ACHSM Asia-Pacific Journal of Health Management

RESEARCH ARTICLE

HEALTH HAZARD AND RISK ASSESSMENT FOR OCCUPATIONAL HEALTH MANAGEMENT AMONG THREE DIFFERENT FARMER GROUPS IN PHRANAKORN SI AYUTTHAYA PROVINCE, THAILAND

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ABSTRACT

OBJECTIVE:

This study aimed to study occupational health hazards and risk assessment among three farmer groups and to propose guidelines for setting up occupational health management in farmer groups

METHOD:

The cross-sectional study of 315 rice, vegetable, and melon farmers in Phranakorn Si, Ayutthaya province, Thailand. The tool for data collection was a two-part questionnaire: (1) general characteristics, and (2) risk assessment from pesticide use, working behavior, and symptoms from exposure to agricultural chemicals. The questionnaire was scored on 5 levels, and the relationship was assessed using the Chi-square test.

RESULTS:

Farmers in each group are exposed to different health hazards according to the production process. The risk assessment level was low in each group: the melon group (91%), the vegetable group (89.1%), and the rice group (53.3%). The association between risk assessment levels and associated factors was statistically significant in the rice group (p = 0.019; OR = 2.70, 95% CI = 1.22–5.97). (OR = 7.89, 95% CI = 1.98 – 31.35) in the vegetable group, and p = 0.023 (OR= 5.44, 95% CI = 1.32 – 22.43) in the melon group, respectively.

CONCLUSION:

This study suggested that guidelines for occupational health management should account for differences in occupational and health hazards across groups. Nevertheless, the operation of occupational health management will be successful with close cooperation from all three parties: government agencies, community leaders, and local farmers.

KEYWORDS

health hazards, risk assessment, occupational health management, Thailand

INTRODUCTION

The COVID-19 epidemic in 2020-2021 directly and indirectly impacted Thailand's agricultural sector. Farmers need to adapt to this situation to earn enough income to make a living. The agricultural model has shifted from single-crop agriculture to mixed agriculture, with an increasing emphasis on subsistence agriculture. Although the agricultural model has changed, farmers still face workplace risks, including physical, chemical, biological, and ergonomic hazards. The National Institute for Occupational Safety and Health (NIOSH explained that agriculture ranks among the most hazardous industries. It is well recognized that farmers are at very high risk for fatal and nonfatal injuries. In addition, farming is one of the few industries in which family members (who often share the work and live on the premises) are also at risk for fatal and nonfatal injuries [1]. Studies across various countries, including the United States, India, Brazil, and European nations, have shown that pesticide exposure, respiratory conditions, musculoskeletal disorders, and hearing loss among agricultural workers are also a concern. Recent studies from Africa and Southeast Asia reveal the impact of extreme weather conditions, economic instability, and limited access to healthcare on agricultural workers [2-5]. According to the International Labor Organization (ILO), developing countries struggle to enforce occupational health standards due to limited resources and weak regulations. Studies from Vietnam, Indonesia, and Mexico have linked prolonged pesticide use to chronic illnesses such as neurological disorders and cancer. Research in Latin America and Africa highlights the lack of access to proper pesticide training and safety measures, leading to high rates of acute poisoning. However, Canada and Germany have successfully reduced chemical dependence by adopting integrated pest management (IPM) techniques [6,7].

Thailand's agriculture has developed to produce a variety of crops, thereby increasing productivity. Chemical fertilizers are used to accelerate plant growth, and chemical pesticides are used widely. For the past decade, it has been importing chemicals and finished products from abroad, which are then mixed and used domestically, increasing 3 times, and have a rate of use per unit area of up to 100% [8]. In addition, Thailand is located in the humid tropics; heavy rain and high temperatures are suitable for the growth of diseases, insects, and various weeds that hinder the growth of plants, making farmers unable to avoid using chemicals and resulting in both environmental problems and serious negative effects on health in the long term [9]. The ILO emphasizes workplace risk assessment as a critical tool for improving occupational health and safety conditions. However, comprehensive risk assessments remain scarce among certain farmer groups, particularly smallholder farmers with limited access to occupational safety training and resources [10]. Studies in Africa and Latin America report similar findings: farmers are unaware of proper pesticide handling and disposal methods, resulting in high rates of acute poisoning and chronic health effects [11,12].

