similarly widespread. A 2024 national meta-analysis found that 20 % of Chinese adults have a global PSQI score > 5, indicating poor sleep quality (P. Chen et al., 2024). Sleep deprivation is especially pronounced among industrial designers. Economic modelling estimated that insufficient sleep cost China USD 628 billion in productivity losses in 2018—4.6 % of national GDP (Getzzg, 2024, pp. 2010–18). Musculoskeletal disorders add another layer of burden. In 2021, 85.0 million Chinese adults were living with MSDs, a 20 % increase since 1990, and prevalence is projected to triple by 2050 (S. Liu et al., 2025). In the United States, work-related MSDs cost employers over USD 50 billion in direct expenses, with indirect costs roughly five times higher (OHS, 2020). In China, the treatment market for WRMSDs alone already exceeds RMB 66.45 billion (Gongyanwang, 2025). Taken together, the economic damage linked to occupational stress, poor sleep, and WRMSDs is substantial and demands urgent attention. Despite the rapid growth in the number of industrial designers, empirical research on their occupational health remains scarce—highlighting the need for focused investigation into this crucial professional group.

Due to the working environment and job demands, the occupational stress levels among Chinese industrial designers have become an undeniable occupational health issue (Cuenca & María, 2022; DouFuNao, 2021). These professionals often work in poorly optimized environments where ergonomic considerations are neglected (Petersen *et al.*, 2022; Zeverdegani *et al.*, 2022). Inadequate workstation design, including inappropriate chair and desk heights, poor screen positioning, and insufficient lighting, can lead to sustained physical strain. Additionally, open-plan offices with frequent noise and interruptions, limited space for movement, and lack of privacy may increase cognitive overload and psychological stress. Combined with high job demands, long working hours, and tight deadlines, such conditions contribute significantly to poor sleep quality and a high prevalence of WRMSDs (Bai & Peng, 2014; United Nations Global Compact, 2023).

They face poor sleep quality and a risk of WRMSDs. High job demands(Lukan *et al.*, 2022), work intensity (Lukan *et al.*, 2022), and long working hours (Lukan *et al.*, 2022) have been identified in previous studies as significant risk factors contributing to high occupational stress. These factors are prevalent among Chinese industrial designers (DouFuNao, 2021; Ruotsalainen *et al.*, 2020; Sigursteinsdóttir *et al.*, 2020). High stress levels (Garbarino *et al.*, 2019), prolonged working hours (Tucker *et al.*, 2015), and extended screen time (Arshad *et al.*, 2021) have been observed to affect both the duration and quality of sleep, a frequent complaint among Chinese industrial designers. Extended periods of sitting (Seeberg *et al.*, 2019), prolonged use of computer devices (X. Wang *et al.*, 2022), desk and chair design (Eggleston, 2020), and mental workload (X. Wang *et al.*, 2022) are all factors contributing to the occurrence of WRMSDs among computer workers. A review indicated that compared to office workers and students, designers spend longer