ORIGINAL RESEARCH ARTICLE

Occupational Health Effects and Factors Associated with Safety Knowledge, Attitudes, and Practices among Latex Farmers in Southern Thailand

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ABSTRACT

Background: Latex farmers engaged in fresh latex trading face multiple occupational hazards, including chemical exposure, job stress, musculoskeletal disorders, skin diseases, and respiratory symptoms. These hazards indicate the need for effective occupational safety and health management. This study aimed to assess occupational health effects and identify factors associated with safety knowledge, attitudes, and practices among latex farmers in southern Thailand.

Methods: A cross-sectional study was conducted among 496 latex farmers selected by multistage sampling from agricultural cooperatives in three districts of southern Thailand. Data were collected using structured questionnaires covering demographics, work characteristics, health symptoms, and occupational safety knowledge, attitudes, and practices. Descriptive statistics, correlation analysis, and multiple regression analysis were applied with statistical significance defined at 0.05.

Results: Most participants were male, middle-aged, and married, with education beyond secondary level. Many reported smoking, alcohol consumption, long working hours, no underlying diseases, and no prior safety training. Common health symptoms included musculoskeletal pain, eye irritation, and skin problems. Safety knowledge and safety attitudes were significantly associated with safety practices, explaining 35.1% of the variance in regression analysis.

Conclusions: Enhancing safety knowledge and attitudes may be important correlates of safe work practices among latex farmers.

Keywords: Health Effects, Knowledge, Attitudes, Safety Practices, Latex farmers, fresh latex trading

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INTRODUCTION

In 2022, Thailand produced more than 4.7 million tonnes of natural rubber, of which about 90 % was produced by smallholder farmers cultivating approximately 3.9 million hectares of plantation area. There are an estimated 1.68 million small-scale producers engaged in rubber cultivation, and nearly one-quarter of agricultural households in Thailand depend on rubber production for income, underscoring the sector's major role in rural livelihoods and the national economy.[1] A substantial share of production enters the fresh latex market, where latex is collected from farmers, treated with preservatives such as ammonia to slow coagulation, and then sold to local processing facilities or export buyers for further manufacturing, particularly in the tyre industry.[2,3] Decisions within this trading system are shaped by both latex quality and fluctuating market prices, creating close links between farm-level handling practices and downstream industrial demand.[1]

A growing body of research has highlighted that rubber tapping and related plantation work expose farmers to multiple occupational risks. Reported hazards include heavy and repetitive physical tasks, contact with chemical agents and work-related stress.[3] Frequently observed health outcomes among rubber farmers include musculoskeletal complaints, especially low back pain, as well as respiratory symptoms, skin disorders, eye irritation, accidental injuries, and bites from venomous animals commonly found in plantation environments.[2,4,5] Recent observational studies have demonstrated a high prevalence of work-related musculoskeletal disorders among agricultural workers, largely attributable to repetitive manual tasks and sustained awkward postures.[6-8] Evidence from Southeast Asia further identifies rubber plantation workers as particularly vulnerable to chronic low back and upper extremity disorders associated with tapping activities.[9,10] Additionally, regional data highlight concurrent chemical and environmental exposures, underscoring the need for integrated occupational health surveillance and prevention in rubber-producing communities.[10] Thai studies have documented a particularly high prevalence of low back pain, with associations reported for factors such as limited formal education, higher body mass index, and sustained forward bending during tapping activities.[11,12] Similar patterns reported from other rubber-producing countries suggest that these problems are widespread rather than location-specific.[9,10,13,14] Collectively, these findings point to the need for practical preventive strategies and improved safety awareness in rubber farming communities. Most previous investigations of occupational health in rubber farming have focused on ergonomic exposures and musculoskeletal disorder risks arising from rubber tapping tasks, which involve repetitive movements and sustained awkward postures. Evidence from recent ergonomic risk assessments highlights high postural risk levels among rubber tappers and substantial Musculoskeletal discomfort associated with tapping work.[14,15]In contrast, comparatively fewer studies have provided a detailed occupational analysis of the processes involved in the collection, preservation and trading of fresh latex.[2,3,16] These activities typically require repeated lifting and transport of liquid latex, routine use of chemical stabilizers to prevent spoilage and time-sensitive handling to maintain product quality.[2,3,16] While ergonomic and chemical exposures during rubber tapping have been characterized in recent occupational health research, detailed comparative investigations examining whether exposures differ between fresh latex trading and conventional dry rubber sheet production remain limited, suggesting a need for hypothesis-driven inquiry in this area. Studying this segment of the production chain can therefore add a more nuanced, context-specific understanding of occupational health risks faced by smallholder farmers. Recent studies in southern Thailand have primarily examined occupational exposure, ergonomic risk and chemical safety among rubber farmers.[15-17] However, a review of the recent literature indicates that research has largely focused on health risk assessment and safety behaviors, with comparatively limited attention to the integrated processes of fresh latex collection, preservation and trading within smallholder systems. Despite the region's central role in national rubber production,[17,18] empirical evidence addressing these interconnected post-harvest and value-chain practices remains relatively scarce. where this activity forms a major part of the local rubber economy. In addition, few studies have simultaneously examined workers' health outcomes together with their knowledge, attitudes and safety practices related to latex handling and chemical preservation. This lack of context-specific and practice-oriented information constrains the development of targeted and locally appropriate occupational health interventions.