Phranakhon Si Ayutthaya province in central Thailand dedicates 71.8% of its land to farming—primarily rice, vegetables, and melons. The province has more than 42,000 farming households, with informal agricultural workers representing 18.1% of the informal workforce (National Statistical Office and Provincial Labor Office, 2018). Health and safety concerns persist among farmers: 54–74 work injuries and four pesticide poisoning cases were recorded. A local survey found that 1.4% of farmers who used chemicals experienced work-related illnesses, and 23.1% experienced pesticide-related allergies (rashes, dizziness, nausea, vomiting). Most farmers (88.9%) reported using personal protective equipment (PPE) during pesticide application and recognizing the importance of safety education [13,14]. However, most present information focuses on injuries and illnesses and lacks risk assessment. An in-depth study of the three groups' personal factors, working environment, and safety conditions is needed. It informs farmers about the root causes of health conditions. Thus, this study aimed to identify occupational health hazards and conduct risk assessments among three farmer groups, and to provide guidelines for establishing occupational health management appropriate to their respective work processes.

METHOD

STUDY DESIGN AND SETTING

This quantitative survey was a cross-sectional study in Phranakhon Si Ayutthaya province, a central lowland region characterized by its suitability for diverse cultivation. From September 2020 to May 2021, three groups of farmers were studied: rice and melon farmers in Lat Bua Luang district and vegetable farmers in Phak Hai district. These groups represent the province's diverse agricultural landscape, with unique work processes and exposure patterns from large-scale field crops (rice) to intensive cultivation (vegetables) and greenhouse farming (melons).

Data collection covered various agricultural stages and seasonal shifts to capture farmers' routine safety practices and exposure risks.

PARTICIPANTS

The study included farmers in Phranakhon Si Ayutthaya province; data from the National Statistical Office indicated that 44,242 farmers were registered. The researcher determined the sample size using Taro Yamane's formula, yielding a total sample of 363 participants. Therefore, they were divided into three groups, with approximately 120 farmers in each group. However, during the data collection period, there was still an ongoing COVID-19 outbreak in the area; thus, data were collected from a sample of only 315 persons, comprising 105 rice farmers, 110 vegetable farmers, and 100 melon farmers. Inclusion criteria: participants aged 20 years or older (ensuring legal majority and reliable self-reporting) with at least one year of active farming experience (consistent occupational exposure history). The study excluded individuals who did not perform farming activities themselves (e.g., landowners who only manage labor) to maintain the validity of data on direct safety behaviors.

RESEARCH INSTRUMENT

Health risk assessment used a semi-quantitative risk matrix model from Thailand's Department of Disease Control, with two components:

Section I: Behavioral Risk Scoring: Fifteen items assessed farmers' work habits and pesticide use. Nine risky behavior items were scored 1 (never) to 3 (regularly), and six preventive practice items were reverse scored. Total scores (15–45) were categorized as Low (15–24), Moderate (25–30), or High (31–45).

Section II: Symptom Severity Categorization: Post-exposure health symptoms were grouped into three severity levels:

Mild (Group 1): Eye or nose irritation, cough, dizziness.

Moderate (Group 2): Skin rashes, numbness, nausea/vomiting.

Severe (Group 3): Muscle twitching, seizures, loss of consciousness.

Final health risk levels were determined by integrating behavioral risk scores and symptom severity using a prioritized risk matrix (Table 1).

TABLE 1: HEALTH RISK ASSESSMENT MATRIX

Behavioral Risk Score	No Symptoms	Mild Symptoms (Group 1)	Moderate Symptoms (Group 2)	Severe Symptoms (Group 3)
Low (15-24 points)	Low	Moderate	Fairly High	High
Moderate (25-30 points)	Moderate	Fairly High	High	High
High (31-45 points)	Fairly High	High	High	Very High

The quality was assessed using the content validity index (CVI), which was 0.85; reliability was assessed in another farmer group of 30 participants; the coefficient was 0.88.

DATA COLLECTION

The researcher collected data from three farmer groups—rice, vegetable, and melon—in the sample area. Participants were recruited through local agricultural officers and village leaders, who assisted with inclusion and exclusion criteria and selected participants via purposive sampling and direct contact with village and farmer group leaders. The questionnaires and face-to-face interviews collected data on general characteristics, pesticide use, work behavior, and health symptoms. Data were collected during the day at the farming sites, allowing the researcher to observe agricultural activities and the actual work environment. Each interview session took approximately 15–30 minutes, ensuring enough time for clarified responses and data verification."

