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Review Article

Work-Related Musculoskeletal Disorders Among Farmers in the Southeast Asia Region: A Systematic Review

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ABSTRACT

Background: Southeast Asia has many people who work in the agriculture sector. Not many stakeholders pay special attention to the health of farmers, even though they are exposed to various types of hazards. One of the most common health complaints among farmers is related to work-related musculoskeletal disorders (WMSDs). This study aims to assess the prevalence of WMSDs and factors associated with them among farmers in Southeast Asia.

Methods: A literature search on PubMed, ScienceDirect, Scopus, and EBSCO was conducted. Articles were included if they studied ergonomic problems among farmers from 11 countries in the Southeast Asia region and were published during 2015–2022. The Critical Appraisal Skills Program was used to evaluate the quality of the articles. The search process and retrieval process reflected PRISMA's recommendation.

Result: There were 14 studies found from 3 countries that had published articles in PubMed and ScienceDirect, including Thailand [8], Indonesia [4], and Malaysia [2]. The prevalence of WMSDs in Thailand, Indonesia, and Malaysia was 78,31%, 81,27%, and 88,39%, respectively. Common factors associated with WMSDs include age, sex, smoking habits, drinking alcohol habits, working period (years), type of work, awkward position, non-ergonomic equipment, repetitive movements, and lifting heavy loads.

Conclusion: The prevalence of WMSDs among farmers in Southeast Asia is considerably high. Effective intervention is essential for reducing the prevalence and protecting workers' health and well-being.

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1. Background

Southeast Asia is a region in Asia with a large population that works in the agricultural sector. The Southeast Asian region itself consists of 11 countries, namely the Philippines, Malaysia, Indonesia, Thailand, Laos, Cambodia, Vietnam, Myanmar, Brunei Darussalam, Timor Leste, and Singapore. The agricultural sector serves as the main contributor of the gross domestic product (GDP) of each country. According to the 2020 data, the percentage of GDP generated from the agricultural sector in each country was Indonesia 12.8%; Thailand 8.1%; Myanmar 24.6%; Philippines 9.3%; Vietnam 14.7%; Malaysia 7.5%; Cambodia 22%; Timor Leste 17.5%; Brunei 1%, and Singapore 0%. From these data, countries in Southeast Asia still rely on the agricultural sector for their state income [1].

In 2017, an International Labour Organization (ILO) report showed that 28.5% of the total population of Asia were workers who worked in the agricultural sector. This shows that this sector dominates the distribution of jobs in the Asian region, including in Southeast Asia [2]. "Agricultural sector workers" themselves are defined in preference to "farmworkers", as the name better reflects the broad nature of plantations, horticulture, and primary agriculture [3].

The size of the agricultural sector in Southeast Asia is not in line with technological developments in the sector. Road access rates of 19% and environmental improvement rates of 9% are the main aspects that receive attention in Southeast Asian countries with a promising agricultural sector. In contrast, regarding technology in agriculture, working conditions only impact 2% of the developments caused by the development of the agricultural sector

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[4]. This can be seen from the amount of investment and the technology industry in the agricultural sector. There is no agricultural technology industry originating from Southeast Asia, despite enormous opportunities in the Southeast Asian market. It turns out that the investment in agricultural technology equipment is very minimal. The USA and China still control the agricultural technology industry [5].

The lack of investment in the agricultural technology sector has resulted in a low level of automation and mechanization in the agricultural sector in Southeast Asia. As a result, farmers rely more on their ability to farm manually. The manual work then has an impact on the use of excess muscles. It is not surprising that work-related musculoskeletal disorders (WMSDs) are so common among farmers. Various studies in South Asia, America, East Asia, and Africa show that the prevalence of WMSDs is between 60 and 80% of the total farmers in these areas [6–10].

The high prevalence of WMSDs will certainly affect worker productivity [11–13]. Decreased worker productivity will cause a decrease in the production of a country's agricultural sector, which of course, will affect the country's GDP. The severity of WMSDs will also determine the ability of workers to produce and manage agriculture [9]. Therefore, it is essential to understand the factors that influence the incidence of WMSDs in farmers [14–16]. Although factors in other parts of the world have been widely discussed, the characteristics of different Southeast Asian countries allow for new findings regarding the factors associated with the incidence of WMSDs in Southeast Asian countries.

