



Work-related Musculoskeletal Disorders among Rubber Tappers in Phatthalung Province, Thailand

Sutee Inraksa^{1*}, Angoon Sungkha¹, Supapan Chaiprapat², and Klangduan Pochana²

¹ Faculty of Engineering, Prince of Songkla University, Songkhla, 90110, Thailand

² Smart Industry Research Center, Department of Industrial and Manufacturing Engineering, Faculty of Engineering, Prince of Songkla University, Songkhla, 90110, Thailand

* Correspondence: juk007@hotmail.com

Citation:

Inraksa, S.; Sungkha, A.; Chaiprapat, S.; Pochana K. Work-related musculoskeletal disorders among rubber tappers in Phatthalung province, Thailand. 2026, 29(4), e262782. <https://doi.org/10.55164/ajstr.v29i4.262782>.

Article history:

Received: December 12, 2025

Revised: February 5, 2026

Accepted: February 7, 2026

Available online: March 24, 2026

Publisher's Note:

This article is published and distributed under the terms of the Thaksin University.

Abstract: This cross-sectional study presents the prevalence of Work-related Musculoskeletal Disorders (MSDs) among rubber tappers in Pa Phayom District, Phatthalung Province, Thailand. The results were assessed using descriptive statistics and binary logistic regression at the 95% confidence interval, with consideration of variables influencing MSDs. The results showed that most participants (51.90%) were female, with a sample mean age of 43.95 ± 10.77 years, an average work experience of 13.68 ± 8.87 years, and a working time per day of 3.75 ± 1.52 hr. The physical work characteristics of the sample group revealed that the rubber plantations were on flat land (87.01%), more than 500 rubber trees were tapped per day (62.99%), the tapping height was below waist level (61.04%), and the rubber trees were older than 10 years (73.38%). The results for the severity of musculoskeletal disorders at the unbearable level showed that the lower back had the highest incidence (9.1%), followed by the upper back (2.6%). At the severe level, the lower back (26.6%) had the highest incidence, followed by the shoulder (7.8%) and the upper back (7.1%). When considering overall pain levels across different body parts, the hand/wrist was the most common (87.7%), followed by the neck (83.1%) and the lower back (82.5%). Factors associated with MSD symptoms among rubber farmers include the age of the trees and exercise. The reported acute MSD in their lower backs throughout the one-month study duration. Therefore, ergonomic knowledge should be promoted to help rubber farmers improve their working posture and reduce injuries.

Keywords: Musculoskeletal disorders; rubber tappers; ergonomics; rubber farmers

1. Introduction

Rubber tapping is a primary source of income for smallholder farmers across Southeast Asia, but the work is hazardous, exposing rubber tappers to multiple occupational hazards that can adversely affect health and productivity. Rubber tappers perform repetitive actions, such as cutting, forward bending, and trunk twisting, during prolonged standing—movements strongly associated with musculoskeletal disorders (MSDs). Studies in Thailand and neighboring countries reported high prevalence of lower back pain, shoulder pain, and upper-limb disorders among rubber farmers [1–3]. Rubber tappers are also vulnerable to injuries from knives, slipping on wet terrain, and encounters with insects or wildlife [4]. Many plantations use agrochemicals for weed and pest control, increasing chemical exposure linked to reduced quality of life and other chronic health effects among rubber farmers [5]. Assessment of

