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Rabbani, U., Fatmi, Z. (2018). Incidence, patterns and associated factors for occupational injuries among agricultural workers in a developing country. *Medical Journal of the Islamic Republic of Iran*, 32(88).

Available at: https://ecommons.aku.edu/pakistan_fhs_mc_chs_chs/684



Incidence, patterns and associated factors for occupational injuries among agricultural workers in a developing country

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Received: 10 Aug 2018

Published: 20 Sep 2018

Abstract

Background: Injuries are common among agricultural workers, and a large section of the population is employed in agriculture worldwide. We aimed to determine the incidence, patterns and associated risk factors of occupational injuries among the agricultural workers in a developing country.

Methods: A cross-sectional study in Hyderabad, Pakistan was conducted from December 2012 to February 2013. Information was collected about incidence, pattern and associated risk factors of occupational injuries from 472 agricultural workers. Injury incidence and patterns for place, severity, type, agent, parts of body affected and work activity were calculated. Analysis was performed using SPSS version 19.0. Multivariate logistic regression was performed to calculate the adjusted odds ratio (OR) with 95% confidence interval, to identify the putative risk factors for occupational injuries.

Results: Incidence of occupational injuries was 35.0 per 100 per year (95% CI: 28.9 - 42.7). Cuts (70%) and hand tools (71%) were the most common type and agent for injury, respectively. Majority of injuries occurred during harvesting (55%). Increasing age [AOR 1.03 (95% CI: 1.01 - 1.05)], income <6000PKR/month [AOR 2.27 (95% CI: 1.08 - 4.76)] and driving tractor [AOR 2.58 (95% CI: 1.25 - 5.33)] increase the risk for injuries.

Conclusion: There was a high burden of injuries among the agricultural workers in Pakistan. Large-scale studies are required to further characterize the risk of injuries and develop preventive strategies to protect agricultural workers.

Keywords: Agriculture, Developing country, Incidence, Occupational injuries, Pakistan

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Cite this article as: Rabbani U, Fatmi Z. Incidence, patterns and associated factors for occupational injuries among agricultural workers in a developing country. *Med J Islam Repub Iran.* 2018 (20 Sep);32:88. <https://doi.org/10.14196/mjiri.32.88>

Introduction

Globally, occupational injuries are associated with loss of 10.5 million Disability Adjusted Life Years (DALYs) every year and constitute 8% of mortality due to unintentional injuries (1). Annually 318,000 workers die due to occupational accidents and 374 million encounter non-fatal injuries and illnesses (2). Nonetheless, these were gross underestimates as the majority of the occupational injuries go unreported (3).

High and variable rates of injuries have been reported among agricultural workers, (2, 4, 5) both from developed and developing countries. Machineries, hand tools, tractors, heavy lifting, farm animals, pesticides and other chemicals predispose agricultural workers to injuries (4, 6, 7). Moreover, certain seasonal tasks may lead to long working hours and sleep deprivation which may increase the risk of injury (8).

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↑What is “already known” in this topic:

Injuries are one of the leading causes of morbidity and mortality across the globe. Information on agricultural injuries is scant, in particular for developing countries. Available studies have shown high burden of occupational injuries among agricultural workers.

→What this article adds:

This paper estimated overall injuries, incidence, cumulative incidence, severity, place and type of injuries among agricultural workers in a developing country. Identified the differences in the pattern of injuries occurring between developed and developing country. Cuts were the most common and limbs were commonly affected by agricultural injuries. Hand tools as major agents, while increasing age, low income and harvesting season were important factors for agricultural injuries among these workers.

Agriculture is the largest sector employing 43.7% of the working population of which about 96% lives in rural areas and contributes to 21% of the total economy of Pakistan (9). A large section of the population is involved in agricultural work, and there is a dearth of information about burden and characteristics of injuries in Pakistan.

Therefore, we aimed to determine the incidence, pattern and associated risk factors of occupational injuries among the agricultural workers in a rural setting in Pakistan.

