ERGONOMICS RISK FACTOR ASSOCIATION WITH WORK-RELATED MUSCULOSKELETAL DISORDER AMONG MIDDLE SCHOOL TEACHERS IN HEJIANG COUNTY, CHINA

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摘要

标题:合江县中学教师人体工程学危险因素与职业相关肌肉骨骼疾病的关系

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教师作为教学的核心力量，普遍面临高强度的工作和多重非教学负担，长期从事此类工作易患职业相关肌肉骨骼疾病（WMSD）。本研究旨在了解合江县中学教师 WMSD 的患病率，识别 WMSD 的工效学风险因素，并评估与 WMSD 相关的因素。采用横断面描述性研究，采用整群抽样技术，对合江县 356 名中学教师进行调查。研究工具包括个人因素、职业相关肌肉骨骼疾病和工效学因素。采用频数、百分比、均值和卡方检验对数据进行分析。

结果显示，教师主要疼痛部位为下背部（73.03%）、颈部（65.17%）和肩部（62.09%）。高危因素包括长时间保持同一姿势、频繁弯腰扭动、提举重物、重复性劳动。与颈部疼痛相关的因素包括运动和每日工作时间；与肩部疼痛相关的因素包括年龄、文化程度、教室数、每日工作时间、每日使用电脑时间和每日家务时间；与上背部疼痛相关的因素包括年龄、教室数、工龄、每日工作时间、每日使用电脑时间和每日家务时间；与下背部疼痛相关的因素包括年龄、文化程度、教室数、工龄、每日工作时间、每

日使用电脑时间和每日家务时间；与腕/手部疼痛相关的因素包括年龄、文化程度、教室数、工龄、每日工作时间、每日使用电脑时间和每日家务时间。与髋部/大腿/臀部疼痛相关的因素包括性别、年龄、文化程度和工龄。与踝部/足部疼痛相关的因素包括运动。研究表明，教师群体中职业相关肌肉骨骼疾病（WMSD）患病率较高，主要原因是长期不良的工作姿势和高强度的劳动负荷。这不仅影响教师的身体健康，还可能降低教学质量。

关键词: 人体工程学、风险因素、与工作相关的肌肉骨骼疾病、教师、中学

ABSTRACT

Title: Ergonomics Risk Factor Association with Work-Related Musculoskeletal Disorder among Middle School Teachers in Hejiang County, China.

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Teachers, as the core force of teaching and educating people, are generally faced with high-intensity work and multiple non-teaching burdens, which are prone to work-related musculoskeletal diseases (WMSDs) in the long term. This study aims to determine the prevalence of WMSDs, to identify the ergonomics risk factor of WMSDs, and to assess the factors associated with WMSDs among middle school teachers in Hejiang County. A cross-sectional descriptive study was used to investigate 356 middle school teachers in Hejiang County, who were selected using a cluster sampling technique. The research instruments included a questionnaire on personal factors, work-related musculoskeletal disorders, and ergonomic factors. Data were analyzed using frequency, percentage, mean, and the Chi-square test.

The results showed that the main pain sites of teachers were lower back (73.03%), neck (65.17%), and shoulders (62.09%). High risk factors include holding the same position for long periods, frequent bending and twisting, lifting objects, and repetitive work. The factors associated with the neck pain included exercise, daily working hours. Factors associated with the shoulder pain included age, education level, number of teaching classes, daily working hours, daily computer use time, and daily housework time. Factors associated with upper back pain included age, number of teaching classes, years of work, daily working hours, daily computer use time, and daily housework time. Factors associated with lower back pain included age, education level, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time. Factors associated with wrist/hand pain included age, education level, number of teaching classes, years of work, daily working hours, daily computer use time, and daily housework time. Factors associated with hip/thigh/buttocks pain included gender, age, education level, and years of work. Factors associated with ankle/foot pain included exercise. Studies have shown that the prevalence of WMSDs in teachers is high, mainly due to long-term poor working posture and high intensity labor load. This not only affects the physical health of teachers but also may reduce the quality of teaching.

Keyword: Ergonomics, Risk factor, Work- related musculoskeletal disorders, Teachers, Middle school

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CHAPTER I

INTRODUCTION

Background and Rationale

Teachers are full-time personnel who spread and transmit human civilization. They undertake the mission of teaching and educating people. As the main implementers of school education functions, teachers have greatly contributed to developing my country's education. Teachers have heavy workloads and have not received corresponding respect. For a long time, many teachers have faced the problem of too many inspections, reflecting that in addition to the daily heavy teaching work, teachers also have a variety of non-teaching burdens. The occupational pressures currently faced by high school teachers are the one-sided pursuit of enrollment rate and student performance, heavy and trivial work, challenges of student management, competitive culture, and meticulous assessment (Li,2021). However, with the continuous efforts of teachers, health is gradually overdrawn, and some occupational diseases such as cervical spondylosis, lumbar spondylosis, pharyngitis, anxiety, depression and insomnia have appeared. With the gradual popularization of high-tech products in teaching, teachers' frequent use of computers at work has also caused some new occupational diseases to come quietly. After long-term mechanical use of mouse and keyboard, emerging occupational diseases such as "mouse hand" and "keyboard wrist" have appeared. Due to the specific teaching needs of teachers and long-term, mechanical movements, they teach, correct homework, write lesson plans, etc. repeatedly, and many people suffer from occupational diseases to varying degrees, with an occupational disease prevalence rate of up to 83.5% (Deng,2021). The highest incidence

rates are cervical spondylosis, lumbar spondylosis, headache, and pharyngitis (Wei,2010). Teachers spend a long-time correcting homework and preparing lessons at their desks, which can easily lead to cervical spondylosis and lumbar disc herniation, which evolve into cervical degenerative arthritis over time. In severe cases, the shoulders and back feel weak, and even have headaches. Chronic pharyngitis is also a common occupational disease, which is related to teachers' long- term excessive use of their voices, improper pronunciation, and frequent stimulation by chalk smoke (Hou & Ma, 2011).

Work-related musculoskeletal disorders (WMSDs) have a high prevalence and serious harm. They can be seen in many types of work in various industries of physical labor, mental labor, and mixed mental and physical labor, and are very prevalent. The standardized prevalence of WMSDs in key industries in China is 41.2%. The standardized prevalence of WMSDs in various industries as follows: flight attendants (55.7%), medical staff (54.2%) vegetable greenhouses (50.7%) toy manufacturing (49.0%) biopharmaceutical manufacturing (48.4%), automobile manufacturing (43.5%), electronic equipment manufacturing (40.4%), shipbuilding and related equipment manufacturing (40.1%), animal husbandry (39.7%), automobile 4S stores (38.6%), coal mining and washing (38.4%), shoemaking (34.2%), furniture manufacturing (28.5%), construction (23.4%), and petrochemical industry (11.5%) (Jia,2021). In 2014, the number of confirmed WMSDs cases in Belgium, Italy, Spain and France accounted for 69.22%, 68.89%, 74.51% and 87.55% of the total number of occupational disease cases in each country (Bandyopadhyay et al., 2012). However, according to a survey in Shenzhen, China, the total prevalence of WMSDs among teachers was 73%, the highest among people in key industries (Weng et al., 2023). Indian research shows that the prevalence of WMSDs among teachers is 48.27%, and the risk of disease is at a medium level (Kundra et al., 2024). Another Indian research

report showed that 20.9% of 537 teachers reported musculoskeletal pain. 50.9% suffered from chronic pain, and 71.4% reported that pain interfered with daily work. 48.2% reported sleep disorders (Murugan et al., 2021). The prevalence of work-related musculoskeletal diseases among teachers in UAE schools is 71.4% (Zohair et al., 2024).

WMSDs affect the physical and mental health of workers and may lead to absenteeism, and even cause loss of workability in severe cases. They have become an important occupational health issue in the world. In 2018, musculoskeletal diseases accounted for 35-39% of sick leave absences in Norway. The total absenteeism rate due to WMSDs in China is 18.3%. The total absenteeism rates of different occupational groups are 31.6%, 24.5%, 20.9%, 20.2%, 15.2%, 12.4%, 9.3%, and 6.7% respectively for bus drivers, couriers, teachers, traditional occupational groups, police, video workers, medical staff and sanitation workers. The absenteeism rate of teachers due to WMSDs is relatively high (Weng et al., 2023). With the development of the social economy, people's occupational division of labor has become more and more detailed, and there are great differences in the working methods and labor intensity of different industries, and the prevalence of WMSDs is also different. The most common symptoms in China are shoulder and neck pain (58%), followed by low back pain (49%), lower limb pain (37%) and upper limb pain (25%) (Shuai et al., 2014). A study in Saudi Arabia showed that the most common body parts among female middle school teachers were waist (68.4%), knees (58.6%), shoulders (47.7%), neck (45.4%), elbows (23.6%) and wrists (14.4%)(Abdel-Salam et al., 2021). Teachers suffer from musculoskeletal diseases due to long hours of working with their heads down, long hours of standing in class repeated writing on the blackboard, and long hours of sitting due to frequent reading, lesson preparation, and marking homework, especially the neck, shoulders and lower back (Wang,2009).

Malaysian research shows that standing for long periods (more than 2 hours) can cause muscle pain in the body (Alias et al., 2020).

According to the survey (Kong et al., 2023), the average working hours of primary and secondary school teachers are about 9.80 hours a day and about 2.43 hours of overtime every weekend, so the average working hours of primary and secondary school teachers are about 51.43 hours a week. Compared with TALIS 2018 international data, the weekly working hours of primary and secondary school teachers in China are significantly higher than the average working hours of secondary school teachers in 48 countries and regions of 38.30 hours. In addition, the work of primary and secondary school teachers is highly uncertain and complicated, including 11 routine tasks: teaching competitions, open classes, project research and paper writing, professional training, non-educational teaching meetings, non-school examination invigilation, assessment and evaluation, inspection preparation and inspection, dispute handling and coordination, cultural and sports activities, street community affairs and government work transfer.

According to the results of descriptive statistical analysis (Li, 2021), the average total workload of primary and secondary school teachers is 3.83, close to the level of "relatively heavy", indicating that the overall workload of primary and secondary school teachers is heavy. When it comes to working hours, high school teachers work the longest, while elementary school teachers work the shortest. In terms of direct teaching workload, the load of high school teachers is significantly higher than that of primary and middle school teachers. Despite the evident workload pressure on educators, work-related musculoskeletal disorders (WMSDs) among teachers remain a largely overlooked issue in China. Compared with other occupational groups, teachers have received relatively little attention in terms of WMSD-related research and intervention. As the number of

educational institutions and educators continues to grow, there is an urgent need to better understand the occupational health risks faced by this group. WMSDs can significantly affect teachers' physical well-being, job satisfaction, and long-term work performance.This study takes middle school teachers in Hejiang County as the research subjects, which has a clear practical background and theoretical value. First, from the perspective of occupational characteristics, middle school teachers are a high-risk group for work-related musculoskeletal disorders (WMSDs). Their daily work requires long hours of standing and teaching, repeated blackboard writing, preparing lessons and correcting homework, and most working postures have strong repetitive and static load characteristics. In addition, under the influence of exam pressure and teaching evaluation system, teachers often have to bear overtime work tasks and psychological load, but in real work, their ergonomic risk factors are often ignored and have not been systematically evaluated and intervened (Liu et al., 2009). Therefore, conducting an epidemiological survey of WMSDs on middle school teachers has clear occupational health significance and practical intervention value.

Second, from the perspective of the educational ecological environment, Sichuan Province is a typical province with fierce competition in the college entrance examination. According to 2024 data, the undergraduate admission rate of the college entrance examination in Sichuan Province is only 26.4%, ranking last in the country (College Entrance Examination 100, 2024). Due to the huge pressure of entering higher education, students and parents have high expectations for teachers' teaching performance, which leads to the accelerated pace of teachers' work and heavy teaching tasks. The physical health of teachers in this special education background is greatly challenged and is prone to chronic musculoskeletal diseases. Therefore, studying the occurrence mechanism and

related factors of WMSDs among teachers in Sichuan is of great significance for educational equity and the maintenance of teachers' occupational health.

From the perspective of regional representativeness, Hejiang County is located in the southern part of Sichuan. It is a typical third-tier urban-rural area with relatively limited educational resources, large middle school classes and relatively tight teaching staff. Compared with provincial capitals or eastern cities, middle school teachers in Hejiang County generally have a heavy workload, but there is still a lack of systematic research on their occupational health status. Selecting this area as a research sample can not only reflect the universal characteristics of teachers' occupational disease risks in the general middle school education environment in the central and western regions, but also provide experience reference and data support for occupational health intervention and policy formulation in other similar regions (Zhang et al., 2020).

This study focuses on middle school teachers in Hejiang County, aiming to investigate the prevalence of WMSDs, identify ergonomic risk factors, and explore other related contributing factors. The findings are expected to contribute valuable insights to educational institutions, policymakers, and health professionals in designing strategies to prevent and manage WMSDs among school teachers.

Objective

1. To determine the prevalence of WMSDs among middle school teachers in Hejiang County.

2. To identify the ergonomics risk factor of WMSDs among middle school teachers in Hejiang County.

3. To assess the factors associated with WMSDs among middle school teachers in Hejiang County.

Research question

1. What is the prevalence of WMSDs among middle School teachers in Hejiang County?

2. What are the ergonomic risk factors for WMSDs among middle School teachers in Hejiang County?

3. What are the factors associated with WMSDs among middle School teachers in Hejiang County?

Hypothesis

1. There is a high prevalence of work- related musculoskeletal disorders (WMSDs) among middle school teachers in Hejiang County.

2. The main ergonomic risk factors are physical load and repetitive work among middle school teachers in Hejiang County.

3. The personal factors such as age, gender, years of work, and workload are significantly associated with WMSDs among middle school teachers in Hejiang County.

Operational definition

Work-related musculoskeletal disorders (WMSDs) refers to conditions caused by physical stress from work, including excessive exertion, repetitive movements, and prolonged or awkward postures, which often affects muscles, joints, tendons, nerves, blood vessels, and bursa structures in various parts of the body. leading to pain, numbness, and limited mobility that may impair daily or occupational functioning.

Ergonomic risk factors refer to physical, biological, chemical, and psychological factors that may adversely affect worker health and safety. The ergonomic risk factors include the following aspects: poor working posture or frequent repetitive movements may lead to muscle fatigue, bone problems, and other physical discomfort; poor working environment, narrow or crowded working space, which may increase discomfort and accident risk; stress, working schedule, mismatches between individual ability and task requirements, etc.,

Middle school teacher refers to middle school teachers in Hejiang County, Sichuan Province, China, and refers to junior and senior high school teachers who are mainly responsible for arranging teaching progress, preparing lessons according to the requirements of the syllabus, taking class notes, submitting them to the Academic Affairs Office for inspection on time, and imparting knowledge.

WMSDs prevalence refer to frequency or proportion of WMSDs occurring among secondary school teachers, and can be used to quantify the prevalence or risk level of a certain WMSD among secondary school teachers. The WMSDs prevalence indicates the proportion of secondary school students suffering from WMSDs in a specific period of time, expressed as a percentage.

BMI refer to Body Mass Index, is a common measure used to assess a person's body mass. It is calculated by dividing your weight in kilograms by the square of your height in meters. The formula is as follows: BMI=kg/m^2.

Dynamic load refers to the changing load on various parts of the body (especially muscles and joints) during work or activity. Dynamic load involves changing forces, pressure, or posture during an activity. It mainly includes trunk movement, neck, shoulder and wrist movement.

Static load refer to fixed load that is maintained or sustained in a certain position for a long time. Focus on constant stress on body parts in fixed positions or postures, including standing for long periods of time, sitting, working, holding a slight bend for long periods of time, holding the neck forward, backward, twisting for long periods of time, etc.

Physical load refers to the physical stress and demands placed on the body when performing a task or activity. Physical loads can be dynamic (involving frequent changes in movement and posture) or static (involving holding a fixed position for a long time), including lifting, pushing, pulling heavy objects, etc.

Repetitive work refers to Perform the same movement or posture frequently and continuously over a period of time. This includes doing repetitive operations multiple times per minute and doing the same movements for the upper arms, fingers, torso and head every minute.

Work environment refers to the physical and social environment in which employees perform work tasks, including office space, equipment, tools, and the surrounding social atmosphere, including insufficient operating space, improper posture, lack of support, slipping, and difficulty using force.

Expected Benefits and applications

Individuals

1. Improving health awareness and understanding of the prevalence and impact of muscle pain can help teachers realize the seriousness of this problem and motivate them to take measures to prevent or relieve pain.

2. Promote healthy habits, the results may encourage teachers to increase physical activity, participate in regular physical exercise, and perform occupation-related muscle-strengthening exercises.

3. Improving teaching methods, and understanding how pain affects teachers' work performance may prompt teachers to explore more comfortable and efficient teaching methods that reduce the need for long periods of standing or repetitive movements.

Organizations

1. Improve working conditions: Understanding the causes and frequency of pain can guide school management to improve the working environment and facilities, such as providing ergonomic chairs and tables that encourage correct sitting and standing posture.

