International Journal of
Medical Toxicology & Forensic Medicine

October 2024, Volume 14, Number 4

Research Paper

Occupational Hazards Among the Agricultural Workers in a Rural Area of South India

Bhavana SV[1], Pavithra Cheluvaraj[2*], Nanda Kumar Bidare Sastry[2], Shivaraj Nallur Somanna[2]

1. National Health Mission, Bangalore, India.
2. Community Medicine, Ramaiah Medical College, Bangalore, India.

Use your device to scan and read the article online

Citation SV B, Cheluvaraj P, Bidare Sastry NK, Nallur Somanna Sh. Occupational Hazards Among the Agricultural Workers in a Rural Area of South India. International Journal of Medical Toxicology and Forensic Medicine. 2024; 14(4):E45237. https://doi.org/10.32598/ijmtfm.v14i4.45237

https://doi.org/10.32598/ijmtfm.v14i4.45237

Article info:
Received: 06 May 2024
First Revision: 08 May 2024
Accepted: 25 Sep 2024
Published: 12 Oct 2024

Keywords:
Agricultural workers, Rural population, Occupational exposure, Environmental exposure, Occupational injuries, Chemical hazard release, Biological hazard release

ABSTRACT

Background: Agriculture is one of the most hazardous occupations, employing around 60% of India's workforce. Agricultural workers face occupational hazards in the form of physical, chemical, biological, mechanical, ergonomic, psychosocial, and so on. This study assessed the physical, chemical, biological, and mechanical health hazards among agricultural workers.

Methods: A cross-sectional study was conducted among 400 agricultural workers selected through multistage random sampling in a rural area to assess their occupational hazards.

Results: Physical hazards were the most common hazards reported by 390 workers (97.5%), followed by mechanical hazards by 200(50%), and biological hazards by 79(19.7%). Chemical hazards were noted in 136(86.4%) out of 155 participants who used chemicals in the form of pesticides and insecticides.

Conclusion: All agricultural workers experience one or the other types of occupational hazards. These hazards have a bearing on the quality of life among the agricultural workers who form the primary workforce in our country and contribute significantly to the economy. It is crucial to ensure a robust health information system to track down and respond to agricultural workers' various health events, develop and implement a need-based intervention program through the formal healthcare system, and prevent and avert occupational health hazards in this group.

***Corresponding Author:**
Pavithra Cheluvaraj, Assistant Professor.
Address: *Community Medicine, Ramaiah Medical College, Bangalore, India.*
Tel: *+91 (994) 5192922*
E-mail: *pavi.rajs@gmail.com*

Introduction

Agriculture provides one of the necessities of human life, i.e. food. George Washington quoted agriculture as the man's most healthful, useful, and noble employment. India is a global agricultural powerhouse. The history of Indian agriculture is as old as 10000 years. India is the world's largest producer of milk, pulses, and spices and has the world's largest cattle herd. It is the second-largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep and goat meat, fruits, vegetables, and tea [1].

India has an agricultural economy, with over 54% of its land classified as cultivable, which forms its largest economic sector. Agriculture is the backbone and has a significant role in the country's socioeconomic development, with 60% of the Indian population working in this industry, contributing to 18% of India's gross domestic production [2].

As per the 2011 census, the number of agricultural workers increased from 234.1 million in 2001 to 263.1 million in 2011 in India [3]. More than 60% of the workforce of Karnataka is made up of agricultural workers [4].

The International Labor Organization (ILO) has stated that agriculture is the most hazardous occupation for health. Around 1.3 billion world's agricultural workers suffer serious injuries or occupational diseases. The main occupational hazards among agricultural workers are physical, mechanical, ergonomic, chemical, and biological.

Physical health hazards rank first among the threats faced by agricultural workers. Exposure to the sun for long hours causes dehydration, heat stroke, heat syncope, etc. The extensive use of pesticides and machinery has increased the risk of occupational diseases and injuries. Workers in developing countries are more at risk because of inadequate education, training, and safety systems [5]. Indian farmers have been adapting to newer farm mechanization faster in the recent past [6]. Many agricultural workers experience workplace accidents involving machinery or poisoning by pesticides and other insecticides [7]. According to the World Health Organization (WHO), 500000 to 1000000 people per year around the world suffer from health effects due to pesticide poisoning [8].

