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Occupational agricultural injuries among the preadolescent workers of West Bengal, India

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Abstract:
Introduction: Agricultural injuries are an important factor in mortality and morbidity for populations of preadolescents globally. Working preadolescents in agricultural sector are exposed to occupational risks and injury in India.
Objective: This study mainly assesses the nature of injuries among the preadolescent agricultural workers of West Bengal, India.
Methods: The survey was done by collecting the data on agricultural injuries from the Hooghly district of West Bengal. The injury data for 7 years between years 2010 and 2016 were collected by conducting a survey and personal interviews with the victims. The questionnaire-based approach was used for data collection information on the injury characteristics.
Results: The agricultural injury incident rate was 8.99 (male) and 7.89 (female) per 1000 workers/year. The leading causes of farm injuries were hand tools (65.7%). The most frequently involved tools were spades and sickles. The main cause of hand tool injuries was repetitive work, which lead to fatigue and slippage of hand tools from the hand. The study indicated that preadolescent workers are highly prone to injuries in their occupation, mostly affecting the toes (27.8% and 26.3%) and fingers (24.8% and 25%) in both male and female preadolescents, which consequently affected their health, productivity and work performance.
Conclusion: This study concludes that (1) agricultural injuries affecting different body parts such as toes, fingers, feet and ankles. (2) Occurrence of injuries was much higher among males than females. (3) Hand tools accounted for the majority of injuries followed by farm machinery. (4) Cut injuries are the main ones followed by lacerations, abrasions, sprains and contusions.

Keywords: agriculture, farm machineries, hand tools, injuries, preadolescent
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Introduction

Agriculture is one of the most important and oldest industries in India, one in which millions of workers suffered from work-related musculoskeletal disorders (WMSDs). Agricultural injuries are an important factor in mortality and morbidity for populations of preadolescents globally [1], [2]. According to the International Labor Organization (ILO) [3], approximately 218 million of the world's preadolescents aged 5–17 years old are in the workforce, and most of them are laboring in hazardous occupations [4]. According to the ILO, international standards dictate that children less than 15 years of age not be allowed to work and that those less than 18 years of age do not work in dangerous occupations [5]. In India, especially in West Bengal, preadolescents are mainly involved in agricultural work in rural areas due to their socio-economic disadvantage. Their poor socio-economic status, due to the poverty and unemployment of their parents, force the preadolescents into employment [6], [7].

Agriculture is more hazardous than most other industries. Agricultural activities cover many operations both manual and mechanical and include hoeing, digging, cutting, tending animals, driving tractors, applying pesticides and storing materials. Each activity has its risk to agriculture workers resulting in injuries and illness [8]. The most prominent injuries are severe cuts or bruising and loss of limbs. A recognized but less cited risk arises from poor work practices, for example, from repetitive actions or incorrect body posture, which can lead to a variety of disabilities [8], [9].

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Agriculture has been considered a hazardous industry due to the physically demanding manual material handling (MMH). Manual work may have a negative impact on the health and development of preadolescents [10], [11]. Nag et al., [12] suggested that the physical strain, fatigue, long working hours, and having inconsistent schedules may increase the risk of work-related injuries and illnesses. MMH is one of the main causes of agricultural injuries among farm workers [13]. Due to carrying heavy loads in agricultural fields, preadolescents are affected by physical strain, tiredness and fatigue which may lead to different types of injuries [14]. Injury remains the leading cause of death and disability among preadolescents worldwide [15], [16]. Previous studies have examined specific causes of preadolescent death involved in agricultural work and attributed many to agricultural machinery, especially tractors [17] and other hazards like snake bites and heat stroke [18], [19].

The main aims of this study were to survey agricultural injuries occurring from 2010 to 2016 in West Bengal to know their magnitude and severity. The other aim of the study was to assess the nature of injuries along with the causes of injuries as well as with the affected body parts due to injury among the preadolescent agricultural workers of West Bengal. This study was also undertaken to assess the rate, type of the injuries prevalent among preadolescent agricultural workers and whether these injuries affected the work performance of the preadolescents and their parents.