2. Reduce absenteeism: By reducing muscle pain, teachers may reduce absences due to health problems, and maintain the quality of teaching and the stability of school operations. Improve overall well-being: By identifying and responding to muscle pain, teachers may feel more valued and supported, which can improve their overall job satisfaction and well-being.

3. Professional development planning: By understanding teachers' pain issues educational institutions can design professional development plans that better meet teachers’ needs, including occupational health education and regular health checks.

CHAPTER II

LITERATURE REVIEW

This chapter outlines several concepts and explains the overall conceptual framework within which the study is situated. The following are specific studies that support this study:

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6. Conceptual Framework

Middle school teachers

Background of Middle school teachers

Education is the foundation of a country. It can be said that the country will prosper if education prospers. Teachers play a vital role in the development of education. In the context of the new era, teachers are not only promoters of students' learning and development, but also builders and developers of courses. However, with the development of the times, the multi-faceted pressure problems faced by teachers have begun to emerge. In an article published on People's Daily Online titled "Middle School Teachers Are Facing the Dilemma of "High Pressure"," it is mentioned that teachers are now facing multi-faceted work pressure. First, society, schools and students have higher and higher requirements for teachers' daily work, and their expectations for teachers are also increasing. Teachers' own work has become more arduous. Secondly, in daily work, they have to prepare lessons, correct homework, prepare for students' weekly exercises, monthly exams, unified exams, mid-term and final exams, etc., and at this stage, most schools generally use the admission rate and online rate as evaluation indicators for teachers. As teachers of different identities, the extracurricular work they handle is different. For example, as a subject teacher, they have to prepare lessons, teach classes, attend classes, write plan summaries, write reflections, make and mark papers, carry out educational research, evaluate professional titles, participate in basic skills competitions, participate in party member activities, etc.; as a class teacher, they have to deal with student conflicts, hold parent-teacher meetings, arrange classroom culture, keep student file

records, and many other matters; as a young teacher, they have to participate in master-apprentice pairing, participate in various subject competitions, participate in school activities, prepare for entry-level assessments, etc.

According to the "Standards for the Construction of School Buildings for Urban Ordinary Primary and Middle Schools" and "Standards for the Construction of Rural Ordinary Primary and Middle Schools", the current standard class size for primary and Middle schools is 45 students for primary schools and 50 students for junior high schools (Xinhua,2016). The "14th Five-Year Plan for the Development and Improvement of County Ordinary High Schools" stipulates that the class size for new students in ordinary high schools shall not exceed 55 (Ministry of Education,2021). However, in rural primary schools in five regions such as Jinan and Qingdao, 20% of rural primary school teachers teach classes that exceed the standard range. Nearly 80% of rural primary school teachers mentioned that the number of students they teach is too large, the class size is too large, and the amount of homework they have to correct is large (Feng Yanling, 2021).

Risk factors affecting teachers' health

Common occupational diseases among teachers include:strep throat, musculoskeletal diseases, varicose veins, etc. Teachers serve as a bridge to transmit knowledge and wisdom, and verbal communication has become an indispensable part of their work. However, hoarseness is not uncommon among teachers. Especially those passionate and motivated young teachers who have little experience often unconsciously raise their voices when teaching, causing their vocal cords to vibrate at high frequencies for a long time. This not only easily causes hoarseness, but may also induce chronic pharyngitis. In addition, teachers are often exposed to chalk dust during teaching, which is also an important factor causing throat discomfort. Teachers in primary and Middle schools need to teach an

average of 15 lessons per week, with each lesson lasting about 40 to 45 minutes. During a day's teaching activities, they spend an average of more than two hours standing, which does not include the time they spend walking back and forth in front of the blackboard or in the classroom, and the time they spend answering students' questions before and after class. This kind of long-term standing working state makes teachers' leg muscles often in a state of tension, and blood return is blocked, which can easily cause varicose veins in the lower limbs(Guo,2016) . Long-term desk work and lack of physical activity have become two independent risk factors for neck and shoulder pain among college teachers. The study found that if teachers increase their working time by two hours a day, their risk of chronic cervical pain will increase by 24.7%. In addition, those who exercise less than one day a week are 2.808 times more likely to suffer from chronic cervical pain than those who exercise more than five days a week (Wu et al., 2021). In addition, sedentary teaching, a body mass index (BMI) of more than 28 kg/m², working for more than ten years, smoking habits, and teaching more than 30 classes per week significantly increase teachers' risk of non-specific low back pain. Regular physical exercise can significantly reduce these risks. The results of this study warn us that college teachers should pay more attention to their own health habits, especially actively take measures in daily work, such as reasonably arranging sitting and standing time, insisting on regular physical exercise, controlling weight, quitting smoking, and rationally arranging teaching work amount, thereby reducing the probability of neck, shoulder and lower back pain. (Yang,2020).

Work-Related Musculoskeletal disorders

Definition of Work-Related Musculoskeletal disorders

Musculoskeletal disorders are a general term for a wide range of diseases and injuries of the muscles, tendons, ligaments, joints, and bones. Musculoskeletal disorders can affect the back, neck, and upper and lower limbs, causing pain and disability includes a variety of signs and symptoms such as pain, paresthesia, fatigue, and limited range of motion, which can be related to work tasks. Workplace-related factors include physical, psychological, social, and biomechanical hazards. The main kinetic factors associated with musculoskeletal disorders include repetitive motion, excessive force, improper posture, compression, and mechanical vibration.

Prevalence of Work-Related Musculoskeletal disorders

An estimated 1. 71 billion people worldwide suffer from musculoskeletal disorders, which are a major cause of disability and human suffering. Of the 204 countries surveyed, high-income countries have the highest number of affected people, at 441 million (Cieza et al., 2021). In 2017, the global prevalence of musculoskeletal disorders was higher in women than in men and was gradually increasing in the elderly population, but there were some differences between countries (Safiri et al.,2021). Population growth and an aging workforce are important factors contributing to the increase in the number of people with musculoskeletal disorders worldwide. The number of people with disabilities related to musculoskeletal disorders is also increasing, and this trend is expected to continue in the coming decades. Although musculoskeletal disorders are not usually life-threatening, they can cause chronic pain, limited mobility, and reduced flexibility, leading to early

retirement, reduced quality of life, and reduced ability to fully participate in society (World Health Organization, 2022).

The prevalence of musculoskeletal diseases in various industries abroad is as follows: In low- and middle-income countries, the prevalence of musculoskeletal diseases is found to be very high, especially in agriculture, manufacturing and service industries. Thailand is one of the world's three largest palm oil producers, and Krabi Province has the largest oil palm plantation area in Thailand. Oil palm agriculture is one of the main occupations of the people in Krabi Province. In the past 12 months, the prevalence of WMSD among oil palm workers was 98.4% (Tewtow et al., 2019). 82.6% of physical therapists in Egypt reported having suffered from WRMD in the past two years (Khairy et al., 2019). The prevalence of pain in multiple parts of the body among construction workers in Pakistan within 12 months was 89% (Kashif et al., 2022). The standardized prevalence of WMSD in key industry groups in China is 41.2%. The standardized prevalence of WMSD in various industries from high to low is as follows: flight attendants (55.7%), medical staff (54.2%), vegetable greenhouses (50.7%), toy manufacturing (49.0%), biopharmaceutical manufacturing (48.4%), automobile manufacturing (43.5%), electronic equipment manufacturing (40.4%), shipbuilding and related equipment manufacturing (40.1%), animal husbandry (39.7%), automobile 4S stores (38.6%), coal mining and cleaning industry (38.4%), shoemaking industry (34.2%), furniture manufacturing (28.5%), construction industry (23.4%), and petrochemical industry (11.5%) (Jia et al., 2021).

Prevalence of Work-Related Musculoskeletal disorders in different parts of the body

In Africa, a systematic review of musculoskeletal disorders among the Ethiopian workforce found that the total prevalence of occupational-related elbow pain, wrist pain, leg pain, foot pain, and hip pain in the past year was 19.7%, 24.2%, 25.0%, 20.2%, and 15.5%, respectively (Mengistu et al., 2022). A study in Nigeria showed that the prevalence of WMSD among respondents in the driving industry was 21.2%, and the annual prevalence of WMSD in each part was lower back pain (34%), neck pain (18.9%), upper back pain (22.3%), shoulder pain (18.2%), knee pain (14.9%), ankle pain (17%), wrist pain (7.5%), elbow pain (7.5%), and hip pain (15.1%) (Maduagwu et al., 2022). Musculoskeletal disorders are the most common diseases, accounting for 66.7% of all occupational diseases diagnosed in Italy in 2018, with back pain being the most common health problem, followed by upper and lower limb muscle pain (51.6%, 46.7%, and 29.3%, respectively). The three areas with the highest overall morbidity in China and the industry are the neck (24.8%), shoulders (20.8%), and lower back (16.8%).

Factors affecting Work-Related Musculoskeletal disorders

Psychology aspect: The risk of developing WRMSD is high due to overloading the body due to long working hours (Sukadarin et al., 2016). Malaysian nurses occasionally experience mental fatigue (44.3%) and frequent physical fatigue (44.0%), and 97.3% of nurses complain of work-related pain in the past 12 months (Krishnan et al., 2021). Results from Italy showed that people with moderate to high levels of work-related stress, anxiety, and insomnia had significantly higher odds of back pain. There are similar associations between these factors and pain in the lower extremities and shoulders, neck, and/or upper extremities. In addition, research has found that depression is significantly related to lower

limb pain and shoulder, neck and/or upper limb pain (Russo et al., 2020).

Physical aspect： These factors include working posture, spatial parameters, workplace layout, ergonomics of equipment and tools, overall physical load at work, heavy lifting, local muscle loading, repetitive work, vibration exposure, adverse climatic conditions at work (cold, hot) (Gauthy, 2007). Among dentists in Kuwait, the risk of WMSD is significantly related to age, years of practice, and working hours. Dentists' professional procedures hold their bodies in uncomfortable positions for extended periods, subjecting the dentist's critical movement and functional joints to unnatural forces and stresses. Long-term exposure to such postures can lead to WMSD (Alnaser et al., 2021).

Prevention of Work-Related Musculoskeletal disorders

Health education and training: In the field of occupational health, health education and training play a vital role in the intervention strategy for musculoskeletal diseases. Cognitive behavioral intervention strategies have been proven to be effective means of preventing and controlling occupational musculoskeletal diseases. Enterprises should regularly conduct popular education on ergonomics knowledge and adopt diversified publicity methods, such as regularly organizing group learning, publishing online educational short films, posting health posters, etc., so that employees can fully master the relevant knowledge of occupational musculoskeletal diseases , including its concepts , early symptoms, causes, correct working postures and preventive measures. This comprehensive health education activity can not only improve employees' awareness of occupational musculoskeletal diseases, but also enhance their self- protection awareness, thereby effectively reducing the incidence of occupational musculoskeletal diseases. Professional ergonomic skills training is not only the key to ensuring the standardization of the production process, but also an effective way to improve employees' self- care ability. By

providing on-site training for employees, teaching them how to identify bad working postures and mastering correct working skills, unreasonable ergonomic pressure can be reduced and the occurrence of occupational musculoskeletal diseases can be effectively prevented. This kind of training is not only a necessary condition for improving production efficiency, but also a strong guarantee for building a harmonious working environment. Therefore, companies should attach great importance to health education and training, and use it as an effective means to prevent occupational musculoskeletal diseases, protect the physical and mental health of employees, and improve the overall occupational health level of the company (Chen, 2023).

Good ergonomic design in the workplace: The workplace is the source of WMSDs, and disease prevention and control should start from the source. Enterprises should design and improve facilities and equipment in the workplace according to ergonomic principles. For example, the height of workshop assembly lines, work surfaces, and chairs can be freely adjusted. The design of related equipment should be in line with the anatomical, physiological, and psychological characteristics of the human body and anthropometric data, and minimize the external force required for workers to complete their work tasks and reduce excessive force. Reasonable workplace design can save workers from the effort of maintaining the same working posture, allowing workers to freely choose to operate in a standing, sitting, or a combination of sitting and standing postures, and should also be suitable for the body shape of workers. Enterprises should create a good working environment and provide workers with places to rest during work. Reasonable arrangement of labor: Unreasonable labor such as high work requirements, shortage of personnel, frequent overtime, fast work pace, repetitive work, and insufficient time to complete work are closely related to the occurrence of WMSDs. Reasonable arrangement of labor is an

important means of preventing WMSDs. Enterprises should formulate appropriate work plans based on actual conditions, comprehensively consider work quotas, labor quotas, and working hours, and avoid excessive workload and long working hours; formulate a reasonable work and rest system. Enterprises should reasonably arrange working hours and strictly implement the system according to the labor intensity, working hours, and physiological and psychological adaptability of workers; reasonably allocate labor content. Enterprises should formulate scientific and reasonable job systems, clarify job division and cooperation, disperse labor intensity, and avoid workers getting tired of repetitive work content and taking on too much work; regularly assess health occupational risks. Enterprises should regularly organize health examinations for workers to achieve early detection, early diagnosis, early management, and early intervention of WMSDs to protect the health of workers. Develop ergonomic load assessment methods: Accurately assessing adverse ergonomic factors in the workplace is a key step in preventing WMSDs. The subjective judgment method, systematic observation method, and direct measurement method of ergonomic load assessment are organically combined and used flexibly to achieve accurate, fast, and convenient assessment of adverse ergonomic factors in the workplace. With the advancement and maturity of information technology, ergonomic load assessment can be based on the overall design concept of the work system. With the help of computer vision and machine learning technology, ergonomic load assessment methods can be automated, intelligent, and complex. Use of Supportive Equipment for Ergonomic Intervention. At the technical level of ergonomic intervention, the use of supportive equipment particularly exoskeleton technology has emerged as a growing trend both domestically and internationally. Exoskeletons, developed from the principles of bionics, are increasingly applied in the field of occupational health. These wearable human-machine

systems integrate artificial intelligence and robotic mechanics, and are designed to be worn on the human body to provide physical assistance. Research indicates that upper limb exoskeletons can enhance lifting strength, reduce energy expenditure, and alleviate muscle fatigue during repetitive tasks. Exoskeleton devices help distribute loads, offer support, and assist movement, thereby minimizing physical strain. With advancements in materials science, sensor technology, bionics, and control systems, exoskeletons are becoming an effective tool for ergonomic intervention and the prevention of work-related musculoskeletal disorders (WMSDs).

Ergonomics

Definition Ergonomics

Ergonomics is a branch of mechanical engineering that studies the reasonable relationship between people, machines and the environment based on human psychology, physiology and body structure to ensure that people work safely, healthily and comfortably and achieve satisfactory work results. Work- related ergonomics research is still an important part of the discipline, and this part is occupational ergonomics. The core concept of occupational ergonomics is to focus on people, study the relationship between people, machines and the environment at work, achieve people's health, safety and comfort at work, and improve work efficiency (He, 2022). In the man-machine-environment system, it has gone through several stages of people adapting to machines, machines adapting to people, and people and machines adapting to each other. Now it has gone deep into the coordinated system of man-machine-environment. In the man-machine system, the size of various parts of the human body, the posture of people at work, the range of human activities, the rhythm

and speed of movements, the degree of fatigue caused by labor conditions, and the energy consumption and replenishment of people; the machine's display, buttons and other equipment that are connected to people; the ambient temperature, humidity, sound, vibration and lighting will affect people's work efficiency. In teachers' work, the main focus is on the relationship between teachers and desks and chairs, and the relationship between teachers and the overall environment and layout of the office.

Ergonomic risk factors

Ergonomic factors such as poor working posture, repetitive work, and static muscle load can cause blood, muscle, and bone injuries (Kee, 2022) , and are common risk factors for WMSDs at work. The results of Dalbøge et al. showed that in a Danish worker cohort, upper arm elevation, repetitive work, and shoulder overload work (such as lifting, carrying heavy objects, pushing and pulling loads) were associated with subacromial impingement syndrome in workers and were the main risk factors for shoulder pain in workers (Dalbøge et al., 2022). Similarly, Meyers found in a prospective study of American manufacturing workers and medical staff that when workers were performing repetitive force work, they were prone to shoulder WMSDs when accompanied by upper arm flexion ≥ 45°, external rotation ≥ 30°, or external rotation ≥ 60° (Meyers et al., 2023) . Petersen conducted a survey of workers of different types of work in Denmark from 1986 to 2016 and found that the rotation range and posture of the neck at work are risk factors for cervical disc herniation, and the incidence rate of cervical disc herniation increases steadily with the angular velocity of neck rotation, extension and flexion exposure levels (Petersen et al., 2022). French scholars implemented epidemiological monitoring related to upper limb musculoskeletal diseases based on the local occupational physician network in the Loire River region , and concluded through research that workers' working posture,

physical exertion during work, work rhythm, repetitive work and social needs are risk factors for upper limb musculoskeletal diseases (Nambiema et al., 2021) . Studies have shown that workers with arm posture higher than the neck have a risk of upper limb musculoskeletal diseases that is twice that of the low exposure group , those who exert high physical exertion at work have a risk of upper limb musculoskeletal diseases that is 1.63 times that of the low exposure group, those with poor working posture and low social support have a risk of upper limb musculoskeletal diseases that is 2.17 times that of the low exposure group, and those with high physical exertion and low social support have a risk of upper limb musculoskeletal diseases that is 2.37 times that of the low exposure group. In addition, Andersen et al. analyzed cohort data from the Danish Work Environment and Health Study and concluded that for the general working population, if the work process involves a variety of adverse working postures (such as standing for a long time, raising hands above shoulder height, bending or twisting the back, kneeling or squatting for a long time), accompanied by ergonomic factors such as repetitive operations, lifting or carrying heavy objects, pushing/pulling, etc., under such comprehensive exposure to ergonomic factors, workers are more likely to develop musculoskeletal diseases, and the more adverse factors involved, the higher the proportion of exposure time relative to working time, and the higher the severity of the workers' musculoskeletal symptoms (Andersen et al., 2021) .