Methods

Study Design and Population

Agriculture employs half of the labor force and about 61.6% population lives in rural areas in Pakistan. A community-based cross-sectional survey was conducted from December 2012 to February 2013 in one of four talukas (sub-district) of district Hyderabad (i.e. 'Hyderabad Rural') of the province of Sindh, Pakistan. The study was conducted in 6 of the 11 union councils (UCs) of 'Hyderabad Rural'. The other five UCs were urban area and not included in the survey. Estimated population of farmers in 11 UCs was 150,000 based on Pakistan labor force survey 2012. Agriculture farms are privately owned, and there is no record of farms and workers available in Taluka administration offices. The sample was proportionately divided according to the population size of included UCs. In each of the selected UCs, all villages were identified, and local heads were approached to take permission for data collection. Farms were identified, and two participants were selected randomly from each of the farms. Adults 18 years or above working in the agriculture farms for at least the last one year were eligible to participate in the study. Those who had any congenital physical deformity were excluded. Two field staff administered a pre-tested questionnaire, in the local language, Sindhi.

Measures

Primary outcome in this study was occupational injury which was defined as "any injury from an occupational activity for which farmer was not able to carry on the task, either temporarily or permanently, and for which medical care was sought".

Frequency about injuries was obtained for six months preceding the interviews. Secondary outcomes were type, severity, site (body parts affected), place, agents of injury and activity during which injury occurred. The severity of the injuries was classified as 'mild' (treatment at home or outpatient department of hospital), 'moderate' (hospitalization or observation in hospitals) and 'severe' (affecting vitals or leading to permanent disability). Independent variables were age, gender, education level, experience in agriculture, working hour per day, nature of work, type of work, manual work or use of machine, type of machine, use of tractors, use of personal protective equipment, income, land ownership, and animals ownership. In addition, place and cost of treatment, and associated work days lost were also inquired.

Sample Size

We took 12% prevalence of occupational injuries

among agricultural workers from previous studies (10, 11) and considering 95% confidence level and 3% bound on error, at least 451 individuals were required to fulfill the objectives of the study.

Statistical Analysis

The data was double entered in Epi Data 3.1 and analyzed using SPSS version 19.0. Socio-economic and demographic characteristics and occupational history of workers were presented as mean and standard deviations for continuous variables and frequencies with percentages for categorical variables. Rate of injuries per 100 workers per year was calculated by dividing the number of events with sample size (472) and then multiplying the estimates by 2, as data was collected for six months to convert into an annual rate. Injury rates for place, severity, type, agent, parts of body affected and work activity with associated 95% confidence interval were calculated. Patterns of injuries were described according to agent, activity, type, and site of injury. Univariate and multivariate logistic regression was performed to calculate crude and adjusted odds ratio (OR) with 95% confidence interval, to identify the putative risk factors for injuries. We assessed the multicollinearity between independent variables. Variables having p-values less than 0.25 in univariate analysis were assessed further in multivariable models (12).

Ethics Statement

Written informed consent was obtained from all participants. This study was reviewed and approved by the Ethical Review Committee of Aga Khan University Karachi, Pakistan. (Ref #2145-CHS-ERC-12)

Results

A total of 472 agricultural workers consented and completed the interviews. Ten refused to participate (2%) and three provided incomplete information (1%).

Table 1 describes the socio-economic and demographic characteristics of the agricultural workers. Mean age of the participants was 35.7±11.9 years range 18-74 years. The majority was married (86.4%), had low income (median 5000 PKR per month), uneducated (82.4%) and Sindhi speaking (94%).

Table 2 reports the occupational history and the type of activities of the farmers including the types of crops and land area harvested. Common agricultural activities were done manually (98.7%) and included tilling (98.1%), planting (98.1%), harvesting (95.3%) and spreading manure (59.1%). About 15% also applied chemicals to crops other than fertilizers.

Only 1% and 3% of the participants used gloves and masks, respectively. None of the participants reported the use of long boots. Only about 60% of the workers wore slippers while working in the field.

Table 3 shows estimates of the annual incidence of injuries among agricultural workers. Annual incidence of occupational injuries was 35.0 per 100 per year (95% CI: 28.9-42.7). The non-occupational injuries were 9.0 per 100 workers per year (95% CI: 6.4-11.6). Annual cumulative incidence of occupational injuries was 75.0 per 100

Table 1. Socio-economic and demographic characteristics of agricultural workers in rural Hyderabad, Pakistan (n=472)