Accidents with machinery like tractors, hand tools, and so on can lead to injuries, disability, and death. Every year, about 760000 accidents resulting in 45000 deaths occur in the agriculture sector in India. Repeated work, profuse sweating leading to fatigue, and instrument slippage are common reasons for injuries [9].

The presence of harmful biological agents in the workplace poses a threat to agricultural workers, which is often overlooked in occupational medicine and public health. Systematic detection, diagnosis, and treatment facilities do not fully cover agricultural occupations. Introducing preventive and promotive services can play a significant role in protecting the health of agricultural workers [10]. This study assessed the physical, chemical, biological, and mechanical health hazards among agricultural workers. We aimed to assess the physical, chemical, biological, and mechanical health hazards among agricultural workers.

Materials and Methods

Study design

This cross-sectional study was conducted on adult agricultural workers living in the Avathi PHC area, Devanahalli taluk, Bangalore rural district, from January 2020 to March 2021. The inclusion criterion comprised adult agricultural workers who were residents in that area for at least 6 months, irrespective of the number of months per year or working hours per day. The exclusion criterion included those involved only in agricultural supervisory activity.

Sample size estimation

In a study by Ojha and Singh, musculoskeletal pain (50%) was the highest, and hazard due to noise (10%) was the least observed occupational hazard among farm workers. Assuming the proportion of occupational hazard to be 30%, considering the average of the previous study, the present study required a minimum of 398 subjects with a relative precision of 15% and a desired 95% confidence level. The samples were recruited by multistage random sampling. Avathi PHC, Devanahalli taluka, Bangalore rural, consists of 16 villages with a population of 15295 (Figure 1). The primary sampling unit was a village. In stage 1, villages with populations <1000, 1001-2000, and >2001 were stratified into strata 1, 2 and 3, respectively. The stratum 1, 2, and 3 populations were 5738, 6037, and 3520, respectively. As per the Karnataka census 2011, the percentage of agricultural workers was 49.28%. So, the population of farm

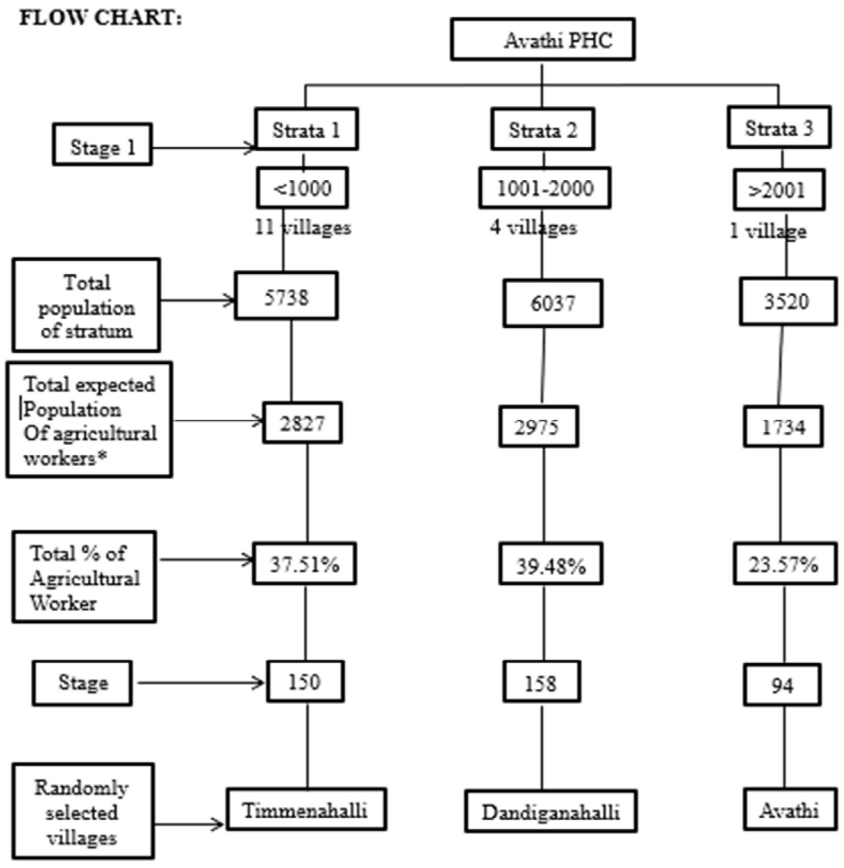

Figure 1. Steps of multistage sampling to recruit the participants

workers in strata 1, 2, and 3 were 2827, 2975, and 1734, respectively. The percentage of agricultural workers selected to achieve the required sample size was 37.51%, 39.48%, and 23.57%, respectively, and the sample size being 398, number of samples to be selected from each stratum was 150, 158, and 94, respectively.