Materials and methods

Study population

The study population was selected randomly from villages near Tarakeswar in West Bengal. The selection was restricted to 10–16 year old boys and girls living in the rural area of the Hooghly district as in this age group (10–16 years) the preadolescents usually help their family members in their farm activities. Below this age group (10 years of age) preadolescents are not involved in agricultural activities due to physical as well as some ethical conditions. Preadolescent agricultural workers are mainly involved in different types of agricultural activities as a result of socio-economic disadvantages. Before conducting the survey written permission for the project was obtained from the Institutional Human Ethical Clearance Committee of the Indian Council of Medical Research Guidelines. In this study, a total of 788 preadolescent agricultural workers participated randomly and 123 preadolescent agricultural workers were found to be affected by injuries. The incident rate of injuries is (201/788) * 100 = 25.5%. A total of 121 and 80 injuries were found in preadolescent male and female farm workers, respectively, from the total 788 surveyed preadolescent farm workers.

The survey was done by collecting the data on agricultural injuries from four contiguous villages (Ichhaapur, Chowtara, Banna and Gopinagar) of the Hooghly district near Tarakeswar in West Bengal. The choice of the location was due to the availability of preadolescent farm workers in these areas. Tarakeswar and surrounding area of West Bengal, India is an agricultural sector, where thousands of farm workers are involved in agricultural work. Preadolescent farm workers are found along with their parents, helping their families who also work as daily low paid laborers. These four villages were chosen due to the availability of the preadolescent subjects, who are mainly involved in agricultural work especially in potato, rice, groundnut and jute cultivation.

The injury data for 7 years between years 2010 and 2016 were collected by conducting a survey and personal interviews with the victims. The questionnaire-based approach was used for data collection. The questionnaire contains detailed information on demographics and injury characteristics. The demographic information included gender, age and injury characteristics including the nature of the injury, the body part injured, and the type of tools and equipment that caused the injury.

The incident rate of injuries

The incident rate was calculated by the formula per 1000 workers as days active: $I = E/T$

where E = event or incidence, T = time/days active [20], [21], [22].

Statistical analysis

For statistical analysis of the quantitative variable results, under normal data distribution, one-way analysis of variance (ANOVA) was used to identify whether there is any significant difference, viz. between the occurrence of total injuries among the preadolescent male and preadolescent female agricultural workers. One-way ANOVA was also used to find the significant difference between the rate of injury incidence and affected body

parts through the study period among male and female preadolescent agricultural workers. Linear correlation, Spearman's rank order correlation and regressions were performed to explore the magnitude and direction of the association between the two variables, viz. the total number of injury incidents and workdays lost in both types of preadolescent agricultural workers in a year. Statistical analysis was performed using the statistical package Primer of Biostatistics (Primer of Biostatistics 5.0. MSI, Msi Version 1.20.1827.0, Primer for Windows, McGraw-Hill, USA).

Results

A total 201 agricultural injuries were recorded during the study period (2010–2016). Among the 201 agricultural injuries, 121 male and 80 female preadolescent agricultural workers were injured during the 7-year study period. It was observed (Table 1) that the occurrence of a total number of injuries was much higher among male than female agricultural workers. Table 2 represents the number of injuries along with the number of surveys, by which the incident rate of injuries has been found. Table 2 showed that female preadolescent agricultural workers have a higher incidence rate of injuries than male preadolescent agricultural workers. Table 3 represents how the injuries occurred during the study period among male and female preadolescent agricultural workers. From this study, it was observed that, among the total agricultural injuries, hand tools accounted for the biggest amount at 132 (65.7%) followed by farm machinery at 23 (11.4 %), heat stroke (10.4%), electrocution (7.5%) and snake bites (5.0%) were also other reasons for injuries.

Table 1: Injuries occur among male and female preadolescent agricultural workers.

Agricultural workers (n = 123)	Injury type	Number of incidents							Total			F-value[c]	Remarks
		2010	2011	2012	2013	2014	2015	2016					
Male (n = 75)	Minor[a]	16	18	14	15	12	12	16	103	121	201	35.02	$p < 0.001$
	Major[b]	3	2	4	3	4	1	1	18				
Female (n = 48)	Minor[a]	10	9	11	12	10	10	10	72	80			
	Major[b]	2	1	2	1	1	0	1	08				

[a]Minor injury denotes the injury which was treated at home. [b]Major injury denotes the injury was treated in hospital. [c]One-way ANOVA between total injuries which occurred among the preadolescent male and preadolescent female agricultural workers.