Variables	Frequency	Percentage
Age (years) [†]		Mean: 35.7, SD ±11.9
Gender		
Male	453	96.0
Female	19	4.0
Marital status		
Single	64	13.6
Married	408	86.4
Ethnicity		
Sindhi	442	93.7
Gujrati	26	5.5
Punjabi	3	0.6
Urdu	1	0.2
Education		
No schooling	389	82.4
Primary	81	17.2
Higher than primary	2	0.4
Own house	325	68.9
Type of house ^a		
Kacha	339	71.8
Pakka	58	12.3
Kacha/Pakka	75	15.9
Number of rooms in the house [†]		Mean: 2.7, SD ±0.9
Number of household members [†]		Mean: 9.87, SD ±2.7
Income PKR [†]		Mean: 5486, SD ±3229 Median: 5000, IQR 4000-6000
Keep animal at home	225	47.7
Own vehicle (other than tractor)	10	2.1

[†] Continuous variable^a Kacha house refers to thatched/mud dwelling; Pakka house refers to concrete/brick dwelling, whereas Kacha/Pakka refers to mixed construction including thatched/mud and concrete/brick dwelling.

IQR: Inter Quartile Range

Table 2. Occupational history of agricultural workers in rural Hyderabad, Pakistan (n = 472)

Variables	Frequency	Percentage
Duration in agriculture (in years) [†]		Mean: 20.8, SD ±11.9
Working hours per day [†]		Mean: 7.4, SD ±1.2
Type of agricultural work		
Tilling	463	98.1
Planting	463	98.1
Harvesting	450	95.3
Handle fertilizer	299	63.3
Spread manure	279	59.1
Apply chemicals (other than fertilizers including pesticides)	71	15.0
Drive tractor	41	8.7
Adjust equipment	25	5.3
Crop harvesting		
Manual	466	98.7
Type of crop		
Multiple ^a	258	54.7
Perennial	118	25.0
Seasonal	91	19.3
Biannual	5	1.0
Land area harvested (acres) [†]		Mean: 6.4, SD ±3.0
Past occupation other than agriculture	12	2.5

[†] Continuous variable^a More than one crop at one point in time

per year (95% CI: 66.7-84.2). The rate of moderate degree of injuries was highest 20.2 per 100 per year (95% CI: 15.5-26.6). Incidence of injuries resulting from hand tools was highest followed by injuries due to animal handling. Cuts were most frequently occurring injuries 24.6 per 100 per year (95% CI: 9.3-31.3), while the rate of injuries involving hands 14.4 per 100 per year (95% CI: 10.4-19.9) was highest than other parts of body. Incidence of injuries occurred during harvesting was highest (19.5 per 100 per year (95% CI: 14.8-25.6) followed by animal handling and tilling. Number of working days lost due to occupa-

tional injuries was 111 days/100 workers per year.

Table 4 shows the patterns of occupational injuries among agricultural workers. Most of the injuries took place on the farm, 91.6%. More than half of the occupational injuries were of moderate severity, and about one-third of the injuries were mild in nature. Cuts were the most common type of injuries (69.9%). Common agents of injury were hand tools which accounted for 71% of the injuries. Hand tools included garden hoe, harrow, shovel, and sickle. Limbs were the most frequently affected body parts.

Table 3. Annual incidence of injuries (overall and occupational) among agricultural workers in rural Hyderabad, Pakistan (n=472)

Variables	Frequency	Rate per 100 workers per year*
Any injury	134	56.6 (49.2 - 65.5)
Injuries for which medical care was sought	104	44.0 (37.2 - 52.2)
Place of injuries (n=104)		
Farm	77	32.6 (26.6 - 40.0)
Home	24	10.2 (6.8 - 15.0)
Road	2	0.8 (0.2 - 3.3)
Under construction building	1	0.4(0.06 - 3.0)
Characteristics of occupational injuries (n=83)		
Injuries	83	35.0 (28.9 - 42.7)
Cumulative incidence	177	75.0 (66.7 - 84.2)
Severity of injuries ^a		
Mild	27	11.4 (7.9 - 16.5)
Moderate	48	20.2 (15.5 - 26.6)
Severe	8	3.4 (1.7 - 6.7)
Type of injuries		
Cut	58	24.6 (19.3 - 31.3)
Fracture	13	5.5 (3.2 - 9.4)
Other ^b	12	5.0 (2.9 - 8.8)
Agent of injury		
Hand tools	59	25.0 (19.6 - 31.7)
Animals	21	8.9 (5.8 - 13.5)
Machine	2	0.9 (0.2 - 3.4)
Fall	1	0.4 (0.1 - 3.0)
Part of body involved in injury		
Hands	34	14.4 (10.4 - 19.9)
Lower limbs (excluding feet)	20	8.4 (5.5 - 13.0)
Feet	13	5.4 (3.2 - 9.4)
Upper limbs (excluding hands)	9	3.8 (2.0 - 7.2)
Trunk	6	2.5 (1.1 - 5.6)
Face/Neck	1	0.4 (0.1 - 3.0)
Work activity		
Harvesting	46	19.5 (14.8 - 25.6)
Handling animals	26	11.0 (7.5 - 16.0)
Tilling	10	4.2 (2.3 - 7.8)
Driving tractor	1	0.4 (0.1 - 3.0)
Working days lost due to occupational injuries	262	111(102 - 120)

