บทความวิจัย

ความผิดปกติทางระบบโครงร่างและกล้ามเนื้อของผู้ปฏิบัติงานในกระบวนการเตรียมเส้นไหมของกลุ่มอาชีพทอผ้าไหมจังหวัดสุรินทร์ ประเทศไทย

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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาความชุกและปัจจัยที่ส่งผลต่อความผิดปกติทางระบบโครงร่างและกล้ามเนื้อของผู้ปฏิบัติงานในกระบวนการเตรียมเส้นไหมของกลุ่มอาชีพทอผ้าไหม จังหวัดสุรินทร์ จำนวน 378 คน เก็บรวบรวมข้อมูลด้วยแบบสอบถามที่ประยุกต์จาก Standardized Nordic Questionnaire และประยุกต์ใช้แบบประเมินความเสี่ยงอาการผิดปกติของระบบโครงร่าง และกล้ามเนื้อของกรมควบคุมโรค วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนาและการถดถอยพหุคูณ (Binary Logistic Regression) ผลการศึกษาพบว่า ตำแหน่งที่มีการปวดเมื่อยกล้ามเนื้อของผู้ปฏิบัติงานมากที่สุด คือ ไหล่ขวา และหลังส่วนล่าง คิดเป็นร้อยละ 98.94 มือและข้อมือซ้าย และมือและข้อมือขวา คิดเป็นร้อยละ 98.68 และไหล่ซ้าย คิดเป็นร้อยละ 97.35 ตามลำดับ ปัจจัยที่ส่งผลต่ออาการผิดปกติทางระบบโครงร่างและกล้ามเนื้อ ได้แก่ ดัชนีมวลกาย เวลาพักต่อวัน การนั่งทอทำงานเป็นเวลามากกว่าครึ่งหนึ่งของเวลาทำงานโดยไม่มีการเปลี่ยนอิริยาบถ ขณะทำงานต้องมีการเงยคอ หรือแอ่นหลังขณะทำงานเสมอ และขณะทำงานมือหรือแขนทำงานในลักษณะที่เคลื่อนไหวซ้ำกันตลอดเวลา (อย่างน้อย 30 นาที)

คำสำคัญ: ความผิดปกติทางระบบโครงร่างและกล้ามเนื้อ การเตรียมเส้นไหม ความเมื่อยล้า

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Research Article

Musculoskeletal Disorders in Workers of the Silk Weaving Preparation Process: A Study Case of Surin Province, Thailand

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Abstract

This study aimed at exploring the prevalence rate and factors affecting musculoskeletal disorders of 378 members of a local silk-weaving community in Surin province, Thailand. Target weavers are engaged in the preparation of silk thread preparation before the weaving phase. The data was collected by using questionnaires applied from the Standardized Nordic questionnaire and the musculoskeletal disorders evaluation developed by the Department of Disease Control. Descriptive statistics and binary logistic regression were used to analyze data. As results, the most prevalence of musculoskeletal problems among the samples were pain in the shoulder blade and lower back, accounting for 98.94 %, followed by aching in both hands or wrists which account for 98.68%; and left shoulder pain (97.35%). Factors affecting musculoskeletal disorders found were: 1) body mass index, 2) break time, 3) unchanged weaving posture that takes more than half of work time, 4) long-term excessive bending of neck and back, and 5) repetitive, prolonged arm and hand movements (at least 30 minutes).

Keywords: Musculoskeletal Disorders, Silk Weaving Preparation, Fatigue

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1. Introduction

Musculoskeletal Disorders (MSDs) are injuries or pain in the human musculoskeletal system, including the joints, ligaments, muscles, nerves, tendons, and structures that support limbs, neck and back. The conditions of MSDs are feeling pain, irritable, beriberi, discomfort and limited muscles or joints movement. This also includes the condition of Myasthenia Gravis (MG) [1]. The level of disease severity could be ranked from low severity that causes the irritable (consider this word instead of annoyed) feeling to the highest severity that causes disabilities. MSDs arise out of many factors such as: 1) Personal factors which refer to daily life and work habits such as, heavy object lifting, and repetitive working posture [2], [3], 2) Biomedical factors which refer to age in that elderly workers have more MSDs than teenagers, and women who are older than 40 years have the condition of knee osteoarthritis more than men. Moreover, an overweight condition is also concordant with backaches [3] and 3) a psychosocial factor which refers to strain [4].