In stage 2, one village was selected from these strata using simple random sampling. In the case of a village with a large population, the village was divided into four equal geographical clusters, and the clusters were selected randomly to meet the sample size.

Study procedure

A cross-sectional study was conducted among agriculture workers aged 18 years or older in the Avathi PHC area, Devanahalli Taluk of Bangalore rural district. Ethical clearance was obtained from the Institutional Review Board before the study was conducted. A pilot study was conducted to test and validate the study instrument and to know the feasibility of the study. Informed written consent was obtained from the study participants after explaining the purpose of the research and maintaining confidentiality. Those individuals who fulfilled the inclusion criteria were included in the study. House A house survey was conducted, and data were collected with the help of a pre-tested semi-structured questionnaire consisting of socio-demographic details, occupational details, and details regarding any occupational hazards faced. Occupational health hazards were assessed based on physical, chemical, biological, and mechanical hazards with a recall period of 6 months. General physical examination, blood pressure (BP), and general random blood sugar (GRBS) were performed by adopting standard guidelines for measurement using a digital BP apparatus and glucometer. Any participant who detected significant health hazards was referred to the higher center for further management.

Statistical analysis

Data were entered in Microsoft Excel and analyzed using IBM SPSS software, version 18.0. All the quantitative variables were expressed in Mean±SD and median. All categorical variables were expressed as percentages.

All the occupational hazards were quantified using proportion with a 95% confidence interval. The association between occupational risk factors such as exposure to sun, pesticides, and occupational hazards was assessed using the chi-square test and a univariate analysis.

Results

This community-based cross-sectional study was conducted in a rural area of Bangalore to assess the physical, chemical, biological, and mechanical health hazards among agricultural workers. The majority of the agriculture workers belonged to the age group of 40-59 years. The baseline characteristics of the study participants are given in Table 1. Agricultural workers had a median experience of 25 years (interquartile range [IQR]: 25%-75%; 15-40); 86.8% were full-time agriculture workers, and 13.3% were seasonal workers. Their mean work hours reported was 6 (+2) hours per day. Physical hazards (97.5%) were the most common type of occupational hazards among the agricultural workers, followed by chemical hazards (86.4%), mechanical hazards (50%), and biological hazards (19.7%) (Table 2). Musculoskel-

Table 1. Baseline characteristics of study population (n=400)

Baseline Characteristics		No. (%)	
		Male	Female
Age (y)	18-39	76(19)	72(18)
	40-59	77(19.2)	69(17.2)
	≥60	59(14.8)	47(11.8)
Education	Illiterate	54(13.5)	69(17.2)
	Primary school	7(1.8)	20(5.0)
	Middle school	37(9.2)	29(7.2)
	High school	51(12.8)	39(9.8)
	Pre-university	38(9.5)	24(6.0)
	Graduate degree	25(6.2)	7(1.8)
	Morbidities	94(44.3)	61(32.4)
	Diabetes	30(31.9)	20(32.7)
	Hypertension	25(26.5)	15(24)
	Epilepsy	2(2.1)	2(3.2)
	Asthma	3(3.1)	4(6.5)
	Diabetes and hypertension	18(19.1)	10(16.3)
	Other morbidities	16(17.0)	10(16.3)
Experience in agriculture (y)	≤5	27(12.7)	21(11.2)
	6-15	29(13.7)	42(22.3)
	≥15	156(73.6)	125(66.5)
Total		212(53)	188(47)

Table 2. Distribution of agricultural workers based on the type of occupational health hazards

Occupational Health Hazards	No. (%)
Physical health hazards (n=400)	390(97.5)
Biological health hazards (n=400)	79(19.7)
Mechanical health hazards (n=400)	200(50)
Chemical health hazards (n=155)*	136(86.4)

Notes: One individual may present with more than one type of manifestation.