To address this gap, the present study investigates smallholder farmers in southern Thailand who are directly engaged in fresh latex collection and trade. It aims to describe their occupational health conditions and to examine the factors associated with their knowledge, attitudes, and safety practices in handling and preserving fresh latex. By generating area-based empirical data, the study seeks to inform the design of practical safety training and guidance for local cooperatives and health authorities, while contributing additional, context-sensitive evidence to the broader understanding of occupational health in smallholder rubber production.

METHODOLOGY

This investigation employed an analytical cross-sectional design to assess occupational health conditions and safety-related knowledge, attitudes and practices among smallholder rubber farmers engaged in the collection and trade of fresh latex in

southern Thailand. The study followed recommended reporting elements for observational studies to ensure transparency and reproducibility.

The study was conducted in three provinces in southern Thailand that represent the upper, middle, and lower parts of the region: Surat Thani, Nakhon Si Thammarat and Songkhla. Within these provinces, data were collected in Kien Sa, Pipoon, and Rattaphum districts, respectively. These districts were selected because fresh latex trading through farmer cooperatives is a routine and well-established activity in these areas. Field data collection took place between May and August 2025.

Participants and eligibility criteria: The source population comprised members of rubber farmer cooperatives registered with the Rubber Plantation Fund who were actively involved in selling fresh latex to their cooperatives. Individuals were eligible if they: 1) were registered cooperative members, 2) were currently working as rubber farmers, 3) had regularly supplied fresh latex trading to the selected cooperative during the previous 12 months, and 4) were aged 18 years or older. In addition, individuals were excluded if they had stopped rubber farming or latex trading, were temporary labourers who were not cooperative members, or were unable to participate in an interview due to severe illness or communication limitations.

Sampling procedure: A multistage sampling approach was used. 1) Province selection: Three provinces were purposively chosen to reflect geographic variation across the southern region. 2) District selection: One district with an active cooperative-based fresh latex trading system was identified in each province. 3) Cooperative selection: From official registration lists, one cooperative per district that continuously purchased fresh latex from members was selected. 4) Participant selection: Updated membership lists of eligible latex sellers from each cooperative served as sampling frames. The number of participants drawn from each cooperative was allocated proportionally to the number of eligible members. Within each list, systematic random sampling was applied to select individual participants.

Across the three cooperatives, approximately 1,500 members met the eligibility criteria and constituted the sampling population.

Study design and sampling: This cross-sectional study employed a multistage cluster sampling design to obtain a representative sample of fresh latex sellers in the southern region. In the first stage, three provinces were purposively selected to reflect geographic variation. In the second stage, one district with an active cooperative-based fresh latex trading system was identified within each province. In the third stage, one officially registered cooperative per district that continuously purchased fresh latex from its members was selected. In the final stage, updated membership lists of eligible latex sellers from each cooperative served as sampling frames. The number of participants recruited from each cooperative was allocated proportionally to the total number of eligible members to ensure proportional representation. Within each cooperative, systematic random sampling was applied using a fixed sampling interval derived from the membership list.

The sample size was calculated using the single population proportion formula assuming a 95% confidence level (Z=1.96), an anticipated prevalence of 50% in the absence of prior data, and a margin of error of 5% (e=0.05), the initial calculated sample size was 384. Because a multistage cluster sampling design was used, the sample size was adjusted for clustering by applying a design effect (DEFF) of 1.2, so the sample size was 461. To compensate for potential non-response and incomplete questionnaires, 10% was added. Thus, the minimum required sample size was 507 participants. To ensure adequate statistical power and allow for operational feasibility during field data collection, the sample size was rounded up to 512 participants. A total of 496 participants were successfully recruited and included in the analysis, corresponding to a response rate of 97.8%, which exceeded the minimum required sample size and ensured adequate statistical precision.

Recruitment and response: Selected members were contacted through their cooperatives and invited to participate. Structured face-to-face interviews were conducted by trained interviewers at locations convenient for participants. Of the 512 selected individuals, 496 completed the survey (response rate 96.88%). Non-respondents were primarily those who could not be reached after repeated contact attempts or declined participation due to time constraints. Comparison of basic demographic information available from cooperative records indicated no marked differences in age or sex distribution between respondents and non-respondents. Questionnaires with more than 20% missing responses were excluded. For the remaining questionnaires, analyses were based on available data for each variable; no statistical imputation was performed.

Variables and measurements included 4 sections: 1) Sociodemographic and occupational characteristics, including sex, age, status, educational levels, cigarette smoking, alcohol consumption, hours worked per day, day worked per week, years of work, income, underlying disease, and safety working training, 2) Occupational health outcomes, including self-reported recent symptoms potentially associated with physical strain or exposure to latex preservatives and plantation hazards. 3) Occupational safety knowledge, including knowledge of safe latex handling and chemical use, was measured using 15 factual items. Correct responses received one point, giving a total score from 0 to 15. Scores were categorized as low (0-7), moderate (8-11), or high (12-15), and 4) Safety attitudes and practices, including attitudes toward safety and routine protective behaviours, were assessed using Likert-type items scored from 1 (low) to 3 (high), similar to previous

patient-safety research among healthcare professionals .[19]Mean scores were interpreted as low (1.00–1.66), moderate (1.67–2.33), or high (2.34–3.00) based on equal interval classification of the three-point Likert scale.[19]