STATISTICAL ANALYSIS

SPSS for Windows was used to analyze the data, and the chi-square test was used to assess the association between demographic characteristics and risk assessment levels. A p-value of <0.05 was considered statistically significant. Testing to compare the three farmer groups was conducted using contingency tables and Fisher's exact test.

ETHICAL CONSIDERATIONS

The study received ethical approval from the Ethical Review Committee for Human Research of the Faculty of Public Health, Mahidol University, which evaluated and approved the research procedure under project number MUPH 2021-014.

RESULTS

OCCUPATIONAL HEALTH HAZARD

All the farmer groups were exposed to a high level of physical hazards; the most common hazards were hot weather, glare, noise, and vibration from the machine; however, in melon production, they were exposed to lower levels of these hazards. In chemical hazards, most hazards encompass multiple factors: plant dust, soil dust, and pesticide mist; biological hazards from fungi/bacteria; working in waterlogged/muddy soil; and poisoned animals. Most ergonomic hazards include prolonged sitting or standing, head movements, forward bending, twisting and tilting, and lifting heavy objects. The psychosocial hazards were working hastily, an uncontrollable situation, a greater workload, and uncertain income (Table 2).

TABLE 2: HAZARDS OF THE WORKING PROCESS IN THE FARMERS' GROUP

Group	Process	Hazard category
Rice	1) Soil preparation by plowing the field and release the water into puddy 2) Seeding preparation by water soaking for one night and covering seeds in one day 3) Seeding and taking care of the rice consists of chemical spray for weed control, fertilizer by scattering, and insecticide use 4) Harvesting by harvester truck and keeping straw to make straw bales, destroy straw and stubble by burning	1) Physical: hot weather, sunlight, noise, and vibration from tractors and sprayers 2) Chemical: soil dust, seeds dust, dust/ vapor/ mist from chemicals/fertilizer 3) Biological: bacteria/fungi in the field, poison animals 4) Ergonomics: abnormal posture, fatigue, heavy lifting 5) Psychosocial: speed up work, workload, water shortage, inclement weather, wages
Vegetable	1) Preparation of planting by plowing the plots at the plant area with a tractor, scattering straw to cover the soil, and watering by boat 2) Planting, take the sprout into the planting area, and implant the sprout into the soil by hand, watering by boat or sprinkler system	1) Physical: hot weather, sunlight, noise, and vibration from tractors, boats, and sprayers 2) Chemical: soil dust, straw dust, dust/ vapor/mist from chemicals or fertilizer

Group	Process	Hazard category
	3) Take care of the sprouts by watering every day, insecticide spraying, chemical fertilizer by scattering, spraying nutrients/ micronutrients, and controlling weeds every month by hand 4) Harvesting in the early morning, use a small sharp knife to cut nearly the base of plants, storage in a cool place or good ventilation, pick out, quality test, and packing	3) Biological: bacteria/fungi in the field, poison animals 4) Ergonomics: abnormal posture, fatigue, heavy lifting 5) Psychosocial: speed up work, workload, water shortage, wages
Melon	1) Seed preparation by soaking the seeds in warm/normal water for 2-6 hrs. 2) Cultivation of seedlings by mixing seedling material and filling into the seedling tray and taking it to greenhouses 10 – 13 days, transplant seedling to plant in greenhouses 3) Preparing for planting by applying fertilizer and covering the planting area with rice husk. 4) Planting: Remove the seedling from the seedling tray and put it in pots or soil 5) Take care of the sprouts by holding them onto the melon tree using a rope tied to the iron stick, pulling the string upward, and holding the top of the melon with the rope. Pollinate fruit when the melon is the size of an egg, choose only one fruit per group, water by a sprinkler system, spray pesticides, and provide nutrients/micronutrients. 6) Harvesting by cutting and putting it into the container	1) Physical: hot weather, sunlight, noise from tractor 2) Chemical: seeds dust, soil dust, ride husk dust/vapor/mist from fertilizer 3) Biological: fungi 4) Ergonomics: abnormal posture, heavy lifting 5) Psychosocial: workload, stress from fewer seedlings or damage

HEALTH RISK LEVEL

Following the assessment of occupational health risks and work-related symptoms using the matrix in Table 1, the resulting risk levels among the farmer groups are presented in Table 3.

