Nonfatal work-related injuries among agricultural machinery operators in northern China: A cross-sectional study

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A R T I C L E I N F O

A B S T R A C T

Purpose: To identify the annual prevalence and potential risk factors of nonfatal agricultural machinery injuries among agricultural machinery operators in the northern areas of China.
Methods: A quota sampling method was used to study 1921 agricultural machinery operators in 5 provinces in northern China. Agricultural machinery injuries that occurred between July 1, 2008, and June 30, 2009 were investigated. Data on nonfatal injuries and related factors were obtained by in-person interviews.
Results: The prevalence of agricultural machinery-related injuries among the surveyed operators was 13.1%. Being male, having lower family income and/or poor hearing, being in debt, and feeling stressed were five significant risk factors for injuries. The majority of injuries took place on farmlands (46.6%), roads (26.3%), or in backyards (17.5%). The four most common causes of injuries were being stuck by starting handles that slipped, being slashed or stabbed by sharp objects, being struck by falling objects, and falls from stationary vehicles.
Conclusions: The prevalence of agricultural machinery-related injuries in our study was high. Males, low family income, poor hearing, and stress were associated with high risk of injury occurrence.

Introduction

As the most populated country in the world, agriculture is one of the most important national economic sectors in China. With rapid economic development and industrialisation, the mode of agricultural production has been changing from manual into mechanised production in China. The proportion of agricultural production using mechanisation increased from 36% in 2006 to 52% in 2010 [1].

Therefore, agriculture machinery is receiving increased attention from various researchers, and study efforts have focused on machinery design, utilisation, and maintenance [2–4]. Unfortunately, researchers, public health professionals, and the government in China have neglected to assess agriculture machinery-related injuries. Few investigations of this important public health issue among the 800 million Chinese farmers have been conducted. The prevalence and characteristics of these injuries are unknown. In contrast, many studies on agriculture machinery-related injuries have been conducted in developed and other developing countries [5–9]. A report from Canada indicated that almost half of all agricultural fatalities were due to machine-related causes. Additionally, on Canadian farms, machine-related injuries were also the leading cause of injuries requiring hospitalisation [5], which is consistent with studies in the United States that estimated that agricultural machines account for between 18% and 35% of all non-fatal farm injures [6]. Indian researchers have reported that the increased use of farm machinery has increased occupational health hazards on farms [10]. These studies suggest that agricultural machinery is dangerous and that related injuries are a serious public health issue among agricultural workers.

Considering that the agricultural machinery-related injury rate is high in many countries and the rapid increase in agricultural mechanisation in China, we hypothesise that the agricultural

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machinery-related injury rate might be high in China. To our knowledge, studies of agricultural machinery-related injury are rare in China. Thus, we conducted an epidemiological study to estimate the prevalence and characteristics of agricultural machinery-related injuries and investigated potential risk factors among agricultural machinery operators in northern China, the primary agricultural region in which agricultural machinery are widely used.

Methods

Study design

This was a cross sectional study using purposive sampling to select 5 provinces (Heilongjiang, Shanxi, Hebei, Henan, and Shandong) in northern China. From each province, 2 counties with middle income and 5 villages from each county with middle income were selected. All machinery operators in the selected villages were screened for eligibility. Eligibility criteria included the following: living in a farming area; owning at least one type of agricultural machinery; and having used agricultural machines for at least one year.

The interviewers, with the help of village leaders, conducted face-to-face interviews with eligible machinery operators. The data collection was conducted either in farmers' homes or at farm workplaces between August and November 2009.

Definition of machinery injuries

Agricultural machinery-related injuries were defined as injuries that occurred during agricultural activities involving agricultural machinery between July 1, 2008, and June 30, 2009, that resulted in a reduction of usual activities for at least half a day or required professional medical treatment, having been diagnosed with an impairment, or receiving emergency nursing care from family, colleagues, teachers, or partners. Injuries occurring during travel that was unrelated to farm work or chores or injuries unrelated to agricultural machinery were excluded. For operators who had several injuries during the study time period, we analysed only the most serious injury.

