Published in final edited form as:

Injury. 2014 March ; 45(3): 599–604. doi:10.1016/j.injury.2013.07.004.

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

Lei Zheng^{a,d}, Na Zhao^a, Dingyan Chen^{a,e}, Meirong Hu^a, Xianghua Fu^a, Lorann Stallones^b, Huiyun Xiang^c, and Zengzhen Wang^{a,*}

Lei Zheng: mastjmu2l@gmail.com; Na Zhao: zn0794@163.com; Dingyan Chen: chendyan@gmail.com; Meirong Hu: mymy1212@163.com; Xianghua Fu: fuxianghua202@sina.com; Lorann Stallones: Lorann.Stallones@ColoState.EDU; Huiyun Xiang: Huiyun.Xiang@nationwidechildrens.org; Zengzhen Wang: wzzh@mails.tjmu.edu.cn

^aDepartment of Epidemiology and Health Statistics, School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, China

^bColorado Injury Control Research Center, Department of Psychology, Colorado State University, Fort Collins, CO 80526, USA

^cCenter for Injury Research & Policy, Columbus Children's Research Institute, Columbus, OH 43205, USA

^dAnhui Institute of Geriatrics, Ma Anshan 243011, China

^eShenzhen Center for Disease Control and Prevention, Shenzhen 518055, China

Abstract

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.

Keywords

Agricultural workers; Occupational; Injuries; China

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 injuries [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 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 participated, yielding a return response rate of 89.7%. The injury rate reported in the repeat interviews was 13.8%, which is similar to the rate of the total sample (13.1%).

Demographics of the study sample

A majority of agricultural machinery operators were male (89.9%), married (90.5%), and reported a low education level (81.8%). The mean age was 38 years, and nearly half of the respondents (48.3%) had an annual income per family member of less than 2000 Yuan.

Injury prevalence

The overall annual prevalence of agricultural machinery-related injuries among the operators was 13.1 per 100 workers. Table 1 shows the crude injury prevalence was significantly higher among males (13.9%) and among those with low family income (23.5% for <1000 Yuan). By age, the highest injury prevalence was among those 30–39 years (14.6%). Table 2 shows the injury prevalence among those who regularly had difficulty sleeping (19.8%), reported being sleepy (21.9%), or had chronic diseases (17.6%) were significantly higher than those who did not have these characteristics. As shown in Table 3, the injury prevalence rates among those who smoked during machinery operation (15.5%), drank beer or wine during the previous month (14.5%), who were dissatisfied with their family income (14.7%), who had current debt (20.6%), and who suffered significant life stress (21.3%) were significantly higher compared to those who did not have these habits or life circumstances.

Risk factors for agricultural machinery-related injuries

Table 4 presents the unadjusted and adjusted ORs and 95% confidence intervals of selected risk factors for agricultural machinery-related injuries. The results of the logistic regression analyses indicated that operators with the following factors were significantly more likely to suffer agricultural machinery injuries: males (males vs. females, adjusted OR = 3.58, 95% CI: 1.56–8.23), low family income (<1000 Yuan vs. >2000 Yuan, adjusted OR = 2.09, 95% CI: 1.27–3.45; 1000–2000 Yuan vs. >2000 Yuan, adjusted OR = 1.59, 95% CI: 1.12–2.24), poor hearing (poor vs. good, adjusted OR = 3.25, 95% CI: 2.08–5.09), current debt (yes vs. no, adjusted OR = 2.10, 95% CI: 1.45–3.04), and significant life stress (a lot of stress vs. no stress, adjusted OR = 2.20, 95% CI: 1.15–4.23). Difficulty sleeping, daytime sleepiness, chronic diseases, smoking while operating equipment, drinking, and dissatisfaction with family income were statistically significant risk factors in the univariate models but not in the multivariate model.