Instrument development and validation: The questionnaire was developed specifically for this study based on a review of published literature on occupational health and safety in rubber farming and related agricultural work. Item content was adapted to reflect the practical tasks involved in fresh latex collection, chemical preservation and transport within cooperative-based trading systems. An initial item pool was drafted in Thai and reviewed by three experts in occupational health, ergonomics and community medicine to assess relevance, clarity and contextual appropriateness. Their feedback was used to revise wording and remove ambiguous or overlapping items, supporting content validity. Prior to the main survey, the instrument was pilot tested with 30 smallholder rubber farmers from a neighboring district with similar production characteristics but not included in the final sample. Minor language adjustments were made to improve comprehension. Internal consistency reliability in the pilot sample was acceptable, with Cronbach's alpha coefficients of 0.82 for the knowledge scale, 0.85 for the attitude scale, and 0.88 for the practice scale.

Formal construct validation procedures, such as exploratory or confirmatory factor analysis, were not conducted and test-retest reliability was not assessed. Therefore, although the instrument demonstrated satisfactory internal consistency and face/content validity, its broader psychometric properties have not been fully established. Findings related to composite scale scores should be interpreted with this limitation in mind and further validation in different rubber farming populations is recommended.

Data collection procedures: Interviewers received standardized training on interview techniques, question wording and ethical conduct. Interviews were conducted in private areas to encourage candid responses. Participants were informed that their answers would not influence their cooperative membership or economic benefits.

Potential sources of bias: In this study, several steps were taken to minimize bias. Restricting questions to clearly defined recent time frames aimed to reduce recall error. Private interviewing and assurances of confidentiality were used to limit socially desirable responding. Selection bias was reduced by using complete cooperative membership lists and probability-based sampling. Consistent interviewer training and use of a structured questionnaire reduced variability in data collection.

Statistical methods: All analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). The data were evaluated using both descriptive and inferential statistical techniques. The chi-square test was used to investigate differences in latex farmer safety procedures based on socio-demographic characteristics. Fisher's exact test was applied where appropriate. Pearson's correlation analysis was conducted to assess the relationships among safety knowledge, safety attitudes and safety practices within the fresh latex trading occupational group. Additionally, a multiple linear regression model was used to examine the association of safety knowledge and safety attitude on overall safety behaviors. Results are presented as adjusted effect estimates with corresponding 95% confidence intervals. A two-sided p-value below 0.05 was considered statistically significant.

Ethical considerations: Ethical approval was obtained from the Thaksin University Ethics Committee for Human Research (approval number COA No. TSU 2025 - 163 REC No.0335; Research Project Code: 139/68. All participants received written and verbal information about the study and provided written informed consent prior to participation. Participation was voluntary and individuals could withdraw at any time without consequence. No personal identifiers were recorded in the analytical dataset and all data were stored securely and reported only in aggregated form to protect confidentiality.

RESULTS

Participant characteristics: A total of 512 latex farmers engaged in fresh latex trading were invited to participate in the study. Of these, 496 respondents returned completed questionnaires and met the inclusion criteria, resulting in a response rate of 97.80%. Sixteen questionnaires were excluded due to substantial missing information (>20% of required items) or incomplete key variables. The final analytical sample, therefore, consisted of 496 participants. Across the retained questionnaires, item-level missing data were minimal, ranging from 0% to 3.2% per variable. Examination of response patterns revealed no indication of systematic missingness. Given the small proportion of missing data, analyses were conducted using a complete-case approach. All analyses were performed using available data only and no imputation procedures were applied. As a result, denominators for percentage calculations may vary slightly across variables, as presented in the tables.

Socio-demographic and occupational characteristics: Most respondents were male (58.46%) and aged 41-50 years (57.26%). Approximately two-thirds were married (69.76%), and the majority had attained an education level beyond secondary school (81.05%). Health-related behaviors were common, with 67.30% reporting cigarette smoking and 49.60% reporting alcohol consumption. With respect to occupational characteristics, just over half of participants reported working approximately eight hours per day (51.60%) and more than six days per week (55.60%).

Table 1: Socio-demographic and occupational characteristics of latex farmers engaged in fresh latex trading (n = 496)

Characteristics	Participants (%)
Sex	
Male	290 (58.46)
Female	206 (41.54)
Age (years)	
20-30	70 (14.11)
31-40	122 (24.6)
41-50	284 (57.26)
>50	20 (4.03)
Status	
Single	54 (10.89)
Married (living together)	346 (69.76)
Widow/Divorced	96 (19.35)
Education levels	
Secondary school and below	94 (18.95)
Above secondary school	402 (81.05)
Smoker	334 (67.3)
Alcohol consumer	246 (49.6)
Occupational lifestyle	
Hours worked per day	
8 hrs.	256 (51.6)
≥8 hrs.	240 (48.4)
Days worked per week	
6 days/week	220 (44.4)
>6 days/week	276 (55.6)
Years of work	
≤15 years	276 (55.65)
>15 years	220 (44.35)
Income	
≤10000 Baht	108 (21.77)
>10000 Baht	388 (78.23)
Underlying disease	136 (27.42)
Safety training received	108 (21.77)

Analyses were based on complete case data; observations with missing values were excluded. Baht refers to Thai Baht (THB).