musculoskeletal disorders is therefore critical for estimating their severity and developing targeted preventive measures. Previous community-based studies in Southern Thailand have reported that musculoskeletal diseases (MSDs) are a concern among rubber tappers. Rubber tappers are more likely to experience lower back pain if they use improper ergonomics. It is necessary to implement preventive measures to reduce this issue in the future [1]. Current rubber tapping practices lack adequate health safeguards and pose significant health risks, including musculoskeletal injuries. Therefore, it is crucial to survey rubber tapping injuries to gather data for prevention, health promotion, and the development of activities to reduce work-related injuries [6,7]. In Pa Phayom District, Phatthalung Province, rubber farming is economically significant, but work-related musculoskeletal disorders have not been adequately documented. Therefore, a systematic investigation of musculoskeletal injuries in this local context is crucial to identify key causes, understand contributing factors, and propose concrete solutions to meet the needs of farmers. This study surveyed the musculoskeletal injuries and factors associated with MSD symptoms of rubber tappers in Pa Phayom District, Phatthalung Province. This study aims to present appropriate rubber tapping practices that reduce injuries and promote sustainable livelihoods among rubber farmers in southern Thailand.

2. Materials and Methods

This descriptive cross-sectional study evaluated the ergonomics of MSDs among rubber tappers in Phatthalung Province. A structured questionnaire and in-person interviews were used to gather data. The research was carried out between January 1, 2024, and September 30, 2025. The posture of rubber tapping is shown in Figure 1.



Figure 1. Rubber tapping posture of a rubber farmer (waist level)

2.1 Sample size

Phatthalung Province, Pa Phayom District has 256 registered rubber tappers. A simple sampling method [8] was employed to select 154 rubber tappers. The inclusion criteria included over one year of work experience, voluntary participation, and proficiency in Thai communication and comprehension. Rubber tappers with a history of MSDs or congenital diseases and ensuing musculoskeletal conditions such as gout, rheumatoid arthritis, or renal disease, as well as a history of injuries and conditions affecting the skeletal system and muscles, were excluded.

Sample Size Calculation

The sample size was calculated using the Krejcie and Morgan equation (1970), as shown in Equation 1, with a population of 256 members of a farmer group in Pa Phayom District (Phatthalung Provincial Agricultural and Cooperative Office, 2023).

$$n = \frac{x^2 N p (1-p)}{e^2 (N-1) + x^2 p (1-p)} \quad (1)$$

n = Sample size

N = Population size

e = Acceptable sample error (e=0.05)

x^2 = Chi-square value at df = 1 and 95% confidence level ($x^2 = 3.841$)

p = Proportion of the characteristic of interest in the population (p = 0.5)

Substituting the values into the Krejcie-Morgan equation yields a sample size of 154.

2.2 Ethical approval

The Thaksin University Ethics Committee approved this study (COA No. TSU 2024_070 REC No. 0174). All the participants were informed of the study's purpose and signed informed consent forms before data collection.

2.3 Questionnaire

The research used a structural questionnaire adapted from Meksawi S. [1]. The three components comprising the questionnaire were 1) The demographic questionnaire includes gender, age, work experience, work time per day, marital status, religion, smoking, and drinking., 2), The physical work characteristics questionnaire consists of 9 questions: plantation ground level, trees tapped per day, tapping light, handedness, break time, standing posture, ages of trees, tapping height, and exercise., and 3) The MSDs assessment tool is adapted from the Nordic Musculoskeletal Disorder Questionnaire[9] and evaluates 12 body parts: lower back, upper back, hip/thigh, shoulder, hand/wrist, upper arm, foot, lower arm, calves, neck, knee, and elbow. The severity of the symptoms is categorized into four levels: 1) slight, 2) moderate, 3) severe, and 4) unbearable.

2.4 Statistical analysis

A statistical program was used to analyze the data. Frequency, percentage, mean, and standard deviation (SD) were calculated for physical work characteristics and demographic traits using descriptive statistics. Factors associated with MSD were identified using binary logistic regression, with ORs set at the 0.05 significance level. The prevalence of MSDs for every body part was recorded throughout the one-month study period.

3. Results and Discussion

3.1. Demographic data

Personal characteristics of a sample of 154 rubber farmers in Phatthalung province revealed that the majority were female (51.90%), with an average age of 43.95 ± 10.77 years. A quarter of the subjects were non-smokers, and one-third were teetotalers. Most participants were Buddhists (81.17%), and 69.48% were married. The sample group had relatively high work experience (13.68 ± 8.87) and rubber tapping time per day (3.75 ± 1.52). (Table 1).