In Southeast Asia, in recent years, several studies have attempted to observe the prevalence of WMSDs in farmers, although the data and research results are only local to each country. Meanwhile, research studies that focus on the prevalence of WMSDs at the Southeast Asian regional level are still not available. This study aims to look at the prevalence of WMSDs among farmers in Southeast Asia and collect information on what causes WMSDs in Southeast Asia. The study results are expected to be a guideline for understanding the severity of WMSDs and how to prevent them from increasing at the regional level in Southeast Asia.

2. Methods

2.1. Search strategy and inclusion criteria

This systematic review was conducted following PRISMA guidelines. The published articles related to WMSDs were searched through the scientific article databases, including the PubMed, ScienceDirect, Scopus, and EBSCO databases. The inclusion criteria for articles that we will choose are articles published from January 2015 to March 2022, published in English. The subject was farmers from 11 Southeast Asian countries.

In this study, WMSDs refers to the injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and spinal discs that are related to the work environment and the performance of the work contribute significantly to the condition; and/or the condition is made worse or persists longer due to work conditions [17]. "Farmer" is defined as being used in preference to "farmworkers" as it better reflects the broad nature of plantations, horticulture, and primary agriculture [3]. Southeast Asia is an Asian region consisting of 11 countries: the Philippines, Malaysia, Indonesia, Thailand, Laos, Cambodia, Vietnam, Myanmar, Brunei Darussalam, Timor Leste, and Singapore [18].

The process of searching for articles in 4 databases is carried out using several keywords, including "WMSDs," "Farmer," "Ergonomic," "Health Problem," and "Southeast Asia," and specific country names, the Philippines, Malaysia, Indonesia, Thailand, Laos, Cambodia, Vietnam, Myanmar, Brunei Darussalam, Timor Leste, and Singapore. We also made exclusion criteria related to the articles: experimental study articles, systematic review articles, qualitative studies, and case-control and cohort study articles, and the articles that did not provide the prevalence of WMSDs were excluded. The article selection was cross-validated by the researchers in this study to ensure the eligibility and quality of the articles.

After the final selection process, 14 articles were included in this systematic review (Fig. 1).

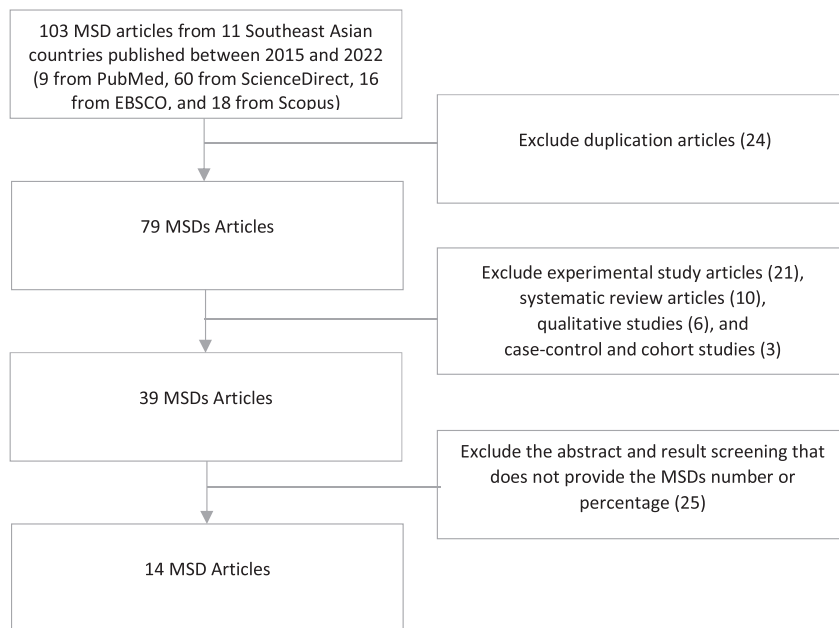


Fig. 1. Selection flowchart diagram following PRISMA guidelines.

2.2. Data analysis

The article quality analysis was carried out using the Critical Appraisal Skills Program (CASP). The CASP was used because it provides a specific checklist to review articles according to the desired design study. The CASP is expected to reduce bias due to differences in study designs and the checklists used in reviewing articles.