*Annual rates were calculated by multiplying the estimates by 2, as data was collected for six months

¶ Continuous variable

^a Injury severity: Mild = Injuries requiring treatment at home or outpatient department of hospital, Moderate= Injuries requiring hospitalization or observation in hospital, Severe= Injuries affecting vitals or leading to disability

^b Others include: Bruise, sprain/twist, puncture/stab and loss of body parts.

Table 4. Patterns of occupational injuries among agricultural workers in rural Hyderabad, Pakistan (n=472)

Variable	Frequency	Percentage (95% CI)
Place of injuries		
Farm	76	91.6 (85.6 - 97.6)
Home	7	8.4 (2.4 - 14.4)
Severity		
Mild	27	32.5 (22.4 - 42.6)
Moderate	48	57.8 (47.1 - 68.4)
Severe	8	9.7 (3.2 - 15.9)
Type of injuries		
Cut	58	69.9 (60.0 - 79.7)
Fracture	13	15.7 (7.9 - 23.5)
Bruise	5	6 (0.9 - 11.1)
Sprain/Twist	5	6 (0.9 - 11.1)
Puncture/Stab	1	1.2 (-1.1 - 3.5)
Loss of body parts	1	1.2 (-1.1 - 3.5)
Agent of injury		
Hand tools	59	71.1 (61.3 - 80.8)
Animals	21	25.3 (15.9 - 34.6)
Machine	2	2.4 (-0.9 - 5.7)
Fall	1	1.2 (-1.1 - 3.5)
Part of Body involved in injury		
Hands	34	41(30.4 - 51.6)
Feet	20	24.1 (14.9 - 33.3)
Lower limbs (excluding feet)	13	15.7 (7.9 - 23.5)
Upper limbs (excluding hands)	9	10.8 (4.1 - 17.5)
Trunk	6	7.2 (1.6 - 12.8)
Face/Neck	1	1.2 (-1.1 - 3.5)

About 17% of occupational injuries were treated at home, and the rest were treated at a health facility. Most

common means of transport to the health facility was bus (87%). Median cost of treatment for last injury event was

Table 4. Cntd

Work activity		
Harvesting	46	55.5 (44.7 - 66.1)
Handling animals	26	31.3 (21.3 - 41.3)
Tilling	10	12 (5.0 - 19.0)
Driving tractor	1	1.2 (-1.1 - 3.5)
Injuries associated with loss of work days	20	24.1(14.9 - 33.3)
Cost of last injury (PKR) [‡]		Mean: 781, SD ±925 Median: 500, IQR 300-1000

¶ Continuous variable

£ Injury severity: Mild = Injuries requiring treatment at home or outpatient department, Moderate= Injuries requiring hospitalization or observation in hospital, Severe= Injuries affecting vitals or leading to disability

IQR: Inter Quartile Range

Table 5. Multivariable logistic regression analysis for factors associated with agricultural injuries among farmers in rural Hyderabad (n=472)

Variable	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age [£]	1.03(1.01 - 1.05)	0.002	1.03(1.01, 1.05)	0.012
Education				
Yes	Reference			
No	1.18 (0.62 - 2.25)	0.613	---	
House ownership				
Yes	Reference		Reference	
No	0.51 (0.29 - 0.91)	0.023	0.65 (0.36, 1.19)	0.161
House type				
Pakka	Reference			
Kacha	1.03 (0.50 - 2.12)	0.942	---	
Income				
More than 6000	Reference		Reference	
Less than 6000	1.72(0.84 - 3.48)	0.135	2.27(1.08, 4.76)	0.029
Animals at home				
No	Reference		Reference	
Yes	1.85(1.14 - 3.00)	0.012	1.55(0.90, 2.65)	0.111
Experience in agriculture (number of years) [¶]	1.00(0.99 - 1.01)	0.650	---	
Working hours [¶]	0.93(0.77 - 1.12)	0.453	---	
Number of tasks (per unit task)	0.80(0.59 - 1.09)	0.154	---	
Land area (working) [¶]	1.01(0.93 - 1.09)	0.870	---	
Type of crop				
Fixed	Reference		Reference	
Multiple	0.59 (0.36 - 0.99)	0.044	0.58 (0.34, 0.98)	0.042
Driving tractor				
No	Reference		Reference	
Yes	2.27(1.36 - 5.4)	0.005	2.58(1.25-5.33)	0.01