Table 2: Incident rate of injuries occur among male and female preadolescent agricultural workers.

Agricultural workers (n = 123)		**Incident rate of injuries**							**Total**	**F-value**	**p-Value**
		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**			
Male (n = 75)	No. of injuries	19 (31.7%)	20 (30.8%)	18 (28.6%)	18 (24.3%)	16 (21.3%)	13 (17.3%)	17 (22.6%)	121 (24.84%)	114.12	p < 0.001
	Incident rate										
	Surveyed	60	65	63	74	75	75	75	487		
Female (n = 48)	No. of injuries	12 (28.6%)	10 (25.0%)	13 (31.0%)	13 (28.3%)	11 (22.9%)	10 (25.0%)	11 (26.6%)	80 (26.57%)	307.44	p < 0.001
	Incident rate										
	Surveyed	42	40	42	46	48	40	43	301		

Table 3: Sources of injuries among male and female preadolescent agricultural workers.

Preadolescent agricultural workers (n = 123)	Sources of agriculture					Total injuries
	Hand tools	Farm machineries	Electrocution	Heat stroke	Snake bite	
Male (n = 75)	78 (64.5%)	12 (9.9%)	10 (8.3%)	15 (12.4%)	06 (4.9%)	121 (100%)
Female (n = 48)	54 (67.5%)	11 (13.8%)	05 (6.2%)	06 (7.5%)	04 (5.0%)	80 (100%)
Total injuries	132 (65.7%)	23 (11.4%)	15 (7.5%)	21 (10.4%)	10 (5.0%)	201 (100%)

Table 4 shows the body parts affected of the male and female preadolescent agricultural workers. Among the preadolescent agricultural workers, toes and fingers were most affected. Toes of 27.8% of the male and 26.3% of the female preadolescent agriculture workers were injured and fingers of the 24.8% male and 25% of the female workers were affected.

Table 4: Different body parts affected due to injuries among male and female preadolescent agricultural workers.

Agricultural workers (n = 123)	Body parts affected							
	Hand	Feet	Fingers	Toes	Wrist	Ankle	Lower back	Remarks
Male (n = 75)	16 (13.2%)	22 (18.2%)	30 (24.8%)	33 (27.8%)	02 (1.6%)	12 (9.9%)	06 (4.5%)	F = 22.6 Significant p < 0.05
Female (n = 48)	12 (15.0%)	18 (22.5%)	20 (25.0%)	21 (26.3%)	02 (2.5%)	06 (7.5%)	01 (1.2%)	F = 21.7 Significant p < 0.05

Of the 201 agricultural injuries among preadolescent agricultural workers, the predominant types of injuries (Table 5) were cuts (29.0% in male and 37.5% in female preadolescent agricultural workers) followed by lacerations (22.3% and 25.0%, repectively). Apart from these types, there are several other types of injuries such as abrasions, avulsions and sprains/strains and contusions, reported by male and female preadolescent agricultural workers. The annual incident rate (Table 6) among males was 8.99 and 7.89 in females. Table 7 suggests that there is a significant linear correlation between injuries occurring and working days lost among both male and female preadolescent agricultural workers.

Table 5: Type of injuries among the male and female preadolescent agricultural workers.

Type of injury	Male (n = 75)	Female (n = 48)
Cut	35 (29.0%)	30 (37.5%)
Laceration	27 (22.3%)	20 (25.0%)
Sprain and strain	20 (16.5%)	11 (13.8%)
Scratches/abrasion	16 (13.2%)	08 (10.0%)
Avulsion	12 (9.9%)	06 (7.5%)
Contusion	11 (9.1%)	05 (6.2%)

Table 6: Incident rates in male and female preadolescent agricultural workers.

Preadolescent agricultural workers	Male	Female
Incident rate I = E/T of injuries	8.99	7.89

I = E/T; I, incident; E, event or incidence; T, total working days in a year.

Table 7: Linear correlation between the total number of injuries and total working days lost among the preadolescent agricultural workers.

