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Christopher Tougeron
University of Nebraska Medical Center

Chandran Achutan
University of Nebraska Medical Center

Kenesh Dzhusupov
International School of Medicine

Lorena Baccaglini
University of Nebraska Medical Center

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TITLE

Evaluating occupational hazards and personal protective equipment use on farms in Kyrgyzstan

CORRESPONDING AUTHOR

Dr. Chandran Achutan, PhD, CIH
College of Public Health
Department of Environmental, Agricultural & Occupational Health
University of Nebraska Medical Center
42nd and Emile, Omaha, Nebraska 68198, USA
402.559.8599
cachutan@unmc.edu

CO-AUTHORS

Christopher Tougeron
College of Public Health
Department of Environmental, Agricultural & Occupational Health
University of Nebraska Medical Center
Omaha, USA

Dr. Kenesh Dzhusupov, MD, PhD
Department of Public Health
International School of Medicine
Bishkek, Kyrgyzstan

Dr. Lorena Baccaglini, DDS, PhD
College of Public Health, Department of Epidemiology
University of Nebraska Medical Center
Omaha, USA

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ABSTRACT

Objectives – The purpose of this study was to identify occupational hazards and personal protective equipment use on farms operating in Kyrgyzstan.

Methods – We recruited 20 farmers in Kyrgyzstan. They completed a questionnaire and responded to interview questions to determine their occupational hazards, personal protective equipment use, and work-related injuries. We measured noise levels using the National Institute for Occupational Safety and Health sound level meter application for Apple iOS.

Results – Most farmers reported knowing how and when to use personal protective equipment, however 95 percent had not received training on how to use them. Observation of farmers revealed gaps in protective equipment use. Farmers reported workplace injury (15 percent) and one farmer reported time off due to the injury. Farmers reported suffering from one or more heat-related health symptom (30 percent). In six farms (30 percent), noise levels, originating from animal and equipment sources, exceeded 85 decibels on an A-weighted scale.

Conclusion – Farmers in Kyrgyzstan are potentially exposed to workplace hazards. While stated farmer knowledge of personal protective equipment use was high, the implementation of personal protective equipment appeared to be low. Providing low to no cost personal protective equipment along with training to farmers and their colleagues may be an effective strategy in reducing barriers to increase protective equipment use and reduce workplace injuries.

INTRODUCTION

Annually, global occupational injuries account for 340 million worker injuries and 2.3 million worker fatalities(1). The cost of occupational injuries is estimated to be between 1.8 percent and 6.0 percent of a country's total gross domestic product(1). To address occupational injuries countries have instituted occupational laws that aim to protect worker safety. In the United States the Federal Occupational Safety and Health Administration actively regulates and promotes worker safety protections through inspection and consultation services(2). However, agricultural operations with ten or fewer employees meeting the requirements found in 29 Code of Federal Regulations section 1928.21 are exempted from the Occupational Safety and Health Administration enforcement activities. The attention to and promotion of overall worker safety has led to worker injury rates dropping from 8.4 per 100 workers in 1994 to 2.8 per 100 workers in 2017(3). While the overall industry wide worker injury rate has fallen, agricultural worker injuries have consistently remained higher at 5.0 per 100 workers(3).

In Kyrgyzstan the adoption of worker protection laws by their Occupational Safety and Health Ministry has provided worker injury data in annual reports on injury rates per industry and types of injuries incurred by workers(9). In 2014, Kyrgyzstan had an industry-wide worker injury rate of 3.3 per 10,000(1). However, an independent investigation by the Solidarity Center American Federation of Labor and Congress of Industrial Organizations, revealed that the Kyrgyzstan Occupational Safety and Health Ministry did not report over 500 injuries in 2018 and may be under reporting additional workplace injuries(10). Additionally, the International Labor Organization stated that underreporting of workplace injuries in Kyrgyzstan is likely caused by three factors: (1) only worker injury data from union members is being reported; union members only make up 30 percent of the workforce;, (2) Kyrgyzstan occupational inspectors are only reporting 30 percent of all worker injuries; and (3) the reporting form requires minimal information indicating that one workplace injury counts as one incident regardless of the number of actual injuries(1).