¶ Continuous variable

US\$ 5 (IQR 3-10) (PKRs 500, IQR 300-1000).

Table 5 reports the associated factors for agricultural injuries. Older age, less income and driving tractors were associated with occupational injuries, while working with multiple crops was protective.

Discussion

This study was one of the few attempts towards assessment of the burden of injuries among the agricultural workers in a developing country like Pakistan. Incidence of occupational injuries was found to be 35.0 per 100 workers per year. Most common type of injury was cuts (70%), and hand tools were most common agents (71%). More than half 55% of the injuries occurred during harvesting. Increasing age, low income, and tractor driving were found to be associated with risk factors.

The rate of occupational injuries among the agricultural workers was 35 per 100 workers per year. This rate was higher than reported for the general population of Pakistan in the national survey - the annual incidence of injuries was 4.59 per 100 persons per year (13). The calculated standardized morbidity ratio (SMR) was 7.6 for occu-

pational injuries for agricultural workers. This indicates that agricultural workers in Pakistan were at much higher risk of injuries. The rate of workplace injuries reported in the national survey of Pakistan was lower (0.61 per 100 workers per year) compared to our study estimates. A possible reason for this difference was the inclusion of all occupations and age groups over five years in the national survey compared to only adults in our survey. Children and older individuals are generally not working population. In addition, some of the occupations may have very low rates of injury. Furthermore, these estimates were more than 20 years old, and the injury rates may have increased over time (13).

There was a wide variation in the reported injury rates among agricultural workers in literature. The reasons for this variation relates to the level of mechanization of farming, injury definition and differences in study settings. The more mechanized farming lead to fewer injuries. Therefore, any comparison between rates of developed and developing countries should be made cautiously considering these factors.

Studies from developing countries reported higher rates of injuries among agricultural workers. Two studies from

China reported 12.2-16.5% occupational injuries among agricultural workers (11, 14). These estimates were lower compared to our study. A study from India also reported lower incidence rate of agricultural injuries (6.4 per 1000 workers per year) (15). Another study from India reported even further lower rates of occupational injuries among agricultural workers (0.8 per 1000 workers per year) (16). Nonetheless, these latter studies from India have captured more severe events of injuries, i.e. injury requiring 24 and 48 hours of activity restriction, respectively. Furthermore, these studies had longer recall period, which may have underestimated the injury events. The author also reported that there might be fear among farmers for the loss of job and that have led to under-reporting of injuries by the study participants (15). A study from Ethiopia showed a very high rate of injuries (78.3 per 100 workers per year) among agricultural workers (17). This study was conducted in state-owned farms where workers were compensated for injuries and could have over-reporting bias. Furthermore, this study used a broad definition and had included both major and minor injuries.

Developed countries, on the other hand, reported lower incidences of occupational agricultural injuries. A study from United States (US) reported agricultural injury rate of 9.3 per 100 workers per year among migrant workers (7). The reported rate of injuries among agricultural workers in Britain was 1.95 per 100 worker years (18). This might be due to mechanized farming, better occupational health services and training of workers compared to developing countries like Pakistan.

Our study found that hand tools were the most common agents (71%) of injuries, which was similar to studies conducted in India (67.7%) (19), Ethiopia (53%) (17) and China (50%) (14). The agent of injury depends on the agricultural practices. For example, in developed countries where most of the work was carried out by machines, hand tool contribute less to the injuries compared to machines. A study reported that in Alabama and Mississippi US among agricultural workers only 6% of the injuries were due to hand tools while machines and tractors caused 38% and 15% of the injuries, respectively (20). Our study found that injury rates due to hand tools and machines were higher than reported in other studies from India and UK (18, 19).

