

# Prevalence of work-related musculoskeletal disorders and ergonomic risk assessment among production workers of pig slaughterhouse in the town municipality of Ang Thong, Thailand

Sompan R<sup>1</sup>, Keeratisiroj O<sup>2</sup>, Aungudornpukdee P<sup>3</sup>, Mahaboonpeeti R<sup>3</sup>

<sup>1</sup>Doctor of Public Health Program, Faculty of Public Health, Naresuan University, Phitsanulok, Thailand,

<sup>2</sup>Division of Community Health, Faculty of Public Health, Naresuan University, Phitsanulok, Thailand,

<sup>3</sup>Division of Environmental Health and Occupational Health, Faculty of Public Health, Naresuan University, Phitsanulok, Thailand

## ABSTRACT

**Introduction:** Work-related musculoskeletal disorders (WMSDs) are a significant health concern among workers, especially in the meat processing industry. Their impacts have been well documented and reported on numerous occasions. The study aimed to determine the prevalence of WMSDs and the ergonomic assessment of exposure to their risk factors.

**Methods:** This cross-sectional study was conducted in a pig slaughterhouse in the town municipality of Ang Thong, Thailand. Data were collected from April to July 2021 from 108 participants who answered a questionnaire. The descriptive questionnaire for WMSDs was adapted from the Standardized Nordic Questionnaire in Thai and the Bureau of Occupational and Environmental Diseases, Department of Disease Control of Thailand. Ten individuals received an ergonomic assessment of their exposure to risk factors using the Rapid Entire Body Assessment (REBA) method.

**Results:** According to the study, 94.4% of participants working in pig slaughterhouse production reported experiencing the prevalence of WMSDs in the last seven days. Additionally, 93.5% of workers reported experiencing the prevalence of these disorders within the past 12 months. It has been observed that 29.6% of participants experience higher pain levels in their hands, while 25.9% experience it in their wrists, respectively. Based on the results of an ergonomic risk assessment using the REBA method, the half-cutting operator position presents a moderate level of risk.

**Conclusion:** The study revealed that most of the workers at the pig slaughterhouse had to use their hands and arms to apply repeated pressure consistently. The occurrence rates of WMSDs within the last seven days and 12 months were highest in the hands or wrists, followed by the upper arms and shoulders. Therefore, it is crucial to implement ergonomic measures to minimize the risk factors for WMSDs among production workers in pig slaughterhouses.

**Keywords:** Prevalence, Rapid Entire Body Assessment, Slaughterhouse, Work-related Musculoskeletal Disorders

### Corresponding author:

Rittikon Sompan,  
Faculty of Public Health,  
Naresuan University,  
Phitsanulok, 65000, Thailand

Tel.: +66 5596 7413 ,

E-mail: [rittikorns59@nu.ac.th](mailto:rittikorns59@nu.ac.th)

ORCID ID:

<https://orcid.org/0000-0002-4579-4719>

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## Introduction

Work-related musculoskeletal disorders (WMSDs) are a significant health problem in many countries. Workers may be subjected to hazardous working environments and potential risks resulting in physical pain, discomfort, and restricted mobility in bones, joints, ligaments, tendons, blood vessels, or muscles.<sup>1,2,3</sup> The risk factors include physical and biological factors, social psychology, workers, equipment, work environment, and working conditions. The significant risk factors are usually related to increased compensation and health costs, reduced productivity, and lower quality of life for workers.<sup>4</sup>

In 2020, WMSDs were reported as the major cause of sickness in the USA at a prevalence rate of 31% in 0.35 million people (29.8 per 10,000 labor force). The most common parts of the body affected by injury or illness were the trunk (47.03%); back, including the spine and spinal cord (32.64%); and upper extremities (31.42%).<sup>5</sup> According to the Social Security Office of Thailand's 2013–2020 annual report, the prevalence of WMSDs from poor working conditions was continuously top-ranked, with a significant increase of 1,104 cases in 2020. The report also showed that the most common reasons were sprains and muscle stiffness caused by poor working posture and lifting (16.4%).<sup>6</sup>