Agricultural production accounts for one third of all global gross domestic product and employs 300-500 million people(1). When including non-paid work on small holding farms, the number of agricultural workers worldwide is estimated to be 1.3 billion(1). Annually the worldwide agriculture occupation results in an estimated 170,000 deaths and millions of injuries(4). The most common injuries/illnesses in agriculture include; slips, trips, falls, crush, skin conditions, cancer, vibrations, and amputations caused by machinery, animals, noise, chemical and dust exposures, and physical stresses(2,5). In Kyrgyzstan, agriculture makes up 20 percent of the nation’s gross domestic product and employees 30 percent of the country’s workforce(6). This is a significant change from 2000 where approximate 49 percent were employed in agriculture. The World Bank estimates that in 2016, 55 percent of land in Kyrgyzstan was used for agriculture(7) with 97 percent of all agricultural production being generated by small holding farms with 3-5 individuals actively working on farms averaging 2.7 hectares (6.6 acres) in size(6). According to the United Nations Food and Agricultural Organization

there is no worldwide consensus when defining small holding farms. The United Nations Food and Agricultural Organization specifies that a farm size less than 2 hectares is the determining factor(11). However, the World Bank includes a condition of having a low asset base in addition to the farm being less than 2 hectares(11). Farms in Kyrgyzstan predominantly grow potatoes, maize, sugar beets, and sunflower(8). Farming is largely non-mechanized in Kyrgyzstan and relies primarily on manual labor(6,7). According to the world bank, in 2000, there were 188 tractors per 100 square kilometers and later in 2009 the rate is still 188 tractors per 100 square kilometers(7). In contrast the neighboring country of Kazakhstan has 17 tractors per 100 square kilometers and Tajikistan has 310 tractors per 100 square kilometers(6,7). Overall, in high income countries the rate is 434 tractors per 100 square kilometers and in low income countries the rate is 26.8 tractors per 100 square kilometers(6,7).

To the best of our knowledge there are no scientific studies published in international peer-reviewed journals on agricultural health and safety issues in Kyrgyzstan. Our study addresses this paucity. The purpose of this study is to identify occupational hazards and personal protective equipment use on farms operating in Kyrgyzstan. Additionally, this study aims to set a foundation for additional research that characterizes and quantifies the health and safety hazards on farms in Kyrgyzstan and other developing countries.

METHODS

Study Design

In this cross-sectional study, we selected a convenience sample of 20 farms operating near Bishkek and Lake Issyk-Kul, in the Republic of Kyrgyzstan. We conducted this study over two weeks in June of 2019. Farms locations were recruited in several ways. Some farms were identified by community leaders and individuals knowledgeable in Kyrgyzstani farming activities; others were recruited by the researchers approaching the farms directly. At each farm, we identified a farm owner or manager who was at least 18 years old. After obtaining informed consent, we administered a questionnaire, followed by oral questions conversationally, and collected environmental noise measures. We compensated the study participants 700 Kyrgyzstani Com, which was equivalent to 10 United States Dollars. This study was approved by the Institutional Review Boards of the University of Nebraska Medical Center, Omaha Nebraska and the International School of Medicine, Bishkek Kyrgyzstan.

Questionnaire

We developed a 16-item questionnaire that was translated into Russian by the research team. The questionnaire sought to obtain the following information from farmers: their age range, number of years of farming experience, agricultural commodities produced, association with labor unions, personal protective equipment use and knowledge, knowledge of heat illnesses and prevention, and injuries occurring in the past six months. We also asked questions on farming practices, farm size, personal protective equipment use, pesticide use, other occupational exposures, and additional injury information such as the extent, type of injury, cause, duration of injury until recovered, time away from work, and if medical attention was sought and subsequently received.