Most farmers had low health risk levels, but the distribution varied among groups. Rice farmers had the highest moderate-risk levels (40.0%), indicating greater exposure to hazardous conditions. Vegetable farmers (89.1%) and melon farmers (91.0%) were predominantly low risk, likely due to the controlled environments and more effective protective measures.

TABLE 3: NUMBER AND PERCENTAGE OF INDIVIDUAL FARMERS CLASSIFIED BY HEALTH RISK LEVELS

Farmer group	Health Risk Level, n (%)		
	Low (15-24 points)	Moderate (25-30 points)	High (31-45 points)
Rice (n=105)	53.3%	40.0%	6.7%
Vegetable (n=110)	89.1%	10.0%	0.9%
Melon (n=100)	91.0%	9.0%	-

While Table 2 provides a comprehensive breakdown of all hazards across the entire work process, Table 4 synthesizes these findings to highlight the most significant occupational hazards and their associated health risk levels for each farmer group. This summary enables a direct comparison of risk profiles, revealing that although the majority of farmers fall within the 'Low' risk category, specific activities—such as chemical application in rice farming and high-heat greenhouse work in melon cultivation—pose distinct health challenges that require targeted interventions.

TABLE 4: SUMMARY OF PREDOMINANT HAZARDS AND HEALTH RISK LEVELS ACROSS FARMER GROUPS

Farmer Group	Key Work Processes with Elevated Risk	Primary Occupational Hazards Identified	Predominant Health Risk Level
Rice	Chemical spraying (weed and insecticide control) and scattering fertilizer	**Chemical:** Dust, vapors, and mists from pesticides. **Ergonomics:** Abnormal posture and heavy lifting	Low (53.3%), with significant moderate and fairly high risk (46.7%)
Vegetable	Harvesting, manual weeding, and planting sprouts by hand.	**Ergonomics:** Fatigue from repetitive movement and heavy lifting **Physical:** Sunlight and hot weather.	Low (89.1%)
Melon	Greenhouse maintenance (holding sprouts) and pesticide spraying.	**Physical:** Extreme heat and sunlight (greenhouse effect). **Chemical:** Fertilizer and pesticide mists.	Low (91.0%)

GENERAL CHARACTERISTIC

Overall, the three farmer groups had more females than males (46.1% and 53.9%, respectively). The mean age across all farmer groups was 50–56 years, and most had a primary education level (65.4%). The mean working period was 25 years in the rice group and 22 years in the vegetable group, but in the melon group, it was 10 years. Most farmers (75.6%) do not have a chronic disease, and do not exercise (60.9%). Significant differences were observed across farmer groups in education level ($p < 0.001$), chronic disease ($p = 0.016$), and exercise behavior ($p < 0.001$). (Table 5)

THE FACTOR OF ASSOCIATION

Regarding factors associated with health risk levels (Table 6), gender was found to be a significant factor among rice farmers ($p = 0.019$); specifically, males had a 2.7 times higher risk than females (OR = 2.70, 95% CI = 1.22–5.97). Among vegetable farmers, age was significantly associated with health risk ($p = 0.002$), with those aged 60 and older exhibiting a 7.89 times higher risk compared to those under 60 (OR = 7.89, 95% CI = 1.98–31.35). For the melon farmer group, alcohol consumption was a significant predictor ($p = 0.023$), where the alcohol-drinking group had 5.44 times the risk of the non-drinking group (OR = 5.44, 95% CI = 1.32–22.43).

TABLE 5: DESCRIPTIVE CHARACTERISTICS IN THE FARMERS' GROUP (N=315)

Information	Rice (n=105)	Vegetables (n=110)	Melons (n=100)	Average (%)	F	p-value
Gender						
- male	55 (52.4%)	46 (41.8%)	44 (44%)	46.1	1.327	0.267
- female	50 (47.6%)	64 (58.2%)	56 (56%)	53.9		
Mean age (year)	56	55	50			
(Min-max) (year)	40 – 81	40 – 74	21 – 81			
Education						
- primary education	84 (80%)	66 (60%)	56 (56%)	65.4	6.630	**<0.001***