International Journal of
Medical Toxicology & Forensic Medicine

*155 participants were considered based on their exposure to pesticides and insecticides.

etal pain was the most common manifestation of physical hazards. The commonest site for acute pain was the shoulder (53.5%) and lower back (37.3%) for chronic pain. Headache (72%) was the common manifestation of prolonged exposure to the sun (Table 3). Burning of eyes (83.9%) and headache (80.6%) were common manifestations of using chemicals for agricultural purposes (Table 4). Machine usage led to injuries among 42.5%, followed by weakness due to vibrations in 31.8% of participants. Dog bites (29%), followed by bee stings (24%), were the common biological hazards among agricultural workers (Table 5).

Univariate analysis determined the association between baseline characteristics like age, gender, education, socioeconomic status, years of experience in agriculture, and occupational hazards. No statistical significance was found between these characteristics and physical hazards. A significant association was found between gender and chemical hazards, age and biological hazards, age and socioeconomic status, and mechanical hazards (Table 6).

Table 3. Site of musculoskeletal pain and manifestations due to prolonged sun exposure among agricultural workers (n=326)

Site of Pain	No. (%)	
	Physical Hazards	
	Acute Pain (≤12 wk)	Chronic Pain (>12 wk)
Neck	138(34.5)	7(1.8)
Shoulder	214(53.5)	50(12.5)
Elbow	167(41.8)	22(5.5)
Wrist/Hand	103(25.8)	6(1.5)
Upper back	191(47.8)	83(20.8)
Lower back	149(37.3)	149(37.3)
Hips	86(21.5)	35(8.8)
Knees	91(22.8)	112(28)
Ankle	66(16.5)	5(1.3)
Generalized body ache	184(46)	19(4.8)

Effects Due to Prolonged Sun Exposure	No. (%)
Headache	286(71.5)
Increased thirst	232(58)
Heavy sweating	191(47.8)
Dizziness	107(26.8)
Palpitations	77(19.3)
Dark colored urine	32(8)
Heat cramps	12(3)
Mental confusion	11(2.8)
Heat syncope	9(2.3)
Heat stroke	8(2)
Nausea, vomiting, diarrhea	3(0.8)
Hot, dry, red skin	3(0.8)

International Journal of Medical Toxicology & Forensic Medicine

Table 4. Chemical health hazards among agricultural workers (n=136)

Chemical Hazards	
Effects of Chemical Exposure	**No. (%)**
Burning of eyes	130(83.9)
Post-acute exposure headache	125(80.6)
Difficulty in breathing	102(65.8)
Irritability	80(51.6)
Dizziness	64(41.3)
Blurring of vision	27(17.4)
Allergy of skin	25(16.1)
Restlessness	12(7.7)
Tingling sensation in limbs/body	11(7.1)
Low mood	11(7.1)
Other symptoms after pesticide application	2(1.3)

International Journal of Medical Toxicology & Forensic Medicine

Table 5. Mechanical and biological health hazards among agricultural workers (n=400)

Hazards Type	Effects Attributed to Machine Use	No. (%)
Mechanical	Injuries	170(42.5)
	Generalized weakness due to vibrations	127(31.8)
	Reduced sensation in the limbs	73(18.3)
	Electric shock	42(10.5)
Biological Hazards	Dog bite	116(29.0)
	Bee sting	96(24.0)
	Wasp sting	84(21.0)
	Snake bite	56(14.0)
	Animal attack	32(8.0)
	Scorpion sting	16(4.0)

International Journal of
Medical Toxicology & Forensic Medicine

Discussion

In the current study, 212 participants (53%) were males, and 188(47%) were females. Also, 148 participants (37%) belonged to the 18-39 years group; their median age was 45 years (IQR: 25-75%; 35-60). Their median agricultural experience was 25 years (IQR: 25-75%; 15-40). Agriculture was the only occupation for 89.2% in a study by Andersen. similar to our findings of 86.8% [11]. The mean hours of work reported was 6 (+2) hours per day, similar to a study conducted by Suganya et al. [12]. In a study by Gadhavi and Shukla, musculoskeletal pain was 80% among farmers, similar to our findings of 81.5% [13]. The most common site for

Table 6. Association between baseline characteristics and manifestations attributed to different hazards among agriculture workers