The CASP for the cross-sectional study was used in this study. It consists of 10 checklists related to the systematic review. The 10 checklists are divided into 3 sections, including study validity, results, and impact on the local community.

The CASP checklist gives the preview option to select three options for each “Yes,” “Can’t tell,” and “No” checklist. These answers will later determine the CASP score for each article. The minimum CASP score is 0, and the maximum score is 10 [19].

3. Results

Table 1 shows the information about the articles that are included in this study. Based on the 14 articles obtained, 8 articles originated from research in Thailand, 4 articles were from Indonesia, and 2 articles were from Malaysia. Based on the selection

Table 1

The information of articles included in this study

Article code	Title	Authors	Journal	CASP Score
A1	Agricultural Risk Factors and Related Musculoskeletal Disorders among Older Farmers in Pathum Thani Province, Thailand	Kaewdok et al., 2021 [20]	Journal of Agromedicine	9
A2	Difference in Accidents, Health Symptoms, and Ergonomic Problems Between Conventional Farmers Using Pesticides and Organic Farmers	Nankongnab et al., 2020 [21]	Journal of Agromedicine	7
A3	Risk Factors for Musculoskeletal Disorders Among Oil Palm Fruit Harvesters During the Early Harvesting Stage	Ng et al., 2015 [22]	Annals of Agricultural and Environmental Medicine	8
A4	The Prevalence of and Risk Factors Associated with Musculoskeletal Disorders in Thai Oil Palm Harvesting Workers: A Cross-Sectional Study	Bhuanantanondh et al., 2021 [23]	International Journal of Environmental Research and Public Health	9
A5	A Cross-sectional Study of Musculoskeletal Symptoms and Risk Factors in Cambodian Fruit Farm Workers in the Eastern Region of Thailand	Thetkathuek et al., 2018 [24]	Safety and Health at Work	10
A6	Farmers Injuries, Discomfort, and Their Use in the Design of Agricultural Hand Tools: A Case Study from East Java, Indonesia	Wibowo et al., 2016 [25]	Agriculture and Agricultural Science Procedia	7
A7	Prevalence and Associated Factors of Health Problems Among Indonesian Farmers	Sutanto et al., 2017 [26]	Chinese Nursing Research	8
A8	Malaysian Oil Palm Workers Are in Pain: Hazard Identification and Ergonomics Related Problems	Nawi et al., 2016 [27]	Malaysian Journal of Public Health Medicine	7
A9	Musculoskeletal Disorders and Quality of Life of Sugarcane Farmers in the Northeast of Thailand: A Cross-Sectional Analytical Study	Prommawai et al., 2019 [28]	Journal of Clinical and Diagnostic Research	9
A10	Working Hazards and Health Problems Among Rubber Farmers in Thailand	Saksornngmuang et al., 2019 [29]	Walailak Journal	8
A11	Ergonomic Checkpoint in Agriculture, Postural Analysis, and Prevalence of Work Musculoskeletal Symptoms Among Indonesian Farmers: Road to Safety and Health in Agriculture	Widyanti, 2018 [30]	Jurnal Teknik Industri	7
A12	Factors Related to Musculoskeletal Disorders in Quality Control Palm Workers at Palm Purchasing Establishments in Sichon District, Nakhon Si Thammarat, Thailand	Mongkonkansai et al., 2020 [31]	Annals of Agricultural and Environmental Medicine	8
A13	Ergonomic Task Analysis for Prioritization of Work-Related Musculoskeletal Disorders Among Mango-Harvesting Farmers	Boriboonsuksri et al., 2022 [32]	Safety	7
A14	Correlation Between Age and Period of Working with the Musculoskeletal Disorders Complaints on Palm Farmers in Pt. X	Oktavianoor et al., 2015 [33]	Asian Journal of Epidemiology	8