Characteristics of agricultural machinery-related injuries

Table 5 shows the characteristics of the reported injuries among the operators. A majority of injuries occurred on farmland (46.6%), roads (26.3%), around house (17.5%). The most common external causes of injuries were being struck by stationary object (21.9%), being slashed or stabbed by sharp objects (13.9%), falls from stationary vehicles (12.4%), and being struck by falling objects (11.2%). The three leading types of injuries were scratches (55.8%), strains and sprains (29.9%), and fractures (17.5%). The injuries typically affected extremities: hands (46.2%), arms (31.5%), legs (23.5%), and feet (12.0%). Machines most commonly causing injuries included: tractors (67.2%); transport machinery (8.0%); and harvesters, cultivators, cutting machines, and mechanical equipment used irrigation and drainage (24.8%). A majority of the injuries (76.2%) occurred between April and September, when farmers are busiest in China. Approximately 40% of the injuries were treated by the operators or family members or received no treatment.

Discussion

The utilisation of agricultural machines has dramatically increased in China, and agricultural machinery operators face many and varied risks. Nonetheless, agricultural machinery-related injuries are an under-recognised public health concern by Chinese researchers and public health professionals. This study revealed that the prevalence of agricultural machinery injury in northern China was 13.1 per 100 workers. Compared with the prevalence in other population-based studies of occupational injury in China, we found that the prevalence of agricultural machinery-related injuries was higher than injuries reported for iron factory workers [15] and shipyard workers [16], but lower than injury rates in construction workers [17] and all farmers [18].

In our study, despite being 10.1% of the total agricultural machinery operators, women only accounted for 4.4% of all injuries. The prevalence of work-related injuries among male operators was 2.5-fold higher than the injury rate among female operators (13.90% vs. 5.67%). Perhaps female operators were exposed to high-risk work less frequently than male operators. However, this might also be related to the types of machines women operated and differences in the number of hours males and females worked.

Our results also demonstrated a statistically significant association between income and occupational injuries among agricultural machinery operators. We hypothesise that low-income operators needed to perform more work to increase their income and were therefore more likely to be injured. However, the result was inconsistent with a study that evaluated a higher income level as a risk factor for occupational injuries among farmers in Finland [19].

Our result was also inconsistent with previous studies in China [20,21]. Two previous Chinese studies reported that income was not significantly related to occupational injuries. However, these two studies evaluated railway workers and iron factory workers. Therefore, future studies are warranted to investigate the interaction between income and occupational injuries in agricultural workers, specifically machine operators, in China.

Our study revealed that life stresses, such as having chronic diseases, low family income, and debt, were significantly associated with machinery-related injuries. This finding is consistent with a previous study [22]. This might indicate that stressors influence ability to concentrate during work [22-25]; thereby, increasing the risk of work-related injuries.

Previous studies have reported that safety education and machinery safety training might prevent agricultural machinery-related injuries [26,27]. In our opinion, safety training may be useful, but our study did not support provide evidence that safety training was a key component of injury risk. We believe that the contents, methods, hours, and factors which need to be included to develop safety training programmes for Chinese workers require more in-depth study.

The primary cause of injuries in our study was being struck by a slipping starting handle. This might be related to the high frequency of the use of tractors, which are started with a handle. In addition, our data demonstrated that the highest injury frequencies occurred in April, May, and June, whereas the lowest occurred in the winter. This seasonal trend reflected the long hours of work and tight work schedules from April to June of agricultural machinery operators.

In summary, agricultural machinery-related injury is serious in China, and preventive strategies are urgently needed. We suggest the following approaches to prevent agricultural machinery-related injuries: (1) educational campaigns: health education may increase safety knowledge and change individual behaviours; (2) protective equipment (i.e. rollover protective structures (ROPS) and falling-object protective structures) should be installed, and other work environment changes should be identified; (3) strict enforcement of machinery safety standards and government supervision of operator training and proper machinery use and maintenance are needed.