3.2. Physical work characteristics

The tapping light was sufficient (89.60%) on the plantation ground level, which was mainly flat (87.01%), with tapping height below waist level (61.04%). Most rubber tappers balance standing posture (88.30%) and right-handedness (87.00%). The majority of the sample tapped rubber at a height below the waist (61.04%), and most rubber trees were older than 10 years (73.38%). Most rubber farmers take breaks between rubber tapping sessions (53.20%). It was also found that the majority of rubber farmers exercise (64.30%). (Table 2).

Table 1. Demographic characteristic (n =154).

Characteristic	n (%)
Age (mean± SD) yrs = 43.95 ± 10.77	
Work experience (mean ± SD) yrs = 13.68 ± 8.87	
Work time per day (mean ± SD) hr = 3.75 ± 1.52	
Gender	
Male	
Female	
Status	74(48.10)
Single	80(51.90)
Marry	
Widow/Divorced	29(18.83)
Religion	107(69.48)
Buddha	18(11.69)
Islam	
Smoking	125(81.17)
No	29(18.83)
Yes	
Drinking	118(76.62)
No	36(23.38)
Yes	109(70.78)
	45(29.22)

Table 2. Physical work characteristics (n =154).

Characteristics	n (%)
Plantation ground level	
Flat	134(87.01)
Slope	20(12.99)
Trees tapped per day	
≤ 500	57(37.01)
>500	97(62.99)
Tapping light	
Sufficient	138(89.60)
Insufficient	16(10.40)
Handedness	
Right	134(87.00)
Left	20(13.00)
Break time	
Yes	82(53.20)
No	72(46.80)
Standing posture	
Balance	136(88.30)
Not balance	18(11.70)

Table 2. Physical work characteristics (n =154). (Continue)

Characteristics	n (%)
Ages of trees	
≤ 10 yrs	41(26.62)
>10 yrs	113(73.38)
Tapping height	
Below waist	94(61.04)
Above waist	60(38.96)
Exercise	
No	55(35.70)
Yes	99(64.30)

3.3. Musculoskeletal disorders (MSDs)

The severity of musculoskeletal disorders, categorized by body part over the past month, has been reported as follows: Moderate discomfort was most commonly reported in the lower back (39.6%), hands and wrists (35.1%), and knees (30.5%), followed by the hip/thigh (26.6%) and neck regions. (26.0%) regions. and upper back (26.0%) regions. Severe to intolerable symptoms were recorded in the lower back (26.6%), shoulder (7.8%), and upper back (7.1%). In addition, it was found that at the unbearable level, the body parts with the highest values are the lower back (9.1%) and the upper back (2.6%) (Table 3 and Figure 2).

Table 3. Number and percentage of rubber tappers with levels of musculoskeletal discomfort, classified by body part (n =154).

Body Part	Discomfort Level				
	Not Discomfort	Slight	Moderate	Severe	Unbearable
Lower back	27(17.5)	11(7.1)	61(39.6)	41(26.6)	14(9.1)
Upper back	31(20.1)	68(44.2)	40(26.0)	11(7.1)	4(2.6)
Hip/ Thigh	62(40.3)	43(27.9)	41(26.6)	8(5.2)	0
Shoulder	29(18.8)	83(53.9)	29(18.8)	12(7.8)	1(0.6)
Hand /wrist	19(12.3)	70(45.5)	54(35.1)	10(6.5)	1(0.6)
Upper arm	71(46.1)	58(37.7)	16(10.4)	8(5.2)	1(0.6)
Foot	29(18.8)	81(52.6)	35(22.7)	8(5.2)	1(0.6)
Lower arm	54(35.1)	66(42.9)	29(18.8)	5(3.2)	0
Calves	53(34.4)	60(39.0)	35(22.7)	5(3.2)	1(0.6)
Neck	26(16.9)	84(54.5)	40(26.0)	3(1.0)	1(0.6)
Knee	38(24.7)	66(42.9)	47(30.5)	2(1.3)	1(0.6)
Elbow	84(54.5)	55(35.7)	13(8.4)	2(1.3)	0