Ergonomic prevention

1. Seriously carry out relevant health education, conduct pre-job training and regular education for workers, so that they understand the labor protection precautions for the type of work they are engaged in. Try to make them aware of possible early symptoms so that problems can be discovered and dealt with as soon as possible.

2. Work organization should be arranged reasonably according to different types of work and different labor intensities. For various operation methods such as pushing, pulling, lifting and other heavy external load operations, the load standards should be scientifically formulated. Overload operation is strictly prohibited. The length of working hours and rest time should be reasonably arranged.

3. Make efforts to improve working conditions. The working environment should be beneficial to the physical and mental health of workers. Appropriate temperature, humidity and lighting should be provided, and the influence of harmful occupational factors such as vibration and noise should be minimized. A good man-machine system should be established, and the design of reasonable or adjustable workbenches, chairs and working tools should be suitable for the size characteristics of human hands.

4. Strengthen the physical training of workers. Workers should actively participate in sports activities, conduct endurance and cold- resistance training, and continuously enhance the body's tolerance and resistance. It is recommended to do exercises during breaks and after work.

5. Conduct research on protective equipment. For example, in 1994, the Japanese National Labor Administration issued a guideline for the prevention of back injuries, recommending the use of back straps in some special working conditions to achieve the purpose of labor protection.

In the past decade, Chinese government departments and researchers have paid more and more attention to occupational ergonomics and WMSDs. The action goal planned by the Healthy China Action (2019-2030) issued by the National Health Commission is: for personnel engaged in long-term, high-intensity repetitive force, rapid movement, and video work, take measures such as promoting advanced technology and adjusting work and

rest time to prevent and control excessive fatigue and work-related musculoskeletal system diseases. Especially for occupational groups who work for a long time with their heads down or sit forward for a long time, as well as teachers, traffic police, doctors, nurses, and drivers, it is proposed that attention should be paid to relieving muscle tension through stretching activities and avoiding the occurrence of cervical spondylosis, periarthritis of the shoulder and low back pain. In the current status and problems of occupational health in the National Occupational Disease Prevention and Control Plan in 2021- 2025, work-related disease prevention and control, work pressure, and musculoskeletal diseases are also specifically mentioned, raising this important occupational health issue to the national strategic level (National Health Commission, 2019) (National Health Commission, 2021).

Risk factor

Personal factors

Personal factors play an important role in influencing work-related musculoskeletal disorders (WMSDs). These factors involve the individual's physiological, psychological ifestyle aspects, which directly affect their ability to adapt to the work load and the risk of injury.

Liu et al. found that the older the nurses were, the higher the risk of WMSDs in the knee, and the older the nurses were and the higher the education level, the higher the risk of WMSDs in the lower back. The possible reason is that nurses with long working years and high education have taken on more technical and higher work tasks during the working process, thus increasing the work load and working time (Liu et al.,2024).

The results of Xu et al. 's study on the status quo of lower limb musculoskeletal diseases of workers in 17 industries were similar to the results of Jia et al. Smoking,

educational level, marital status, monthly income, physical exercise, BMI and gender had significant effects on the occurrence of lower limb musculoskeletal diseases. Slightly more men than women; The number of smokers is higher than that of non-smokers or former smokers. People with a moderate BMI are lower than those who are underweight or overweight; The higher the education level and monthly income, the lower the incidence of WMSDs. Regular physical exercise can reduce the incidence of wmsd in lower limbs (Xu et al, 2023) (Jia, 2021).

Ergonomic risk factors

The occurrence of WMSDs is closely related to several ergonomic factors. These factors mainly include work posture, work load, tool and equipment design, work space layout, and rest and recovery.

1. Poor posture

A study of nurses found that working in an uncomfortable position was a risk factor for all body parts (9), and the OR value was the highest among all risk factors for neck, shoulder/arm, elbow, hip/thigh, and foot/ankle, indicating that working in an uncomfortable position had the greatest impact on the incidence of WMSDs (Zhang et al., 2020). Uncomfortable working posture and long sitting working time in shoe factory workers may be risk factors for the occurrence of neck WMSDs (Li et al., 2020).

2. Tool and equipment design

The incidence of pain was significantly higher among dentists using treatment chairs without waist support and without handrails (Pejčić et al., 2017). When automotive workshop operators are grinding, the vibration acceleration and frequency spectrum line position of the grinder exposed to the vibration of the grinder using the grinder, Angle grinder and internal grinder are also one of the reasons for WMSDs (Kang et al., 2020).

3. Workspace layout

Due to the labor-intensive and complex production process of shoe factory workers, although they are mainly seated, there are still a large number of repetitive operations of both upper limbs and wrists, turning or bending to take things, and other adverse ergonomic factors such as the mismatch between the height of the seat and the workbench and the height of the worker. These have led to a widespread risk of WMSDs in the shoulders, neck, back, hands, and wrists (Shen et al., 2018).

4. Workload

Repetitive operations performed multiple times per minute, such as back slapping during nursing, sputum discharge, and external chest compressions for CPR, are risk factors for the shoulder/upper arm, upper back, and lower back, and pose a potential hazard to caregivers. In addition, carrying objects over 20 kg is a risk factor for the upper back, lower back, wrists/hands and knees. Although China stipulates that objects exceeding 20 kg should not be carried by hand, in practice nursing operations often need to carry patients far exceeding this weight, even if multiple people cooperate, it may still exceed the ergonomic load, resulting in physical damage to the nursing staff (Zhang, 2020). Postural load has the largest effect value and the most important effect on neck WMSDs of airport transporters. The cabin height of narrow-body aircraft is usually 90 ~ 120cm, and the handling personnel need to keep bending and bowing for a long time in the cabin. While baggage sorters are responsible for moving baggage from the conveyor belt to the truck, repeated head turning and baggage extraction also have the problem of posture load (Wang et al., 2019).

5. Rest and recovery

The risk of WMSDs for employees in Internet enterprises who work more than 56h per week is 6.688 times that of those who work less than 40h per week, suggesting that long working hours are a risk factor for WMSDs (Wu et al., 2020). Dentists with more weekly patients had a statistically significantly higher prevalence of MS pain (Pejčić et al., 2018).

6. Task design

The results of a survey of construction workers in China showed that the top four parts in the incidence of WMSDs in construction workers in the past 7 days were neck, shoulder, upper back/back, and wrist/hand (Kang et al, 2021). However, surveys of construction workers in Pakistan and the United States show that the lower back/waist is the main occurrence site of WMSDs (Kashif et al., 2022) (Choi et al., 2016). This difference may be related to the difference in construction tasks at the time and the type of work performed by the respondents. In addition, in a survey of occupational musculoskeletal disorders among employees of telecommunications companies and nurses, the neck, shoulders, and upper back were also common sites for WMSDs (Odebiyi et al., 2016) (Yan et al., 2019).

Research related to this study

Khairy et al. (2019) investigated the prevalence, profile, predictors, and responses of work-related musculoskeletal disorders (WMSDs) among Egyptian physiotherapists. The study was distributed to 564 physiotherapists through manual distribution and email self-administered questionnaires. The study showed that 414 respondents (82.6%) reported

having suffered WMSDs in the past two years, with the lower back being the most commonly affected area (68.8%). More than half of the physiotherapists (54.8%) said their injuries occurred in private settings. Important predictors of WMSDs included age and years of experience in physiotherapy practice. About 73.9% of the respondents said they did not formally report their injuries, of which 55.8% reported losing half a day or more of work time due to injuries.

Alias et al. (2020) studied the correlation between long-term standing and WMSDs among teachers. Through a systematic analysis of relevant literature, it was found that the most common health problem caused by long-term standing among teachers was musculoskeletal diseases (WMSDs). The discomfort of long-term standing can be alleviated by disseminating and training ergonomic and non-ergonomic interventions.

Krishnan et al. (2021) evaluated the prevalence and risk factors of MSD pain in different anatomical regions of nurses. A cross-sectional study was conducted, with 300 registered nurses with clinical experience filling out questionnaires. Nurses experienced occasional mental exhaustion (44.3%) and recurrent physical exhaustion (44.0%). Almost all (97.3%) nurses complained of work-related pain in the past 12 months. The most common areas of lumbar pain were the lower back (86.7%), ankle (86.7%), neck (86.0%), shoulder (85.0%), lower limbs (84.7%), and upper back (84.3%). The frequency of pain in the neck and upper back was occasional pain, and pain was common in other areas. Nurses complained of low back pain (19.7%), right shoulder pain (29.7%), and left shoulder pain (30.3%). The frequency of musculoskeletal symptoms in any part of the body increases with age, low education, gender, BMI, years of work, and lifestyle.

Alnaser et al. (2021) conducted a study in Kuwait to investigate the prevalence and risk factors of work-related musculoskeletal disorders (WMSDs) among dentists and

explore the relationship between absenteeism/productivity. The study used a descriptive cross-sectional design and distributed a self-administered questionnaire to dentists in government, private, and academic dental clinics. A total of 186 questionnaires were returned, and the results showed that 47% of dentists experienced WMSDs. Dentists who reported WMSDs were older, had more years of practice, and worked longer hours than those who did not report WMSDs. There was a significant association between pain levels and days lost from work.

Murugan et al. (2021) surveyed 537 teachers by distributing questionnaires to 20 schools, reporting that 20.9% had musculoskeletal pain. The lower back (48.2%) was commonly affected. 50.9% had chronic pain, and 71.4% reported that the pain interfered with daily work. 48.2% reported sleep disorders. The most common factor was standing for long periods of time (76.8%). Risk factor analysis of the cause of pain using a logistic regression model showed statistical significance. Women were 3.952 times more likely to show pain than men.

Maduagwu et al. (2022) studied work-related musculoskeletal disorders (WMSDs) among drivers in northern Nigeria. The study determined the prevalence of risk factors in this group, analyzed the prevalence of WMSDs, and investigated drivers' experiences with ergonomic training, coping strategies, and treatment options. An adapted version of the standardized Nordic Musculoskeletal Questionnaire was used for a cross-sectional survey. Descriptive statistics and X^2 analysis were used. The survey results showed that the prevalence of WMSDs among respondents was 21.2%, and the main WMSDs included low back pain (34%), neck pain (18.9%), upper back pain (22.3%), shoulder pain (18.2%), knee pain (14.9%), ankle pain (17%), wrist pain (7.5%), elbow pain (7.5%), and hip/thigh pain (15.1%). X^2 analysis showed that age, marital status, and

education level were significantly associated with the prevalence of WMSDs. In addition, most drivers (92.5%) had not received ergonomic training, and 77.4% did not seek treatment.

Kashif et al. (2022) investigated the prevalence, pain characteristics, and associated risk factors of musculoskeletal diseases among construction workers in Pakistan. The study was a cross-sectional survey of 666 construction workers. Data were collected using a questionnaire consisting of 4 parts: demographic information, pain intensity numerical rating scale, and a Nordic questionnaire to report prevalence and pain characteristics. 397 of the 666 participants reported pain, and 269 reported no pain. The 12-month prevalence of pain in more than one body part among construction workers was 89%, and the 7-day prevalence was 52%; low back pain was the most common type of pain, with a 12-month prevalence of 27% and a 7-day prevalence of 17%. In terms of pain characteristics, 26% of the workers had occasional pain, 27% of the participants had pain ≤2 hours per day, and 32.9% had dull pain. In addition, it was found that musculoskeletal diseases were significantly correlated with age, lifestyle, work experience, smoking habits, and absenteeism.

Xu et al. (2023) investigated the occurrence of work-related musculoskeletal disorders (WMSDs) of the lower limbs among workers in 17 key industries and analyzed their adverse ergonomic factors. A stratified cluster sampling method was used to select 69,402 workers from 17 key industries in 7 regions as research subjects, and the "Chinese Version of Musculoskeletal Disease Questionnaire" was used to investigate the occurrence of lower limb WMSDs in the past year. The incidence of lower limb WMSDs in the survey subjects was 20.22%, of which 10.37% were in the legs, 10.63% were in the knees, and 13.17% were in the ankles. Industries with a high incidence of WMSDs include

biopharmaceuticals, at 33. 74% ; greenhouse vegetable operations, at 32. 10% ; and nonferrous metal smelting and rolling processing, at 25.50%. The incidence of lower limb WMSDs in male occupational groups is slightly higher than that in females; smokers have a higher incidence than non- smokers or those who have quit smoking; people with moderate BMI index have a lower incidence than those who are underweight or overweight; the higher the education level and monthly income, the lower the incidence of lower limb WMSDs; regular physical exercise can reduce the incidence of lower limb WMSDs. The results of multivariate logistics regression showed that the main influencing factors for the occurrence of lower limb WMSDs were the inability to stretch or change leg posture at work, keeping the knees bent for a long time at work, often repeating the same action in the lower limbs and ankles at work, and having a working age of more than 30 years.

Zohair et al. (2024) evaluated the prevalence of work-related musculoskeletal diseases among school teachers in the United Arab Emirates and their relationship with physical activity. Information on physical activity levels was collected from 206 teachers using the Nordic Musculoskeletal Questionnaire (NMQ) and the Global Physical Activity Questionnaire (GPAQ) The study found that the prevalence of work- related musculoskeletal disorders (WMSDs) among teachers in UAE schools was high (71.4%), with neck pain being the most common (74.3%). The main risk factors included age, workload, and low physical activity. Pearson correlation test showed a weak positive correlation between WMSD and PA, which was a contributing factor, but other factors besides PA influenced the prevalence of WMSD.

Kundra et al. (2024) studied the correlation between ergonomics and musculoskeletal disorders among school teachers, assessing the prevalence of musculoskeletal disorders (WMSDs) using the standardized Nordic Musculoskeletal Questionnaire (NMQ), and assessing ergonomics in the classroom and when using computers/smartphones, and the awareness of ergonomics was recorded with the help of a checklist and the Rapid Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) tools. The REBA score showed that teachers' risk of WMSD was mainly at a moderate level, with 72.72% of primary school teachers and 75.86% of secondary school teachers performing tasks, respectively, whereas the RULA score concluded that 48.27% of secondary school teachers and 45.45% of primary school teachers were at moderate risk of WMSD.

Conceptual Framework

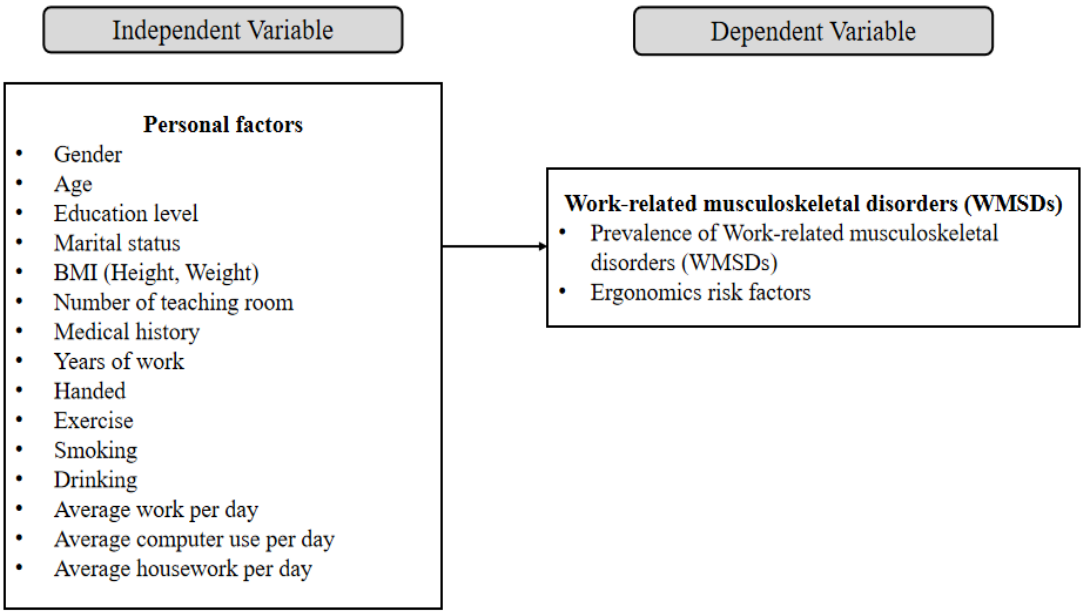

Figure 1 Conceptual Framework of this study

CHAPTER III

RESEARCH METHODOLOGY

This chapter mainly conducts a methodological study on the prevalence of WMSDs among middle school teachers in Hejiang County, the ergonomic risk factors of WMSDs among middle school teachers in Hejiang County, and the factors related to WMSDs among middle school teachers in Hejiang County, as follows:

1 Research design

2. Population and sample size

    2.1 Population

    2.2 Sample Size and Sampling Technique

    2.3 Inclusion Criteria

    2.4 Exclusion Criteria

3. Study area

4. Study period

5. Measurement instruments

    5.1 Measurement Tool

    5.2 Tool development process

    5.3 Research tool quality

    5.4 Reliability

6. Data collection

7. Data analysis

Research design

The research design of this study was a cross-sectional descriptive study. All samples were collected in Hejiang County.