This study has several limitations. First, the sample was not randomly selected. Second, information regarding agricultural machinery-related injuries was self-reported, with a 12-month recall period. There is a possibility of recall bias, which might have caused underestimation of injury prevalence and reporting errors regarding injury characteristics. Third, our study was a cross-sectional survey, and it is therefore not possible to determine causal relationships between potential risk factors and agricultural machinery-related injuries.

Acknowledgments

This study was funded by U.S. National Institutes of Health (NIH), Fogarty International Center (1D43TW007257-01A2). The contents of this publication are solely the responsibility of the authors and do not necessarily represent the official views of the NIH Fogarty International Center.

We thank the staff and students from School of Public Health of the Tongji Medical College, Qiqihaer Medical College and Shandong Traditional Chinese Medicine University, 2 medical retired staff from Puyang city, Henan Province, China, all of whom provided assistance for the data collection.

References

1. Lin Y. Analysis of agricultural machinery market in China. *Hebei Agric Mach.* 2011; 2:6–9.

2. Yin HD. Optimal design of planet transmission mechanism in agricultural machinery based on genetic algorithm. *Agric Mach.* 2011; 3:127–9.
3. Cui YB, Yi JG, Hou WH, Hu CH. Web-based virtual model base system for agricultural machinery design. *Agric Mach.* 2011; 2:150–3.
4. Zhang QY. Repairing and maintenance of agricultural machinery. *Hunan Agric Mach.* 2012; 39:129–30.
5. Young SK. Agriculture-related injuries in the parkland region of Manitoba. *Can Fam Physician.* 1995; 41:1190–7. [PubMed: 7647624]
6. McCurdy SA, Carroll DJ. Agricultural injury. *Am J Ind Med.* 2000; 38:463–80. [PubMed: 10982988]
7. Sprince NL, Park H, Zwerling C, Lynch CF, Whitten PA, Thu K, et al. Risk factors for machinery-related injury among Iowa farmers: a case-control study nested in the Agricultural Health Study. *Int J Occup Environ Health.* 2002; 8:332–8. [PubMed: 12412851]
8. Solomon C. Accidental injuries in agriculture in the UK. *Occup Med (Lond).* 2002; 52:461–6. [PubMed: 12488516]
9. Okhan A, Seda O, Polat D, Avsarogullari L, Koyuncu M, Ikizceli I. Machine-related farm injuries in Turkey. *Ann Agric Environ Med.* 2010; 17:59–63. [PubMed: 20684481]
10. Patel SK, Varma MR, Adarsh K. Agricultural injuries in Etawah district of Uttar Pradesh in India. *Safety Sci.* 2010; 48:222–9.
11. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep.* 1991; 14:540–5. [PubMed: 1798888]
12. Ewing JA. Detecting alcoholism. The CAGE questionnaire. *J Am Med Assoc.* 1984; 252:1905–7.
13. Kohout FJ, Berkman LF, Evans DA, Cornoni-Huntley J. Two shorter forms of the CES-D (Center for Epidemiological Studies Depression) depression symptoms index. *J Aging Health.* 1993; 5:179–93. [PubMed: 10125443]
14. Linn MW. Modifiers and perceived stress scale. *J Consult Clin Psychol.* 1986; 54:507–13. [PubMed: 3745603]
15. Yue Q, Lan YJ. Epidemiological study on occupational injury during 1995–2004 in an iron factory. *Mod Prevent Med.* 2006; 33:2363–6.
16. Wang YL, Xia ZL, Zhuang HM. Epidemiological study of occupational injuries in a shipyard during the period of 1994–2005. *J Environ Occup Med.* 2008; 25:49–50.
17. Huang F, Zhang XT, Yang LS, Wang XB, Wang JF, Ye DQ, et al. Epidemic characteristics of accident injury among migrant rural workers at building site and preventive countermeasures. *Chin Health Serv Manage.* 2008; 238:270–2.
18. Guo XL, Xu AQ, Zhang JY, Liu HY, Chen XF, Ma JX. Study on the epidemiological survey and economic burden of injuries among rural residents in Shan Dong Province. *Mod Prevent Med.* 2007; 34:866–9.
19. Risto HR, Johannes L, Kelley JD, Ohsfeldt RL, Zwerling C. Risk factors for serious injury in Finnish agriculture. *Am J Ind Med.* 2009; 52:419–28. [PubMed: 19189350]
20. Wang J, Lu GL, Tu P, Zhang J, Shao T, Ge ZC, et al. A case-control study on occupational injuries in railway workers. *J Environ Occup Med.* 2006; 23:24–7.
21. Hu WJ, Zhou AS. Study on the risk factors of occupational injuries in steel enterprise. *Chin J Ind Med.* 2009; 22:260–2.
22. Xiang H, Wang Z, Stallones L, Keefe TJ, Huang X, Fu X. Agricultural work-related injuries among farmers in Hubei, People's Republic of China. *Am J Public Health.* 2000; 90:1269–76. [PubMed: 10937008]
23. Hardy CJ, Riehl RE. An examination of the life stress–injury relationship among noncontact sport participants. *Behav Med.* 1988; 14:113–8. [PubMed: 3167238]
24. Simpson K, Sebastian R, Arbuckle TE, Bancej C, Pickett W. Stress on the farm and its association with injury. *J Agric Safety Health.* 2004; 10:141–53.
25. Rautiainen RH, Lange JL, Hodne CJ, Schneiders S, Donham KJ. Injuries in the Iowa certified safe farm study. *J Agric Safety Health.* 2004; 10:51–63.