Preadolescent farmers	Total injuries in 7 years	Working days lost in 7 years	Linear correlation and regression	p-Value
Male	121	387	r = 0.695 t = 2.16 df = 5	p = 0.059
Female	80	256	r = 0.736 t = 2.43 df = 5	p = 0.082

Figure 1 represents the cause of injuries associated with different body parts. From this figure, it was revealed that slippage of hand tools is the main cause of injuries among male and female preadolescent agricultural workers. Neglect of safety precautions during threshing operations, unsafe conditions of electricity, heat stroke and snake bites are also important causative factors of injuries in the agricultural sector.

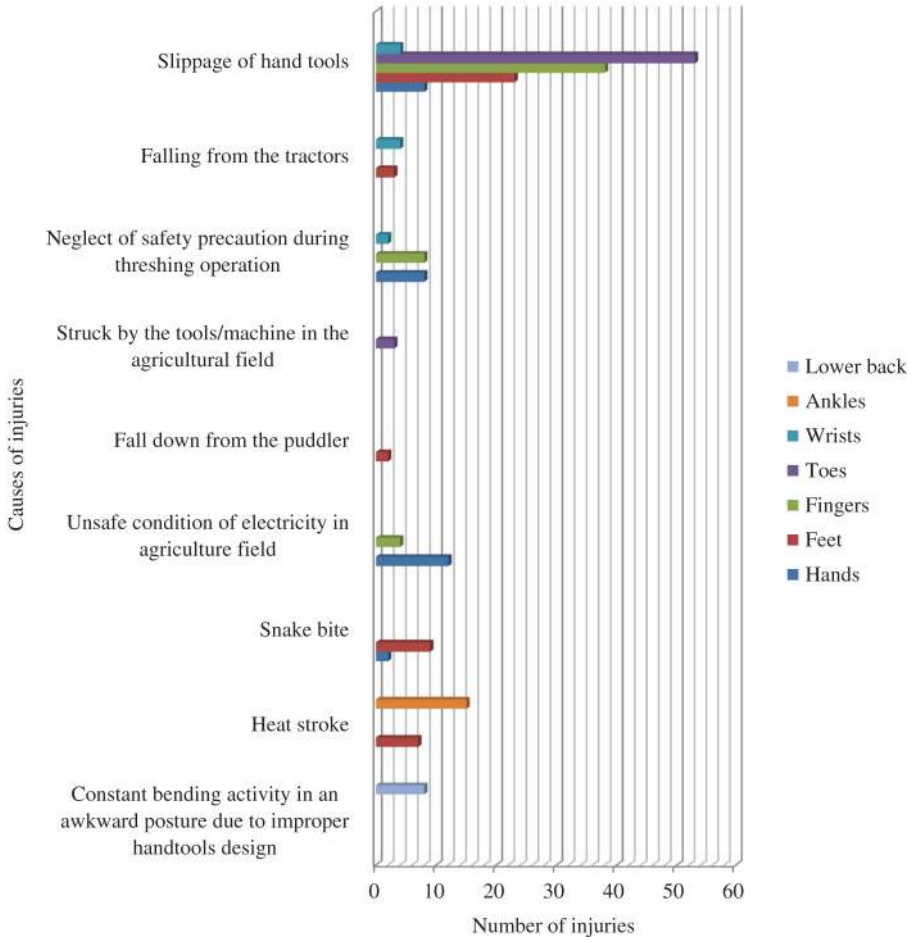

Figure 1: Causes of injuries associated with different body parts.

Figure 2 represents the number of injuries occuring with the association of different hand tools used in the agricultural sector. Among the hand tools, a spade was the most prevalent. Fifty-five percent of male and 44% of female preadolescent agricultural workers suffered from injuries due to performing agricultural activities with a spade, whereas 37% of male and 35% of female preadolescent agricultural workers suffered from injuries due to performing agricultural activities with a sickle.