Population and sample size

Population

The population of this study consisted of 13 middle school teachers in Hejiang County, Luzhou City, Sichuan Province. The total student population was 1,665 teachers.

Sample Size and Sampling Technique

The subjects included in this study were 1,665 teachers from middle schools in Hejiang County. The subjects were determined according to the inclusion and exclusion criteria, but the proportion of researchers withdrawing from the study due to illness or unavoidable accidents is expected to be no more than 10%.

$$n = \frac{N}{1 + N_{e^2}}$$

$$n = \frac{1665}{1+1665\times0.05^2} \qquad n\approx323$$

Error level=323×10%=32.3

Sample size=323+33=356

The required sample size is calculated to be 356 people.

Sampling Technique

This study used the cluster sampling method, divided into 4 zones from 13 schools in Hejiang County, and obtained sampling total 4 schools. Then, the sample was divided into groups according to the population proportion, and simple random sampling was used in each school according to the inclusion criteria and exclusion criteria. The number of people is selected as follows:

Table 1 Population and sample size

School	Population (N)	Sample size(n)
MaJie Middle School	297	109
HeJiang Middle School	274	101
RongShan Middle School	150	55
ChengGuan Junior Middle School	247	91
Total	**968**	**356**

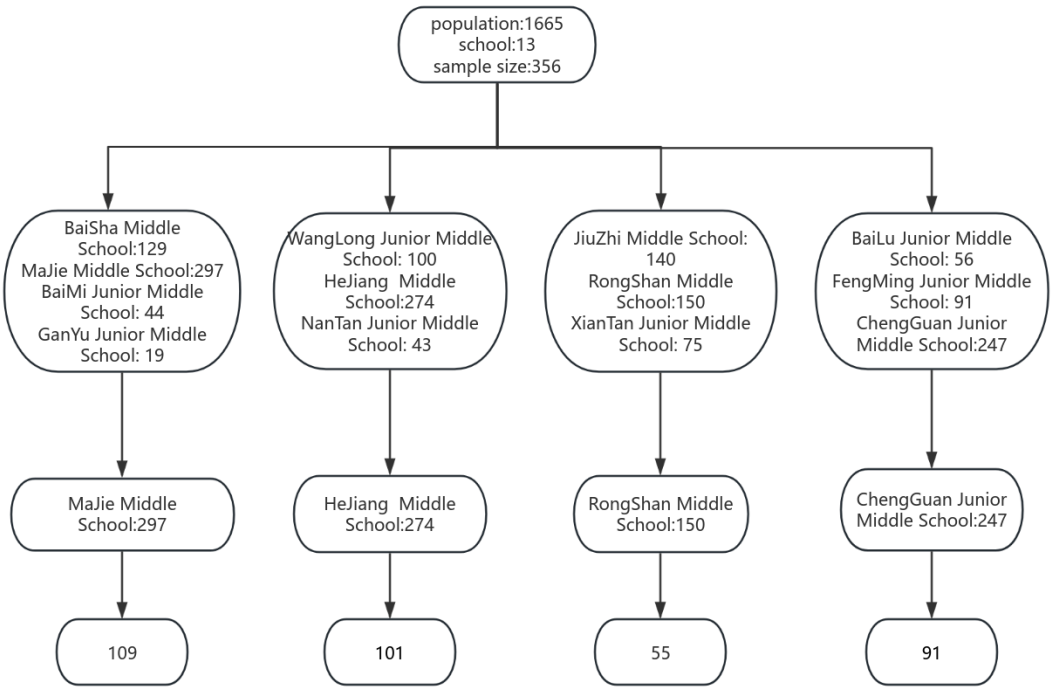

Figure 2 cluster sampling

Inclusion Criteria

1. Both men and women about 18-60 years old

2. Full-time teacher

3. At least one year of work experience

4. Willing to participate in the study

Exclusion Criteria

1. Pregnant female teachers

2. Person with musculoskeletal symptoms caused by trauma, infectious diseases, malignant tumors, rheumatism

3. Person with rheumatoid diseases, and congenital neck, shoulder, and back deformities.

Study area

The study area is Sichuan Province in southwest China, and the study site is Hejiang County in southeastern Sichuan Province. There are three reasons for choosing Hejiang County: first, the prevalence of musculoskeletal discomfort among teachers in Hejiang County is high; second, Hejiang County lacks ergonomic training to prevent health risks for teachers; third, there is research feasibility. Therefore, this study understands the prevalence of muscle pain in the teacher group, which can provide a scientific basis for relevant departments to formulate targeted health policies and intervention measures.

Figure 3 Map of Hejiang County，Source（From Google Maps，2024）

Study period

This study was conducted from August 2024 to March 2025.

Measurement instruments

Measurement Tool

The data were collected using an online questionnaire, which was divided into 3 parts: musculoskeletal discomfort, personal factors, and ergonomic factors as follows

Part I Personal factors

The respondents of the questionnaire include two factors. Personal factors include gender, age, education level, marital status, BMI (height, weight), medical history, exercise, smoking, drinking, years of work, number of teaching rooms, average teaching hours per week, average computer use per day.

Part II Work-related musculoskeletal disorders

The questionnaire was based on the Nordic standard questionnaire. It was modified or added according to the actual situation to adapt to the working environment characteristics of middle school teachers in Hejiang County. The questionnaire assessed the pain or discomfort in nine body parts over the past month, namely the neck, shoulders, back, waist, elbows, wrists, hips/ buttocks, knees, and ankles/ feet. In addition, the questionnaire also investigated whether the respondents had taken leave due to pain or discomfort or cramps above parts in the past month.

The prevalence rate of work-related musculoskeletal will be computed as follows;

$$\text{WMSDs} = \frac{\text{all new and pre} - \text{exsting cases during a time period}}{\text{Population during the same period}} \times 100\%$$

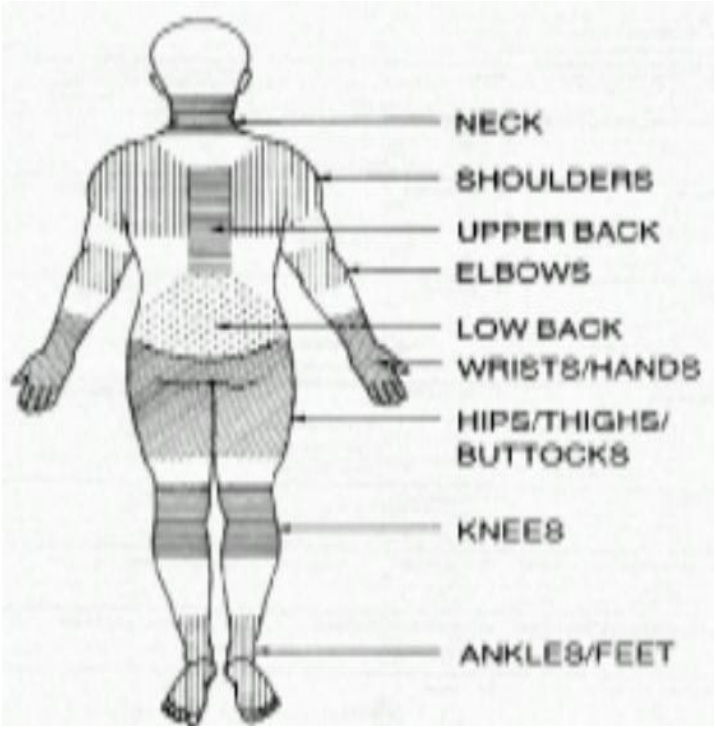

Figure 4 Musculoskeletal regions，Source（From Pintakham, K. 2014）

Part III Ergonomic factors

The questionnaire applies from the Dutch Musculoskeletal Questionnaire was used to analyze musculoskeletal workload and associated potentially dangerous working conditions as well as musculoskeletal symptoms in a worker population. The scale contains 7 dimensions, among which dynamic load refers to trunk movements, neck, shoulder and wrist movements, etc.; static load includes standing for a long time, sitting and working, keeping a slight bend for a long time, keeping the neck forward, backward and twisting for a long time, etc.; physical load includes lifting, pushing and pulling heavy objects, etc.; repetitive work includes doing multiple repetitive operations per minute and the upper arm, fingers, trunk and head doing the same action every minute, etc.; environmental ergonomic

factors include not having enough space to operate properly, it is difficult to use strength due to inappropriate posture, lack of support, slipping and falling, etc. Considering the actual working environment of teachers, the dimensions of "vibration" and "climate" were deleted in this study, including items such as "whether to drive a vehicle", "whether to work outdoors", "whether the work involves cold, cool wind or temperature changes", and "whether the work requires frequent driving of vehicles". The remaining five dimensions are static load, dynamic load, physical load, repetitive work, environmental ergonomic factors.

Tool development process

1. Research literature, including literature related to the research, to optimize the research questionnaire.

2. Consult the supervisor's research questionnaire

3. Submit the questionnaire to three experts for evaluation

4. Modify the questionnaire according to expert suggestions. The above is appropriate

5. Conduct sample tests in the study area

Research tool quality

The accuracy of the study content requires the expert to believe that the research question is determined to meet the measured content or the purpose of the study

A score of +1 means to be certain of the content/purpose of the question.

A score of 0 means being uncertain about the content/purpose of the question.

A score of -1 means to identify an issue without measuring its content/purpose

index of item-objective congruence IOC

According to the formula:

$$IOC = \Sigma R/N$$

R stands for the sum of expert reviews.

N represents the number of majors

If the IOC criterion is 0.5 or above, then the problem is objective

Reliability

The modified questionnaire was pilot- tested on a sample of 30 teachers' representative of the target population. Data from the pilot study were analyzed to assess the instrument's reliability. The section measuring work-related musculoskeletal disorders yielded a Cronbach's alpha coefficient of 0.83, while the section on ergonomic risk factors achieved a coefficient of 0. 94, indicating excellent internal consistency. These results confirm the instrument's suitability for use among teachers in Hejiang County, Luzhou City, Sichuan Province.

Data collection

In this researcher will follow these steps to collect data:

1. Request a letter of certification from I-SEM, Chiang Rai Rajabhat University, to authorize the data collection process.

2. Clear objectives: clarify the data to be collected and the purpose of collecting data.

3. Sampling: determine the research population and sample size based on the research questions and objectives.

4. Data collection methods: select an online questionnaire survey method to collect data based on the research questions, sample characteristics, and feasibility.

5. Data collection tools: design questionnaires, mainly including three parts: musculoskeletal discomfort, personal factors, and ergonomic factors

6. Ethical considerations: ensure that the data collection process meets ethical standards and obtain informed consent from participants.

7. Data quality assurance: pre-test tools to ensure the accuracy, reliability and validity of the collected data.

Data analysis

The descriptive statistics analyzed the prevalence of WMSDs and ergonomics risk factors of WMSDs among middle school teachers in Hejiang County were frequencies, percentages, mean, and standard deviation.

The inferential statistics analyzed the personal factors associated with WMSDs among middle school teachers in Hejiang County as Chi-square test.

CHAPTER IV

RESULTS

This chapter aims to determine the prevalence of WMSDs, to identify the ergonomics risk factor of WMSDs and to assess the factors associated with WMSDs among middle school teachers in Hejiang County, Sichuan Province. The results include 4 components as follows;

1. Personal factors
2. Work-related musculoskeletal disorders
3. Ergonomic risk factors
4. Factors associated with WMSDs

Personal factors

Table 2 Frequency and percentage of teachers by gender(n=356)

Gender	Number (n=356)	Percentage (%)
Male	156	43.82
Female	200	56.18
Total	**356**	**100.00**

Table 2 shows the frequency and percentage of teachers by gender. The majority of teachers were female, with a total of 200 teachers (56.18%) and 156 teachers (43.82%) were male.

Table 3 Frequency and percentage of teachers by age(n=356)

Age (Years)	Number (n=356)	Percentage (%)
24-31	102	28.65
32-39	108	30.34
40-47	83	23.31
48-55	63	17.70
Mean=37.8 Minimum =24 Maximum=53		
Total	**356**	**100.00**

Table 3 shows the frequency and percentage of teachers by age. The average age was 37.8 years, with a range from 24 to 53 years. The majority of teachers were 32-39 years old, totaling 108 teachers (30.34%), followed by 102 teachers (28.65%) aged 24-31years and the smallest group consisted of teachers aged 48-55 years, totaling 63 teachers (17.70%).

Table 4 Frequency and percentage of teacher by educational attainment (n=356)

Education	Number (n=356)	Percentage (%)
Junior High School	6	1.69
Senior High School	54	15.17
Bachelor degree	251	70.51
Graduate students and above	45	12.63
Total	**356**	**100.0**

Table 4 shows the frequency and percentage of teachers by educational attainment. The majority were bachelor's degree, totaling 251 teachers (70.51%), followed by high school degree with 54 teachers (15.17%), and the smallest group consisted of junior high school, totaling 6 teachers (1.69%).

Table 5 Frequency and percentage of teachers by marital status(n=356)

Marital	Number	Percentage (%)
Single	40	11.24
Married	294	82.58
Widowed/ Divorced/Separated	22	6.18
Total	**356**	**100.0**

Table 5 shows the frequency and percentage of teachers by marital status. The majority of the teachers are married, totaling 294 (82.58%), followed by single 40 (11.24%), and the smallest are widowed/divorced/separated 22 (6.18%).

Table 6 Frequency and percentage of teachers by BMI(n=356)

BMI	Number	Percentage (%)
＜18.5	21	5.90
18.5-24	286	80.34
24-28	49	13.76
Total	**356**	**100.0**

Table 6 shows the frequency and percentage of teachers by BMI. The majority of teachers had a BMI in the normal range, totaling 286 (80.34%), followed by 49 (13.76%) teachers who were overweight, and the smallest 21 (5.90%) teachers who were thin.

Table 7 Frequency and percentage of classes taught by teachers(n=356)

Number of teaching room	**Number**	**Percentage(%)**
2	132	37.08
3	104	29.21
4	74	20.79
5	42	11.80
6	4	1.12
Mean=3.11 Minimum =2 Maximum=6		
Total	**356**	**100.0**

Table 7 shows the frequency and percentage of the number of teaching room by teachers. The majority of teachers teach 2 classes, a total of 132 teachers (37.08%), followed by 104 teachers (29.21%) who teach 3 classes, and the smallest 4 teachers (1.12%) who teach 6 classes.

Table 8 Frequency and percentage of teachers by years of service(n=356)

Years	Number	Percentage(%)
＜10	136	38.20
11-20	118	33.15
21-30	93	26.12
＞30	9	2.53
Mean=14.76 Minimum =1 Maximum=34		
Total	**356**	**100.0**

Table 8 shows the frequency and percentage of teachers by years of service. The majority of teachers have less than 10 years of service, a total of 136 (38.20%), followed by 118 (33.15%) teachers with 11-20 years of service, and the smallest number of teachers have more than 30 years of service, a total of 9 (2.53%).

Table 9 Frequency and percentage of teachers by dominant hand(n=356)

Hands	Number	Percentage(%)
Left Hand	5	1.40
Right hand	351	98.60
Total	**356**	**100.0**

Table 9 shows the frequency and percentage of teachers by dominant hand. 351 (98.60%) teachers were right-handed and 5 (1.40%) teachers were left-handed.

Table 10 Frequency and percentage of teachers by history of WMSDs(n=356)

Illness	Number	Percentage (%)
No	331	92.98
Yes	25	7.02
Total	**356**	**100.0**

Table 10 shows the frequency and percentage of teachers by WMSDs disease history. 331 teachers (92.98%) had no WMSDs disease history, and 25 teachers (7.02%) had WMSDs disease history.

Table 11 Frequency and percentage of teachers by exercising(n=356)

Exercise	Number	Percentage(%)
Never	93	26.12
Work out at 1-2 times/week	124	34.83
Work out at 3-4 times/week	88	24.72
Work out at 5-7 times/week	51	14.33
Total	**356**	**100.0**

Table 11 shows the frequency and percentage of teachers by exercise. The majority of teachers exercise 1-2 times a week, a total of 124 teachers (34.83%), followed by 93 teachers (26.12%) who never exercise, and the smallest teachers who exercise 5-7 times a week, a total of 51 teachers (14.33%).