According to a survey conducted on 250,000 private establishments, it was found that the rate of workers having MSDs has increased to fourteen times. In 2013, it was found that the ratio of workers suffering MSDs was at 327.50 workers out of a thousand workers in a population [5]. This kind of condition was found in various kinds of work characteristics and careers. MSDs are one of the occupational health hazards in both developing and developed countries [6].

The results of an annual survey in the United Kingdom showed that workers lost more than 28.4 million of their working days due to MSDs on their necks, shoulders, and backs [6]. A survey on workers in the informal sector in Thailand found that the number of workers increased from 20.80 million workers in 2018 to 21.20 million workers in 2019. Most of them work in the agricultural sector at the rate of 55.50%. The result revealed that 6.70 million workers or 31.60% had health problems due to their work environment at the rate of 46.30%, and unsafe operation at the rate of 40.30% whereas these workers had no social security supports [7].

The problems of small and medium-sized enterprise groups in the ASEAN Economic Community (AEC) are similar to the problems of small and medium-sized enterprise groups in Thailand. For instance, small and medium-sized enterprise groups in Indonesia found that they have a limitation in technology [8]. After considering the production of weaving community enterprise group, it was found that rate of the production efficiency is low due to the workers' fatigue and working postures that are against the ergonomics [9]. This included inappropriate working environment, such as insufficient light, inappropriate environmental facilities, and longer than 8 hour a day sitting work without changing posture. According to the information on the injury of the weaving workers in the west of Bengal bay, it was found that MSDs are related to the continuity of work [10]. Female workers have a two time risk in their upper and lower backache compared to other workers. This causes an accumulated injury at the skeleton system, muscles and nervous system [11] due to working posture or continuous repetitive motion disorders [12].

In Payao province, it was found that inappropriate design of the workstations and the errors of ergonomics

in working postures led to problems of the endoskeleton and muscles. The parts that got the most serious problem were shoulders, waists, and upper back [13]. In the southern northeast of Thailand 1 (Nakhonchaiburin group), there were 51,531 agriculturalists who planted mulberry and raised silkworms and could earn 8,621.42 million baht selling silk products of the group in the province in 2016 [14].

In order to weave silk, two sets of threads are interlaced by the weaver. There is a weft thread set perpendicularly called "Mai Yuan" and the other thread set as a warp thread in the shuttle called "Mai Poong Sen". Both sets need to be prepared before the weaving process. The preparation is made with "Tee Glyo" process which means combining the silk threads together to increase the thickness and stickiness. The process is made by twisting them together as strain. Then the twisted thread will be winded onto a tube and pulled in and out with appropriate length and speed. Traditional thread preparation tool is operated by a weaver's force of moving the wheel to rolling the thread with the right hand while the left hand pulls thread in the appropriate length and speed to get the required thickness and strains. Due to the mentioned process, workers get fatigue which leads to different number of strains in the thread. In order to solve the problem, an ergonomic process was considered to solve the problem and prevent any further problem by paying attention to the appropriate design of work and the workers [13]. This study aimed at exploring the prevalence of muscle aches due to working and factors affecting MSDs of the workers in silk thread preparation in a weaving group in Surin province.

Figure 1: Silk thread preparation.

The result of the study is expected to be used later in developing a weaving process with appropriate ergonomic work process.

2. Materials and Methods

This research was made as analytical cross-sectional study. The sample group was 378 women weaving (population 17,510 people) as shown in Figure 1. The sample size was determined by using Krejcie and Morgan Table [15]. Simple random sampling was through a lucky draw process to provide a better chance for all workers to be selected equally. The survey was used to obtain work data, the prevalence of muscle aches, and factors affecting the causes of MSDs in workers. Binary logistic regression was used to analyze the obtained data.

A questionnaire adapted from the Standardized Nordic questionnaire [16] was used in this study. The developed questionnaire covered information about the condition of MSDs which was examined by experts in terms of the validity and reliability. The musculoskeletal disorders evaluation form developed by The Department of Disease Control was also applied to obtain the data [17]. The data

collected included personal information, health condition that increased the risk to get hurt, work experience, after work free time activity, the evaluation of workers' MSDs, and work environment evaluation. After that, researchers summarized the indicators of possibilities of the workers to get MSDs.