Instruments

The questionnaire was developed by our research team and was pilot tested among 100 machinery operators in these five provinces. The final questionnaire contained detailed information on the demographic characteristics, self-perceived health status, annual family income, self perceived stress, psychological status, work tasks, machinery exposures, and non-fatal work-related injuries. The information on injury characteristics included the following: nature of the injury, body part injured, place that the injury occurred, external causes of injury, type of machine that caused the injury, month the injury occurred, whether the injury required medical attention, medical costs, prognosis, and days of restricted activity due to the injury. The personal demographics collected included age, gender, marital status, average annual income per family, and education. Marital status was classified into three groups (never married, married, and divorced/widowed). Average annual income per family was divided into 3 groups (less than 1000 Yuan, 1000 to 2000 Yuan, and more than 2000 Yuan). Education was divided into 5 categories (college or above, senior high school or secondary vocational technical school, junior high school, primary school, and illiterate).

To measure health status, our questionnaire asked self-perceived visual acuity, self-perceived hearing acuity, sleep disorders (whether they had sleep disorders and whether they were sleepy during the day), selected diseases (arthritis, rheumatism, heart disease, hypertension, and asthma), and consumption of alcohol and tobacco in the past year. Daytime sleepiness was assessed by the Epworth Sleepiness Scale [11]. Hazardous and harmful alcohol use was identified by CAGE (Cut down, Annoyed, Guilty, Eye-open) questions [12].

Data regarding machinery operation included years of operating equipment, specific education and training about safe operation of the equipment, frequency of machine maintenance, and use of any protective equipment.

The Center for Epidemiologic Studies Short Depression Scale-10 question scale (CES-D 10) and Perceived Stress Scale 4 question scale (PSS-4) were used to measure depression and stress, respectively [13,14]. Additionally, self-perceived satisfaction with household income and debt in the past year were also investigated.

Quality control

In August 2009, 11 students from the School of Public Health of Tongji Medical College, 4 students and staff from Qiqihar Medical College, 8 students and staff from Shandong Traditional Chinese Medicine University, and 2 retired health staff from Puyang City, Henan Province, were trained as interviewers for this project. The contents of training included general information about the study, how to contact village leaders, interview techniques for obtaining questionnaire data from machine operators, and quality control of the data collection procedures.

To verify the validity of the data collected, we randomly selected 5% of the total sample for repeat interviews by telephone.

Statistical analysis

Both SPSS 12.0 and SAS 9.1 were used for the data analysis. The unit for analysis was the individual machine operator, regardless of the number of injuries the farmer reported. We analysed the data in three steps. First, we described the demographic characteristics of the sample including gender, age, education, marital status, and average annual income. Second, the crude annual prevalence of agricultural machinery-related injuries was calculated as was the prevalence by demographic characteristics, health status including visual acuity, hearing acuity, sleep disorders, related diseases, smoking and drinking status, machine operation, and perceived stress. Third, the unadjusted odds ratios and 95% confidence intervals were computed using univariate logistic regression analyses. Adjusted odds ratios with 95% confidence intervals were calculated using a multivariate logistic regression analysis by including all the potential risk factors in the model. Finally, we described the characteristics of the injuries with regard to the external cause of injury, body part injured, injury type, machinery causing the injury, and the month the injury occurred.

For all comparisons, differences were tested using a two-tailed test, and P values < 0.05 were considered statistically significant.

Ethical considerations/statements

Our study protocol was reviewed and approved by the IRBs of the School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, and Colorado State University. Verbal consent was obtained from the machinery operators.

Results

A total of 1921 agricultural machinery operators participated in the survey. The overall response rate for the survey was 96.6%. Of the total sample, 97 agricultural machinery operators were selected in our telephone validation of interview data, and 87