Table 2
Systematic review table

Article code	Location	Participants	Measurement tools	Main result
A1	Thailand	481 older farmers (≤ 60 y/o)	Self-report of MSDs, and the Nordic Musculoskeletal Questionnaire. Level of burden work: N/A	The prevalence of musculoskeletal symptoms over the past 7 days and 12 months was 87.9% and 88.9%, respectively
A2	Thailand	243 conventional (pesticide using) farmers and 235 organic farmers	Validated questionnaires in face-to-face interviews. Level of burden work: N/A	Organic farmers reported significantly more musculoskeletal pain, numbness, or weakness over the past 3 months compared to conventional farmers.
A3	Malaysia	446 male farmers	Nordic Musculoskeletal Questionnaire and Ovako Working Posture Assessment System (OWAS) Level of burden work: N/A	Awkward posture was a particularly significant risk factor of MSDs among FFB collectors (86% of the respondents' complained of experiencing MSDs)
A4	Thailand	334 oil palm harvesting workers	Nordic Musculoskeletal Questionnaire, Job Content Questionnaire, Level of burden work: N/A	The prevalence of MSDs during the past 12 months was 88.0%
A5	Thailand	861 Cambodian farm workers	Nordic Musculoskeletal Questionnaire, Rapid Upper Limb Assessment (RULA), and Hazard Zone Jobs Checklist technique Level of burden work: N/A	The prevalence of musculoskeletal was 83.6%. The study showed significant differences between men and women with respect to their current drinking history, duration of work (years), and use of insecticide spraying methods. In addition, the difference in proportion of exposure to hazards between men and women, including heavy work and standing work
A6	Indonesia	502 farmers	Measurement of body anthropometry and measurement of the dimensions handles of agriculture tools. Level of burden work: N/A	Majority of farmers complained to suffer fatigue in upper back (92.8%), mid back (93.6%), and lower back (91.8%), respectively
A7	Indonesia	179 farmers	Self-administered questionnaire and physical examination Level of burden work: <ul style="list-style-type: none"> • Not stressed ($<$ median score) • Stressed (\geq median score) 	The prevalence of varying health problems was 28.5% underweight, 10.6% overweight, 62.6% anemia, and 50.3% joint and bone pain.
A8	Malaysia	88 oil palm workers	Nordic Musculoskeletal Questionnaire (MNQ) and Field observation for awkward posture Level of burden work: N/A	99% of workers have MSDs problems caused by manual material handling, awkward postures, repetitive works, heavy load, excessive force and not using ergonomic tools
A9	Thailand	529 sugarcane farmers	Nordic Musculoskeletal Questionnaire and WHO-QOLBREF questionnaire Level of burden work: N/A	It was found that as high as 74.29% (of sugarcane farmers had MSDs and 36.29% had poor QOL. MSDs were significantly associated with poor QOL
A10	Thailand	370 rubber farmers	Job content questionnaire, CES-D, Musculoskeletal disorders questionnaire Level of burden work: N/A	The prevalence of MSDs in the past 12 months was 87.7 % and 47.6% for the past 7 days, depression symptoms (15.7 %), and hand eczema (8.9 %). Additionally, nearly half of the Thai rubber farmers had an accident at work (45.1 %), while 22 % reported to have been bitten by a poisonous animal
A11	Indonesia	251 farmers	Nordic body map, REBA Level of burden work: N/A	Indonesian agriculture is in a poor ergonomics condition and is associated with high musculoskeletal symptoms. The most common symptom is lower back pain (82.1%).
A12	Thailand	50 farmers	Validated MSDs questionnaire and Rapid Entire Body Assessment (REBA) Level of burden work: N/A	The prevalence of musculoskeletal disorders after one year at work was 78%
A13	Thailand	14 mango farmers	Modified Nordic Questionnaire, Borg CR-10, RULA, REBA, FEI Level of burden work: N/A	This study indicated clearly that WMSDs are highly prevalent in mango-harvesting farmers 100%

Table 2 (continued)

Article code	Location	Participants	Measurement tools	Main result
A14	Indonesia	40 farmers	Nordic Body map Level of burden work: N/A	Most of the respondents, with as many as 24 (60%) of respondents having complaints of MSDs. There was no significant correlation between age and the period of working with MSDs complaints. There was no significant correlation between age and period of working with MSDs

Note: The definition of the outcome prevalence and magnitude of association are provided in Supplemental Materials [Table S2](#).

criteria carried out, the other eight countries did not have articles that matched the research. The articles used in this systematic review were published between 2015 and 2022, two journals published in 2015, two journals published in 2016, one journal published in 2017, two journals published in 2018, two journals published in 2019, two journals published in 2020, two journals published in 2021, and one journal published in 2022.