Noise Sampling

One noise sample was obtained at each of the 20 farms, over a one-minute interval, from the highest perceived noise source observed by the researchers at the time of sampling. The noise levels were measured by the National Institute for Occupational Safety and Health Sound Level Meter application for Apple iPad products. The application was downloaded from the iTunes App Store onto an Apple iPad 9.7 model A1893. We used the National Institute for Occupational Safety and Health recommended exposure limit of 85 decibels as a threshold to identify noise sources that had the potential to damage hearing. For noise sources exceeding 85 decibels, the application produced an A-frequency weighted 8-hour time weighted average, as a percent dose where doses up to 100% are acceptable to human health.

Farm Descriptions

Farms 1-5 are part of the Kyrgyzstani Dungan Muslim community located in the village of Ken-Bulan. The Dungan community was hierarchical in structure with farming practices and crop plantings directed by the elder Iman of the community. The majority of the crops grown, cabbage and onions, were sold to local markets near Bishkek. In this community farms ranged from two to ten hectares and hired contractors for labor and equipment needs. Farm 5 diverged slightly from farms 1-4 by cultivating tomatoes under hoop houses for markets in Russia.

Farms 6-10 are part of the Kyrgyzstani community located in and around the village of Janyyjer. The farms ranged in size from three to 100 hectares growing vegetable crops, raising, animals and producing animal feed. The animal feed was used in raising their animals for markets in Kyrgyzstan and Kazakhstan. Farm 10 diverged from farms 6-9 by being associated with an agricultural school with six instructors. The school trains approximately 250 students annually in farming practices for the cultivation of vegetables, use of equipment, tractors, and the raising of animals. The School produced a wide array of crops for markets in Kyrgyzstan.

Farms 11-15 are part of the Kyrgyzstani community located in the foothills south and east of Bishkek. These farms produced agricultural products ranging from dairy cows, horses, oxen, sheep, animal feed, and fruit trees. Farms in this area ranged from 6 to 50 hectares, focusing primarily on the raising of animals for milk, meat, and riding. Farm 15 diverged from farms 11-14 by cultivating a wide variety of fruit trees.

Farms 16-20 are part of the Kyrgyzstani community located in the foothills north of Lake Issyk-kul. Farms in this area ranged from 0.5 to 14 hectares cultivating hay, clover, potatoes and raining sheep, cows, and horses. Farm 19 diverged from all other farms by stating they do not use pesticides.

RESULTS

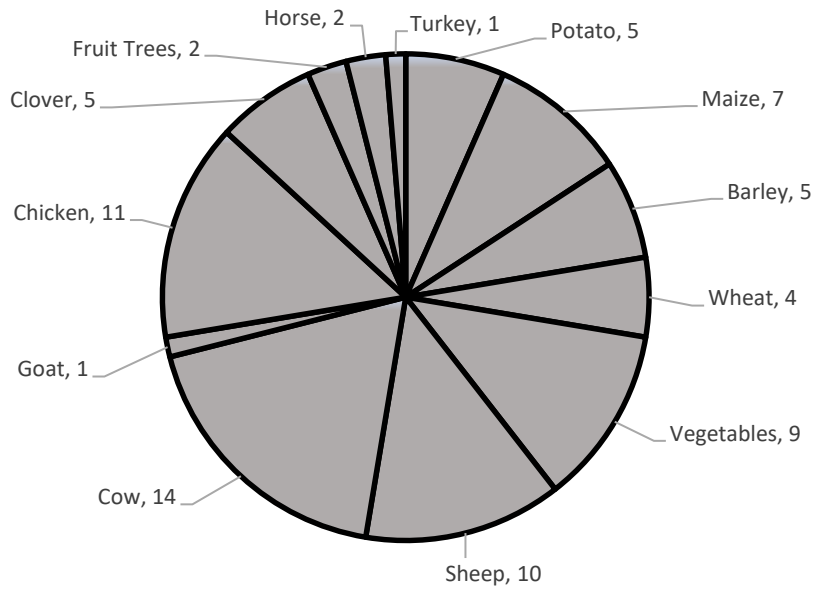
Table 1 summarizes study participant demographics.