Table 12 Frequency and percentage of teachers by smoking(n=356)

Smoking	Number	Percentage(%)
No	274	76.97
Yes	82	23.03
Total	**356**	**100.0**

Table 12 shows the frequency and percentage of teachers by smoking, 227 (76.97%) teachers do not smoke, and 82 (23.03%) teachers smoke.

Table 13 Frequency and percentage of teachers by drinking alcohol (n=356)

Alcohol	Number	Percentage (%)
No	229	64.33
Yes	127	35.67
Total	**356**	**100.0**

Table 13 shows the frequency and percentage of teachers by drinking alcohol, 229 (64.33%) teachers do not drink alcohol, and 127 (35.67%) teachers drink alcohol.

Table 14 Frequency and percentage of teachers by working hours per day (n=356)

Work (Hr.)	Number	Percentage (%)
8	74	20.79
9	73	20.51
10	81	22.75
11	63	17.69
12	36	10.11
13	29	8.15
Mean=10.00 Minimum =8 Maximum=13		
Total	**356**	**100.0**

Table 14 shows the frequency and percentage of teachers by working hours per day. The majority of teachers work 10 hours per day, totaling 81 teachers (22.75%), followed by 74 teachers (20.79%) working 8 hours per day, and the smallest number of teachers working 13 hours per day, totaling 29 teachers (8.15%).

Table 15 Frequency and percentage of time teachers spend using computers every day (n=356)

Computer (Hr.)	Number	Percentage (%)
1	7	1.97
2	17	4.79
3	98	27.53
4	88	24.72
5	89	25.00
6	57	16.01
Mean=4.14 Minimum =1 Maximum=6		
Total	**356**	**100.0**

Table 15 shows the frequency and percentage of teachers spend using computers every day. The majority of teachers use computers for 3 hours a day, totaling 98 teachers (27.53%), followed by 89 teachers (25.00%) who use computers for 5 hours a day, and the smallest number of teachers who use computers for 1 hour a day, 7 teachers (1.97%).

Table 16 Frequency and percentage of time teachers spend doing housework every day (n=356)

Housework (Hr.)	Number	Percentage (%)
0	11	3.09
1	166	46.63
2	175	49.16
3	4	1.12
Mean=1.48 Minimum =0 Maximum=3		
Total	**356**	**100.0**

Table 16 shows the frequency and percentage of teachers doing housework every day. The majority of teachers do housework for 2 hours a day, totaling 175 teachers (49.16%), followed by 1 hour a day, 166 teachers (46.63%), and the smallest number of teachers doing housework for 3 hours a day, 4 teachers (1.12%).

Work-related musculoskeletal disorders

Table 17 Prevalence of Work-related musculoskeletal disorders (n=356)

Part of body	No		Yes	
	Number (n=356)	**Percentage (%)**	**Number (n=356)**	**Percentage (%)**
Neck	124	34.83	232	65.17
Shoulder	135	37.91	221	62.09
Upper back	155	43.54	201	56.46
Elbow	342	96.07	14	3.93
Lower back	96	26.97	260	73.03
Wrists/Hands	174	48.88	182	51.12
Hips/Thighs/Buttocks	232	65.17	124	34.83
Knees	162	45.51	194	54.49
Ankle/Foot	182	51.12	174	48.88

Table 17 shows the prevalence of WMSDs among middle school teachers in Hejiang County. The highest prevalence was reported in the lower back (73.03%), followed by the neck (65.17%). The elbow had the lowest prevalence, with only 3.93% of teachers reporting symptoms.

Ergonomic risk factors

Table 18 Frequency and percentage of ergonomic risk factors (n=356)

Ergonomic risk factors	No		yes	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
Dynamic load	2,362	66.35	1,198	33.65
Static load	3,033	65.54	1,595	34.46
Physical load	597	41.92	827	58.08
Repetitive work	335	48.41	357	51.59
Work environment	794	55.76	630	44.24

Table 18 shows the frequency and percentage of various ergonomic risk factors among middle school teachers. The most commonly reported ergonomic risk was physical load, with 58.08% of respondents indicating exposure. This was followed by repetitive work at 51.59%, and work environment at 44.24%. Meanwhile, dynamic load and static load were reported by 33.65% and 34.46% of participants, respectively.

Table 19 Frequency and percentage of dynamic load risk factor (n=356)

Dynamic load	No		yes	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
1.bent slightly with your trunk?	113	31.74	243	68.26
2.bent heavily with your trunk?	347	97.47	9	2.53
3.twist slightly with your trunk?	110	30.90	246	69.10
4.twist heavily with your trunk?	345	96.91	11	3.09
5.bent and twist simultaneously with your trunk?	218	61.24	138	38.76
6.make sudden, unexpected movements?	227	63.76	129	36.24
7.perform short, but maximal force-exertions?	216	60.67	140	39.33
8.exert great force with your arms or hands?	230	64.61	126	35.39
9.hold things in a pinch grip with your hands?	232	65.17	124	34.83
10.exert great force on tools or machinery?	324	91.01	32	8.99
Total	**2362**	**66.37%**	**1198**	**33.63%**

Table 19 shows the frequency and percentage of dynamic load risk factor. In dynamic load, the largest number of teachers who chose slight trunk twisting was the ergonomic risk factor was 246 (69.10%), followed by 243 (68.26%) who chose slight trunk bending, and the least number of teachers who chose severe trunk twisting was 11 (3.09%).

Table 20 Frequency and percentage of static load risk factor (n=356)

static load	No		yes	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
in a slightly bent posture for long periods?	165	46.35	191	53.65
in a heavily bent posture for long periods?	344	96.63	12	3.37
in a slightly twisted posture for long periods?	236	66.29	120	33.71
in a heavily twisted posture for long periods?	345	96.91	11	3.09
in a bent and twisted for long periods?	343	96.35	13	3.65
bent your neck forward or hold your neck in a forward posture for long periods?	182	51.12	174	48.88

Table 20 (Continued)

static load	No		yes	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
twist your neck or hold your neck in a twisted posture for long periods?	348	97.75	8	2.25
bent your wrist or hold your wrist bent for long periods?	151	42.42	205	57.58
twist your wrist or hold your wrist twisted for long periods?	160	44.94	196	55.06
stand for long periods?	132	37.08	224	62.92
sit for long periods?	147	41.29	209	58.71
work kneeled or squatted for long periods?	349	98.03	7	1.97
work in the same posture for long periods?	131	36.80	225	63.20
Total	**3,033**	**65.53**	**1,595**	**34.47**

Table 20 shows the frequency and percentage of static load risk factor. Among the static loads, the largest number of teachers, 225 (63.20%), chose to work in the same posture for a long time, followed by 224 (62.92%) teachers who chose standing for a long

time, and the least number of teachers, 7 (1.97%), who chose kneeling or squatting for a long time.

Table 21 Frequency and percentage of physical load risk factor (n=356)

physical load	No		yes	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
Use hands/arms to pick up objects?	114	32.02	242	67.98
hold your hands at or under shoulder level?	156	43.82	200	56.18
hold your hands above shoulder level?	169	47.47	187	52.53
work in uncomfortable postures?	158	44.38	198	55.62
Total	**597**	**41.92**	**827**	**58.08**

Table 21 shows the Frequency and percentage of physical load risk factor. In the physical load, the largest number of teachers chose to pick up objects with their hands/arms, with a total of 242 teachers (67.98%), followed by 200 teachers (56.18%) who chose to put their hands at shoulder level or below the shoulders, and the least number of teachers (187 teachers ,52.53%) who chose to put their hands above the shoulders.

Table 22 Frequency and percentage of repetitive work risk factor (n=356)

repetitive work	No		Yes	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
the same movements with your arms, hands of fingers many times per minute?	223	62.64	133	37.36
the same movements (bending, twisting) with your head many times per minute?	112	31.46	244	68.54
Total	**335**	**48.41**	**357**	**51.59**

Table 22 shows the frequency and percentage of repetitive work risk factor. Among repetitive work, the largest number of teachers chose to make the same movement of the head many times per minute, totaling 244 (68.54%), followed by 133 (37.36%) teachers who chose to make the same movement of the arms, hands or fingers many times per minute.

Table 23 Frequency and percentage of work environment risk factor (n=356)

Work environment	No		Yes	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
insufficient space to do your work properly?	209	58.71	147	41.29
insufficient height or reach to be able to reach things with your tools?	185	51.97	171	48.03
difficulties exerting enough force because of uncomfortable postures?	186	52.25	170	47.75
nothing to lean on?	214	60.11	142	39.89
Total	**794**	**55.76**	**630**	**44.24**

Table 23 shows the Frequency and percentage of work environment risk factor. In the work environment, the largest number of teachers, totaling 117 (48.03%), chose that they could not pick up things due to lack of height or reach, followed by 170 teachers (47.75%) who chose that it was difficult to exert enough force due to uncomfortable posture, and the least number of teachers, totaling 142 (39.89%), chose that they had nothing to lean on.

Factors associated with WMSDs

Table 24 Factors associated with neck pain

Personal factor	Neck pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.576
Male	57(36.54%)	99(63.46%)	
Female	67(33.50%)	133(66.50%)	
Age			0.176
24-39	67(31.90%)	143(68.10%)	
40-55	57(39.04%)	89(60.96%)	
Education			0.767
Senior High Schooland below	22(36.70%)	38(63.30%)	
Bachelor degreeand above	102(34.46%)	194(65.54%)	
Marital Status			0.309
Notmarried(Single,Widowed/Divorced/Separated)	18(29.03%)	44(70.97%)	
Married	106(36.05%)	188(63.95%)	
BMI			0.486
Abnormal(＜18.5, 24-28)	27(38.57%)	43(61.43%)	
Normal(18.5-24)	97(33.92%)	189(66.08%)	

Table 24 (Continued)

Personal factor	Neck pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Number of teaching room			0.159
2-3	76(32.20%)	160(67.80%)	
4-6	48(40.0%)	72(60.0%)	
Years of work			0.461
＜20	85(33.46%)	169(66.54%)	
＞21-30	39(38.24%)	63(61.76%)	
Illness			0.831
No	116(35.05%)	215(64.95%)	
Yes	8(32.00%)	17(68.00%)	
Exercise			0.017*
Exercise＜2 times /week	65(29.95%)	152(70.05%)	
Exercise＞3 times /week	59(42.45%)	80(57.55%)	
Smoking			0.186
No	90(32.85%)	184(67.15%)	
Yes	34(41.46%)	48(58.54%)	
Alcohol			0.202
No	74(32.31%)	155(67.69%)	
Yes	50(39.37%)	77(60.63%)	
Work (Hr.)			0.049*

Table 24 (Continued)

Personal factor	Neck pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
8-10	88(38.60%)	140(61.40%)	
11-13	36(28.13%)	92(71.87%)	
Computer (Hr.)			1.000
1-4	73(34.76%)	137(65.24%)	
5-6	51(34.93%)	95(65.07%)	
Housework (Hr.)			0.912
0-1	61(34.46%)	116(65.54%)	
2-3	63(35.20%)	116(64.80%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 24 shows that factors associated with neck pain include exercise and daily working hours, all of which were significant at $p < 0.05$.

Table 25 Factors associated with shoulder pain

Personal factor	Shoulder pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.582
Male	62(39.74%)	94(60.26%)	
Female	73(36.5%)	127(63.5%)	
Age			0.026*
24-39	90(42.86%)	120(57.14%)	
40-55	45(30.82%)	101(69.18%)	
Education			0.028*
Senior High Schooland below	15(25.00%)	45(75.00%)	
Bachelor degreeand above	120(40.54%)	176(59.46%)	
Marital Status			0.668
Notmarried(Single,Widowed/Divorced/Separated)	25(40.32%)	37(59.68%)	
Married	110(37.41%)	184(62.59%)	
BMI			0.133
Abnormal(＜18.5, 24-28)	21(30.00%)	49(70.00%)	
Normal(18.5-24)	114(39.86%)	172(60.14%)	
Number of teaching room			0.004*
2-3	102(43.22%)	134(56.78%)	

Table 25 (continued)

Personal factor	Shoulder pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
4-6	33(27.50%)	87(72.50%)	
Years of work			0.070
＜20	104(40.94%)	150(59.06%)	
＞21-30	31(30.39%)	71(69.61%)	
Illness			0.058
No	130(39.27%)	201(60.73%)	
Yes	5(20.00%)	20(80.00%)	
Exercise			0.146
Exercise＜2 times /week	89(41.01%)	128(58.99%)	
Exercise＞3 times /week	46(33.09%)	93(66.91%)	
Smoking			0.051
No	96(35.04%)	178(64.96%)	
Yes	39(47.56%)	43(52.44%)	
Alcohol			0.496
No	90(39.30%)	139(60.70%)	
Yes	45(35.43%)	82(64.57%)	
Work (Hr.)			0.001*

Table 25 (continued)

Personal factor	Shoulder pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
8-10	105(46.05%)	123(53.95%)	
11-13	30(23.44%)	98(76.56%)	
Computer (Hr.)			0.001*
1-4	97(46.19%)	113(53.81%)	
5-6	38(26.03%)	108(73.97%)	
Housework (Hr.)			0.001*
0-1	88(49.72%)	89(50.28%)	
2-3	47(26.26%)	132(73.74%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 25 shows that factors associated with shoulder pain, including age,education level, number of teaching room,daily working hours, daily computer use time, and daily housework time, were significantly $p<0.05$.

Table 26 Factors associated with upper back pain

Personal factor	Upper back pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.747
Male	66(42.31%)	90(57.69%)	
Female	89(44.50%)	111(55.50%)	
Age			0.040*
24-39	101(48.10%)	109(51.90%)	
40-55	54(36.99%)	92(63.01%)	
Education			0.010*
Senior High Schooland below	17(28.30%)	43(71.70%)	
Bachelor degreeand above	138(46.62%)	158(53.38%)	
Marital Status			0.402
Notmarried(Single,Widowed/Divorced/Separated)	30(48.39%)	32(52.61%)	
Married	125(42.51%)	169(57.48%)	
BMI			0.591
Abnormal(＜18.5, 24-28)	28(40.00%)	42(60.00%)	
Normal(18.5-24)	127(44.41%)	159(55.59%)	
Number of teaching room			0.024*
2-3	113(47.88%)	123(52.12%)	

Table 26 (continued)

Personal factor	Upper back pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
4-6	42(35.00%)	78(65.00%)	
Years of work			0.033*
＜20	120(47.24%)	134(52.76%)	
＞21-30	35(34.31%)	67(65.69%)	
Illness			0.835
No	145(43.81%)	186(56.19%)	
Yes	10(40.00%)	15(60.00%)	
Exercise			0.327
Exercise＜2 times /week	99(45.62%)	118(54.37%)	
Exercise＞3 times /week	56(40.29%)	83(59.71%)	
Smoking			0.376
No	123(44.89%)	151(55.11%)	
Yes	32(39.02%)	50(60.98%)	
Alcohol			0.373
No	104(45.41%)	125(54.59%)	
Yes	51(40.16%)	76(59.84%)	
Work (Hr.)			0.001*
8-10	117(51.32%)	111(48.68%)	
11-13	38(29.69%)	90(70.31%)	

Table 26 (continued)

Personal factor	Upper back pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Computer (Hr.)			0.002*
1-4	106(50.48%)	104(49.52%)	
5-6	49(33.56%)	97(66.44%)	
Housework (Hr.)			0.001*
0-1	96(54.24%)	81(45.76%)	
2-3	59(32.96%)	120(67.04%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 26 shows that factors associated with upper back pain,including age, education level,number of teaching room,years of work, daily working hours, daily computer use time, daily housework time were significantly $p<0.05$.

Table 27 Factors associated with elbow pain

Personal factor	Elbow pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.283
Male	152(97.44%)	4(2.56%)	
Female	190(95.00%)	10(5.00%)	
Age			0.269
24-39	204(97.14%)	6(2.86%)	
40-55	138(94.52%)	8(5.48%)	
Education			0.267
Senior High Schooland below	56(93.30%)	4(6.70%)	
Bachelor degreeand above	286(96.62%)	10(3.38%)	
Marital Status			0.718
Notmarried(Single,Widowed/Divorced/Separated)	59(95.16%)	3(4.84%)	
Married	283(96.26%)	11(3.74%)	
BMI			1.000
Abnormal(＜18.5, 24-28)	68(97.14%)	2(2.86%)	
Normal(18.5-24)	274(95.80%)	12(4.20%)	
Number of teaching room			0.780
2-3	226(95.76%)	10(4.24%)	

Table 27 (continued)

Personal factor	Elbow pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
4-6	116(96.70%)	4(3.30%)	
Years of work			0.126
＜20	247(97.24%)	7(2.76%)	
＞21-30	95(93.14%)	7(6.86%)	
Illness			0.257
No	319(96.37%)	12(3.63%)	
Yes	23(92.00%)	2(8.00%)	
Exercise			1.000
Exercise＜2 times /week	208(95.85%)	9(4.15%)	
Exercise＞3 times /week	134(96.40%)	5(3.60%)	
Smoking			0.536
No	262(95.62%)	12(4.38%)	
Yes	80(97.56%)	2(2.44%)	
Alcohol			0.777
No	219(95.63%)	10(4.37%)	
Yes	123(96.85%)	4(3.15%)	
Work (Hr.)			0.581
8-10	220(96.49%)	8(3.51%)	

Table 27 (continued)

Personal factor	Elbow pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
11-13	122(95.31%)	6(4.69%)	
Computer (Hr.)			0.582
1-4	203(96.70%)	7(3.30%)	
5-6	139(95.21%)	7(4.79%)	
Housework (Hr.)			0.415
0-1	172(97.18%)	5(2.82%)	
2-3	170(94.97%)	14(5.03%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 27 shows the factors associated with elbow pain, none of all factor was significant $p<0.05$.