According to a systematic review using CASP, the CASP scores of 14 articles ranged from 7-10. The score showed that the quality of the articles that are the material for systematic reviews is quite good. From the distribution of the CASP scores in this study, five journals received a CASP score of 7, five journals received a CASP score of 8, three journals received a score of 9, and one journal received a score of 10 ([Supplemental Material Table S1](#)).

A systematic review showed that each country had a high prevalence of WMSDs among farmers. In Thailand, from 8 articles, 3,117 farmers became research respondents, and 2,441 farmers were experiencing WMSDs, so the prevalence of WMSDs among farmers in Thailand was 78.31%. In Indonesia, from 4 articles, 972 farmers became research participants, and 790 farmers experienced WMSDs. Thus, the prevalence of WMSDs among farmers in Indonesia was 81.27%. In Malaysia, with two articles, there were 534 farmers as research participants and 472 farmers experiencing WMSDs. Thus, the prevalence of WMSDs among farmers in Malaysia was 88.39%.

A systematic review of 14 articles showed that as many as 4,623 farmers from various types of agriculture from three countries in Southeast Asia had participated or become participants in 14 studies. From this number, 3,703 farmers experienced WMSDs. The results of this study indicate that the prevalence of WMSDs among farmers in Southeast Asia was 80.10%.

Various factors contribute to the high prevalence of WMSDs among farmers in Southeast Asia. Based on the results of a systematic review of 14 articles that had been carried out, some of these factors included age, sex, smoking habits, drinking alcohol habits, working period (years), type of work, award position, non-ergonomic equipment, repetitive movements, and lifting heavy loads while working in agricultural areas. Detailed information for each article is listed in [Table 2](#).

4. Discussion

Based on the systematic review results, there were 14 published articles from 3 Southeast Asian countries that corresponded with the objective of this study. The small distribution of countries obtained in this systematic review shows the lack of research on the prevalence of WMSDs among farmers in the Southeast Asia region. This is because the agricultural sector is not the focus of development, both from the human aspect and the infrastructure aspect, although it is a significant sector supporting a country's GDP. Not surprisingly, in the Southeast Asia region, the prevalence of WMSDs among farmers is very high compared to other regions in the world [16,34].

Previous studies have demonstrated that the prevalence of WMSDs among farmers worldwide is indeed higher than the prevalence of other occupations [35]. However, technological developments and the occurrence of automation and mechanization in Europe, America, and East Asia have reduced the prevalence of WMSDs from year to year, while the reduction in Southeast Asia is challenging [36,37]. The lack of attention from relevant stakeholders needs to be addressed to encourage the improvement of farmers' health and significantly increase research related to WMSDs in farmers, which is the main problem for farmers' health in this region.

The high prevalence of WMSDs among farmers in Southeast Asia revealed in this systematic review study shows that the number of WMSDs among farmers in Southeast Asia is higher than the incidence of WMSDs in other regions, except for Africa. This is because automation and mechanization are slow to enter and support the infrastructure of agricultural activities in Southeast Asia. The investment rate in agricultural technology in Asia is low [4,5]. In contrast, in other parts of the world, countries are competing to improve the agricultural system, both with automation systems using robots and with mechanization using modern equipment based on research and development results. In Southeast Asia, human labor is still prioritized as a resource that conducts all of the activities in the agricultural and agricultural sectors, and this is mostly performed manually. The high population density in Southeast Asia makes some stakeholders prefer to use more people in their work rather than the developed technology in the agricultural sector. Not surprisingly, people working in the agricultural sector still dominate the distribution of jobs in Southeast Asia.

On the one hand, the need for human resources in the agricultural sector is excellent, namely through the provision of job opportunities for residents of a country. However, on the other hand, if the agricultural sector is left without the improvement of technology and sound equipment, the high need for human resources is similar to plunging people who work in this sector into bad conditions, and this will reduce their health status later.

The systematic review results also show that various factors influence the incidence of WMSDs among farmers in Southeast Asia. Three factors can be concluded from this review including worker personal characteristic factors, behavioral factors, and job-related factors.