3. Results

The results revealed that women workers had an average age of 51.61 years and they had 18.57 years of weaving experience. Their ages confirmed most sample group age were at 50s years. Their Body Mass Index (BMI) was at 24.31 kilograms per square meter which meant they were overweight (obesity level 1). This resulted in their work habit of sitting for a long time while working, having little activity that needed less energy, most of them had no supplementary careers, no free time activities, and no congenital diseases that might lead to MSDs. Work data of the members of the silk weaving is shown in Table 1 below.

The environment in the workplace includes tools, machines, building, location, ventilation, heat, light, noise, and work description [18]. According to Table 2, it can be seen that the temperature at work was an average of 32.53 degree Celsius which was a little higher than the standard average temperature criteria of 32 degree Celsius [18]. The light at work was at the average level of 305.72 Lux which matched the standard light criteria required, 300–400 Lux, for workers who depend on their eyesight to be able to see objects and classify color clearly [18]. The noise level at work was an average of 63.63 Decibels, most of it was the noise of workers talking to each other. This noise level was in the same level of the standard criteria (If the noise level got to 85 Decibels or more at the workplace for eight hours, employers would need to conduct hearing ability conservation measures at the work place) [18]. The weight of tools and all equipment that workers need to lift were at an average level of 1.38 kilograms which was in the same level of the standard criteria (Employers needed to get women workers tools not heavier than 25 kilograms [18].)

The results of the study on the occupational health and worker safety from interviewing the workers found that muscle aches occurred during the silk thread preparation every day at the rate of 81.75%. The muscle aches also included the aches that occurred on the previous day at 79.63% due to repetitive posture or movement at work which was not appropriate based on the Kinematics. These work habits caused workers to face health hazards in terms of ergonomics, from unnatural working

Table 1: Work data of the members of the silk weaving preparation process of silk weaving group in Surin province

	Age (Years)	BMI (kg/m^2)	Working Time (Year)	Working Time (Hours per Day)	Break Time (Minutes per Day)	Number of Work Days (Days per Week)	Production Capacity per Day (Set)
Mean (Min–Max)	51.61 (32–74)	24.31 (18.77–31.86)	18.57 (5–25)	6.38 (4–10)	60.37 (30–120)	5.05 (2–7)	28.80 (11–54)
Standard Deviation	9.57	3.96	6.26	1.26	17.24	1.18	9.69

postures, repetitive movement for a long time [19]. In order to relieve the muscle aches during weaving, they took a 5–10 minute break at the rate of 93.39%. If they wanted to treat their muscle aches, most of them would apply some medicine and massage it at the rate of 98.41% as shown in Table 3.

The injury due to silk thread preparation process occurred every day and continued from the previous day. It was found that the right shoulders and lower back were the body parts that suffered muscle aches the most, at a rate of 98.94%. Both sides of hands and wrists had muscle aches at the rate of 98.68%. The left shoulders had muscle aches at the rate of 97.35% as shown in Table 3. Workers who had shoulder aches had their lives impacted because they need to use their shoulders in their daily lives and work. When they had to raise their hands, they suffered injury which could lead to a chronic illness. Almost half of them had both sides of their shoulders ache and the injury interfered with

Table 2: Environmental factors

	Temperature (°C)	Light (Lux)	Noise (Decibels)	Weight (kg)	Heart Rate (Beat Per Minute)
Mean (Min–Max)	32.43 (25–39)	305.72 (179–331)	63.63 (45–84)	1.38 (0.3–3.6)	102.92 (89–112)
Standard Deviation	3.00	35.21	7.66	0.89	8.05

Table 3: Occupational health and safety information of members of the silk weaving preparation process of silk weaving group in Surin province. (n=378)