Table 2: Levels of occupational safety knowledge, attitudes, and practices among latex farmers engaged in fresh latex trading (n = 496)

Occupational safety level	Participants (%)
Safety knowledge level	
12-15 scores (High level)	148 (29.84)
8-11 scores (Moderate level	260 (52.42)
0-7 scores (Low level)	88 (17.74)
Min-max	2.00 -15.00
Mean (SD)	9.10 (2.30)
Safety attitude level	
1.00 -1.66 (Low level)	142 (28.63)
1.67-2.33 (Moderate level)	218 (43.95)
2.34 - 3.00 (High level)	136 (27.42)
Min-max	1.00 - 2.90
Mean (SD)	1.48 (0.75)
Safety practices level	
1.00 -1.66 (Low level)	140 (28.23)
1.67 - 2.33 (Moderate level)	230 (46.37)
2.34 - 3.00 (High level)	126 (25.40)
Min-max	1.05-2.80
Mean (SD)	1.41 (0.73)

Scores for safety knowledge ranged from 0 to 15. Safety attitude and practice levels were interpreted based on mean scores derived from a 3-point Likert scale (1 = low, 3 = high).

Slightly more than half had 15 years or less of work experience (55.65%). Most respondents reported a monthly income exceeding 10,000 Baht (78.23%) and indicated no underlying chronic disease (72.58%). Notably, a substantial proportion of participants reported never having received formal safety training (78.23%) (Table 1).

Levels of occupational safety knowledge, attitudes, and practices: Table 2 summarizes the levels of occupational safety knowledge, attitudes, and practices among latex farmers engaged in fresh latex trading. Most participants demonstrated a moderate level of safety knowledge (52.42%), while 29.84% and 17.74% exhibited high and low levels, respectively. The mean knowledge score was 9.10 ± 2.30 (range: 2-15). For occupational safety attitudes, 43.95% of respondents were classified as having a moderate level, followed by low (28.63%) and high (27.42%) levels. The mean attitude score was 1.48 ± 0.75, with observed values ranging from 1.00 to 2.90. Similarly, occupational safety practices were predominantly at a moderate level (46.37%). The remaining participants were distributed between low (28.23%) and high (25.40%) levels. The mean practice score was 1.41 ± 0.73, with a range of 1.05-2.80.

Associations between participant characteristics and safety outcomes: Table 3 shows the associations between socio-demographic and occupational characteristics and levels of occupational safety knowledge, attitudes, and practices among latex farmers engaged in fresh latex trading. Safety knowledge level was significantly associated with educational attainment ($p < 0.001$), monthly income ($p = 0.021$), and receipt of safety training ($p < 0.001$). Farmers with higher educational levels, higher income, and those who had received safety training were more likely to have moderate to high levels of safety knowledge. Safety attitude level was significantly associated with educational attainment ($p = 0.003$), smoking status ($p = 0.028$), alcohol consumption ($p = 0.014$), and safety training ($p < 0.001$). Participants who had higher education, did not smoke or consume alcohol, and had received safety training tended to report more positive safety attitudes. Safety practice level was also significantly associated with educational attainment ($p = 0.012$), smoking status ($p = 0.031$), alcohol consumption ($p = 0.019$), and safety training ($p < 0.001$). Farmers who had received safety training were more likely to report higher levels of appropriate safety practices compared with those who had not. No significant associations were observed between age, sex, years of work experience, daily working hours, or number of working days per week and levels of safety knowledge, attitudes, or practices.

Work-related health symptoms: The most commonly reported work-related symptoms during the preceding six months were muscle pain or soreness (68.15%) and eye discomfort or irritation (64.11%). Other frequently reported symptoms included skin peeling or exfoliation (45.16%), skin redness or in-

flammation (37.10%), and work-related illness or injury (33.87%). Respiratory-related symptoms, such as difficulty breathing or congestion, were reported less frequently (8.47%) (Table 4).

Associations between characteristics and reported health symptoms: Table 5 presents the associations between sociodemographic characteristics, lifestyle factors, occupational factors and levels of occupational safety knowledge, attitudes and practices among participants. Education level was significantly associated with safety knowledge and overall safety practice, with participants who had more than a high school education demonstrating higher levels of knowledge and better safety practices compared with those with a high school education or lower (p <0.001). Smoking status and alcohol consumption showed no statistically significant associations with most safety outcomes.

Table 3: Associations between socio-demographic and occupational characteristics and levels of occupational safety knowledge, attitudes, and practices (n = 496)