The effects of WMSDs frequently reported in the meat processing industry were 64.9%, including fatigue, swelling, and pain, which impact the quality of life and ability to perform daily activities.<sup>7</sup> Workers in pig slaughterhouses are exposed to various risk factors that can cause WMSDs due to repetitive motions and poor posture. It has been reported that these workers commonly experience wrist or hand pain, with a prevalence of 54.8%.<sup>8</sup> In addition, according to a report by the New Zealand Industry Training Organization, the meat processing industry has the highest incidence of WMSDs, compared with other sectors in the country.<sup>9</sup> Previous studies have found that WMSDs affect the wrists, shoulders, neck, and back due to the performance

of highly repetitive tasks, lifting heavy weights, and working in suboptimal positions. Health promotion to avoid risk factors can help workers prevent and control occupational diseases, reduce the rate of illness, and achieve a better quality of life. However, only a few studies have been carried out on the topic. Therefore, we aimed to investigate the prevalence of WMSDs and risk factors among production workers of pig slaughterhouses in the past seven days and the past 12 months. We also aimed to evaluate body postures using the Rapid Entire Body Assessment (REBA) method to determine the risk level of WMSDs in pig slaughterhouses.

## Methods

A total of 108 production workers from a slaughterhouse in the town municipality of Ang Thong, Thailand, participated in the study. Due to the small number of participants, all were included in the study. The inclusion criteria for the sample were the ability to communicate in Thai and consent to participate in this research. All participants filled out the questionnaire to determine the prevalence of WMSDs. We collected data by distributing self-administered questionnaires and conducting face-to-face interviews with participants. And to select a purposive sample of 10 individuals working in different sections of the slaughterhouse to conduct an ergonomic assessment of their exposure to risk factors using the REBA method.

Data were collected to evaluate the prevalence of WMSDs through a three-part questionnaire of 108 participants.

- i. The first part included general information, including sex, age, marital status, education, body mass index (BMI), medical history, serious accidents affecting body parts, smoking, and alcohol use;
- ii. The second part included work information, including task and position, working duration (years), accidents at the workplace, and perceived health risks on the job; and
- iii. The third part included a modified standard Nordic questionnaire in the Thai language to

analyze musculoskeletal symptoms.<sup>10</sup>

All the participants were required to fill out a self- or interviewer-administered questionnaire and a sample of 10 individuals were selected for an ergonomic assessment of their exposure to risk factors using the REBA method. Data were collected from April to July 2021. Five experts reviewed the items and tested them for content validity. The questionnaire was analyzed using the item objective congruence (IOC) index, which produced scores between 0.67 and 1.00.<sup>11</sup> In addition, the items were thoroughly reviewed and precisely modified based on feedback from an expert. The questionnaire was tried out on 30 workers in a slaughterhouse who were not included in the study.

The research conducted in Thailand (COA No.: 052/2021; IRB No.: P1-0190/63) was approved by the Institutional Review Board of Naresuan University on February 18, 2021. Informed consent was also obtained from all participants before starting data collection.

Data analysis was performed by using the Statistical Package for Social Sciences (SPSS) version 17.0 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were applied to summarize the study variables (mean and

standard deviation for continuous variables, frequency and percent for categorical variables). The prevalence of WMSDs in the past seven days and past 12 months are presented as frequency and percentage. The REBA method provides a scoring system to assess the required body postures. The method tables are then used to compile the risk factor variables, generating a score representing the risk level of WMSDs.

### Results

The study showed that 58.3% of participants were male, while 41.7% were female, participants' ages ranged from 26 to 33 years (Mean = 33.25, SD = 8.48), 50% were married and 44.4% were single, 35.2% had secondary education, and 42.6% had 1-2 years of experience. Similarly, 15.7% carried out carcass cutting and trimming operations, 98.1% had no additional occupation, and 79.6% perceived health risks on the job. The health status assessment of the participants showed that 37% had a normal BMI and 37% had lower BMI values, 88.9% had no underlying diseases, 81.5% had no serious accident affecting body parts, 50.9% were nonsmokers, 49.1% did not consume alcohol, and 63% had no accidents at workplace (Table 1).

**Table 1:** Characteristics of the production workers of a pig slaughterhouse in the town municipality of Ang Thong, Thailand (N = 108)

Characteristics	Mean ± SD or N (%)
Sex	
Male	63 (58.3)
Female	45 (41.7)
Age (Years): Mean = 33.25, SD = 8.483, Max = 52, Min = 19	
18 - 25	26 (24.1)
26 - 33	30 (27.8)
34 - 38	25 (23.1)
≥ 39	27 (25.0)
Marital status	
Single	48 (44.4)
Married	54 (50.0)
Widowed	3 (2.8)
Divorced/Separated	3 (2.8)
Education	
Primary school	27 (25.0)
Junior high school	38 (35.2)
High school/ Vocational	30 (27.8)