Worker personal characteristic factors are factors that are inherent in farmers in Southeast Asia. These factors include age, sex, and years of service. The age of farmers in Southeast Asia is generally 40 years old and above, and this is because many young people are not interested in working in the agricultural sector. The younger generation prefers to urbanize and work in other industrial sectors. This can be seen from the urbanization rate in Southeast Asian countries, which increases every year. Thus, the farmers who have worked in the agricultural sector until now are people who have worked for a long time, with a working period of more than 10 years and an age that is above 40 years [38]. Apart from age, the sex of the worker has also been the focus of several studies because heavy work is given to men and women without any difference in treatment. This

makes the women's group more vulnerable to WMSDs in this sector because women's physical abilities are lower than those of men.

Behavioral factors are the habits of Southeast Asian farmers before, during, and after work. Habits that affect WMSDs among farmers in Southeast Asia include drinking alcohol and smoking [39]. Farmers in the Southeast Asian region mostly have a smoking habit. In some agricultural sectors, farmers are disturbed by mosquitoes at work. Therefore, one of the efforts to reduce mosquito disturbances at work is smoking, because cigarette smoke can prevent farmers from being disturbed by mosquitoes [40,41].

Job-related characteristics are the important factor that causes a high prevalence of WMSDs in farmers in Southeast Asia. These factors include the type of work, awkward positions, non-ergonomic equipment, repetitive movements, and lifting heavy loads [20,22,27,28,30,31,33]. Some of these factors stem from the lack of ergonomic equipment for farmers in Southeast Asia. When the repair of work equipment and automation and mechanization are carried out based on the development of science and technology, these aforementioned factors can be improved [22,25,27,30].

There is a limitation in this study, even though we summarized the important factors associated with WMSDs. Because of the non-uniformity of the quantitative references to each article obtained in this study, we did not perform the meta-analysis. Given the variation of research related to ergonomics among farmers in Southeast Asia, it is challenging to obtain articles that provide comprehensive investigations that are appropriate for meta-analysis. Moreover, our primary objectives are to investigate the prevalence of WMSDs and associated factors. Therefore, the meta-analysis was not performed.

5. Conclusion

The prevalence of WMSDs among farmers in Southeast Asia is considerably high. The high prevalence of WMSDs among farmers is influenced by individual characteristics, behavioral factors, and occupational factors. This should be a concern for all countries in the Southeast Asian region in attempting to reduce the prevalence of WMSDs. Research related to the prevalence of farmers in Southeast Asia must be carried out sustainably. Effective interventions for resolving the high WMSDs in Southeast Asia are essential for implementation, and they could protect workers' health and well-being, such as an ergonomic campaign based on the ILO guidelines "Ergonomic Checkpoints in Agriculture". Moreover, unnecessary medical expenses due to WMSDs could also be reduced.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.shaw.2023.05.001>.