Table 28 Factors associated with lower back pain

Personal factor	Lower back pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.093
Male	35(22.44%)	121(77.56%)	
Female	61(30.50%)	139(69.50%)	
Age			0.001*
24-39	71(33.81%)	139(66.19%)	
40-55	25(17.12%)	121(82.89%)	
Education			0.025*
Senior High Schooland below	9(15.00%)	51(85.00%)	
Bachelor degreeand above	87(29.39%)	209(70.61%)	
Marital Status			1.000
Notmarried(Single,Widowed/Divorced/Separated)	17(27.42%)	45(72.58%)	
Married	79(26.87%)	215(73.13%)	
BMI			0.369
Abnormal(＜18.5, 24-28)	22(31.43%)	48(68.57%)	
Normal(18.5-24)	74(25.87%)	212(74.13%)	
Number of teaching room			0.001*
2-3	80(33.90%)	159(66.10%)	

Table 28 (continued)

Personal factor	Lower back pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
4-6	16(13.30%)	104(86.70%)	
Years of work			0.001*
＜20	83(32.67%)	171(67.32%)	
＞21-30	13(12.74%)	89(87.25%)	
Illness			0.248
No	92(27.79%)	239(72.21%)	
Yes	4(16.00%)	21(84.00%)	
Alcohol			0.901
No	61(26.64%)	168(73.36%)	
Yes	35(27.56%)	92(72.44%)	
Work (Hr.)			0.001*
8-10	84(36.84%)	144(63.16%)	
11-13	12(9.38%)	116(90.62%)	
Computer (Hr.)			0.001*
1-4	73(34.76%)	137(65.24%)	
5-6	23(15.75%)	123(84.25%)	
Housework (Hr.)			0.001*
0-1	69(38.98%)	108(61.02%)	
2-3	27(15.08%)	152(84.92%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 28 shows that factors associated with lower back pain, including age,education level, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time were significantly $p<0.05$.

Table 29 Factors associated with wrists/hands pain

Personal factor	Wrists/Hands pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.522
Male	73(46.79%)	83(53.21%)	
Female	101(50.50%)	99(49.50%)	
Age			0.003*
24-39	117((55.71%)	93(44.29%)	
40-55	57(39.04%)	89(60.96%)	
Education			0.001*
Senior High Schooland below	17(28.30%)	43(71.70%)	
Bachelor degreeand above	157(53.04%)	139(46.96%)	
Marital Status			0.780
Notmarried(Single,Widowed/Divorced/Separated)	29(46.77%)	33(53.23%)	
Married	145(49.32%)	149(50.68%)	
BMI			0.287

Table 28 (continued)

Personal factor	Wrists/Hands pain		Exact-P
	No n (%)	Yes n (%)	
Abnormal(＜18.5, 24-28)	30(42.86%)	40(57.14%)	
Normal(18.5-24)	144(50.35%)	142(49.65%)	
Number of teaching room			0.001*
2-3	134(56.78%)	102(43.22%)	
4-6	40(33.30%)	80(66.70%)	
Years of work			0.001*
＜20	138(54.33%)	116(45.67%)	
＞21-30	36(35.29%)	66(64.71%)	
Illness			1.000
No	162(48.94%)	169(51.06%)	
Yes	12(48.00%)	13(52.00%)	
Exercise			0.913
Exercise＜2 times /week	107(49.31%)	110(50.69%)	
Exercise＞3 times /week	67(48.20%)	72(51.80%)	
Smoking			0.133
No	140(51.09%)	134(48.91%)	
Yes	34(41.46%)	48(58.54%)	
Alcohol			0.826
No	113(49.34%)	116(50.66%)	

Table 29 (continued)

Personal factor	Wrists/Hands pain		Exact-P
	No	**Yes**	
	n (%)	**n (%)**	
Yes	61(48.03%)	66(51.97%)	
Work (Hr.)			0.001*
8-10	132(57.89%)	96(42.11%)	
11-13	42(32.81%)	86(67.19%)	
Computer (Hr.)			0.001*
1-4	119(56.70%)	91(43.30%)	
5-6	55(37.67%)	91(62.33%)	
Housework (Hr.)			0.001*
0-1	115(64.97%)	62(35.03%)	
2-3	59(32.96%)	120(67.04%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 29 shows that factors associated with wrists/hands pain, including age, education level, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time were significantly $p<0.05$.

Table 30 Factors associated with hips/thighs/buttocks pain

Personal factor	Hips/Thighs/Buttocks pain		Exact -P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.003*
Male	115(73.72%)	41(26.28%)	
Female	117(58.50%)	83(41.50%)	
Age			0.001*
24-39	153(72.86%)	57(27.14%)	
40-55	79(54.11%)	67(45.89%)	
Education			0.001*
Senior High Schooland below	27(45.00%)	33(55.00%)	
Bachelor degreeand above	205(69.26%)	91(30.74%)	
Marital Status			0.309
Notmarried(Single,Widowed/Divorced/Separated)	44(70.97%)	18(29.03%)	
Married	188(63.95%)	106(36.05%)	
BMI			0.676
Abnormal(＜18.5, 24-28)	44(62.86%)	26(37.14%)	
Normal(18.5-24)	188(65.73%)	98(34.27%)	
Number of teaching room			0.290
2-3	149(63.14%)	87(36.86%)	

Table 30 (continued)

Personal factor	Hips/Thighs/Buttocks pain		Exact -P
	No n (%)	Yes n (%)	
4-6	83(69.17%)	37(30.83%)	
Years of work			0.026*
＜20	175(68.90%)	79(31.10%)	
＞21-30	57(55.88%)	45(44.12%)	
Illness			0.831
No	215(64.95%)	116(35.05%)	
Yes	17(68.00%)	8(32.00%)	
Exercise			0.494
Exercise＜2 times /week	138(63.59%)	79(36.41%)	
Exercise＞3 times /week	94(67.63%)	45(32.37%)	
Smoking			0.896
No	179(65.33%)	95(34.67%)	
Yes	53(64.63%)	29(35.37%)	
Alcohol			0.063
No	141(61.57%)	88(38.43%)	
Yes	91(71.65%)	36(28.34%)	
Work (Hr.)			0.420
8-10	145(63.60%)	83(36.40%)	
11-13	87(67.97%)	41(32.03%)	

Table 30 (continued)

Personal factor	Hips/Thighs/Buttocks pain		Exact -P
	No	**Yes**	
	n (%)	**n (%)**	
4-6	83(69.17%)	37(30.83%)	
Computer (Hr.)			1.000
1-4	137(65.24%)	73(34.76%)	
5-6	95(65.07%)	51(34.93%)	
Housework (Hr.)			0.149
0-1	122(68.93%)	55(31.07%)	
2-3	110(61.45%)	69(38.55%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 30 shows the factors associated with hips/thighs/buttocks pain, including gender, age, education level, years of work experience were significantly $p<0.05$.

Table 31 Factors associated with knees pain

Personal factor	Knees pain		Exact -P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.453
Male	67(42.95%)	89(57.05%)	
Female	95(47.50%)	105(52.50%)	
Age			0.451
24-39	92(43.81%)	118(56.19%)	
40-55	70(47.95%)	76(52.05%)	
Education			0.571
Senior High Schooland below	25(41.70%)	35(58.30%)	
Bachelor degreeand above	137(46.28%)	159(53.72%)	
Marital Status			0.207
Notmarried(Single,Widowed/Divorced/Separated)	33(53.23%)	29(46.77%)	
Married	129(43.88%)	165(56.12%)	
BMI			0.141
Abnormal(＜18.5, 24-28)	26(37.14%)	44(62.86%)	
Normal(18.5-24)	136(47.55%)	150(52.45%)	
Number of teaching room			0.072
2-3	99(41.95%)	137(58.05%)	

Table 31 (continued)

Personal factor	Knees pain		Exact -P
	No	Yes	
	n (%)	n (%)	
4-6	63(52.50%)	57(47.50%)	
Years of work			0.907
＜20	115(45.28%)	139(54.72%)	
＞21-30	47(46.08%)	55(53.92%)	
Illness			0.678
No	152(45.92%)	179(54.08%)	
Yes	10(40.00%)	15(60.00%)	
Exercise			0.663
Exercise＜2 times /week	101(46.54%)	116(53.46%)	
Exercise＞3 times /week	61(43.88%)	78(56.12%)	
Smoking			0.313
No	129(47.08%)	145(52.92%)	
Yes	33(40.24%)	49(59.76%)	
Alcohol			0.912
No	105(45.85%)	124(54.15%)	
Yes	57(44.88%)	70(55.12%)	
Work (Hr.)			0.121
8-10	111(48.68%)	117(51.32%)	
11-13	51(39.84%)	77(60.16%)	

Table 31 (continued)

Personal factor	Knees pain		Exact -P
	No	**Yes**	
	n (%)	**n (%)**	
Computer (Hr.)			0.914
1-4	95(45.24%)	115(54.76%)	
5-6	67(45.89%)	79(54.11%)	
Housework (Hr.)			0.831
0-1	82(46.33%)	95(53.67%)	
2-3	80(44.69%)	99(55.31%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 31 shows the factors associated with knees pain, none of all factors was significant $p<0.05$.

Table 32 Factors associated with ankle/foot pain

Personal factor	Ankle/Foot pain		Exact -P
	No	**Yes**	
	n (%)	**n (%)**	
Gender			0.915
Male	79(50.64%)	77(49.36%)	
Female	103(51.50%)	97(48.50%)	
Age			0.196
24-39	101(48.10%)	109(51.90%)	
40-55	81(55.48%)	65(44.52%)	
Education			0.481
Senior High Schooland below	28(46.70%)	32(53.30%)	
Bachelor degreeand above	154(52.03%)	142(48.97%)	
Marital Status			0.125
Notmarried(Single,Widowed/Divorced/Separated)	26(41.94%)	36(58.06%)	
Married	156(53.06%)	138(46.94%)	
BMI			0.143
Abnormal(＜18.5, 24-28)	30(42.86%)	40(57.14%)	
Normal(18.5-24)	152(53.15%)	134(46.85%)	
Number of teaching room			1.000
2-3	121(51.27%)	115(48.73%)	

Table 32 (continued)

Personal factor	Knees pain		Exact -P
	No	**Yes**	
	n (%)	**n (%)**	
4-6	61(50.83%)	59(49.17%)	
Years of work			0.412
＜20	126(49.61%)	128(50.39%)	
＞21-30	56(54.90%)	46(45.10%)	
Illness			0.536
No	171(51.66%)	160(48.34%)	
Yes	11(44.00%)	14(56.00%)	
Exercise			0.022*
Exercise＜2 times /week	100(46.08%)	117(53.92%)	
Exercise＞3 times /week	82(58.99%)	57(41.01%)	
Smoking			0.802
No	139(50.73%)	135(49.27%)	
Yes	43(52.44%)	39(47.56%)	
Alcohol			0.912
No	118(51.53%)	111(48.47%)	
Yes	64(50.39%)	63(49.61%)	
Work (Hr.)			0.269
8-10	122(53.51%)	106(46.49%)	
11-13	60(46.88%)	68(53.12%)	

Table 32 (continued)

Personal factor	Knees pain		Exact -P
	No	**Yes**	
	n (%)	**n (%)**	
Computer (Hr.)			0.591
1-4	110(52.38%)	100(47.62%)	
5-6	72(49.32%)	74(50.68%)	
Housework (Hr.)			0.203
0-1	84(47.46%)	93(52.54%)	
2-3	98(54.75%)	81(45.25%)	

*** significant at p-value < 0.05, Fisher's Exact Test**

Table 32 shows the factors associated with ankle/foot pain, including exercise was significantly $p<0.05$

CHAPTER V

CONCLUSION AND DISCUSSIONS

The title of the study was ergonomics risk factor association with work-related musculoskeletal disorder among middle school teachers in Hejiang county, China. This study aims to determine the prevalence of WMSDs among middle school teachers in Hejiang County and to determine the ergonomics risk factor of WMSDs among middle school teachers in Hejiang County and assess the factors related WMSDs among middle school teachers in Hejiang County. The study population consists of 1,665 individuals. The sample size was determined using Taro Yamane's formula, yielding a final sample of 356 individuals, selected through the cluster sampling method. The study employed a structured questionnaire as the primary research instrument, comprising the following sections: section 1: personal factors, section 2: work-related musculoskeletal disorders and section 3: ergonomic factors. The collected data were analyzed using statistical software, employing the Chi-square test analysis method for data processing. The study findings are structured as follows:

1. Conclusion
2. Discussion of Results
3. Generalizability
4. Research Recommendations

Conclusion

Personal factors

The study sample comprised 356 teachers, with a majority being female (56.18%). The mean age was 37.8 years (range: 24–53). Most held a bachelor's degree (70.51%) and were married (82.58%). The majority had a normal BMI (80.34%). Regarding teaching characteristics, most taught two courses (37.08%) and had less than 10 years of experience (38.20%). Nearly all were right-handed (98.60%) and had no history of WMSDs (92.98%). In terms of lifestyle, most exercised 1–2 times per week (34.83%), did not smoke (76.97%), and did not drink alcohol (64.33%). Most worked 10 hours per day (22.75%), used computers for 3 hours (27.53%), and did housework for 2 hours daily (49.16%).

Prevalence

The prevalence of WMSDs among middle school teachers in Hejiang County. The highest prevalence was reported in the lower back (73.03%), followed by the neck (65.17%). The elbow had the lowest prevalence, with only 3.93% of teachers reporting symptoms.

Ergonomic risk factors

The frequency and percentage of various ergonomic risk factors among middle school teachers. The most commonly reported ergonomic risk was physical load, with 58.08% of respondents indicating exposure. This was followed by repetitive work at 51.59%, and work environment at 44.24%. Meanwhile, dynamic load and static load were reported by 33.65% and 34.46% of participants, respectively.

Factors associated with WMSDs

This study found that the factors associated with work-related musculoskeletal disorders (WMSDs) among middle school teachers in Hejiang County. Factors associated with neck pain include exercise and daily working hours. Factors associated with the shoulder pain included age,education level, number of teaching room, daily working hours, daily computer use time, and daily housework time. Factors associated with upper back pain included age,education level,number of teaching room,years of work, daily working hours, daily computer use time, and daily housework time. Factors associated with lower back pain included age,education level, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time. Factors associated with wrist/hand pain included age, education level, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time. Factors associated with hips/thighs/buttocks pain included gender, age, education level, and years of work. Factors associated with ankle/foot pain included exercise.

Discussion of Results

The prevalence of the WMSDs

This study investigated the prevalence of musculoskeletal pain among school teachers. Through a cross-sectional survey of 356 teachers in Hejiang County, the results showed that the prevalence of musculoskeletal pain in the teacher group was high, especially in the lower back (73.03%), neck (65.17%) and shoulder (62.09%), while the elbow (3.93%) had the lowest prevalence. This result is consistent with a study in Pakistan (Arshad, 2021), which showed that the most common pain site for teachers in the past 5

months was the waist (60.2%), followed by the neck (50.2%). In addition, Mohammad (2023) also reached a similar conclusion, finding that 62.39% of teachers reported neck pain, 41.28% reported shoulder pain, 40.37% reported upper back pain, and elbow pain accounted for only 9.7%, further supporting the findings of this study. Similarly, a study in New Delhi, India (Kundra, 2024) also pointed out that the most common sites of musculoskeletal diseases among primary and secondary school teachers were the lower back, neck and shoulders. This trend was reflected in teacher groups in different countries, indicating that this profession has a higher risk of musculoskeletal health. This prevalence distribution shows that musculoskeletal diseases in the lower back, neck and shoulders are particularly prominent in the teacher group, which is mainly related to their work characteristics and long-term poor posture. First, lower back pain often comes from teachers standing for long periods of time while teaching, and maintaining a bad sitting posture for a long time when correcting homework and preparing lessons, which causes excessive pressure on the lumbar spine. Secondly, neck pain is related to teachers frequently bowing their heads to correct homework, prepare lessons, and use electronic devices (such as computers and projectors) for a long time. The forward-leaning posture will keep the cervical muscles in a state of tension for a long time, increasing the risk of disease. In addition, shoulder pain is mainly caused by repetitive actions such as writing on the blackboard or whiteboard, raising the arms for a long time, and frequently using a mouse or keyboard. These actions keep the shoulder muscles tense and easily lead to strain.