Factors	Number of Members	Percentage
The frequency of muscle aches		
1. Muscle aches every day	309	81.75
2. Muscle aches 3–4 times a week	58	15.34
3. Muscle aches 1–2 weeks at a time	11	2.91
4. Muscle aches 1 time per month	0	0.00
5. Muscle aches 1–5 times per year	0	0.00
The effect of muscle aches from silk weaving		
1. Muscle aches from the previous day	301	79.63
2. No muscle aches	77	20.37
Reducing muscle aches		
1. Taking a break for 5–10 minutes	353	93.39
2. Taking a break for 1 day	21	5.56
3. Taking a break for 2–3 days	4	1.06
4. Taking breaks for 4–5 days	0	0.00
Treating muscle aches		
1. Massage with medicine	372	98.41
2. Going to the doctor	6	1.59

their sleep [20]. This was because they had to work continuously for a long time (average 6.38 hours per day) and had little time to rest (60.37 minutes per day). Sitting while working continuously for more than four hours would relate to the backache condition [21]. The way they sat and projected their faces toward the work tools for a long time caused their back neck muscles to work more to support their necks. This led to their muscles' fatigue [22]. Their thighs and calf had the least ache at the rate of 3.70% and 13.23%, respectively, because these parts were not used much in working as shown in Table 4.

Table 5 shows the factors affecting musculoskeletal disorders in workers at Surin province. They were 1) Body Mass Index, 2) Rest time per day, 3) Sitting while working for more than half of working hours without changing the posture 4) Repetitive raised neck or back during working, and 5) Hands or arms working in repetitive movements (at least 30 minutes).

The problems found in silk thread preparation of the weaving group in Surin province were found to be of low proficiency [9]. The analysis of the problems and their causes pointed to the tool used for silk thread preparation in twisting the thread into strain and increasing thickness and stickiness. The tool needed workers' energy while sitting and using their right hand to steer the wheel which passes the power to another wheel, their left hands pulling the thread in and out in the appropriate length and speed as shown in Figure 2.

Table 4: The prevalence of muscular disorders (n=378)

Data	7 days		1 year	
	Frequency	Percent	Frequency	Percent
Neck	309	81.75	307	81.22
Left shoulder	368	97.35	366	96.83
Right shoulder	374	98.94	375	99.21
Upper back	346	91.53	342	90.48
Left upper arm	357	94.44	359	94.97
Right upper arm	361	95.50	357	94.44
Left elbow	324	85.71	319	84.39
Right elbow	341	90.21	346	91.53
Lower back	374	98.94	372	98.41
Left lower arm	327	86.51	321	84.92
Right lower arm	314	83.07	312	82.54
Buttocks and hips	147	38.89	152	40.21
Left hand and wrist	373	98.68	371	98.15
Right hand and wrist	373	98.68	370	97.88
Thigh	36	9.52	37	9.79
Knee	264	69.84	259	68.52
Calf	14	3.70	12	3.17
Foot and ankle	309	81.75	307	81.22

Table 5: Factors affecting musculoskeletal disorders (n=378)

Factors	Crude OR	Adjusted OR	*p*-value
Age (Years)	0.031	1.031	0.482
BMI (kg/m^2)	0.458	1.944	0.034*
Working time (year)	0.142	1.152	0.281
Additional career	0.332	1.394	0.285
Hobbies	0.409	0.991	0.969
Working time (Hours per day)	0.406	0.994	0.258
Break time (Minutes per day)	0.062	1.063	0.043*
Number of working days (Days per week)	0.019	1.02	0.281
Complete focus on work for 3–5 minutes during working	0.393	1.092	0.994
Sitting for more than half of work time without changing posture	2.621	6.073	0.032*
Weight down on one side of the body	0.274	0.716	0.607
Reaching above the shoulder to pick up or hold the material	1.629	4.098	0.325
The exertion of twisting their bodies back and forth during working	0.233	1.262	0.514
The continuous bending down of their heads to work	0.542	1.762	0.154
Repetitive raised neck or back during working	2.349	4.706	0.026*
Hands or arms working in repetitive movements (at least 30 minutes)	2.909	5.095	0.018*
The exertion of pressing or squeezing objects during work	0.379	0.684	0.282
Congenital disease	0.324	0.976	0.947
Work injury history	0.588	1.801	0.103
Taking medication regularly	0.334	0.712	0.343
Regular exercise	0.214	1.239	0.526
Smoking	0.488	0.916	0.806
Drinking alcohol	0.332	1.394	0.285
Constant			0.735

Figure 2: Working in silk thread preparation process.