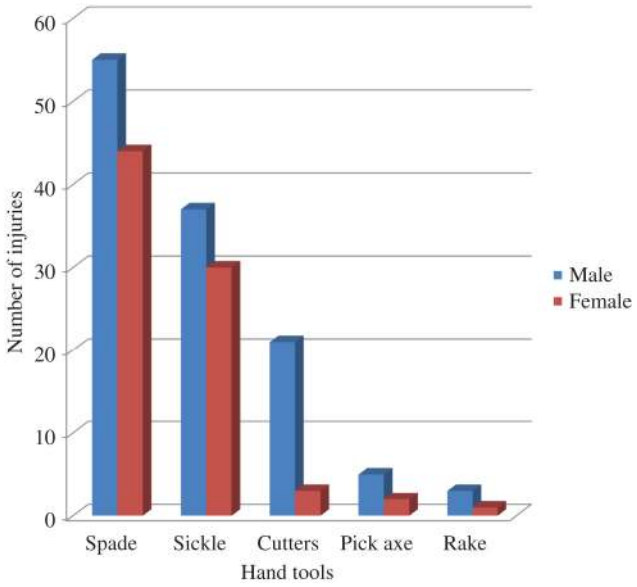

Figure 2: Type of hand tools involved in the causation of agricultural injuries among the male and female preadolescent agriculture workers.

Figure 3 mainly represents the number of injuries which occured associated with different farm machinery used in the agricultural sector. Among the farm machinery, thresher accidents were the highest among both genders (male = 42% and female = 55%). It was also observed (Figure 4) that a linear correlation exists between the total number of injuries and the work days lost in the case of both types of subject.

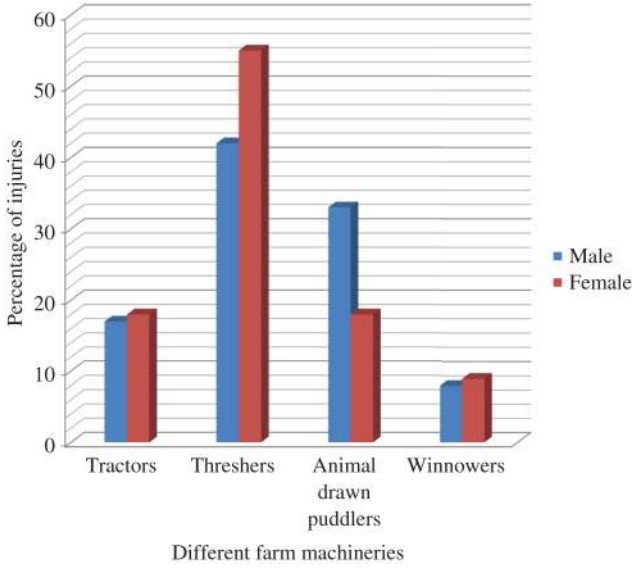

Figure 3: Type of farm machineries involved in the causation of agricultural injuries among the male and female preadolescent agriculture workers.

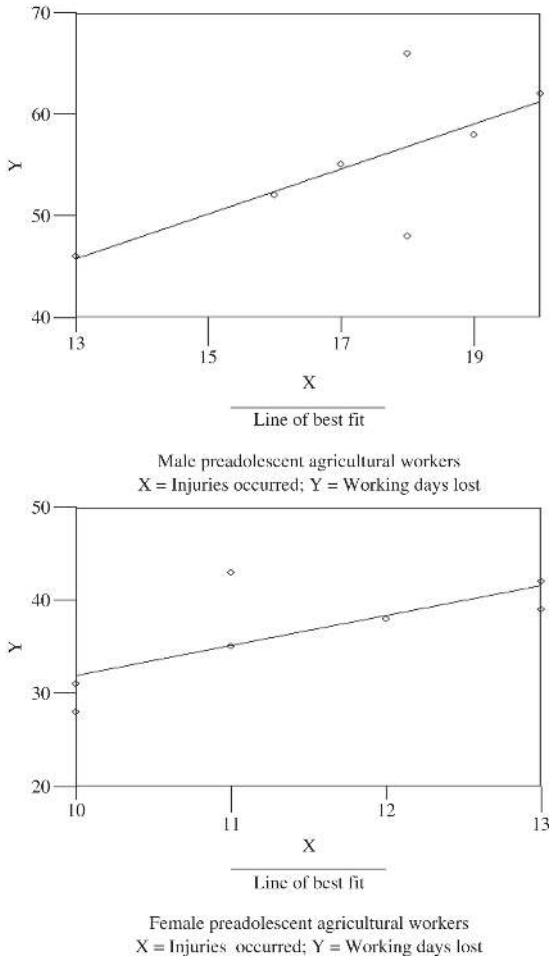

Figure 4: Linear regression between total injuries incidents and working days lost among male and female preadolescent agricultural workers.