Ergonomic risk factors

Teachers' work involves frequent reading, correcting students' homework, using computers, and writing on the blackboard. During classroom teaching, teachers need to constantly turn back and forth between the blackboard and students, and often need to

perform dynamic load activities, which put the trunk in mild and severe bending and mild twisting postures. These movements may increase the risk of musculoskeletal disorders (WMSDs). Studies have shown (Wu et al., 2018) that teachers who are in bad postures for a long time, such as frequent bending and twisting of the trunk, may cause the occurrence of WMSDs such as neck-shoulder syndrome, carpal tunnel syndrome, and low back pain. Ramírez-García et al. (2023) also supported this view in their survey of 134 primary school teachers. The results showed that teachers generally believed that these discomforts were mainly caused by bad postures. Therefore, the working characteristics of dynamic loads may be an important factor in the high incidence of WMSDs among teachers, and corresponding prevention and intervention measures need to be taken. This study found that the static load factors that affect teachers' WMSDs are long periods of standing and sitting and long periods of working in the same posture. The results are consistent with previous studies. Kraemer et al. (2021) found that 80% of teachers stand for long periods of time in class and 84% of teachers sit for more than 60% of the time. A study in Egypt (Fahmy et al., 2022) also proved that long periods of standing or sitting and long periods of sitting in a chair are related to teachers' WMSDs. Teachers' work involves high-frequency physical loads, such as raising their arms and maintaining bad postures, which may lead to WMSDs. The data of this study showed that 68% of teachers need to grab objects with their arms or hands, 52.5% of teachers need to raise their arms above the shoulder level, and 55.6% of teachers need to work in uncomfortable postures, indicating that high-load work movements are one of the main reasons for the high incidence of WMSDs among teachers. Ramírez-García et al. (2023) found that the incidence of shoulder and upper limb pain in teachers who maintain long-term arm raising or bowing their heads at desks is significantly higher than that of other occupational groups, further indicating

that excessive upper limb load is an important cause of WMSDs. Long-term use of arms raised or maintaining uncomfortable postures, especially musculoskeletal diseases of the shoulders, neck and upper back, has become a major risk factor for these parts (Murugan et al., 2021). Additionally, the study found that more than half of teachers (55.6%) work in uncomfortable postures, which can lead to injuries to the lower back, knees, and hips (Kundra et al., 2024). Teachers need to frequently raise their arms to write or perform other high-frequency upper limb movements, and often use computers to prepare teaching materials, conduct online classes, manage student assignments and grades, and communicate with parents and colleagues. These repetitive wrist movements, such as clicking the mouse and tapping the keyboard, may cause symptoms such as pain, numbness, and tingling in the fingers, wrists, and forearms. Kee (2021) pointed out that pain and compulsive postures are closely related to repetitive tasks. In addition, Kraemer (2021) found that frequent use of keyboards and mice may also cause pain in the lower back, shoulders, and neck. Teachers' working environment plays a vital role in the occurrence of WMSDs, and unreasonable working conditions may significantly increase the risk of teachers' illness. Among them, unreasonable classroom layout, long-term standing, non-ergonomic desks and chairs, excessive use of electronic devices, and high work pressure are all important factors leading to WMSDs. Iavarasi (2010) pointed out that if the desks used by teachers do not match the human body in width and height, it is easy to cause various musculoskeletal problems. Similarly, in a study in Ghana, 98% of teachers and researchers suffered from different types of diseases due to ergonomic factors in the school environment (such as furniture type, physical environment, teaching materials, social environment and teaching aids), of which 86% of respondents attributed pain and discomfort to unreasonable school furniture design. In addition, teachers work with their

arms raised for a long time without support, especially when writing on the blackboard. Because they need to maintain a specific posture, this repetitive movement can easily lead to friction, tension and strain in the cervical humeral area (Temesgen, 2019). It is worth noting that a study showed that teachers in private schools who used adjustable blackboards had a lower incidence of WMSDs than teachers in public schools that were not equipped with adjustable blackboards (Amoakohene, 2022), which further shows that reasonable configuration of teaching facilities plays a positive role in reducing the risk of WMSDs.

Factors associated with WMSDs

This study found that the factors associated with work-related musculoskeletal disorders (WMSDs) among middle school teachers in Hejiang County. Factors associated with neck pain include exercise and daily working hours. Existing literature has clearly pointed out that there is a significant positive correlation between sitting for more than 6 hours a day and musculoskeletal discomfort in the neck (Meng et al., 2025). In addition, working for long periods of time and maintaining a uniform posture increases the risk of neck pain (Kallings et al., 2021). On the other hand, regular exercise, especially strength training for the neck and shoulders, has been shown to effectively relieve and prevent neck pain (Jones et al., 2024). Studies have shown that 2-3 times a week of targeted shoulder and neck resistance training can significantly improve pain levels and disability scores (Sitthipornvorakul et al., 2021). At the same time, even light physical activity, such as intermittent walking and stretching exercises, can help interrupt the negative effects of sedentary behavior, thereby reducing the risk of neck discomfort (Kallings et al., 2021).

Factors associated with the shoulder pain included age,education level,number of teaching rooms, daily working hours, daily computer use time, and daily housework time. In a study in Ethiopia, the risk of shoulder and neck pain increased by approximately 2.85

times for every additional year of age among teachers (Temesgen et al., 2019). This may be related to age-related musculoskeletal degenerative changes, decreased tissue repair capacity, and the accumulation of long-term occupational load. Educational level may affect the content and working methods of teachers, thereby indirectly affecting the incidence of shoulder pain. For example, teachers with higher education may be more engaged in activities such as research, lesson preparation, and computer use, which often involve long periods of static posture and repetitive movements, increasing the burden on shoulder muscles (Fahmy et al., 2022). The increase in the number of classes taught means that teachers need to take on more teaching tasks and lesson preparation, leading to overuse of shoulder muscles. In a study conducted in Gondar, Ethiopia, it was found that the prevalence of shoulder and/or neck pain was significantly higher among teachers who taught more than 30 hours per week than among teachers who taught less. The study pointed out that an increase in teaching time is closely related to the occurrence of shoulder pain (Temesgen et al., 2019). Longer working hours per day were also associated with a higher incidence of shoulder pain. Long working hours without adequate rest can lead to muscle fatigue and overuse injuries. This is consistent with the results of a systematic review and meta-analysis that reported a high prevalence of musculoskeletal disorders among teachers due to ergonomic risk factors (Tahernejad et al., 2024). Similarly, long hours of computer use per day were significantly associated with shoulder pain. Continuous computer use often leads to poor postures, such as constant elevation of the arms and weight bearing on the shoulders, which are recognized risk factors for shoulder musculoskeletal disorders (Argus et al., 2023). In addition, longer daily housework hours were also associated with shoulder pain. Housework often involves repetitive overhead activities, heavy lifting, and uncoordinated postures, which can put considerable stress on the

shoulder muscles and joints, thereby increasing the risk of musculoskeletal symptoms (Lin et al., 2024).

Factors associated with upper back pain included age, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time. Age and BMI are important factors affecting upper back pain. Studies have shown that with age, the body's metabolic function and the recovery capacity of the musculoskeletal system gradually decline, increasing the risk of upper back disease (Seaman, 2013). Studies have shown that an increase in the number of classes taught may be associated with the occurrence of upper back pain. A study of Egyptian teachers found that teachers who taught more than 20 classes per week had a 31% increased risk of musculoskeletal diseases. In addition, another study pointed out that the prevalence of upper back pain was significantly increased among teachers who taught more than 7 classes (Fahmy et al., 2022). These studies suggest that an increase in the number of classes taught may lead to the occurrence of upper back pain by increasing workload and repetitive movements. In addition, in a study in Ethiopia, 754 teachers were surveyed and the prevalence of shoulder and/or neck pain was found to be 57.3%. The study pointed out that the prevalence of shoulder and/or neck pain among teachers with more than 30 years of teaching experience was as high as 77. 2%, which was significantly higher than that of teachers with shorter teaching experience (Temesgen et al., 2019).Secondly, the length of daily working hours is also an important risk factor for upper back pain. Long working hours are often accompanied by long static postures, which increase muscle fatigue and spinal pressure, leading to upper back pain (Amiri, 2023). Similarly, the relationship between computer use time and upper back pain has also been verified. Studies have shown that long computer use time, especially frequent use of mouse and keyboard activities in office environments, can

overload the shoulder and back muscles, leading to the occurrence of pain (Tantipanjaporn et al., 2019). Studies have shown that there is a significant relationship between the physical demands of housework and upper back pain in women. Long-term high-intensity housework, especially cleaning and lifting heavy objects, may lead to excessive burden on the spine and muscles, increasing the risk of upper back pain (Osinuga et al., 2021). In summary, the results of this study are consistent with previous studies, indicating that factors such as age, BMI, working hours, computer use time, and housework time all have a significant impact on teachers' upper back pain.

Factors associated with lower back pain included age, education level, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time. As people age, physiological changes such as disc degeneration, decreased spinal stability, and weakened muscle strength can significantly increase the risk of lower back pain (Tesfaye et al., 2023). The characteristics of the teaching profession determine that when there are more classes, teachers need to bear more repetitive load labor such as standing, walking, preparing lessons and correcting them. Long-term accumulation can easily cause chronic strain of the lower back soft tissue and spine (Almansour et al., 2024). In addition, the longer the working years, the longer the accumulated occupational exposure time, which also means that the lumbar spine is subjected to small but continuous occupational stress for a long time, increasing the risk of lower back injury and pain (Mohseni Bandpei et al., 2014). The risk is further increased by longer working hours, especially when there is a lack of proper rest and changes in body position. Maintaining a fixed posture (such as standing or sitting) for a long time can easily lead to muscle fatigue, blood circulation disorders and increased pressure on small joints, thereby inducing lower back pain (Raizah et al., 2023). In modern educational environments, teachers use

computers extensively for lesson preparation, grading and teaching management. Long-term use of computers in an unhealthy sitting posture, such as sitting for a long time, leaning forward, and tense shoulders and neck, causes abnormal pressure on the lumbar spine, which is one of the important causes of low back pain (Galof et al., 2021). At the same time, in addition to completing daily teaching work, teachers still need to undertake housework, such as cooking, cleaning and taking care of the family. Repeated bending, lifting heavy objects and continuous postural loads during housework will also significantly increase the risk of lumbar spine injury (Chakravarthy et al., 2020).

Factors associated with wrist/hand pain included age, education level, number of teaching rooms, years of work, daily working hours, daily computer use time, and daily housework time. First, age is an important factor affecting teachers' wrist pain. With age, tendon elasticity decreases, soft tissue degenerates, and the wrist is more susceptible to chronic strain and pain problems (Tahernejad et al., 2024). Recent studies have shown a significant association between lower education levels and an increased prevalence of wrist pain, particularly work-related musculoskeletal disorders (WMSDs) (Yang et al,2023). In addition,Feng et al. (2021) pointed out that office workers with lower education levels were more likely to report wrist and hand symptoms, suggesting that lower education level may be an important risk factor for upper limb musculoskeletal diseases such as carpal tunnel syndrome. Regarding the number of classes taught, the larger the teaching workload, the more blackboard writing, homework correction, and data organization teachers need, and the more repetitive hand movements they need, which increases the probability of wrist injury (Souza et al., 2021). The longer the working years, the more severe the cumulative hand muscle strain experienced by teachers, which increases the risk of wrist/hand pain (Darwish et al., 2013).The results of this study show that the longer the daily working hours

of teachers, the higher the incidence of wrist pain. This is consistent with the analysis results of Amiri, which showed that long working hours significantly increased the risk of musculoskeletal pain (including upper limbs). Maintaining a single posture for a long time (such as typing, correcting homework) may cause continuous force on the wrist, leading to fatigue injury (Amiri, 2023). Computer use time is also an important factor. Studies have shown that long-term computer operation is closely related to diseases such as carpal tunnel syndrome and tendonitis (Saito et al., 2021). Continuous mouse clicking and keyboard tapping can cause damage to the wrist and hand structure. Finally, increased housework time is also an important risk factor. Repeated washing, carrying, cleaning and other actions put the wrist joints under continuous load, aggravating strain and pain (Norouzi et al., 2023).

Factors associated with hips/thighs/buttocks pain included gender, age, education level, and years of work. Gender is a significant influencing factor. Studies have found that men have larger muscle cross-sectional area (CSMA) and lower fat infiltration (MFI) in the buttocks and hip regions, while women show more obvious differences in fat area and structure, such as smaller femoral neck width and flatter femoral head, which may make women more susceptible to hip/groin injuries. In addition, women's income and career development are often limited by gender roles, and this social structural difference may also indirectly affect the intensity of their labor and the degree of exposure to related health problems (Li et al., 2024).In terms of age, the incidence of pain increases with age. Older teachers may be more prone to chronic pain problems due to soft tissue degeneration, decreased mobility and weakened recovery ability (Aldhafian et al., 2021).Studies have shown that people with lower education levels are more likely to experience musculoskeletal pain in the buttocks, hips, and thighs, which is related to their high-

intensity physical labor, lack of ergonomic knowledge, and lack of health awareness. A Danish study showed that the incidence of musculoskeletal pain in people with lower education levels was significantly higher than that in people with higher education levels (Hansen et al., 2023); another large study on patients with hip osteoarthritis also found that people with lower education levels had higher pain scores and used more painkillers (Johnsen et al., 2021).Years of work have a cumulative effect in this process, especially in occupations that engage in heavy physical labor or maintain static postures for a long time (such as the shoemaking industry). As the length of work increases, the incidence of hip and lower limb musculoskeletal diseases increases significantly (Zhang et al., 2024).

Factors associated with ankle/ foot pain included exercise. A study found that people who lack exercise for a long time are prone to pain and dysfunction in the ankle and foot due to insufficient muscle strength, limited joint mobility and poor proprioception. Exercise can enhance muscle strength and joint stability, thereby reducing the risk of injury and pain in the ankle and foot. Lack of exercise can reduce the fatigue tolerance of the ankle and foot muscles and increase the chance of injury(JANMI,2021).

Generalizability

1.The results of this study are applicable to teachers in other counties and cities in China with similar teaching environments, work content, and work intensity (such as standing for long periods of time, correcting homework, using electronic devices, etc.).

2.This study is suitable for people who work at a desk or stand for a long time, such as office workers, scientific researchers, medical staff, service personnel, etc.

Recommendation for Further Research

1. Expand the scope of the study: Conduct similar studies in other counties and cities in China, especially in urban, rural and economically developed areas, to understand the impact of different environments on teachers' WMSDs.

2. Effectiveness of intervention measures: Test the long-term effects of different ergonomic intervention measures (such as standing teaching, adjusting desk height, and increasing rest time) on teachers' health.

3. Teachers of different subjects such as mathematics, physical education, and music may face different musculoskeletal risks, and further study the specific effects of each subject.

4. Study whether psychological factors such as work stress and burnout exacerbate teachers' musculoskeletal diseases.

5. Study intervention and prevention strategies, including evaluating the effectiveness of ergonomic training (such as correct standing and sitting postures, exercise recommendations), optimizing the working environment (such as adjustable tables and chairs, electronic teaching tools) to reduce teachers' musculoskeletal diseases, and adjusting the work system (such as reasonable course arrangement and increasing break time between classes) to reduce occupational risks.

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APPENDIX

Appendix A

Interview forms

Prevalence and ergonomics risk factor association with work-related of musculoskeletal disorders among middle school teachers in Hejiang County.

Consent Day Date.....Month.....Year.....

I am Mr. / Mrs. / Miss. . . . . address..... Read the details from the information sheet for participants in the research project and I agree to voluntarily participate in the research project.

I have received a copy of the consent form that I signed and dated, along with an information sheet for research participants. This is before signing the consent form to conduct this research. I explained to the researcher the purpose of the study. The duration of the research, research methods, dangers or symptoms that may arise from the research. or from the medicine used Including the benefits that will emerge from the research and guidelines for treatment by other methods in detail, I have had enough time and opportunity to ask questions until I have a good understanding. The researcher answered various questions willingly and without concealment until I was satisfied.

I have the right to terminate my participation in the research project at any time. There is no need to inform the reason. and termination of my involvement in this research It will not affect treatment or other rights that I will continue to receive. The researcher guarantees that my personal information will be kept secret. and will be disclosed only

with my consent. Other persons on behalf of the research sponsoring company Human Research Ethics Committee the Food and Drug Administration may be permitted to inspect and process my information. This must be done to verify the accuracy of the information only. By agreeing to participate in this study, I am giving consent to have my medical history reviewed.

I have read the above and have a complete understanding of it. Willing to participate in research willingly. Therefore, signed this consent document.

.....Sign the person giving consent.

(.....) Name of person giving consent

Date .....Month.....Year.....

I have explained the purpose of the research, the research methods, dangers or adverse reactions or risks that may arise from the research. or from the medicine used Including the benefits that will arise from thorough research. Let the participants in the research project named above know and have a good understanding. Ready to sign the consent document willingly

.....

Signed by the researcher

(.....)

Name of the researcher in detail

Date .....Month……..Year…….