Information	Rice (n=105)	Vegetables (n=110)	Melons (n=100)	Average (%)	F	p-value
- secondary education	10 (9.5%)	18 (16.4%)	36 (36%)	20.3		
- high school education	7 (6.7%)	21 (19.1%)	8 (8%)	11.4		
- vocational/high certificate	3 (2.9%)	3 (2.7%)	-	1.9		
- bachelor's degree	1 (1%)	2 (1.8%)	-	0.9		
The working period in agriculture						
(Mean) (year)	25	22	10			
(Min-max) (year)	10 – 50	1 – 60	3 – 25			
Chronic disease						
- have	35 (33.3%)	27 (24.5%)	15 (15%)	24.4	4.162	**0.016***
- without	70 (66.7%)	83 (75.5%)	85 (85%)	75.6		
Smoking behavior						
- no smoking	83 (79%)	88 (80%)	76 (76%)	78.4	0.172	0.842
- ex-smoker	8 (7.6%)	7 (6.4%)	9 (9%)	7.6		
- smoking	14 (13.3%)	15 (13.6%)	15 (15%)	14.0		
Drinking alcohol behavior						
- no drinking	83 (79.1%)	91 (82.7%)	78 (78%)	80.0	0.392	0.676
- used to drink	4 (3.5%)	5 (4.5%)	7 (7%)	5.1		
- drinking	18 (17.1%)	14 (12.7%)	15 (15%)	14.9		
Exercise behavior						
- regular	16 (15.3%)	42 (38.2%)	16 (16%)	23.5	7.793	**<0.001***
- sometimes	14 (13.3%)	9 (8.2%)	26 (26%)	15.6		
- never	75 (71.4%)	59 (53.6%)	58 (58%)	60.9		

*Significant at *p*-value < 0.05

TABLE 6: ASSOCIATION BETWEEN CHARACTERISTICS AND RISK ASSESSMENT LEVEL IN THE FARMERS' GROUP

Factor	Risk assessment level (Percentage)		OR	95%CI	*p-value*
	Moderate to High	Low			
• **Rice farmer group**					
Gender					
Male	32 (58.2%)	23 (41.8%)	2.70	1.22 – 5.97	**0.019***
Female	17 (34.0%)	33 (66.0%)	1		
Age					
60 years up	14 (43.8%)	18 (56.2%)	0.84	0.37 – 1.95	0.692
≤ 59 years	35 (47.9%)	38 (52.1%)	1		
Education					
Primary school	43 (51.2%)	41 (48.8%)	2.62	0.93 – 7.41	0.063
Secondary school and upper	6 (28.6%)	15 (71.4%)	1		
Working period					
21 years up	31 (50.8%)	30 (49.2%)	1.49	0.68 – 3.27	0.330
≤ 20 years	18 (40.9%)	26 (59.1%)	1		
Chronic disease					
Have chronic disease	17 (47.2%)	19 (52.8%)	1.03	0.46 – 2.32	0.934
No chronic disease	32 (46.4%)	37 (53.6%)	1		
Smoking behavior					
Smoking	14 (63.6%)	8 (36.4%)	2.40	0.91 – 6.34	0.073