Discussion

Agriculture is the most hazardous industry in India. Nearly half of all work-related fatalities among children occur in the agricultural sector [23]. Virtually all countries have restrictions in their laws and prohibitions against child or preadolescent labor [24]. In the present study, it can be observed that most of the work-related injury incidents occur, affecting different body parts, among preadolescent agricultural workers.

Several types of hand tools like spades, sickles, pickaxes and cutters are widely used in Indian agricultural fields. Spades are one of the most widely used hand tools in the agricultural sector and especially in potato cultivation. The short handle spade is widely used as an important hand tool during land preparation as well as to cover up the planted or sowed seeds and also during the last stage of potato cultivation; where it is used to keep the soil in the bottom part of the newly grown potato plants to promotes soil aeration. Slippage of sickles and spades from the hand due to profuse sweating while working in a hot and humid environment may be the major cause of cuts and avulsion-type injuries of the lower limbs. Das and Gangopadhyay [25] reported that among the agricultural injuries in children, the use of spades is a main cause. This result corroborates with the work of Das [22] and Kumar et al. [26]. According to them sickles and spades are the major hand tools by which the Indian farm workers are affected due to slippages of the tool from hand because of sweat or pain. The sharper end of the sickle also causes many cut injuries during crop harvesting among children. Litchfield and Xiang et al. [8], [27] also added that hoes and sickles are the main hand tools which are the main cause of agricultural injuries.

Farm machinery is an important contributor to the high rate of occupational injuries. In the agricultural field, tractors play a role in the agricultural injuries. During land preparation tractors are used to plow the fields. Preadolescents generally pick up the weeds from the agricultural field when preparing the land. These unsafe conditions can cause serious injuries among them. Preadolescent agricultural workers get injured while falling from tractors due to overturning of overloaded tractors while traveling in the agricultural fields. Sanderson et

al. [28] also claimed that overturning tractors produce the greatest number of agricultural machinery-related fatalities.

In the present investigation, it is also observed that male preadolescent agriculture workers are predominantly affected by the number of injuries more than female. This can be corroborated by the work of Dimich-Ward et al. [29]. According to them a greater number of male farm workers were injured particularly when farm machinery was involved. But this study also shows that the incidence rate of injuries differs between males and females. In the case of males, 121/487 * 100 = 24.84% and in the case of females, 80/301 * 100 = 26.57%. Females have a high incidence rate of injury most likely due to the tools used for the agricultural jobs as well as they become fatigued quickly due to having less muscular body development and the extra workload at home. This study also revealed that the incidence rate has significantly dropped over the years. This may be due to improved and modified hand tools and an increase of awareness from previous bitter experience.

This study also shows that toes and fingers are the most affected parts among the preadolescent agricultural workers. This result corroborates with the work of Kumar et al. [26]. According to them, feet and legs were the most frequently injured body parts due to these hand tools. This finding is supported by the observations of Litchfield [8] and Das [22]. According to them the most affected body parts among the farm workers are fingers, toes and the lower back. Das and Gangopadhyay [30] also found the same result among adult male potato cultivators.

In the present investigation, cuts and lacerations were identified as the commonest types of injuries. This result is supported by Kuye et al. [31]. They stated that the most common results of hand tools causing agricultural injuries were cuts and lacerations. Nag and Nag [18] stated that a maximum number of cuts and lacerations were identified due to a lack of proper ergonomically-designed hand tools for the farmers. Preadolescent farm workers generally used the hand tools (sickles, cutters and spades) used by the adults, they are unaware how to use those hand tools properly, which may lead to severe injuries (cuts and lacerations) while working in the fields. This study also showed that, despite both male and female preadolescent farm workers using the same tools, females had a higher incidence rate of injury compared with male preadolescent agriculture workers probably due to the strenuous nature of agricultural work as they become fatigued quickly due to having less muscular body development and their extra workload at home. Thus, it was observed that females are more prone to injuries according to the injuries incident rate than male preadolescent agricultural workers, who do the similar jobs.