References

- [1] Fairclough B. Thailand, Vietnam Dominate Southeast Asian Crop Protection Market USA: AgriBusiness Global; 2020 [cited 2022 13 March 2022]. Available from: <https://www.agribusinessglobal.com/agrochemicals/thailand-vietnam-dominate-southeast-asian-crop-protection-market/>.
- [2] International Labour Organization. ILO. Sectoral Distribution of Work in Asia-Pacific Geneva, Swiss: International Labour Organization: ILO [cited 2022 13 March]; 2018. Available from: https://www.ilo.org/global/about-the-ilo/multimedia/maps-and-charts/enhanced/WCMS_650049/lang-en/index.htm.
- [3] Hurst P. Agricultural workers and their contribution to sustainable agriculture and rural development. Geneva Swiss: International Labour Organization (ILO). 2007. Available from: https://www.ilo.org/wcmsp5/groups/public/@ed_dialogue/@actrav/documents/publication/wcms_113732.pdf.
- [4] Zhan J, Mirza H, Speller W. 4 the impact of larger-scale agricultural investments on communities in South-East Asia: a first assessment. *Large-Scale Land Acquisitions*: Brill Nijhoff 2016:79–107.
- [5] Freischlad N. Agriculture tech: next big opportunity in Southeast Asia? [cited 2022 13 March]. *TechinAsia* 2015. Available from: <https://www.techinasia.com/agriculture-tech-big-opportunity-southeast-asia/>; 2015.
- [6] Gadhavi B, Shukla Y. Prevalence of work related musculoskeletal disorders in farmers of Gujarat. *Ergonomics* 2019;6(11).
- [7] Kearney GD, Allen DL, Balanay JAG, Barry P. A descriptive study of body pain and work-related musculoskeletal disorders among Latino farmworkers working on sweet potato farms in eastern North Carolina. *J Agromed* 2016;21(3):234–43.
- [8] Kee D, Haslam R. Prevalence of work-related musculoskeletal disorders in agriculture workers in Korea and preventative interventions. *Work* 2019;64(4):763–75.
- [9] Mahto PK, Gautam BB. Prevalence of work-related musculoskeletal disorders in agricultural farmers of Bhaktapur District, Nepal. *Int J Occup Safety Health* 2018;8(1):3–7.
- [10] Munala JM, Olivier B, Karuguti WM, Karanja SM. Prevalence of musculoskeletal disorders amongst flower farm workers in Kenya. *The South African J Physio* 2021;77(1).
- [11] Davis KG, Kotowski SE. Understanding the ergonomic risk for musculoskeletal disorders in the United States agricultural sector. *Am J Indus Med* 2007;50(7):501–11.
- [12] Heidari Moghadam R, Mohammadfam I, Babamiri M, Soltanian AR, Khotanlou H, Sohrabi MS. Study protocol and baseline results for a quasi-randomized control trial: an investigation on the effects of ergonomic interventions on work-related musculoskeletal disorders, quality of work-life and productivity in knowledge-based companies. *Int J Indus Ergonom* 2020;80:103030.
- [13] Oo TW, Taneepanichkul N. Work-related Musculoskeletal Disorders, Psychosocial Factors, Work Productivity, and Work Ability Among garment factory workers in Myanmar.
- [14] Momeni Z, Choobineh A, Razeghi M, Ghaem H, Azadian F, Daneshmandi H. Work-related musculoskeletal symptoms among agricultural workers: a cross-sectional study in Iran. *J Agromed* 2020;25(3):339–48.
- [15] Amiri F, Attari SG, Karimi Y-A, Motamedzadeh M, Karami M, Moghadam RH, et al. Examination of work-related musculoskeletal disorders and their related factors among farmers of Asadabad city in 2015. *Pharmacophore* 2020;11(1):52–7.
- [16] Kumaraveloo KS, Lunner Kolstrup C. Agriculture and musculoskeletal disorders in low-and middle-income countries. *J Agromed* 2018;23(3):227–48.
- [17] Bernard BP, Putz-Anderson V. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back; 1997.
- [18] Steinberg DJ, Wyatt DK, Smail JR, Woodside A, Roff WR, Chandler DP. *Search of Southeast Asia*. University of Hawaii Press; 2021.
- [19] Critical Appraisal Skills Programme: CASP. UK: OAP Ltd.; 2018 [cited 2022 13 March]. Available from: <https://casp-uk.net/casp-tools-checklists/>.
- [20] Kaewdok T, Sirisawasd S, Taptagaporn S. Agricultural risk factors related musculoskeletal disorders among older farmers in Pathum Thani province, Thailand. *J Agromed* 2021;26(2):185–92.
- [21] Nankongnab N, Kongtip P, Tipayamongkholgul M, Bunngamchairat A, Sitthisak S, Woskie S. Difference in accidents, health symptoms, and ergonomic problems between conventional farmers using pesticides and organic farmers. *J Agromed* 2020;25(2):158–65.
- [22] Ng YG, Tamrin SBM, Yusoff ISM, Hashim Z, Md Deros B, Bakar SA, et al. Risk factors of musculoskeletal disorders among oil palm fruit harvesters during early harvesting stage. *Annals of Agricultural and Environmental Medicine* 2015;22(2).
- [23] Bhuanantanondh P, Buchholz B, Arphorn S, Kongtip P, Woskie S. The prevalence of and risk factors associated with musculoskeletal disorders in Thai Oil Palm Harvesting Workers: a cross-sectional study. *Int J Environ Res Public Health* 2021;18(10):5474.
- [24] Thetkathuek A, Meepradit P, Sa-Ngiamsak T. A cross-sectional study of musculoskeletal symptoms and risk factors in Cambodian fruit farm workers in Eastern Region, Thailand. *Safety and Health at Work* 2018;9(2):192–202.
- [25] Wibowo RKK, Soni P. Farmers' injuries, discomfort and its use in design of agricultural hand tools: a case study from east java, Indonesia. *Agriculture and Agricultural Science Procedia* 2016;9:323–7.
- [26] Susanto T, Purwandari R, Wuri Wuryaningsih E. Prevalence and associated factors of health problems among Indonesian farmers. *Chinese Nurs Res* 2017;4(1):31–7.
- [27] Mohd Nawi NS, Md Deros B, Sukadarin EH, Nordin N. Malaysian oil palm workers are in pain: hazards identification and ergonomics related problems. *Malaysian J Public Health Med* 2016;16(s1):50–7.
- [28] Prommawai N, Laohasiriwong W, Nilvarangkul K. Musculoskeletal disorders and quality of life of sugarcane farmers in the Northeast of Thailand: a cross-sectional analytical study. *J Clin Diagn Res* 2019;13(6).