Table 1. Demographics of study participants

	Number of Farmers (n=20)	Farm size hectares average (range)		Farming experience in average in years (range)	
Age					
18-34	7	6.6	(0.5-15)	7.7	(2-20)
35-54	7	14.7	(1.5-50)	13.3	(2-28)
55 and above	6	21.1	(1.5-100)	24.0	(14-35)
Gender					
Male	17				
Female	3				

Participants, age ranged from 18 to 65 years old and older. The farmers had an average farming work experience of 14. 5 years (range: 1.6-35 years) The average farm size sampled was approximately 14.6 hectares (range: 0.5-100 hectares). The farmers primarily cultivated vegetables and raised livestock (Figure 1). Most farmers (75%), produced more than one commodity. None of the farmers indicated that they were associated with a labor organization.

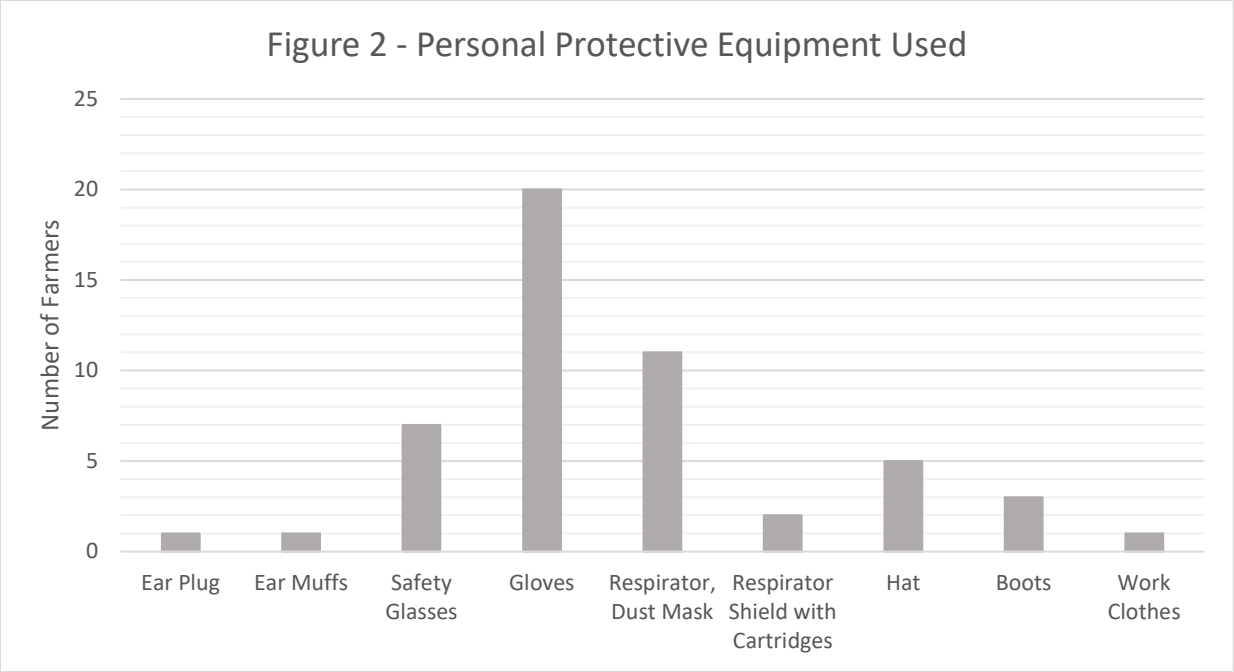
Figure 1 - Number of farms growing agricultural products