Thresher accidents are another important farm machinery accident in which both male and female preadolescent agricultural workers are affected. Thresher injuries occur due to the neglect of safety precautions during the threshing operation. Fingers of the upper limbs are the most affected parts due to thresher injuries. Singh et al. [32] also stated that the upper limb is mostly affected part among the agricultural workers suffering from threshing injuries.

The use of electricity without following the proper safety rules has become a common phenomenon in the Indian agricultural sector. Consequently, this will become the source of major injuries among the preadolescent agricultural workers. According to Solomon [33], the most common reasons for fatal injuries in the agricultural sector is electrocution. Snake bite injuries in the agricultural field are the common occupational hazards in rural areas of India. This study also showed that the preadolescent agricultural workers suffered from snake bites injuries. This result corroborates with the work of Kulkarni and Anees [34]. They stated that a snake bite is a common medical emergency and an occupational hazard, more so in tropical India, where farming is a major source of employment. Four hundred and thirty-three males and 200 female preadolescent farmers were injured due to snake bites [18], [35].

From this study, it was observed that the annual injury incident rate among male and female preadolescent agricultural workers was 8.99 per 1000 workers per year and 7.89 per 1000 workers per year, respectively, which indicates the high magnitude of injuries. Prasanna and Dewangan [36] stated that the agricultural non-fatal accident incident rate was 6.39 per 1000 workers/year. Whereas Kumar et al. [26] suggested that 1700 injuries related to hand tools occurred per 100,000 farm workers in rural India.

Conclusion

The present investigation reveals that preadolescent agricultural workers are highly prone to injuries. As a consequence, they suffer from injuries affecting different body parts especially toes, fingers, feet and ankles, etc. This study also concluded that the number of occurrences of injuries was much higher among males but female preadolescent agricultural workers have a higher incidence rate of injury than males. This study reveals that among the total agricultural injuries, hand tools accounted for the majority of injuries followed by farm machinery. This study also concludes that among the injuries which occurred among the preadolescents, cut

injuries are the main ones followed by lacerations, abrasions, avulsions and sprains/strains and contusions. The injury incident rate among male and female preadolescent agricultural workers was 8.99 per 1000 workers per year and 7.89 per 1000 workers per year, respectively. This study also stated that the most frequently involved hand tool injuries were from spades. The cause of hand tools injuries were a repetition of work. Besides that, the hand tools were designed for adults, by using these hand tools the preadolescent become fatigued which leads to injuries.

Limitation of the study

There are some limitations to the study. These are first – due to the preadolescent labor act in India, the number of subjects (preadolescent agricultural workers) was limited in number in the agricultural field. Secondly – parents, co-workers in the field and neighbors of the preadolescent agricultural workers do not want to give information about the details of injuries due to the child labor act. They also encourage preadolescent workers not to give more information about their injuries. It is very hard to get the data for these types of studies. But after confirmation by the researcher that there is no risk to the farmers in giving the information, they agree to give injury data.

Recommendations

The following suggestion is made to improve the working condition of the workers –

1. First and foremost, to implement the laws to abolish in all forms preadolescent labor throughout the country.
2. The workload of the preadolescents should be reduced.
3. Proper ergonomically designed hand tools should be made for the preadolescent agricultural workers to reduce agricultural injuries.
4. The work periods should be modified; with more rest pauses scheduled in their work which may improve the efficiency of the workers.
5. Improving the awareness of the preadolescents about the use of hand tool and their safety when working.
6. Preadolescents must be forced to wear safe footwear to prevent the foot injuries when using spades.
7. As a strategy for preventing injury caused by farm machinery, intervention and research programs should be introduced.
8. The handles of hand tools are generally made up of wooden structures. There is no handgrips on the hand tools. Handgrips should be introduced to reduce the slippage of hand tools due to profuse sweating of palms during harvesting.
9. Electrical systems or equipment of high power lines used in the agricultural field must be covered and locked during work.
10. Gloves should be introduced to prevent the cut injury. The gloves can be made of soft leather or other soft flexible materials.

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