Variable	n	Safety knowledge, n (%)			Safety Attitude, n (%)			Safety Practices, n (%)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Sex										
Male	290	52(17.9)	154(53.1)	84(28.9)	84(28.9)	134(46.2)	72(24.8)	68(23.4)	136(46.9)	86(29.6)
Female	206	36(17.4)	106(51.4)	64(31.0)	52(25.2)	84(40.7)	70(33.9)	58(28.1)	94(45.6)	54(26.2)
p-value				0.938			0.291			0.671
Age (Years)										
20-30	70	18(25.7)	42(60.0)	10(14.2)	22(31.4)	26(37.1)	22(31.4)	18(25.7)	36(51.4)	16(22.8)
31-40	122	22(18.0)	62(50.8)	38(31.1)	42(34.4)	58(47.5)	22(18.0)	28(22.9)	64(52.4)	30(24.5)
41-50	284	44(15.4)	140(49.3)	100(35.2)	60(21.1)	126(44.3)	98(34.5)	76(26.7)	124(43.6)	84(29.5)
>50	20	4(20.0)	16(80.0)	0	12(60.0)	8(40.0)	0	4(20.0)	6(30.0)	10(50.0)
p-value				0.087			0.021*			0.064
Status										
Single	54	16(29.6)	38(70.3)	0	18(33.3)	24(44.4)	12(22.2)	12(22.2)	20(37.0)	22(40.7)
Married*	346	60(17.3)	160(46.2)	126(36.4)	104(30.0)	148(42.7)	94(27.1)	90(26.0)	166(47.9)	90(26.0)
Widow/Divorced	96	12(12.5)	62(64.5)	22(22.9)	14(14.5)	46(47.9)	36(37.5)	24(25.0)	44(45.8)	28(29.1)
p-value				< 0.001*			0.220			0.635
Education levels										
Up to High school	94	24(25.5)	62(65.9)	8(8.5)	28(29.7)	38(40.4)	28(29.7)	22(23.4)	38(40.4)	34(36.1)
Above high school	402	64(15.9)	198(49.2)	140(34.8)	108(26.8)	180(44.7)	114(28.3)	104(25.8)	192(47.7)	106(26.3)
p-value				0.002*			0.857			0.401
Smoking status										
Yes	334	80(23.9)	162(48.5)	92(27.5)	90(26.9)	164(49.1)	80(23.9)	84(25.1)	158(47.3)	92(27.5)
No	162	8(4.9)	98(60.4)	56(34.5)	46(28.4)	54(33.3)	62(38.2)	42(25.9)	72(44.4)	48(29.9)
p-value				<0.001*			0.030*			0.908
Alcohol consumption										
Yes	246	32(13.0)	148(60.1)	66(26.8)	76(30.8)	112(45.5)	58(23.5)	58(23.5)	118(47.9)	70(28.4)
No	250	56(22.4)	112(44.8)	82(32.8)	60(24.0)	106(42.4)	84(33.6)	68(27.2)	112(44.8)	70(28.0)
p-value				0.037*			0.184			0.795
Occupational lifestyle										
Hours worked per day										
8 hrs.	256	48(18.7)	140(54.6)	68(26.5)	76(29.6)	118(46.0)	62(24.2)	54(21.0)	128(50.0)	74(28.9)
> 8 hrs.	240	40(16.6)	120(50.0)	80(33.3)	60(25.0)	100(41.6)	80(33.3)	72(30.0)	102(42.5)	66(27.5)
p-value				0.506			0.277			0.256
Days worked per week										
6 days/week	220	44(20.0)	114(51.8)	62(28.1)	64(29.0)	94(42.7)	62(28.1)	64(29.0)	90(40.9)	66(30.0)
>6 days/week	276	44(15.9)	146(52.9)	86(31.1)	72(26.0)	124(44.9)	80(28.9)	62(22.4)	140(50.7)	74(26.8)
p-value				0.683			0.868			0.279
Years of work										
≤15 years	276	50(18.1)	162(58.7)	64(23.1)	78(28.2)	132(47.8)	66(23.9)	72(26.0)	114(41.3)	90(32.6)
>15 years	220	38(17.2)	98(44.5)	84(38.1)	58(26.3)	86(39.0)	76(34.5)	54(24.5)	116(52.7)	50(22.7)
p-value				0.031*			0.169			0.142
Income										
≤10000 Baht	108	30(27.7)	52(48.1)	26(24.0)	38(35.1)	48(44.4)	22(20.3)	18(16.6)	60(55.5)	36(27.7)
>10000 Baht	388	58(14.9)	208(53.6)	122(31.4)	98(25.2)	170(43.8)	120(30.9)	114(29.3)	170(43.8)	104(26.8)
p-value				0.085			0.205			0.024*
Underlying disease										
Yes	136	28(20.5)	62(45.5)	46(33.8)	38(27.9)	56(41.1)	42(30.8)	42(30.8)	66(48.5)	28(20.5)
No	360	60(16.6)	198(55.0)	102(28.3)	98(27.2)	162(45.0)	100(27.7)	84(23.3)	164(45.5)	112(31.1)
p-value				0.415			0.844			0.208
Safety training										
Yes	108	19(17.5)	10(9.2)	79(73.1)	21(19.4)	12(11.1)	75(69.4)	23(21.3)	42(38.8)	43(39.8)
No	388	69(17.7)	250(64.4)	69(17.7)	121(31.1)	206(53.0)	61(15.7)	117(30.1)	188(48.4)	83(21.3)
p-value				<0.001*			<0.001*			<0.001*

*living together

Associations were examined using the chi-square test. Fisher's exact test was applied where appropriate. A p-value < 0.05 was considered statistically significant.

Table 4: Prevalence of self-reported work-related health symptoms among latex farmers engaged in fresh latex trading during the past six months (n = 496)

Health symptom	Symptoms Present (%)
Work-related illness or injury	168(33.87)
Eye discomfort or irritation	318(64.11)
Skin redness or inflammation	184(37.10)
Nasal irritation or stinging sensation	136(27.42)
Cough and sneezing	148(29.84)
Difficulty breathing /Respiratory congestion	42(8.47)
Skin peeling or exfoliation	224(45.16)
Muscle pain or soreness	338(68.15)

Multiple symptoms reporting allowed. Percentages were calculated based on the total number of respondents (n = 496).