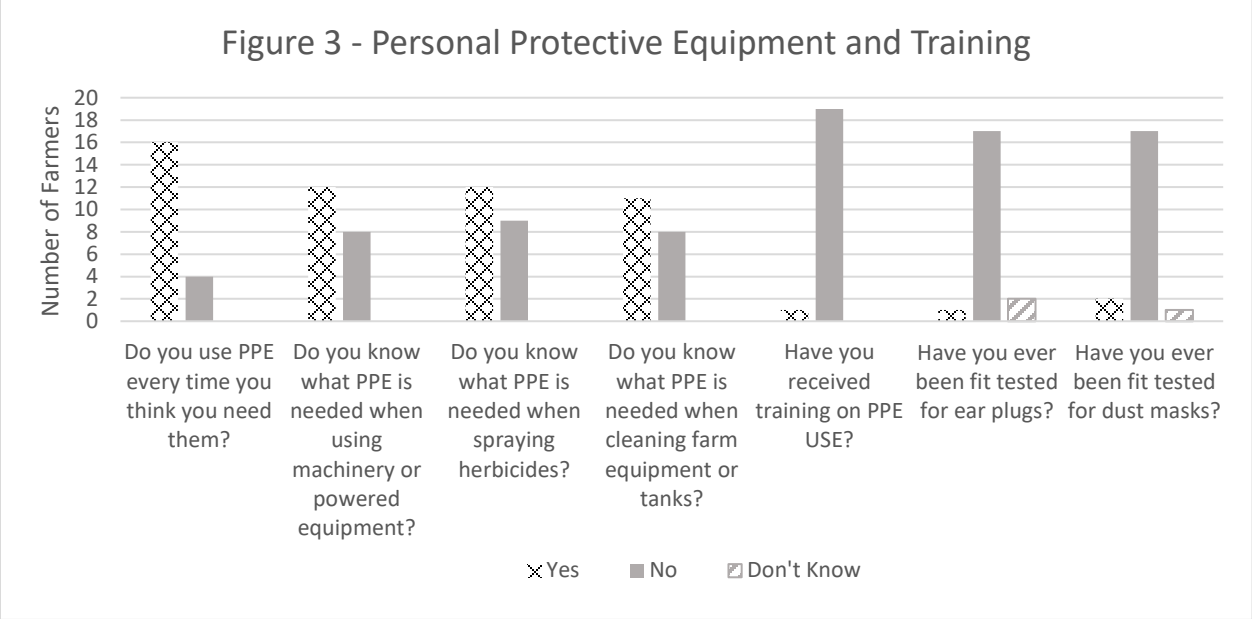
All farmers indicated during the interview that they utilized contracted manual labor for at least one of the following activities: planting, harvesting, and application of pesticides. The contracted labor was responsible to bring their own safety equipment; such as long sleeves, hat, gloves, and shoes. In most cases, the farmers provided the tools and drinking water for the contracted labor to use.

Personal Protective Equipment

Ninety percent of farmers use personal protective equipment; however, 95 percent of farmers also reported that they had not received training on how to use them. One farmer reported being fit tested for ear plugs and 2 farmers reported being fit tested for wearing a dust mask. Furthermore, all farmers reporting wearing gloves when working in the fields. Figure 2 represents the farmers personal protective equipment use.



Out of the 20 farmers, 80 percent stated that they use personal protective equipment every time they needed them. Farmers reported not knowing what personal protective equipment to use when working on machinery (40 percent), spraying herbicides (30 percent), and cleaning equipment / tanks (50 percent). Figure 3 represents the farmers' personal protective equipment knowledge for specific work-related tasks.



Heat Illness

Farmers reported that when working in warm or hot conditions; they wore a hat or head covering (95 percent), took multiple breaks (80 percent), used shade when taking breaks (90 percent), wore long sleeves (70 percent), and drank water / liquids (95 percent). None of the farmers had received training on heat illness prevention techniques or measures. When working in warm or hot conditions, farmers reported experiencing hot and dry skin with no sweating (n=2), high body temperature (n=6), seizure (one farmer), headache (one farmer), and nose bleeding (one farmer). A farmer indicated that several contract workers went to the hospital after working in hot weather with heat illness related symptoms; however, no further information on the extent of these injuries was known.