Injuries lead to temporary or permanent disability, therefore keeps worker away from performing the full activities. This loss of productivity has a bearing on workers as well as society. Millions of workdays were lost due to occupational injuries annually. A study on insurance compensation data reported that more than half a million work days lost due to occupational injuries alone in Brazil (21). However, this is an underestimation as not all the workers seek compensation from social insurance. A study from Ethiopia reported a total of 6153 work days lost in a sample of 810 participants (17). This is equivalent to 760 work days lost per 100 workers per year. We believe that this high rate of disability was due to higher rate of injuries reported in the current study. A previous study supports this relationship (19). There could also be an underestimation of workdays lost in our study. Agriculture

sector in Pakistan is mostly informal, and there is no social security for workers which may lead to an early resumption of work.

Since harvesting was mainly done manually using sharp tools, therefore, the risk of injuries was higher. Similar findings were reported by investigators from China and India (11, 15, 19). Cuts were the most common types of injuries (70%), followed by fractures (15.7%), bruise and sprain/twist, 6% each. Other studies have also found cuts as the most frequent type of injury, but the proportion of cuts in our study was higher compared to these studies (11, 15, 19). However, compared to the community-based studies, hospital-based studies reported fractures as the commonest type of injury. For example, a hospital-based study from India (22) reported that 50% of the injuries among agricultural workers who sought care from the hospital were fractures. Another hospital-based study from Turkey found that nearly 38% of the injuries were fractures (23). Our study found that hands, legs, and feet were commonly affected parts of the body. Similar findings have been reported by various investigators from different countries (11, 14, 17, 19, 20).

Different studies have shown association of injuries with age, experience in agriculture, animal handling, tractors and machines (14, 17, 20, 24-26). This study found that increasing age, low income, fixed type of crop and driving tractors were positively associated with the risk of injuries. Linear relationship of age with risk of injury in this study was consistent with the Rautiainen et al. 2009 (24). They reported that the risk of injury increased with age and this relationship was even stronger for serious injuries. Yiha et al. in 2010 (17) also reported that as compared to agricultural workers older than 30 years, younger workers were at lower risk of injuries in Ethiopia. Our study found that agricultural workers with lower income had significantly higher risk of injuries than those with high income. Xiang et al. 2000 (14) found that in China those farmers who have income less than 500 yen were at significantly higher risk of injuries than with income higher than this level. We found no significant association of injuries with animals at home of workers. This finding was consistent with a study from US (20), but other investigators have found significant associations of injuries with animals at home (24, 27). Our study found that those farmers who worked in farms with multiple crops were at significantly lower risk of injuries compared to those who worked with only one fixed crop. This finding contrasts with Rautiainen et al. study in 2009 (24). According to them, those who produce special crops or vegetables were at higher risk of injuries than those who produce cereals. This phenomenon was not well understood and needs further investigations.

Tractors were one of the major risk factors for injuries among agricultural workers across many studies (20, 24, 28-30). Our study also found that driving tractor significantly increased the risk of injuries. Investigators have suggested that interventions should focus on proper design of tractors.

Our study had several strengths. This was among the few community-based studies on injuries among farm

workers from a developing country. The study used a structured and validated questionnaire to collect comparable information. We used a standard definition of injuries used across different studies and in the national survey of Pakistan. However, some methodological limitations should be considered while interpreting the findings of this study. First, male participants over-represented in our study sample (96%). Due to feasibility, this study was conducted in the farm fields. Secondly, injury events for the last six months were recorded to minimize recall bias; however, this approach limited the scope to capture possible variations in injuries in different seasons. Although we did post hoc power calculations, the study was not powered for all the risk factors explored in this study and should be interpreted cautiously. Cross-sectional nature of the study also weakens our claims for risk factors studied. Based on these strengths and limitation, our estimates of injury burden are generalizable for adult agricultural workers in Pakistan and other similar developing countries.

Conclusion

There is a high burden of injuries among the agricultural workers in Pakistan. This study sets the foundation for further research in this area. Large-scale research studies are needed to further characterize the risk of injuries among the workers and develop preventive strategies so that health and productivity of this important occupational group can be protected.

Funding

This study was funded by the “International Training and Research in Environmental and Occupational Health in South Asia” (ITREOH). The funding was provided by the National Institutes of Health-Fogarty International Center (NIH-FIC). [Grant Number 5 D43TW05750].

Conflict of Interests

The authors declare that they have no competing interests.

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