Regarding occupational lifestyle factors, working more than 6 days per week and having more than 15 years of work experience were significantly associated with higher levels of safety knowledge, attitudes, and practices (p <0.001). Participants who worked ≥8 hours per day demonstrated significantly higher levels of overall safety practice compared with those working less than 8 hours per day (p <0.001), although no significant differences were observed for safety knowledge or attitudes.

Monthly income was associated with all dimensions of occupational safety, except for the use of personal protective equipment, with participants earning more than 10,000 Baht per month showing higher safety knowledge, attitudes, and practices (p <0.001).

Table 5: Associations between participant characteristics and self-reported work-related health symptoms among latex farmers engaged in fresh latex trading (n = 496)

Characteristic	n	Work-related illness or injury	Eye discomfort or irritation	Skin redness/ inflammation	Nasal irritation/ stinging sensation	Cough And sneezing	Difficulty breathing/ respiratory congestion	Skin peeling/ exfoliation	Muscle pain/ soreness
Sex									
Male	290	108 (37.2)	168 (57.9)	92 (31.7)	68 (23.4)	80 (27.5)	20 (6.9)	82 (28.2)	190 (65.5)
Female	206	60 (29.1)	150 (72.8)	92 (44.6)	68 (33.0)	68 (33.0)	22 (10.6)	142 (68.9)	148 (71.8)
p-value		0.045*	<0.001*	<0.001*	0.008*	0.181	0.082	<0.001*	0.038*
Age (years)									
20-30	70	24 (34.2)	30 (42.8)	26 (37.1)	24 (34.2)	20 (28.5)	6 (8.5)	28 (40.0)	36 (51.4)
31-40	122	46 (37.7)	92 (75.4)	88 (72.1)	78 (63.9)	36 (29.5)	6 (4.9)	96 (78.6)	70 (57.3)
41-50	284	88 (30.9)	176 (61.9)	52 (18.3)	22 (7.7)	82 (28.8)	26 (9.1)	84 (29.5)	210 (73.9)
>50	20	8 (40.0)	12 (60.0)	6 (30.0)	6 (30.0)	6 (30.0)	4 (20.0)	4 (20.0)	16 (80.0)
p-value		0.612	<0.001*	<0.001*	<0.001*	0.503	0.268	<0.001*	<0.001*
Education level									
Up to High school	94	50 (53.1)	56 (59.5)	30 (31.9)	24 (25.5)	28 (29.7)	10 (10.6)	34 (36.1)	82 (87.2)
Above high school	402	118 (29.3)	262 (65.1)	154 (38.3)	112 (27.8)	120 (29.8)	32 (7.9)	190 (47.2)	256 (63.6)
p-value		<0.001*	0.327	0.214	0.641	0.991	0.412	0.018*	<0.001*
Smoking status									
Yes	334	114 (34.1)	220 (65.8)	122 (36.5)	100 (29.9)	94 (28.1)	28 (8.3)	154 (46.1)	232 (69.4)
No	162	54 (33.3)	98 (60.4)	62 (38.2)	36 (22.2)	54 (33.3)	14 (8.6)	70 (43.2)	106 (65.4)
p-value		0.861	0.243	0.704	0.067	0.213	0.912	0.536	0.358
Alcohol consumption									
Yes	246	98 (39.8)	154 (62.6)	102 (41.4)	70 (28.4)	72 (29.2)	20 (8.1)	104 (42.2)	164 (66.6)
No	250	70 (28.0)	164 (65.6)	82 (32.8)	66 (26.4)	76 (30.4)	22 (8.8)	120 (48.0)	174 (69.6)
p-value		0.004*	0.484	0.056	0.601	0.784	0.801	0.219	0.489
Hours worked per day									
≤8 hours	256	86 (33.5)	162 (63.2)	84 (32.8)	68 (26.5)	74 (28.9)	22 (8.5)	108 (42.1)	122 (47.6)
>8 hours	240	82 (34.1)	156 (65.0)	100 (41.6)	68 (28.3)	74 (30.8)	20 (8.3)	116 (48.3)	216 (90.0)
p-value		0.892	0.671	0.058	0.713	0.631	0.914	0.174	<0.001*
Days worked per week									
≤6 days	220	52 (23.6)	86 (39.0)	42 (19.0)	62 (28.1)	76 (34.5)	12 (5.4)	98 (44.5)	118 (53.6)
>6 days	276	116 (42.0)	232 (84.0)	142 (51.4)	74 (26.8)	72 (26.0)	30 (10.8)	126 (45.6)	220 (79.7)
p-value		<0.001*	<0.001*	<0.001*	0.612	0.051	0.052	0.821	<0.001*
Years of work									
≤15 years	276	68 (24.6)	158 (57.2)	46 (16.6)	34 (12.3)	32 (11.5)	20 (7.2)	114 (41.3)	126 (45.6)
>15 years	220	100 (45.4)	160 (72.7)	138 (62.7)	102 (46.3)	116 (52.7)	22 (10.0)	110 (50.0)	212 (96.3)
p-value		0.009*	<0.001*	<0.001*	<0.001*	<0.001*	0.315	0.086	<0.001*
Income									
≤10,000 Baht	108	18 (16.6)	40 (37.0)	22 (20.3)	18 (16.6)	16 (14.8)	6 (5.5)	30 (27.7)	32 (29.6)
>10,000 Baht	388	150 (38.6)	278 (71.6)	162 (41.7)	118 (30.4)	132 (34.0)	36 (9.2)	194 (50.0)	306 (78.8)
p-value		<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.081	<0.001*	<0.001*
Underlying disease									
Yes	136	52 (38.2)	76 (55.8)	44 (32.3)	38 (27.9)	46 (33.8)	8 (5.8)	72 (52.9)	90 (66.1)
No	360	116 (32.2)	242 (67.2)	140 (38.8)	98 (27.2)	102 (28.3)	34 (9.4)	152 (42.2)	248 (68.8)
p-value		0.196	0.063	0.218	0.861	0.278	0.213	0.051	0.547
Safety training									
Yes	108	20 (18.5)	34 (31.4)	24 (22.2)	16 (14.8)	20 (18.5)	4 (3.7)	26 (24.0)	22 (20.3)
No	388	148 (38.1)	284 (73.2)	160 (41.2)	120 (30.9)	128 (32.9)	38 (9.7)	198 (51.0)	316 (81.4)
p-value		<0.001*	<0.001*	<0.001*	<0.001*	0.002*	0.061	<0.001*	<0.001*