Injuries

Three farmers reported having a work-related injury, with one reporting an injury that resulted in time off work for four days. Anecdotal evidence suggests that injuries, unless debilitating, are a common occurrence but do not result in time off work. One farmer stated that he continued to work with a broken arm, the farmer further indicating that there was work to be done that could not wait for a full recovery. While conducting the interview a farm worker reported a severe reaction to dust created by ground up animal feed, although they did not seek medical attention and continued to work regardless of the discomfort. Ninety percent of farmers had not received training on injury prevention.

Pesticide Use

Farmers reported using pesticides throughout the growing season. Three sampling locations had pesticides onsite for visual review by the research team. The pesticides observed onsite were pyrethroid and synthetic pyrethroid based insecticides; Orphan 10.5 %, Lambda, Karate, and Polytrin. In 19 sampling locations, the farmers indicated that they contracted out the application of fertilizers and pesticides. The farmers purchased the appropriate pesticide after consultation with a pesticide seller. The farmer then provided the pesticide to the contracted applicator. At one farm location the farmer did not use a pesticide contractor and stated that their workers applied pesticides based on the farmer's instruction. During an onsite farm visit the researchers observed one worker applying pesticides with a backpack sprayer. The worker wore; a hat, long sleeve shirt, blue jeans, but was not wearing gloves or a respirator. The farmer did not recall what pesticide was being applied to the crops. In another instance, a farmer indicated that a contracted pesticide applicator was consistently ill after spraying pesticides and stated that the pesticide applicator sought medical attention on several occasions.

Noise

The 20 noise sampling events contained sources that included one of the following; ambient background noise, intermittent noise from animals, noise from tractors, and noise from feed grinding equipment. Out of the 20 sampling events, 14 noise level samples were below 85 decibel (dBA) and excluded from table 2. Out of the six that exceeded the 85 dBA threshold, two originated from animals, one from a feed grinder, and three from tractors. Table 2 summarizes the noise sources for sampling events above 85 dBA.

Table 2. Noise sources at or above 85 dBA observed on farms

	Noise Level	Projected Dose
	Max dBA	8 hour
Noise Sources		
Farm #7 Animal	89.2	2.1%
Farm #9 Animal	89.8	6.4%
Farm #9 Feed Grinder	97.6	1189.6%
Farm #16 Tractor	87.2	0.5%
Farm #19 Tractor	87.5	1.5%
Farm #20 Tractor	87.3	10.3%

Farmers raising cows or oxen generated intermittent impact noise when the animals wearing metal chains or halters came into contact with metal feeding troughs in animal pens. Impact noises were 89.2 dBA at Farm 7 and 89.8 dBA at Farm 9.

Three farmers stated they used a feed grinder to turn corn into animal feed generated high levels of noise. On one farm, the feed grinder had a noise level of 97.6 dBA when it was operated. The noise level obtained from the grinder resulted in a projected noise exposure dose of 1189.6 percent for an 8-hour work day. According to the farmers, the grinders were normally operated only when needed; one farm stated that the grinder was operated for two hours every day.

Tractors operated by farmers or contractors are sources of loud noise for both the tractor operator and those working near the tractor. In three farms, tractors generated noise that exceeded 85 dBA. The noise exposures (and the percentage projected noise doses for 8 hours) were 87.2 dBA (0.5%), 87.5 (1.5%), and 87.3 (10.3%).

Although the noise levels were high, we were not able to ascertain a time-weighted average without conducting noise dosimetry.

DISCUSSION

Farming size in Kyrgyzstan did not correspond to the United Nations Food and Agricultural Organization or World Bank's small holding farm definition. As a result, all farm sizes were included in this study without excluding the farms solely based on hectare size.