According to Table 4, workers who had more Body Mass Index would have a higher chance of getting musculoskeletal disorders, up to 1.944 times. When they had less rest time, they had a higher chance of getting musculoskeletal disorders, up to 1.063 times.

Based on the work conditions, it was found that sitting while preparing thread for a long time, more than half of working time without changing posture could cause the musculoskeletal disorders, up to 6.073 times. The workers who sat repetitively with

raised necks or back during working had a higher chance of getting musculoskeletal disorders, up to 4.706 times. The workers who used hands or arms in repetitive movements (at least 30 minutes) had a higher chance of getting the musculoskeletal disorders, up to 5.095 times compared to the ones who did not work in the mentioned above work conditions.

4. Discussion and Conclusions

Ergonomics, a principle element for human resource management is a very important factor affecting the proficiency of work. Ergonomics directly affects the proficiency of safety and health as well as the process of organization and staff development [23]. Therefore, it is very important to provide information and knowledge to all workers about the appropriate working posture and enlighten them on the causes of musculoskeletal disorders [24]. Measures to control and reduce the risks of getting diseases or illnesses at work incorporate three main factors, 1) working environment, 2) workers, and 3) working conditions [25].

The work environment of the thread preparation process indicated that the temperature at work during the process was a little higher than the average standard rate criteria. The light, the noise, and the weight of tools that workers had to lift at work were in the standard rate criteria. When the work environment is in support of the ergonomics, health is managed and musculoskeletal disorders will reduce thus increasing workers' efficiency [26].

The data on the worker factors, showed that the workers in weaving group in Surin province were at an average age of 51.6 years. Their Body Mass Index (BMI) was at 24.31 kilograms per square meter (obesity level 1).

A change of diet of overweight workers who had knee ache and osteoarthritis could decrease the pain [27]. The time for silk thread preparation was averaged at 6.38 hours per day which was appropriate (not more than 8 hours per day). However, sitting or standing longer than two hours in the same posture and repetitively raising neck or back during work caused the waist ache. The body twisting during work caused the back ache [28]. Sitting while working for more than 4 hours was concordant to the back ache condition [29]. Sitting in the same posture for more than 8 hours a day may be a cause of the pain on the lower part of the body. A Body Mass Index at 30 or more raised the risk of having chronic pain at the lower back, neck and shoulders [30]. This also may lead to premature osteoarthritis.

Work condition showed that the study on the occupational health and safety revealed the muscle aches during silk thread preparation occurred every day at the rate of 81.75%. The rate of muscle aches which continued from the previous day was at 79.63%. A 5-10 minute break could help reduce the muscle aches at the rate of 93.39%.

Therefore, musculoskeletal disorders, and fatigue should not be ignored because when the workers get a high level of fatigue, they might not be able to recover to normal condition sooner than six months. This might lead to chronic fatigue syndrome [31]. Affecting their physical condition and mind and may bring other opportunistic illnesses, family problems and their general lives in the society [32]. Because persons with acquired disorders of

the musculoskeletal system have a low adaptive capacity, a high level of neuropsychic stress, a low level of self-actualization and self-regulation and are not capable of consciously planning activities [33].

In conclusion, the study on the musculoskeletal disorders in workers of the silk weaving group in Surin found that musculoskeletal disorders in the workers were of high prevalence. The workers suffered muscle aches due to an everyday continuous process of silk thread weaving. Taking a 5–10 minute break helped to reduce muscle aches and most of them treated the aches by applying medicine and massaging the affected areas. The parts of the body afflicted the most were right shoulders, lower backs, right hands and wrists, left hands and wrists, and left shoulders. The factors affecting Musculoskeletal disorders of the workers in workers at Surin province were: 1) Body Mass Index, 2) Resting time per day, 3) Sitting while preparing thread for a long time; more than half of the working time without changing posture, 4) Working repetitively with raised neck or back and 5) using hands or arms in repetitive movements (at least 30 minutes).

The data obtained from this study could be used to develop an appropriate ergonomics in support of reducing musculoskeletal disorders in workers.

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