*P value statistically significant (<0.05) assessed using the chi-square test; Multiple responses were permitted for symptom reporting.

Table 6: Correlations among occupational safety knowledge, attitudes, and practices among latex farmers engaged in fresh latex trading (n = 496)

Variable	P value
Safety knowledge vs Safety attitude	0.658***
Safety knowledge vs Safety practice	0.581***
Safety attitude vs Safety practice	0.845***

*Pearson's correlation coefficient (r) was used to assess associations among variables. All correlations were statistically significant at p <0.001.

Table 7; Multivariable linear regression analysis of factors associated with occupational safety practice scores of latex farmers engaged in fresh latex trading (n = 496)

Predictor	β	t	p-value
Safety knowledge	0.32	4.90	<0.001
Safety attitude	0.41	5.98	<0.001

Model fit: R^2 = 0.351; adjusted R^2 = 0.342; F = 20.521; p < 0.05.
B = unstandardized regression coefficient; β = standardized regression coefficient.
The model was adjusted for age, sex, education level, income, years of work experience, and prior safety training.

Underlying disease status was not significantly associated with safety outcomes. In contrast, participants who had received safe working training demonstrated significantly higher levels of safety knowledge, attitudes, and practices compared with those who had not received training (p <0.001).

Relationships among safety knowledge, attitudes, and practices: Correlation analysis demonstrated statistically significant positive associations among safety knowledge, safety attitudes, and safety practices (Table 6). Safety knowledge was moderately correlated with safety attitudes (r = 0.658, p <0.001) and safety practices (r = 0.581, p <0.001). Safety attitudes showed a strong positive correlation with safety practices (r = 0.845, p <0.001).

Multivariable analysis of safety practices: Multivariable linear regression analysis showed that both occupational safety knowledge and safety attitude were independently and positively associated with safety practice scores among latex farmers (Table 7). Higher safety knowledge scores were significantly associated with increased safety practice scores (B = 0.49, p <0.001). Similarly, safety attitude demonstrated a significant positive association with safety practice scores (B = 0.59, p <0.001). The overall model explained 35.1% of the variance in safety practice scores (adjusted R^2 = 0.342) and was statistically significant (F = 20.521, p <0.001).

DISCUSSION

The observed associations align with theoretical perspectives that conceptualize occupational safety behavior as shaped by multilevel influences, in which individual knowledge and attitudes may operate within broader organizational, institutional, and structural contexts that influence access to resources, safety training, regulatory support, and working conditions. From this perspective, occupational safety practices may reflect the interaction of personal, organizational and systemic factors rather than individual cognitive determinants alone. However, given the cross-sectional design, these interpretations should be considered conceptual rather than evidence of causal or multilevel mechanisms. This study presents a cross-sectional overview of occupational safety knowledge, attitudes, practices, and self-reported work-related health symptoms among latex farmers involved in fresh latex trading. Overall, the findings indicate that safety knowledge, attitudes, and practices were predominantly at a moderate level. This pattern suggests that existing attitudes and perceptions of occupational safety may be insufficient to support consistent and sustained adoption of safe work behaviors. Similar findings have been reported in occupational health research, where knowledge alone does not necessarily translate into optimal safety practices in the absence of adequate institutional or structural support. Safety-related behaviors are shaped not only by individual attitude but also by organizational resources, safety climate and broader labor conditions, particularly in resource-constrained settings.[20-24] Associations observed between higher educational attainment, prior participation in safety training, and greater safety knowledge are consistent with previous research highlighting the role of education and training in increasing exposure to occupational safety information.[22,23] However, due to the cross-sectional design of this study, these relationships should be interpreted strictly as correlational. Causality cannot be inferred from education and training contributing to improved safety knowledge, or whether individuals with higher baseline attitudes are more likely to access training opportunities.