Factor	Risk assessment level (Percentage)		OR	95%CI	*p-value*
	Moderate to High	Low			
No smoking	35 (42.2%)	48 (57.8%)	1		
Drinking alcohol behavior					
Drinking	14 (63.6%)	8 (36.4%)	2.40	0.91 – 6.34	0.073
No drinking	35 (42.2%)	48 (57.8%)	1		
Exercise Behavior					
No exercise	35 (46.7%)	40 (53.3%)	1.00	0.43 – 2.34	1.000
Exercise	14 (46.7%)	16 (53.3%)	1		
• Vegetable farmer group					
Gender					
Male	4 (8.7%)	42 (91.3%)	0.67	0.18 – 2.36	0.528
Female	8 (12.5%)	56 (87.5%)	1		
Age					
60 years up	9 (25.0%)	27 (75.0%)	7.89	1.98 – 31.35	**0.002***
≤ 59 years	3 (4.1%)	71 (95.9%)	1		
Education					
Primary school	10 (15.2%)	56 (84.8%)	3.75	0.78 – 18.02	0.119
Secondary school and upper	2 (4.5%)	42 (95.5%)	1		
Working period					
21 years up	6 (14.0%)	37 (86.0%)	1.65	0.50 – 5.49	0.533
≤ 20 years	6 (9.0%)	61 (91.0%)	1		
Chronic disease					
Have chronic disease	4 (14.8%)	23 (85.2%)	1.63	0.45 – 5.91	0.484
No chronic disease	8 (9.6%)	75 (90.4%)	1		
Smoking behavior					
Smoking	1 (4.5%)	21 (95.5%)	0.33	0.41 – 2.73	0.453
No smoking	11 (12.5%)	77 (87.5%)	1		
Drinking alcohol behavior					
Drinking	2 (10.5%)	17 (89.5%)	0.95	0.19 – 4.75	1.000
No drinking	10 (11.0%)	81 (89.0%)	1		
Exercise Behavior					
No exercise	4 (6.9%)	54 (93.1%)	0.41	0.12 – 1.44	0.154
Exercise	8 (15.4%)	44 (84.6%)	1		
• Melon farmer group					
Gender					
Male	5 (11.4%)	39 (88.6%)	1.67	0.42 – 6.62	0.501
Female	4 (7.1%)	52 (92.9%)	1		
Age					
60 years up	1 (3.8%)	25 (96.2%)	0.33	0.39 – 2.77	0.439
≤ 59 years	8 (10.8%)	66 (89.2%)	1		
Education					
Primary school	6 (10.7%)	50 (89.3%)	1.64	0.39 – 6.96	0.727
Secondary school and upper	3 (6.8%)	41 (93.2%)	1		
Working period					
21 years up	2 (6.2%)	30 (93.8%)	0.58	0.11 – 2.97	0.715
≤ 20 years	7 (10.3%)	61(89.7%)	1		
Chronic disease					
Have chronic disease	0 (0.0%)	15 (100%)	0.89	0.83 – 0.96	0.348

Factor	Risk assessment level (Percentage)		OR	95%CI	*p-value*
	Moderate to High	Low			
No chronic disease	9 (10.6%)	76 (89.4%)	1		
Smoking behavior					
Smoking	4 (16.7%)	20 (83.3%)	2.84	0.69 – 11.58	0.212
No smoking	5 (6.6%)	71 (93.4%)	1		
Drinking alcohol behavior					
Drinking	5 (22.7%)	17 (77.3%)	5.44	1.32 – 22.43	**0.023***
No drinking	4 (5.1%)	74 (94.9%)	1		
Exercise Behavior					
No exercise	4 (6.9%)	54 (93.1%)	0.55	0.14 – 2.18	0.486
Exercise	5 (11.9%)	37 (88.1%)	1		

* Significant at p-value < 0.05 *

DISCUSSION

The study confirmed that different farming groups face distinct occupational health hazards. Rice farmers had the highest exposure to chemical and physical hazards due to frequent pesticide use and machine operation. Vegetable farmers were primarily affected by ergonomic risks, while melon farmers experienced the lowest levels of occupational hazards due to controlled greenhouse environments. In the rice field, the study of Kawittthararin K and Kanjana S revealed that most of the farmers have a high level of knowledge of how to protect themselves from exposure to pesticides 84.6%, a high level of self-defense attitude from exposure to pesticides at 100% and a high level of self-defense behavior from exposure to chemicals at 96.2% [15]. The study by Tijjani et al. revealed that most farmers were aware of pesticide safety and use practices (64%); factors influencing awareness among farmers were age, household size, and farm size [16]. However, some farmers are unaware of or ignore the potential health effects of improper pesticide use. Still, many chemicals are used by rice farmers, especially in Phachi District, Phranakhon Si Ayutthaya Province; they have been using pesticides for more than ten years, and the dominant pesticides used for their crop are 87.7 % glyphosate (herbicide) and 68.5 % abamectin (insecticide) [17].

The results indicated that gender, age, and alcohol consumption were significant factors influencing health risk levels. These findings suggest that targeted interventions should consider demographic and behavioral characteristics. In 2018, Johnson et al. reported that female farmers in the agricultural workforce face gender disparities in access to healthcare. They have limited access to healthcare resources and are more likely to be exposed to harmful agrochemicals due to inadequate protective equipment. Moreover, household and childcare responsibilities intersect with farm work, increasing physical and psychological strain [18]. Similar to other studies, females had lower mental component scores (MCS) than males [19], and females showed a significantly higher proportion than males for mental component scores (MCS) [20]. However, male farmers are exposed to numerous health risks due to the use of agrochemicals, including pesticides and fertilizers, which are associated with increased risks of pesticide-related health issues such as skin disorders, respiratory problems, and neurological disorders [21]. Furthermore, long-term exposure to these chemicals leads to higher risks of chronic conditions, including certain cancers and reproductive disorders [22]. Male or female farmers are more susceptible to health issues due to a combination of factors. It is important to implement targeted interventions that address their specific health needs. Recognizing and addressing these health risk factors can significantly help safeguard the well-being of all farmers.