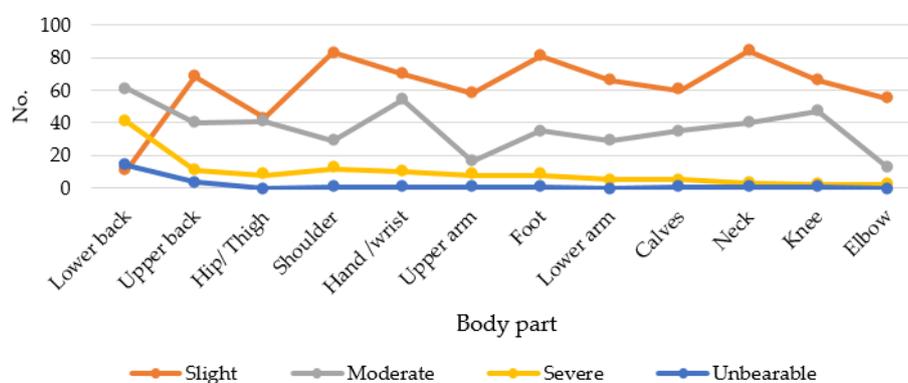


Figure 2. The graph shows levels of musculoskeletal discomfort, classified by body part.

3.4 The MSDs are classified as pain or no pain

The analysis of MSD symptoms, categorized by the presence or absence of pain, showed that most participants reported pain in the hand/wrist (87.7%), neck (83.1%), lower back (82.5%), and shoulder and foot (81.2%). Furthermore, the pain-free body parts were the elbow (54.5%), upper arm (46.1%), hip/thigh (40.3%), and lower arm (35.1%). (Table 4)

Table 4. The MSD results are classified according to whether or not the individual is in pain. (n = 154).

Body part	MSDs			
	Pain		No pain	
	Number	Percentage	Number	Percentage
Lower back	127	82.5	27	17.5
Upper back	123	79.9	31	20.1
Hip/ Thigh	92	59.7	62	40.3
Shoulder	125	81.2	29	18.8
Hand /wrist	135	87.7	19	12.3
Upper arm	83	53.9	71	46.1
Foot	125	81.2	29	18.8
Lower arm	100	64.9	54	35.1
Calves	101	65.6	53	34.4
Neck	128	83.1	26	16.9
Knee	116	75.3	38	24.7
Elbow	70	45.5	84	54.5

3.5 Factors associated with MSD symptoms in rubber farmers.

The results of the binary logistic regression analysis of the relationship between factors affecting MSDs are as follows: Ages of trees (OR=0.12, 95%CI=0.02-0.58) and Exercise (OR=0.15, 95%CI=0.03-0.79). Furthermore, other factors were found not to affect MSD symptoms (This analysis focuses only on the unbearable level) (Table 5).

Table 5. Factors associated with MSDs using binary logistic regression analysis. (n = 154).

Factors	OR	95%CI	P-value
Plantation ground level	0.56	0.05, 5.77	0.626
Trees tapped per day	1.15	0.27, 4.87	0.848
Tapping light	1.27	0.19, 8.30	0.802
Handedness	1.40	1.17, 11.45	0.751
Break time	0.32	0.05, 1.76	0.192
Standing posture	4.67	0.72, 30.09	0.105
Ages of trees	0.12	0.02, 0.58	0.008*
Tapping height	0.44	0.10, 1.85	0.265
Exercise	0.15	0.03, 0.79	0.026*