Type of Hazard	Characteristics		No. (%)		Univariate Odds Ratio (95% CI)	P*
			Yes	No		
Chemical hazards	Gender	Male	120(89.6)	14(10.4)	4.2 (1.48-12.4)	0.01
		Female	14(66.7)	7(33.3)	1	
Biological hazards	Age group (y)	>45	45(20.9)	170(79.1)	2.31 (1.29-4.11)	0.004
		≤45	19(10.3)	166(89.7)	1	
Mechanical hazards	Age group (y)	>45	118(54.9)	97(45.1)	1.52 (1.02-2.26)	0.04
		≤45	82(44.3)	103(55.7)	1	
	Socioeconomic status	Upper class	143(54.4)	120(45.6)	1.76 (1.63-1.14)	0.01
		Middle & Lower class	54(40.3)	80(59.7)	1	
	Years of experience in agriculture	≤5	15(31.2)	33(68.8)	1	
		6-15	20(40.8)	29(59.2)	1.51 (0.65-3.49)	0.39
		≥15	165(54.5)	138(45.5)	0.38 (0.19-0.72)	0.003

Note: *Only the significant associations are presented.

International Journal of
Medical Toxicology & Forensic Medicine

acute musculoskeletal pain was the shoulder (53.5%), followed by the upper back (47.8%), and then generalized body ache (46%). Also, the common chronic musculoskeletal pain reported was lower back (31%) followed by knee pain (23%), which was in contrast to the findings of a study conducted by Paul et al. where acute musculoskeletal pain noted was low backache (32.38%) followed by knee pain (30%) and similar with our study for chronic pain low backache (34.29%) followed by knee pain (32%) [14]. The difference in the site of acute musculoskeletal pain can be due to the different types of crops grown, which require different postures to be adopted. Still, chronic musculoskeletal disorders were common in both studies, indicating prolonged exposure to bending, twisting, squatting, etc. postures adopted the chronic effects were similar in both. Most common effect of sun exposure reported in our study was headache (71%), increased thirst (58%), heavy sweating (47.8%), and dizziness (26.8%). In contrast to this, heavy sweating (93.2%), headache (40.4%), and dizziness (34.1%) were reported by Sadiq et al. in Malaysia [15] randomly selected across Gombe province, Nigeria. The wet bulb globe temperature monitor (WBGT).

Burning of eyes (84%), post-exposure acute headache (81%), difficulty in breathing (66%), and skin allergy (16%) were reported among the 155 study participants who used chemicals. Dizziness (66%), headache (56.5%), anxiety (44%), blurring of vision (35%), and skin disease (19%) were reported by Kori et al. in Sagar district in Madhya Pradesh [16] household, veterinary practices, and occupational settings have increased the risk of human exposure and associated health effects. Objectives: In the present study, an attempt has been made to investigate the toxic symptoms, including neurological effects in pesticide-exposed farm workers. Methods: The data of exposure pattern and symptomatic health effects were collected through questionnaire distributed among 248 male farm workers by purposive sampling method from the district Sagar (MP).

Dog bites (29%), bee stings (24%), wasp stings (21%), and snake bites (14%) were noted in the study by BR et al. They conducted a study in Sri Chamarajendra District Hospital, Hassan, Karnataka. They reported that 54.4% of the cases that came to the hospital with snake bites were from farmers and suggested that snake bites were an occupational disease [17]. Though exposure to these biological agents is very common in agriculture occupations, the data regarding the incidence, prevalence, morbidity, and mortality due to many of these biological agents are unavailable nationally.

Injuries due to machine use and hand tools were noted to be 42.5%, out of which 7.6% reported to be living with disability. Weakness in the limbs (31%), followed by reduced sensation in the limbs (18.3%) due to machinery use, was also reported. In a study by Das, from 2006 to 2010 in West Bengal, 29% had accidents due to farm machines and 64.7% due to hand tools [18] injury and occurrences of work related illnesses. The main objective of the study is to assess types, categories and number of incident rate of the accidents along with the causes of accidents as well as with the affected parts of the different parts of the body among the agricultural workers. The number of injuries that occurred during 2006–2010 for male and female farmers was 214 and 109, respectively, in West Bengal. The leading external causes of farm injury were hand tools (64.7%).