26. Etherton JR, Myers JR, Jensen RC, Russell JC, Braddee RW. Agricultural machine-related deaths. *Am J Public Health.* 1991; 81:766–8. [PubMed: 2029052]
27. Javadi A, Rostami MA. Safety assessments of agricultural machinery in Iran. *J Agric Safety Health.* 2007; 13:275–84.

Table 1

Frequency and prevalence of agricultural machinery injuries by demographics among 1921 operators in northern China, 2008–2009.

	Sample (N)	No. injured	Prevalence (per 100 operators)	95% CI	χ^2	P
<i>Gender</i>						
Male	1727	240	13.90	(12.35, 15.45)	10.372	0.0013
Female	194	11	5.67	(4.64, 6.70)		
<i>Age (years)</i>						
<20	23	3	13.04	(11.53, 14.55)	4.987	0.2886
20–29	457	63	13.79	(12.25, 15.33)		
30–39	540	79	14.63	(13.05, 16.21)		
40–49	613	65	10.60	(9.22, 11.98)		
50–60	288	41	14.24	(12.68, 15.80)		
<i>Education</i>						
College or above	49	10	20.41	(18.61, 22.21)	8.726	0.0683
Senior high school	379	61	16.09	(14.45, 17.73)		
Junior high school	1144	143	12.50	(11.02, 13.98)		
Primary school	326	36	11.04	(9.64, 12.44)		
Illiterate	23	1	4.35	(3.44, 5.26)		
<i>Average annual income per family member (Yuan)^a</i>						
<1000	230	54	23.48	(21.58, 25.38)	30.986	<0.0001
1000–2000	697	98	14.16	(12.60, 15.72)		
>2000	994	99	9.96	(8.62, 11.30)		
<i>Marital status</i>						
Never married	167	25	14.97	(13.37, 16.57)	1.137	0.5663
Married	1738	225	12.95	(11.45, 14.45)		
Divorced or widowed	16	1	6.25	(5.17, 7.33)		
<i>Province</i>						
Hebei	515	61	11.84	(10.40, 13.28)	8.511	0.0746
Henan	529	87	16.45	(14.79, 18.11)		
Heilongjiang	193	25	12.95	(11.45, 14.45)		
Shandong	541	65	12.01	(10.56, 13.46)		

	Sample (N)	No. injured	Prevalence (per 100 operators)	95% CI	χ^2	P
Shanxi	143	13	9.09	(7.80, 10.38)		

^aOne US Dollar equal to six point three Yuan of Chinese RMB.