Farmers reported high usage of personal protective equipment; however, they have not received training on how to use them, possibly creating gaps in protective equipment use. Farmers are potentially being exposed to workplace hazards such as noise, animals, tools, and heat; as evident by the number of workplace injuries over the past 6 months, injuries are a concern for these farmers.

With the farmers reporting high personal protective equipment use every time they think it was needed and our onsite observations; we found inconsistencies between the reported and actual use. The inconsistencies may arise from the definition of personal protective equipment or selective pressures between the farmers and researcher. In each instance this may have resulted in under or over reporting of farmer knowledge and use of protective equipment.

Factors creating barriers to personal protective equipment use can include; perceived effectiveness of equipment, perception of health risks, appropriate training, perceived social acceptance, risk accepting personality traits, and equipment costs(12,14,15). Personal protective equipment training that increases farmer knowledge has been shown to be effective in increasing protective equipment use(13). By including farmers and their colleagues in education and training, along with local authorities providing no cost or low cost personal protective equipment, will begin to address the barriers associated with the low use of personal protective equipment use(14).

With the high number of farmers reportedly using heat prevention techniques and still suffered from heat illness symptoms; a divergence may be occurring between effective prevention techniques and reductions in heat symptoms. Farmers working during warm or hot conditions are at a higher risk for traumatic injures(16). Additionally, workers who are paid an hourly wage are less likely to experience a heat illness related symptom than those that are paid by the piece(17). To reduce the incidence of heat related illnesses effective training techniques and changes in workplace practices have been shown to reduce the number of illnesses workers receive(16,17). With the potential increased risk for traumatic injury while working in warm conditions, effective training, changes to workplace practices, and determining the prevention and injury gaps for Kyrgyz farmers may help in reducing the possibility of workplace injuries.

Farmers using contracted labor to perform farm related work tasks relating to; planting, weeding, watering, and harvesting by utilizing hand tools such as; shovels, hoes, and sickles have limited information on injuries occurring to contracted workers. With all

farmers reporting no association with farm labor unions there was low probability that injury information was reported to the Kyrgyzstani Health Ministry(2,3).

Agriculture workplace injuries continue to have a higher incidence rate than that of other industry(3,12,18). In the United States agricultural injuries leading the highest injury rate are caused by machinery, falls, and animals which result in bone fractures, spinal cord injuries, and damage to internal organs(19). In other countries such as India agricultural injuries are predominantly caused by farm hand tools such as spades, sickles, and axes(18). Increasing the use of personal protective equipment with continual ergonomic training when using hand tools can be advantageous to reduce occupational injuries in India and Argentina(18,19,20). In Kyrgyzstan where farmers were observed wearing open toes shoes performing work with hand tools would likely benefit from training in personal protective equipment and the safe use of hand tools. Additionally, accurate reporting of workplace injuries could focus the development of workplace training activities tailored to benefit the Kyrgyzstani farmers.

Pesticide use in the sampled farms was mainly conducted through contracted applicators. Based on farmers statements they routinely do not apply pesticides; however, they handle pesticides from store to farm and can be potentially exposed during and after application. Pesticide handling and application continue to be the cause of negative health consequences for farmers(21). Training and the proper use of personal protective equipment has been shown to reduce pesticide exposures in farmers(21,22). Although the majority of Kyrgyzstani farmers use contractors to apply pesticides the farmers have the potential to come into contact with pesticides. Additionally, on one farm during a pesticide application there appeared to be inadequate use of personal protective equipment. Training farmers may improve personal protective equipment use and improve overall safe pesticide practices(21,22).

Agricultural noise generated from a wide array of sources; tractors, animals, firearms, striking metal objects, and equipment can result in noise exposures above the National Institute for Occupational Safety and Health Recommended Exposure Limit of 85 dBA(23). Noise induced hearing is a common injury in agriculture that is entirely preventable(24). Noise levels on the six sampled farms exceeded 85 dBA creating a potential for noise-induced hearing loss. An Australian study determined that over half of all noise exposures on farms exceed the recommended exposure limit and could result in noise induced hearing loss(23,24).