*Statistics significant at $p\text{-value} < 0.05$

3.6 Discussion

The rubber tappers numbered more females than males, with those aged 20 to 60, consistent with findings by Meksawi S. [1] and M. Umar H.Y.[10], but different from Chow li Shan [11], S. Arphorn [12], and Chaigliang S. [13] for the age group between 41 and 60 years, because rubber plantations are most extensive in southern Thailand, leading many family members across different age groups to take up rubber tapping as their occupation. Participants who smoked numbered 23.38%, with more men than women, consistent with Shan C. L. [11] smokers being mostly males. The average working time per day was 3.75 hours, corresponding to < 5 hours by Shan C. L. [11] and Chaigliang S. [13], but different from Meksawi S. [1] at 6.2 hours. In Phatthalung, most households have small rubber plantations, so tapping time is shorter than in large rubber

plantations. The majority of rubber plantation areas are flat (87.01%), resulting in a balanced posture for rubber tapping (88.30%). The majority of the sample group is right-handed, consistent with Chaigliang S. [13]. The majority of rubber farmers are right-handed (71.84%). This aligns with the fact that the majority of the population is right-handed, so rubber-tapping knives are also manufactured for right-handed people. Most rubber farmers tap more than 500 trees per day (62.99%), which is inconsistent with Stankevitz's report [4]. This may be because rubber plantations in Sri Lanka are smaller than those in Thailand. The highest prevalence of severe-to-intolerable MSD discomfort occurred in the lower back, followed by the upper back. This result was consistent with previous research reports [1, 7, 11-13], as the posture for tapping rubber trees involves bending, twisting, or squatting below the knees. MSD pain, across all levels, is most commonly found in the hand/wrist, consistent with research reports [14], due to the repetitive hand and wrist movements required in the rubber tapping process. The highest MSD injury rate was recorded in the lower back because the rubber tapping process involves repetitive movements, and tapping below the waist requires continued bending. The analysis of factors related to MSD using binary logistic regression in this study found that exercise was the only significant factor ($p = 0.026$). Exercise helps strengthen the body and reduce injuries from rubber tapping, consistent with the research report by Chaigliang S. [7]. Hand-grip strength has a statistically significant effect on the risk of MSD. Furthermore, it was found that older rubber trees (>10 years) had higher MSD during rubber tapping ($p = 0.008$). Older rubber trees are larger, which helps reduce wrist bending and body twisting during tapping.

4. Conclusions

The study found that rubber farmers experienced MSD in all parts of the body after tapping rubber for 1 month, particularly in the lower and upper back. Furthermore, an analysis of MSD pain levels showed that the hand/wrist pain was the most severe. Factors associated with MSD included tapping light, break time, standing posture, age of trees, and exercise, all of which were statistically significant. The nature of rubber tapping involves twisting and bending the body, repeatedly twisting and jerking the wrists. Furthermore, ergonomically incorrect working postures involving excessive bending and straightening of the body can also lead to injuries. Therefore, ergonomic work postures should be improved, appropriate tools for rubber tapping should be designed, suitable rest periods should be planned, and occupational health and safety should be promoted among rubber farmers to ensure better working conditions and improved health.

5. Acknowledgements

The investigator would like to express gratitude. All of the advisers who consistently give up their precious time to offer thoughtful, considerate guidance, edit, and support until the researcher is finished with their work.

Author Contributions: Conceptualization: Inraksa S.; Methodology: Inraksa S., Chaiprapat S., Pochana K., and Sungkhapong A.; Validation, formal analysis: Chaiprapat S. and Pochana K.; Writing—original draft preparation, review, and editing: Inraksa S., Chaiprapat S., Pochana K., and Sungkhapong A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflict of interest