Association of occupational hazards with baseline characteristics

Univariate analysis determined the association of age, gender, education, socioeconomic status, and years of agricultural experience among the full-year and seasonal workers with occupational hazards.

Regarding the physical hazards, no association was noted between the physical hazard and the variables mentioned above.

Regarding chemical hazards, males had a 4.2 times higher risk of chemical health hazards than females (odds ratio [OR]= 4.2, 95% CI, 1.48%, 12.4%). Comfort et al. reported that males are more susceptible to organophosphates, and various neurodevelopmental and neurodegenerative disorders such as autism and amyotrophic lateral sclerosis are more among them [19].

Regarding the mechanical hazards, older age above 45 increased the risk of mechanical health hazards by 1.52 times (OR=1.52; 95% CI, 1.02%, 2.26%). A significant association between the occurrence of injuries among farmers and age was noted in a study conducted by Bhattarai et al.; the risk of injuries was higher in those over 30. This difference among age groups was attributed to the tendency of agricultural workers to be less careful at work when they have worked for many years [20]. Higher socioeconomic status increases the risk of mechanical health hazards by 1.76 (OR=1.76; 95% CI, 1.63%, 1.14%). This difference can be due to higher affordability and use of machines and tools, indicating higher exposure among the upper class than those of lower socioeconomic status. In a study conducted by Pickett et al. from 2007 to 2009, among farmers in

Canada, it was reported that there was no significant increase in the risk of injuries associated with socioeconomic status. This difference in findings can be due to differences in the study population, the economic status difference between the countries, and the type of classification used for socioeconomic status [21]. There was a significant difference in the occurrence of mechanical health hazards with an increase in experience in agriculture (OR=0.38; 95% CI, 0.19%, 0.72%), indicating that with increase in experience in agricultural work, the risk of mechanical health hazard reduced by 0.38 times which was contrast to the results of a study conducted by Bhattarai et al. in rural Nepal where the risk of injuries was 2.01 times higher with 20 years and more working experience in agriculture [20].

Concerning the biological hazards, the risk of biological hazards was 2.31 times higher among those above 45 (OR=2.31, 95% CI, 1.29%, 4.11%). Verbal autopsies in a national representative Indian million death study by Suraweera et al. noted that nearly half of the deaths due to snake bites occurred at ages 30-69 years [22].

Conclusion

Agriculture is a major occupation and contributes significantly to the country's economy. Occupational health hazards among agricultural workers are a major concern in India. The prevalence of physical hazards was 97.5%, mechanical hazards 50%, chemical hazards 34%, and biological hazards 19.7% in our study. All types of hazards pose health challenges and affect quality of life. Developing and implementing a need-based intervention program through the formal health care system is necessary to prevent and avert occupational health hazards in this group. Additionally, it is crucial to ensure a robust health information system to track and respond to the various health events of agricultural workers.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of MS Ramaiah Medical College (Code: MSRMC/EC/AP-10/10-2019).

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Conceptalization, methodology, validation, data curation, writing the original draft, review & editing: Bhavana SV, Pavithra Cheluvaraj and Nanda Kumar Bidare Sastry; Software and formal analysis: All authors.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgements

The authors would like to thank the Panchayat leaders and members for their support in building rapport with the agricultural workers who participated in this study.

References

[1] World Bank Group. India: Issues and priorities for agriculture [Internet]. 2023 [Updated 2023 October 18]. Available from: [Link]

[2] Statista. Agriculture in India-statistics & facts [Internet]. 2023 [Updated 2023 October 19]. Available from: [Link]

[3] Ministry of Agriculture & Farmers Welfare. Agrarian Land [Internet]. 2020 [Updated 2020 February 4]. Available from: [Link]

[4] SLBC Karnataka. Agriculture [Internet]. 2023 [Updated 2023 October 19]. Available from: [Link]

[5] International Labour Office. Safety and health in agriculture: Sixth item on the agenda. Paper presented in: International Labour Conference, 88th Session. 15 June 2000; Geneva, Switzerland. [Link]

[6] Financial Express. India economic survey 2018: Farmers gain as agriculture mechanisation speeds up, but more R&D needed [Internet]. 2018 [Updated 2018 January 29]. Available from: [Link]

[7] International Labour Organization. Agriculture: A hazardous work [Internet]. 2015 [Updated 2015 March 23]. Available from: [Link]