The sampled feed grinder noise level of 97.6 dBA was higher than those found on a farm in the United States where a feed grinder generated noise levels less than 85 dBA(25). Additionally, sampled tractor noise levels of 87 dBA and the impact noise of 89 dBA from animals on the sampled farms were similar to those found in Turkey and Australia which ranged from 72-99 dBA and 75-90 dBA, respectively(26,27). However, we can only infer about the comparison as we did not obtain the specific make and models of the equipment.

In the six farms where high noise levels were observed, hearing protection was not being utilized. Hearing protection use by farmers in the United States has been shown to be around 27.5 percent(28). Barriers limiting the use of hearing protection such as; perceived use, availability, and accessibility have been identified as the likely cause of low hearing protection use(28,29). Similar to the barriers for other types of personal protective equipment; improving hearing protection usage in farmers should involve education, training, and improving accessibility by providing reduced or no cost hearing protection(14,28,30).

Conclusion

Farmers in Kyrgyzstan are potentially exposed to workplace hazards. Although this study may not represent all farming in Kyrgyzstan or West Asia; the hazards, personal protective equipment use, and injuries identified warrant further investigation to accurately describe the current working conditions on farms in Kyrgyzstan. The identified hazards bear some similarities with other countries specific; workplace practices unique to Kyrgyzstan need further research to develop effective strategies to reduce hazard risk. Providing training and low to no cost personal protective equipment to farmers is an effective strategy to reduce workplace injuries, additional strategies using hierarchy of controls should be considered as well.

Strengths

This study has several strengths.

This study begins to address the workplace hazards, injuries, and personal protective equipment use for farmers in Kyrgyzstan that, based on official reporting data, was widely unknown. Use of this initial data will allow public health entities to develop strategies to address workplace hazards.

The data found in this study describes current farming activities in Kyrgyzstan allowing for benchmark comparisons when ascertaining the effectiveness of prevention measures.

This study begins to fill a gap in the overall lack of available data for workplace hazards, injuries, and personal protective equipment use for farmers in West Asian countries.

Limitations

This study has several limitations.

The convenience sampling and small sampling size for this cross-sectional study limits our ability to compare and generalize out findings for farms throughout Kyrgyzstan and other central Asian countries.

There may be differences in the understanding between the farmers, the written questionnaire, and research team. There was a concern that the farmers may have

overestimated their answers due to their interpretation of the questionnaire or selection bias that was unintentionally placed upon them by a perceived position of authority of the research team.

The farmers limited knowledge of workplace injuries occurring to the hired contracted workers may have prevented us from identifying additional workplace injuries; limiting our understanding of the injury types and severity.

Noise levels obtained from the Sound Level Meter application indicates that farms in Kyrgyzstan had the potential for loud noises. The application is used "to make quick spot measurements to determine if noise levels exist in a workplace that can harm workers' hearing"(31) and not for determining an exposure. Additionally, we did not calibrate the iPad's microphone and did not validate the data with another sound level meter.

Future Implications

Due to the high percentages of farmers indicating that they use personal protective equipment and the lack of personal protective equipment on the farms it was unclear if personal protective equipment was being used. Further investigation is needed to determine the inconsistency as a more thorough evaluation is necessary to determine personal protective equipment use.

Our limited ability to identify the extent of injuries for contracted labor leaves a gap when determining agriculture injuries in Kyrgyzstan. Research is needed to determine the rate, type, and severity of injuries for the contracted laborers.

Effective educational training strategies in personal protective equipment use that reduces hazards will need to be implemented to improve the potentially hazardous working conditions on farms in Kyrgyzstan.

The collection of accurate reliable injury data will help to identify specific farm hazards and preventative measures unique to Kyrgyzstan.

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Conflict of Interest

The authors have no conflict of interest in this research study.

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