References

- [1] Meksawi, S.; Tangtrakulwanich, B.; Chongsuvivatwong, V. Musculoskeletal Problems and Ergonomic Risk Assessment in Rubber Tappers: A Community-Based Study in Southern Thailand. *Int. J. Ind. Ergon.* **2012**, *42*(1), 129–135. <https://doi.org/10.1016/j.ergon.2011.08.006>
- [2] Chokprasit, P.; Yimthiang, S.; Veerasakul, S. Predictors of Low Back Pain Risk among Rubber Harvesters. *Int. J. Environ. Res. Public Health* **2022**, *19*(17), 10492. <https://doi.org/10.3390/ijerph191710492>

- [3] Varghese, V.; Panicker, V. V. Effect of MSDs and Scope of Ergonomic Interventions among Rubber Processing Workers: A Systematic Review. *Med. Lav.* **2022**, *113*(4), e2022032. <https://doi.org/10.23749/mdl.v113i4.12826>
- [4] Stankevitz, K.; et al. Prevalence of Occupational Injury and Its Contributing Factors among Rubber Tappers in Galle, Sri Lanka. *Int. J. Occup. Environ. Health* **2016**, *22*(4), 333–340. <https://doi.org/10.1080/10773525.2016.1247026>
- [5] Nippanon, P.; et al. Chemical Pesticide Use and Quality of Life of Rubber Farmers in the Northeast of Thailand. *Kathmandu Univ. Med. J.* **2019**, *17*(65), 3–8.
- [6] Inraksa, S.; Sungkhapong, A.; Pochana, K. Risk Assessment of Rubber Tapping a Case Study: Pa Phayom District, Phatthalung Province, Thailand. *ASEAN J. Sci. Technol. Rep.* **2024**, *27*(5), e254127. <https://doi.org/10.55164/ajstr.v27i5.254127>
- [7] Chaigliang, S.; Khanaphan, K.; Suggaravetsiri, P. Factors correlated with risk levels of musculoskeletal disorders among rubber planters. *J. Med. Tech. Phys. Ther.* **2020**, *32*(1), 82–94 (in Thai).
- [8] Krejcie, R. V.; Morgan, D. W. Determining Sample Size for Research Activities. *Educ. Psychol. Meas.* **1970**, *30*(3), 607–610. <https://doi.org/10.1177/001316447003000308>
- [9] Kuorinka, I.; et al. Standardised Nordic Questionnaires for the Analysis of Musculoskeletal Symptoms. *Appl. Ergon.* **1987**, *18*(3), 233–237. DOI: 10.1016/0003-6870(87)90010-x
- [10] Hy, M. U.; Agbonaye, O.; Uwumarongie, A.; Eboigbe, G. Impact analysis of occupational hazard on the productivity of Rubber tappers in Rubber Research Institute of Nigeria, Iyanomo, Benin City. *Research Report* **2016**.
- [11] Shan, C. L.; Adon, M. Y. B.; Rahman, A. B. A.; Hassan, S. T. S.; Ismail, K. B. Prevalence of Neck Pain and Associated Factors with Personal Characteristics, Physical Workloads and Psychosocial among Male Rubber Workers in FELDA Settlement Malaysia. *Global J. Health Sci.* **2011**, *4*(1). <https://doi.org/10.5539/gjhs.v4n1p94>
- [12] Arphorn, S.; Chaonesuan, P.; Pruktharathikul, V.; Singhakajen, V.; Chaikittiporn, C. A Program for Thai Rubber Tappers to Improve the Cost of Occupational Health and Safety. *Ind. Health* **2010**, *48*(3), 275–282. <https://doi.org/10.2486/indhealth.48.275>.
- [13] Chaigliang, S. Occupational health risk assessment of musculoskeletal disorders on exposure to working ergonomic factors in para rubber plant farmers. *KKU J. Public Health Res.* **2019**, *14*(2), 32–44 (in Thai).
- [14] Khanaphan, K.; Suggaravetsiri, P.; Chaigliang, S. Ergonomics risk and muscle fitness among rubber planters in Ubon Ratchatani Province. *UBRU J. Public Health Res.* **2019**, *8*(2), 21–31 (in Thai).