Characteristics	Mean ± SD or N (%)
Diploma/High Vocational Certificate	6 (5.6)
Bachelor's degree	7 (6.4)
<b>Additional occupation</b>	
Yes	2 (1.9)
No	106 (98.1)
<b>BMI (Kg/m<sup>2</sup>): Mean = 21.20, SD = 5.50, Max = 43.1, Min = 12.9</b>	
< 18.5	40 (37.0)
18.5 - 22.9	40 (37.0)
23.0 - 24.9	8 (7.4)
25.0 - 29.9	12 (11.2)
≥ 30	8 (7.4)
<b>Medical history</b>	
No underlying disease	89 (82.4)
Diabetes	1 (0.9)
Obesity	1 (0.9)
Kidney disease	1 (0.9)
Gout	1 (0.9)
Hypertension	9 (8.4)
Osteoarthritis	2 (1.9)
Other	4 (3.7)
<b>Serious accident of body</b>	
Yes	20 (18.5)
No	88 (81.5)
<b>Smoking</b>	
Never smoked	55 (50.9)
Former smoker	11 (10.2)
Current smoker	42 (38.9)
<b>Alcohol consumes</b>	
Never	47 (43.5)
Daily or almost daily	3 (2.8)
Quitted drinking	1 (0.9)
Less than monthly	53 (49.1)
Weekly	4 (3.7)
<b>Perception of health risks on the job</b>	
Yes	86 (79.6)
No	22 (20.4)
<b>Position/Job Description</b>	
Pig inspector	8 (7.4)
Stunning/Head cutting operator	8 (7.4)
Half cutting operator	17 (15.8)
Red pork offal portioning operator	5 (4.6)
White pork offal portioning operator	15 (13.9)
Carcass cutting/Trimming operator	17 (15.8)
Sanitary operator	4 (3.7)
Basket cleaning operator	4 (3.7)
Warehouse operator	10 (9.3)
Engineering/Maintenance	3 (2.8)
Safety officer	1 (0.9)
Office operator	7 (6.4)
Weighing/Quick chill operator	8 (7.4)
Manager	1 (0.9)
<b>Working duration (Years): Mean = 2.58, SD = 1.54, Max = 8.0, Min = 0.1</b>	
< 1	9 (8.4)

Characteristics	Mean ± SD or N (%)
1 - 2	46 (42.6)
3 - 4	40 (37.0)
≥ 5	13 (12.0)
Accidents at workplace	
Yes	40 (37.0)
No	68 (63.0)

Note. BMI: Body Mass Index

The prevalence rates of WMSDs in the past seven days and past 12 months were 94.4% and 93.5%, respectively. One person in the past 12 months had no pain or discomfort in any parts of the body. Pain or discomfort occurred mostly in the hand or wrist (29.6%), upper arm (23.1%), and shoulder (18.5%) in the past seven days. The most affected regions in the past 12 months were the hand or wrist, upper arm, and shoulder, with annual prevalence rates of 25.9%, 23.1%, and 22.2%, respectively. Within the past seven days and past 12 months, the most common symptom experienced was sprain at 64.8% and 75.9%,

lasting for an indefinite period at 58.3% and 68.5%, respectively (Table 2).

The risk level distribution of the most frequent body posture was determined using the REBA method. The risk assessment data showed that a moderate risk level was observed in the following tasks or positions: half-cutting operator, stunning operator, head-cutting operator, and carcass-cutting operator. Additionally, a low-risk level was observed in the following positions: pig inspector, trimming operator, weighing operator, quick chill operator, pork offal portioning operator, and basket cleaning operator (Table 3).

**Table 2:** The prevalence of WMSDs among the participants in the past 7 days and past 12 months (N = 108)

Characteristics	N (%)	
	7 days-WMSDs	12 months-WMSDs
Pain or discomfort in parts of the body		
Yes	102 (94.4)	101 (93.5)
No	6 (5.6)	7 (6.5)
The parts of the body in pain		
Neck	2 (1.9)	2 (1.9)
Shoulder	20 (18.5)	24 (22.2)
Upper back	8 (7.4)	7 (6.4)
Lower back	11 (10.2)	17 (15.8)
Upper arm	25 (23.1)	25 (23.2)
Lower arm	3 (2.8)	1 (0.9)
Hand/ Wrist	32 (29.6)	28 (25.9)
Knee	3 (2.8)	0 (0.0)
Calf	3 (2.8)	4 (3.7)
Foot	1 (0.9)	0 (0.0)
The symptoms		
Pain	35 (32.4)	25 (23.1)
Whiplash injury	1 (0.9)	0 (0.0)
Cramp	2 (1.9)	1 (0.9)
Sprain	70 (64.8)	82 (76.0)
Duration of pain condition		
During work time	8 (7.4)	3 (2.8)
After work	36 (33.3)	30 (27.8)