Age affects farmers' health; older farmers frequently have MSDs due to long-term exposure to occupational risk factors and workplace accidents. Many studies have found that older farmers face greater job risks than younger farmers. For example, in Nan Province, Thailand, farmers aged 60 years and older were less likely to experience occupational falls than those aged 40-49 years [23]. A health and safety risk assessment of 114 informal agricultural workers in Amphoe Phu Kamyao, Phayao province, Thailand, found that the group aged 60 years and over had higher health and safety risk scores than the group aged less than 60 years [24]. The study by Asghar et al. found that age and farming experience negatively affected the use of personal protective equipment and safety behavior; namely, older and experienced farmers did not follow safety rules [25]. On the other hand, the young farmer's group had factors associated with joint and bone pain among farmers older than 40 years and 40–60 years old [26]. Similar to data from the Department of Disease Control, Ministry of Public Health, Thailand, reported data on pesticide poisoning disease in 2018, the age group of patients was 15-59 years (67.1%) followed by the age group over 60 years (25.1%). Most patients were field crop and vegetable growers (43.2%) and general contract workers (21.1%) [27]. It is necessary to consider risk factors across age groups to mitigate potential hazards for farmers.

Alcohol consumption is a significant health risk factor in the farming community. It is prevalent among particular subgroups and can compound existing health risks. Excessive alcohol consumption is associated with various health issues, such as liver disease, cardiovascular problems, and mental health disorders. A study by Bangkadanara G. et al. found that drinking alcohol affects working safety behavior, and farmers who do not drink alcohol have better safety working behavior than those who do, with a difference of 1.9 times [28]. Additionally, farmers who consume alcohol or beverages while working are 2.5 times more likely to have injuries than those who do not drink alcohol [29]. Targeted interventions and awareness campaigns are necessary to address alcohol-related risks in the farming community.

CONCLUSION

The study results highlight significant differences in hazard exposure, risk levels, and demographic influences among the farmer groups. The interventions for each farmer group could enhance occupational health management. Rice farmers improved their training on pesticide application and the use of PPE. Vegetable farmers focus on ergonomic hazards and on providing mechanized tools to reduce physical strain. Melon farmers reduce exposure to greenhouse-related heat stress through proper ventilation and hydration programs. Furthermore, they should consider implementing safer agricultural chemical programs and establishing local health monitoring centers dedicated to farming communities. These targets will mitigate health risks and foster long-term, sustainable agricultural practices, thereby improving well-being and productivity for all farmer groups.

The operation of OHS management in agriculture will be successful; it requires close cooperation from all three parties: (1) local government agencies (e.g., Sub-district Health Promoting Hospitals) should provide specialized health screenings for rice farmers exposed to pesticides, (2) community leaders should facilitate safety training and establish equipment-sharing programs for proper PPE, and (3) the farmer group must adopt the recommended work-rest schedules, particularly melon farmers working in high-heat greenhouse environments, to reduce physical strain.

Implementing participatory hazard identification and risk assessment processes will enable farmers to actively prioritize occupational health risks. Additionally, monitoring, evaluation, and continuous improvement of OHS performance are needed to ensure sustainability. Agricultural workers will benefit from safer work environments and improved health outcomes through the integration of these policy-driven, practice-oriented approaches. The participatory approach is central to occupational health interventions. Farmers should be directly involved in hazard identification, decision-making, and evaluation of health and safety programs. It can achieve long-term sustainability and effectiveness by fostering strong partnerships and community-driven occupational health management.

This study collected data during a period in Thailand when an ongoing COVID-19 outbreak and flooding made data collection intermittent. Sometimes, community leaders must collect data on behalf of researchers, which may introduce bias into the data. Future research should examine the long-term effects of the pandemic on agricultural occupational health, including changes in pesticide use patterns, shifts in farming dynamics, and the effectiveness of safety training programs.

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