Safety attitudes among latex farmers engaged in fresh latex trading were also reported at a moderate level. This finding may reflect limited access to occupation-specific safety information, continued reliance on traditional work practices, and perceptions that health risks associated with latex trading are either manageable or not immediately severe. Prior studies have similarly noted that safety attitudes are shaped not only by knowledge but also by contextual factors such as cultural norms, habitual work routines, and perceived occupational vulnerability.[3,24]

In parallel, reported safety practices were moderate, indicating a potential gap between safety attitude and actual behavior. External constraints, including limited availability of personal protective equipment, financial limitations, time pressures, and insufficient institutional support, have been widely recognized as structural determinants influencing safety practices in occupational settings.[24] In agricultural contexts, limited access to protective resources and weak safety governance have been shown to reduce compliance with recommended protective behaviours.[4,11]

Such structural constraints are particularly pronounced in low and middle income country (LMIC) occupational systems, where limited regulatory enforcement, constrained safety infrastructure, and unequal access to protective resources systematically shape workers' capacity to implement recommended safety practices.[25]

Consistent with this perspective, contextual factors should be considered when interpreting self-reported safety practices, as knowledge and attitudes alone may not fully explain observed behavioural patterns. Although safety knowledge and attitudes were significantly associated with reported safety practices, their translation into practice appeared only moderate. This pattern may suggest that contextual or structural conditions are related to variation in how individual-level factors are expressed behaviourally. However, given the cross-sectional design, these findings should be interpreted as associative rather than indicative of causal or constraining effects. Differences in safety-related outcomes across demographic and occupational characteristics such as age, marital status, and work experience suggest that personal and social factors may be associated with perceptions of occupational risk. Older and more experienced farmers tended to report greater caution, potentially reflecting experiential learning accumulated over time. Similar associations between age, work experience and safety culture have been reported in earlier studies.[26] Nonetheless, alternative explanations cannot be excluded, as individuals with a higher safety attitude may be more likely to remain in the occupation for longer periods. Lifestyle-related factors, including smoking and alcohol consumption, were associated with lower levels of safety knowledge and less favorable safety attitudes. These relationships may reflect broader clustering of health-related behaviors, whereby reduced prioritization of personal health coincides with diminished attention to occupational safety.[27] However, the directionality of these associations cannot be established, and unmeasured social or environmental influences may also contribute. The high prevalence of self-reported work-related health symptoms, particularly musculoskeletal discomfort, eye irritation and skin conditions, is consistent with previous studies among rubber farmers and agricultural workers in Thailand and similar settings.[2,7] While these symptoms are plausibly related to occupational exposures such as repetitive movements, awkward postures, and contact with latex or irritants, causal attribution is not possible. The reliance on self-reported data further introduces the potential for recall and reporting bias. In this study, longer working hours, a greater number of working days per week, and extended years of employment were associated with higher levels of safety knowledge and practices. These associations may be related to the accumulated work experience on hazard awareness, task familiarity, and adaptive risk management. Workers with longer tenure may also have greater access to safety information or protective resources through informal learning. However, given the cross-sectional design, causal relationships cannot be established, and reverse causation cannot be ruled out, as individuals who engage in safer behaviors may be more likely to remain in the occupation.

Participants who reported no prior safety training consistently reported a higher prevalence of health symptoms. Although this pattern aligns with existing literature emphasizing the importance of occupational safety education,[26] the present findings should not be interpreted as evidence of training effectiveness. In addition, longitudinal and intervention-based studies are necessary to determine whether safety training leads to measurable improvements in health outcomes or reductions in occupational risk. Correlation and regression analysis demonstrated that higher levels of safety knowledge and more favorable safety attitudes were concurrently associated with better self-reported safety practices. Given the cross-sectional design, these associations should not be interpreted as evidence of predictive or causal effects, indicating that these constructs are interrelated.

LIMITATIONS

Several methodological considerations warrant attention in this study. First, the cross-sectional design limits temporal sequencing and causal inference, as exposures and outcomes were assessed simultaneously. The observed associations should therefore be interpreted as correlational rather than causal. Second, all variables were derived from self-reported measures, which are subject to recall and social desirability biases. Such biases may introduce misclassification or overestimation of compliance with recommended protective behaviors. Third, the study focused on latex farmers engaged in fresh latex trading within a specific regional context. While this enhances contextual specificity, variations in institutional, regulatory, and socioeconomic conditions may limit the transferability of findings to other agricultural or occupational settings. Despite these limitations, the study provides contextually grounded evidence on occupational safety among latex farmers and contributes to a more nuanced understanding of safety-related behaviors within structurally constrained agricultural systems.

CONCLUSION

This cross-sectional study describes occupational safety knowledge, attitudes, practices, and self-reported work-related health symptoms among latex farmers engaged in fresh latex trading. The findings indicate that safety knowledge, attitudes, and practices were predominantly at a moderate level. Variations in the prevalence of reported occupational illness and discomfort were significantly associated with selected socio-demographic and occupational

characteristics, including gender, age, educational level, work duration, income, and prior safety training. These associations reflect concurrent patterns within the study population rather than causal relationships. Given the cross-sectional design, self-reported measures, and context-specific study setting, the findings should be interpreted with caution. Overall, this study provides descriptive and associative evidence on occupational safety and health conditions among latex farmers engaged in fresh latex trading and may serve as baseline information for future studies employing longitudinal or analytical designs.

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Availability of Data: The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access to the data will be provided for academic and research purposes only, subject to submission of a formal email request and signing of a data use agreement to ensure confidentiality and ethical compliance.

Declaration of Non-use of Generative AI Tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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