Characteristics	N (%)	
	7 days-WMSDs	12 months-WMSDs
All-day	1 (0.9)	1 (0.9)
Indefinite period	63 (58.3)	74 (68.5)

Note. WMSDs: Work-related Musculoskeletal Disorders

**Table 3:** The results of an ergonomic risk assessment using the REBA method (n =10)

Task/Job	REBA score			Risk level
	Group A	Group B	Result	
Pig inspector	3	1	3	Low
Stunning	4	2	5	Moderate
Head cutting operator	3	5	5	Moderate
Trimming operator	3	1	3	Low
Carcass cutting operator	2	4	4	Moderate
Half cutting operator	5	5	7	Moderate
Weighing operator	2	1	2	Low
Quick chill operator	2	1	2	Low
Pork offal portioning operator	2	1	2	Low
Basket cleaning operator	2	1	2	Low

Note. REBA: Rapid Entire Body Assessment

## Discussion

The study showed that most of the workers in the pig slaughterhouse had to work with their hands or arms to exert repetitive force all the time, such as holding knives for carcass cutting and trimming, holding carcass splitting saws, and cleaning baskets. The prevalence rates of WMSDs in the past seven days and the past 12 months were higher in the hands or wrists, followed by the upper arms and shoulders, because workers hold tools throughout the workday. This is consistent with research carried out in New Zealand, which reported a prevalence of 64.9% among meat processing workers, and most of the symptoms were observed in the hands or wrists (54.8%).<sup>8</sup> Most of them had sprains and an unstable period of pain, and they experienced the symptoms after work each day. Pain relief can be obtained by using medications and applying a massage or compress. In Brazil, most of the symptoms occurred in the feet (68.8%) and hands (28.1%), with most workers feeling discomfort in

at least one part of their body (83.3%). Their symptoms were pain (56.7%) and fatigue (45.0%), and 50% were treated with medications.<sup>12</sup> In Venezuela, the report showed that the prevalence of musculoskeletal discomfort was 77%, and most of the symptoms occurred in the shoulders (49.4%), back (47.1%), and hands or wrists (31.6%). The sample consisted of 174 workers in the processing and production of meat products.<sup>13</sup>

The REBA method showed that the highest risk score was 7 (moderate risk level), and it was observed in the half-cutting operator position. The moderate risk scores were due to the awkward postures adopted by the entire body when performing tasks such as stunning, head cutting, carcass cutting, and half cutting. With this risk score, it is recommended to develop a new standing tool design to reduce worker discomfort. Appropriate working postures



should be applied for positions with low-risk scores, such as pig inspector, trimming operator, weighing and quick chill operator, pork offal portioning operator, and basket cleaning operator. The report in Brazil also showed that physical activities mostly caused discomfort in worker body parts.<sup>14</sup> A Columbian study reported that the exposure level to risk factors for WMSDs among meat processing workers decreased from very high (risk score = 38) to medium (risk score = 24). The evaluation was conducted using the individual risk assessment (ERIN) method. These studies will reference how ergonomic interventions can be carried out in the meat processing industry.<sup>15</sup> Similarly, it is important that animal slaughterhouse workers have good level of knowledge, positive attitudes, and practices toward the safe handling of meat, and compliance with the local legislations, and it can be improved through workshops and training.<sup>16</sup>

### Recommendations

Several limitations should be considered when applying the results of the present study. Firstly, the study's cross-sectional design makes it difficult to establish causation. Secondly, the study was conducted in a small population,

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meaning that the findings may not be generalizable to larger groups. Therefore, it is recommended that the researcher expand their study to different areas to gain a more comprehensive understanding of the factors involved. Additional qualitative studies should also be conducted, with a focus on factors such as psychological stress, inappropriate temperature, ergonomic parameters, and study area expansion.

This study highlights the need for preventive actions against the chronic symptoms of WMSDs among workers in pig slaughterhouses. Therefore, ergonomic strategies should be implemented to decrease the risk factors associated with these disorders. Future studies should examine all groups of workers in pig slaughterhouses in different regions and explore the relationship between WMSDs and factors such as social psychology, stress, physical activity, and task rotation. Additionally, programs aimed at preventing WMSDs should be considered.

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