- [29] Saksornngmuang P, Kaewboonchoo O, Ross R, Boonyamalik P. Working hazards and health problems among rubber farmers in Thailand. *Walailak J Sci Technol (WJST)* 2019;17(3):222–36.
- [30] Widyanti A. Ergonomic checkpoint in agriculture, postural analysis, and prevalence of work musculoskeletal symptoms among Indonesian farmers: road to safety and health in agriculture. *Jurnal Teknik Industri* 2018;20(1): 1–10.
- [31] Mongkonkansai J, Thanapop C, Madardam U, Cheka A, Epong A, Arwae A. Factors related to musculoskeletal disorders in quality control palm workers at palm purchasing establishments in Sichon District, Nakhon Si Thammarat, Thailand. *Ann Agri Environ Med* 2020;27(2).
- [32] Boriboonsuksri P, Taptagaporn S, Kaewdok T. Ergonomic task analysis for prioritization of work-related musculoskeletal disorders among mango-harvesting farmers. *Safety* 2022;8(1):6.
- [33] Oktaviannoor H, Noor Z, Setyaningrum R. Correlation between age and period of working with the musculoskeletal disorders complaints on palm farmers in Pt. X. *Asian J Epidemiol* 2015;8:78–83.
- [34] Naidoo RN, Haq SA. Occupational use syndromes. *Best Practice & Res Clin Rheumatol* 2008;22(4):677–91.
- [35] Osborne A, Blake C, Fullen B, Meredith D, Phelan J, McNamara J, et al. Prevalence of musculoskeletal disorders among farmers: a systematic review. *Am J Indus Med* 2012;55:143–58.
- [36] Cavalli L, Jeebhay MF, Marques F, Mitchell R, Neis B, Ngajilo D, et al. Scoping global aquaculture occupational safety and health. *J Agromed* 2019;24(4):391–404.
- [37] Barneo-Alcántara M, Díaz-Pérez M, Gómez-Galán M, Carreño-Ortega Á, Callejón-Ferre Á-J. Musculoskeletal disorders in agriculture: a review from web of science core collection. *Agronomy* 2021;11(10):2017.
- [38] Susilowati SH. Attracting the young generation to engage in agriculture. *Enhanced Entry of Young Generation Into Farming* 2014:105–24.
- [39] Bertin M, Bodin J, Fouquet N, Bonvallot N, Roquelaure Y. Multiple exposures and coexposures to occupational hazards among agricultural workers: a systematic review of observational studies. *Safety and Health at Work* 2018;9(3):239–48.
- [40] Gryseels C, Durnez L, Gerrets R, Uk S, Suon S, Set S, et al. Re-imagining malaria: heterogeneity of human and mosquito behaviour in relation to residual malaria transmission in Cambodia. *Malaria J* 2015;14(1):1–12.
- [41] Burfield T, Reekie S-L. Mosquitoes, malaria and essential oils. *Int J Aromatherapy* 2005;15(1):30–41.