.....	.....
Witness signature	Witness signature
(.....)	(.....)
Name of witness in detail	Name of witness in detail
Date .....Month…..Year……	Date .....Month……..Year…….

Prevalence and ergonomics risk factor association with work-related of musculoskeletal disorders among middle school teachers in Hejiang County.

…….

Dear Participants

The research study will be conducted on this prevalence and ergonomics risk factor association with work-related of musculoskeletal disorders among middle school teachers in Hejiang County. The participants in this study are voluntary and the information you give us will be confidential, which means your name will not be mentioned anywhere and information provided by you will be presented only in a summarized form.

Please select carefully the answer for each question and the possible responses. Choose and mask (√) the response option that best represents your opinion, knowledge, attitude, and practice. Please notify the interviewer if you any concern about of the questions or other problem.

The questionnaire is divided into 3 parts as follows;

Part I Personal factors

Part II Work-related musculoskeletal disorders

Part III Ergonomic risk factors

The researcher hopes for your cooperation very much and I would like to thank you very much for this opportunity.

Deng Qing

Master of Public Health

Chiang Rai Rajabhat University

Part I: Personal factors

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents.

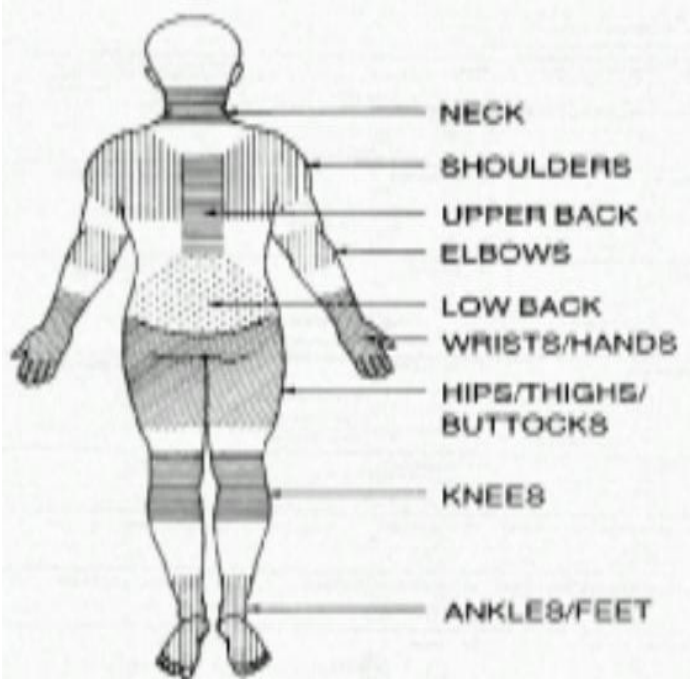
Details	**Code**
1. Gender	Gender
( ) Male ( ) Female	
2. Age ……. years	Age
3. Education	Education
( ) Junior High School ( ) Senior High School ( ) Bachelor degree ( ) Graduate students and above	
4.Marital Status	Marital
( ) Single ( ) Married ( ) Widowed/ Divorced/Separated	
5.BMI……	BMI
Hall……Centimeter **Weight** ……Kilogram	
6. Number of teaching room…… room	teaching
7. Years of work……..	years
8.Are you left-handed or right-handed?	hand
( ) Left Hand ( ) Right hand	
9.History of illness on work-related of musculoskeletal disorders	illness
( ) No ( ) Yes	

Details	Code
10.How often do you exercise?	exercise
( ) Never ( ) Work out at 1-2 times/week ( ) Work out at 3-4 times/week ( ) Work out at 5-7 times/week	
11.Do you smoking?	smoking
( ) No ( ) Yes	
12.Do you drink alcohol?	alcohol
( ) No ( ) Yes	
13.Average work hours per day ……h(including overtime)	work
14.Average computer use hours per day……h	computer
15.Average housework hours per day……h	housework

Part II: Work-related musculoskeletal disorders

Find the neck, shoulders, upper back and other parts mentioned in the scale from the picture. The boundaries of the parts may not be clear or even overlap. Determine the location of the pain (referring to the shaded area continuous pain, cramps or discomfort) based on your own feelings.

Part of body	**Have you had any in the past months (pain, cramps or discomfort)**	**Code**
Neck	☐No ☐Yes	Neck
Shoulder	☐No ☐Yes	Shoulder
Upper back	☐No ☐Yes	Upper back
Elbow	☐No ☐Yes	Elbow
Lower back	☐No ☐Yes	Lower back
Wrists/Hands	☐No ☐Yes	Wrists/Hands
Hips/Thighs/Buttocks	☐No ☐Yes	Hips/Thighs/Buttocks
Knees	☐No ☐Yes	Knees
Ankle/Foot	☐No ☐Yes	Ankle/Foot


NECK
SHOULDERS
UPPER BACK
ELBOWS
LOW BACK
WRISTS/HANDS
HIPS/THIGHS/
BUTTOCKS
KNEES
ANKLES/FEET

Part III :Ergonomics risk factor

1.Dynamic load

Do you in your work often have to:	1.bent slightly with your trunk?	( ) No	( ) Yes
	2.bent heavily with your trunk?	( ) No	( ) Yes
	3.twist slightly with your trunk?	( ) No	( ) Yes
	4.twist heavily with your trunk?	( ) No	( ) Yes
	5.bent and twist simultaneously with your trunk?	( ) No	( ) Yes
	6.make sudden, unexpected movements?	( ) No	( ) Yes
	7.perform short, but maximal force-exertions?	( ) No	( ) Yes
	8.exert great force with your arms or hands?	( ) No	( ) Yes
	9.hold things in a pinch grip with your hands?	( ) No	( ) Yes
	10.exert great force on tools or machinery?	( ) No	( ) Yes

2.Static load

Do you in your work often have to:	1.in a slightly bent posture for long periods?	( ) No	( ) Yes
	2.in a heavily bent posture for long periods?	( ) No	( ) Yes
	3.in a slightly twisted posture for long periods?	( ) No	( ) Yes
	4.in a heavily twisted posture for long periods?	( ) No	( ) Yes
	5.in a bent and twisted for long periods?	( ) No	( ) Yes
	6.bent your neck forward or hold your neck in a forward posture for lang periods?	( ) No	( ) Yes
	7.bent your neck backward or hold your neck in a backward posture for long periods?	( ) No	( ) Yes
	8.twist your neck or hold your neck in a twisted posture for long periods?	( ) No	( ) Yes
	9.bent your wrist or hold your wrist bent for long periods?	( ) No	( ) Yes
	10.twist your wrist or hold your wrist twisted for long periods?	( ) No	( ) Yes
	11.stand for long periods?	( ) No	( ) Yes
	12.sit for long periods?	( ) No	( ) Yes
	13.walk for long periods?	( ) No	( ) Yes
	14.work kneeled or squatted for long periods?	( ) No	( ) Yes
	15.work in the same posture for long periods?	( ) No	( ) Yes

3.Physical load

Do you often	1.lift heavy objects (5 to 20 kg) at work?	( ) No	( ) Yes
	2.push or pull heavy objects (5 to 20 kg)?	( ) No	( ) Yes
	3.carry heavy objects (5 to 20 kg) ?	( ) No	( ) Yes
	4.lift very heavy objects (more than 20 kg) at work?	( ) No	( ) Yes
	5.push or pull very heavy objects (more than 20 kg)?	( ) No	( ) Yes
	6.carry heavy objects (more than 20 kg)?	( ) No	( ) Yes
Do you in your work often have to：	7.Use hands/arms to pick up objects?	( ) No	( ) Yes
	8.hold your hands at or under shoulder level?	( ) No	( ) Yes
	9.hold your hands above shoulder level?	( ) No	( ) Yes
	10.work in uncomfortable postures?	( ) No	( ) Yes
Do you often lift heavy objects in the following situations?	11.In an uncomfortable position?	( ) No	( ) Yes
	12.Lift objects away from your body?	( ) No	( ) Yes
	13.Need to turn around when working?	( ) No	( ) Yes
	14.Lift heavy objects above your shoulders?	( ) No	( ) Yes
	15.Use one hand?	( ) No	( ) Yes

4. Repetitive work

Do you in your work often have to:	1.the same movements with your arms, hands of fingers many times per minute?	( ) No	( ) Yes
	2.the same movements (bending, twisting) with your trunk many times per minute?	( ) No	( ) Yes
	3.the same movements (bending, twisting) with your head many times per minute?	( ) No	( ) Yes

5. Work environment

Do you in your work often have to:	1.insufficient space to do your work properly?	( ) No	( ) Yes
	2.insufficient space above you which forces you to bent forward?	( ) No	( ) Yes
	3.insufficient height or reach to be able to reach things with your tools?	( ) No	( ) Yes
	4.difficulties exerting enough force because of uncomfortable postures?	( ) No	( ) Yes
	5.nothing to lean on?	( ) No	( ) Yes

Appendix B

Validity and Reliability

Part I Personal factors

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents.

Question	Comment score			Total score	IOC	Summary
	1	2	3			
1. Gender ( ) Male ( ) Female	+1	+1	+1	3	1	/
2. **Age** ……. years	+1	+1	+1	3	1	/
3. Education ( ) Junior High School ( ) Senior High School ( ) Bachelor degree ( ) Graduate students and above	+1	+1	+1	3	1	/
4.Marital Status ( ) Single ( ) Married ( ) Widowed/ Divorced/Separated	+1	+1	+1	3	1	/

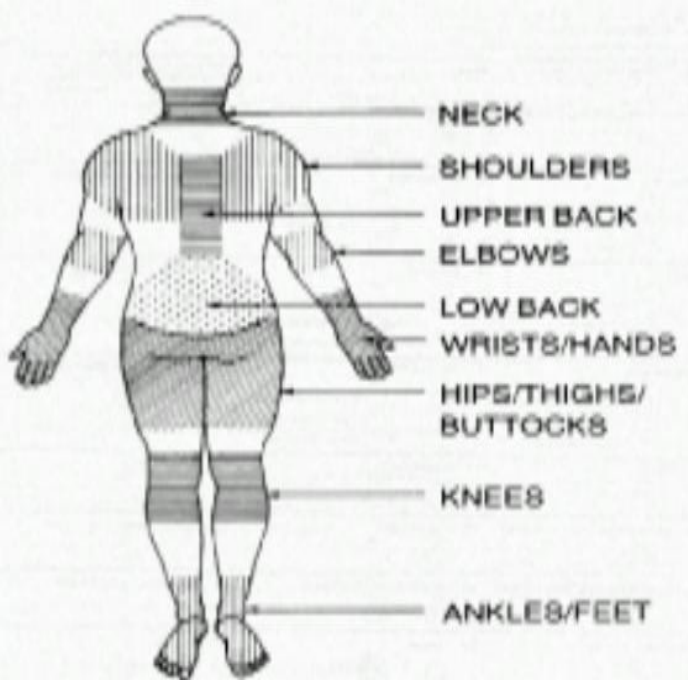
Question	Comment score			Total score	IOC	Summary
	1	2	3			
5. **How tall are you?**……Centimeter	+1	+1	+1	3	1	/
6. **How weight are you?**……Kilogram	+1	+1	+1	3	1	/
7.Courses……	+1	0	0	1	0.33	x
8.How many classes do you teach?……	+1	+1	0	2	0.66	/
9.Length of service……Year	+1	0	0	1	0.33	x
10.Are you left-handed or right-handed? ( ) Left Hand ( ) Right hand	+1	+1	0	2	0.66	/
11.History of illness ( ) No ( ) Yes	+1	+1	0	2	0.66	/
12.Do you take annual medical checkup? ( ) No ( )Yes	+1	+1	0	2	0.66	/

Question	Comment score			Total score	IOC	Summary
	1	2	3			
13.How often do you exercise? ( ) Never ( ) Work out at 1-2 times/week ( ) Work out at 3-4 times/week ( ) Work out at 2-5 times/week	+1	+1	+1	3	1	/
14.Do you smoking? ( ) No ( ) Yes	+1	+1	+1	3	1	/
15.Do you drink alcohol? ( ) No ( ) Yes	+1	+1	+1	3	1	/
16. Average work hours per day ……h (including overtime)	+1	+1	0	2	1	/
17.Average computer use hours per week……h	+1	+1	+1	3	1	/
18.Average homework grading hours per week……h	+1	+1	0	2	0.66	/
19.Average housework hours per week……h	+1	+1	0	2	0.66	/

Part II Work-related musculoskeletal disorders factors

Find the neck, shoulders, upper back and other parts mentioned in the scale from the picture. The boundaries of the parts may not be clear or even overlap. Determine the location of the pain (referring to the shaded area continuous pain, cramps or discomfort) based on your own feelings.

Question			**Comment score**			**Total score**	**IOC**	**Summary**
Have you had any in the past one months								
Part	**Pain or discomfort**	**Absence due to illness**	**1**	**2**	**3**			
Neck	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Shoulder	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Upper back	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Elbow	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Lower back	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Wrists/Hands	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Hips/Thighs/ Buttocks	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Knees	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/
Ankle/Foot	☐No ☐Yes	☐No ☐Yes	+1	+1	+1	3	1	/


NECK
SHOULDERS
UPPER BACK
ELBOWS
LOW BACK
WRISTS/HANDS
HIPS/THIGHS/
BUTTOCKS
KNEES
ANKLES/FEET

art III Ergonomics risk factor

1.Dynamic load

Question				Comment score			Total score	IOC	Summary
Dynamic load				1	2	3			
Do you in your work often have to:	bent slightly with your trunk?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	bent heavily with your trunk?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	twist slightly with your trunk?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	twist heavily with your trunk?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	bent and twist simultaneously with your trunk?	( ) No	( ) Yes	+1	+1	+1	3	1	/
Do you in your work often have to:	make sudden, unexpected movements?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	perform short, but maximal force-exertions?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	exert great force with your arms or hands?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	hold things in a pinch grip with your hands?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	exert great force on tools or machinery?	( ) No	( ) Yes	+1	+1	+1	3	1	/

2.Static load

Question				Comment score			Total score	IOC	Summary
Static load				1	2	3			
Do you in your work often have to:	in a slightly bent posture for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	in a heavily bent posture for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	in a slightly twisted posture for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	in a heavily twisted posture for lang periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	in a bent and twisted for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
Do you in your work often have to:	bent your neck forward or hold your neck in a forward posture for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	bent your neck backward or hold your neck in a backward posture for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	twist your neck or hold your neck in a twisted posture for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/

Question				Comment score			Total score	IOC	Summary
Static load				1	2	3			
Do you in your work often have to:	bent your wrist or hold your wrist bent for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	twist your wrist or hold your wrist twisted for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
Do you in your work often have to:	stand for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	sit for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	walk for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	work kneeled or squatted for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	work in the same posture for long periods?	( ) No	( ) Yes	+1	+1	+1	3	1	/

3. Physical load

Question				Comment score			Total score	IOC	Summary
Physical load				**1**	**2**	**3**			
Do you often	lift heavy objects (5 to 20 kg) at work?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	push or pull heavy objects (5 to 20 kg)?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	carry heavy objects (5 to 20 kg) ?	( ) No	( ) Yes	+1	+1	+1	3	1	/
Do you often	lift very heavy objects (more than 20 kg) at work?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	push or pull very heavy objects (more than 20 kg)?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	carry heavy objects (more than 20 kg)?	( ) No	( ) Yes	+1	+1	+1	3	1	/
Do you in your work often have to：	use hands/arms to pick up objects?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	hold your hands at or under shoulder level?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	hold your hands above shoulder level?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	work in uncomfortable postures?	( ) No	( ) Yes	+1	+1	+1	3	1	/

Question				Comment score			Total score	IOC	Summary
Physical load				**1**	**2**	**3**			
Do you often lift heavy objects in the following situations ?	In an uncomfortable position?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	Lift objects away from your body?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	Need to turn around when working?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	Lift heavy objects above your shoulders?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	Use one hand?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	Objects that are difficult to grasp with your hands?	( ) No	( ) Yes	+1	+1	+1	3	1	/

4. Repetitive work

Question				Comment score			Total score	IOC	Summary
Repetitive work				1	2	3			
Do you in your work often have to:	the same movements with your arms, hands of fingers many times per minute?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	the same movements (bending, twisting) with your trunk many times per minute?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	the same movements (bending, twisting) with your head many times per minute?	( ) No	( ) Yes	+1	+1	+1	3	1	/

5. work environment

Question				Comment score			Total score	IOC	Summary
work environment				1	2	3			
Do you in your work often have to:	insufficient space to do your work properly?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	insufficient space above you which forces you to bent forward?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	insufficient height or reach to be able to reach things with your tools?	( ) No	( ) Yes	+1	+1	+1	3	1	/
Do you in your work often have to :	difficulties exerting enough force because of uncomfortable postures?	( ) No	( ) Yes	+1	+1	+1	3	1	/
	nothing to lean on?	( ) No	( ) Yes	+1	+1	+1	3	1	/

Measurement	Conbach's alpha coefficient
Work-related musculoskeletal disorders questionnaire	0.826
Ergonomic risk factors	0.941

BIOGRAPHY

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