[8] Satya Sai MV, Revati GD, Ramya R, Swaroop AM, Maheswari E, Kumar MM. Knowledge and perception of farmers regarding pesticide usage in a rural farming village, Southern India. Indian Journal of Occupational and Environmental Medicine. 2019; 23(1):32-36. [DOI:10.4103/ijoem.IJOEM_121_18] [PMID] [PMCID]

[9] ICAR–National Institute of Agricultural Economics and Policy Research. Annual report 2016-17. New Delhi: ICAR – National Institute of Agricultural Economics and Policy Research; 2017. [Link]

[10] Zukiewicz-Sobczak WA, Chmielewska-Badora J, Wróblewska P, Zwoliński J. Farmers' occupational diseases of allergenic and zoonotic origin. Postepy Dermatologii i Alergologii. 2013; 30(5):311-5. [DOI:10.5114/pdia.2013.38361] [PMID] [PMCID]

[11] Andersen S, Thygesen LC, Davidsen M, Helweg-Larsen K. Cumulative years in occupation and the risk of hip or knee osteoarthritis in men and women: A register-based follow-up study. Occupational and Environmental Medicine. 2012; 69(5):325-30. [DOI:10.1136/oemed-2011-100033] [PMID]

[12] Suganya M, Thangadurai DK, Munira F, Shanmugapriya P. A cross sectional study to assess the morbidity pattern ofagricultural workers in villages of Thanjavur, Tamil Nadu, India. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2023; 14(4):194-211. [Link]

[13] Gadhavi B, Shukla Y. Prevalence of work related musculoskeletal disorders in farmers of Gujarat. Ergonomics. 2019; 6(11):231-6. [Link]

[14] Paul S, Mitra K, Chakrabarty A, Das DK. Prevalence of musculoskeletal disorders and its correlates among agricultural workers in Bhatar block of Purba Bardhaman District, West Bengal. Journal of Dental and Medical Sciences. 2019; 18(1):22-8. [Link]

[15] Sadiq LS, Hashim Z, Osman M. The impact of heat on health and productivity among maize farmers in a tropical climate area. Journal of Environmental and Public Health. 2019; 2019:9896410. [DOI:10.1155/2019/9896410] [PMID] [PMCID]

[16] Kori R, Thakur R, Kumar R, Yadav R. Assessment of adverse health effects among chronic pesticide-exposed farm workers in sagar district of Madhya Pradesh, India. International Journal of Nutrition Pharmacology, Neurological Diseases. 2018; 8(4):153-61. [DOI:10.4103/ijnpnd.ijnpnd_48_18]

[17] BR H, L H, AJ L, PK C, KB V. A study on the clinico-epidemiological profile and the outcome of snake bite victims in a tertiary care centre in southern India. Journal of Clinical and Diagnostic Research. 2013; 7(1):122-6. [DOI:10.7860/JCDR/2012/4842.2685] [PMID] [PMCID]

[18] Das B. Agricultural work related injuries among the farmers of West Bengal, India. International Journal of Injury Control and Safety Promotion. 2014; 21(3):205-15. [DOI:10.1080/17457300.2013.792287] [PMID]

[19] Comfort N, Re DB. Sex-specific neurotoxic effects of organophosphate pesticides across the life course. Current Environmental Health Reports. 2017; 4(4):392-404. [DOI:10.1007/s40572-017-0171-y] [PMID]

[20] Bhattarai D, Singh SB, Baral D, Sah RB, Budhathoki SS, Pokharel PK. Work-related injuries among farmers: A cross-sectional study from rural Nepal. Journal of Occupational Medicine and Toxicology. 2016; 11:1-7. [Link]

[21] Pickett W, Day AG, Hagel L, Sun X, Day L, Marlenga B, et al. Socioeconomic status and injury in a cohort of Saskatchewan farmers. The Journal of Rural Health. 2011; 27(3):245-54. [DOI:10.1111/j.1748-0361.2010.00344.x] [PMID]

[22] Suraweera W, Warrell D, Whitaker R, Menon G, Rodrigues R, Fu SH, et al. Trends in snakebite deaths in India from 2000 to 2019 in a nationally representative mortality study. Elife. 2020; 9:e54076. [DOI:10.7554/eLife.54076] [PMID]