Table 2

Health status and prevalence of agricultural machinery injuries among 1921 operators in northern China, 2008–2009.

Variables	Sample (N)	No. injured	Prevalence (per 100 operators)	95% CI	χ^2	P
<i>Vision</i>						
Good	1587	207	13.04	(11.53, 14.55)	2.3949	0.3020
Fair	291	34	11.68	(10.24, 13.12)		
Poor	39	8	20.51	(18.70, 22.32)		
<i>Hearing</i>						
Good	1761	224	12.72	(11.23, 14.21)	1.9212	0.3827
Fair	144	23	15.97	(14.33, 17.61)		
Poor	9	2	22.22	(20.36, 24.08)		
<i>Difficulty falling sleep</i>						
Always	96	19	19.79	(18.01, 21.57)	9.9364	0.0070
Sometimes	559	83	14.85	(13.26, 16.44)		
Never	1177	129	10.96	(9.56, 12.36)		
<i>Daytime sleepiness</i>						
Always	119	26	21.85	(20.00, 23.70)	16.9410	0.0002
Sometimes	902	129	14.30	(12.73, 15.87)		
Never	857	85	9.92	(8.58, 11.26)		
<i>Chronic diseases^a</i>						
Yes	454	80	17.62	(15.92, 19.32)	10.8593	0.0010
No	1467	171	11.66	(10.22, 13.10)		

^aChronic diseases refers to arthritis, rheumatism, heart disease, hypertension, or asthma that machinery operators suffered.

Table 3

Risk behaviours and prevalence of agricultural machinery injuries among 1921 operators in northern China, 2008–2009.

Variables	Sample (N)	No. injured	Prevalence (per 100 operators)	95% CI	χ^2	P
<i>Smoking during machine use</i>						
Yes	724	112	15.47	(13.85, 17.09)	6.2485	0.0124
No	1161	133	11.46	(10.04, 12.88)		
<i>Alcohol use</i>						
Yes	1123	163	14.51	(12.94, 16.09)	4.9941	0.0254
No	798	88	11.03	(9.63, 12.43)		
<i>CAGE score</i>						
2	270	48	17.78	(16.07, 19.49)	2.8807	0.0896
<2	818	111	13.57	(12.04, 15.10)		
No drinking	798	88	11.03	(9.63, 12.43)		
<i>Machinery safety training</i>						
Special	338	38	11.24	(9.83, 12.65)	0.9021	0.3422
Non-special	1490	196	13.15	(11.64, 14.66)		
<i>Machinery maintenance</i>						
Yes	1606	202	12.58	(11.10, 14.06)	2.7731	0.0959
No	284	46	16.20	(14.55, 17.85)		
<i>Satisfied with income</i>						
Unsatisfied	382	56	14.66	(13.08, 16.24)	6.5525	0.0378
Satisfied	1218	167	13.71	(12.17, 15.25)		
Very satisfied	311	27	8.68	(7.42, 9.94)		
<i>Current debt</i>						
Yes	427	88	20.61	(18.80, 22.42)	30.1569	<0.0001
No	1464	154	10.52	(9.15, 11.89)		
<i>Self-reported stress</i>						
A lot	160	34	21.25	(19.42, 23.08)	16.3254	0.0010
Some	716	103	14.39	(12.82, 15.96)		
A little	659	74	11.23	(9.82, 12.64)		
None	328	31	9.45	(8.14, 10.76)		
<i>CES-D 10 score</i>						

Variables	Sample (N)	No. injured	Prevalence (per 100 operators)	95% CI	χ^2	P
10	474	75	15.82	(14.19, 17.45)	4.3217	0.0376
<10	1349	163	12.08	(10.62, 13.54)		

Table 4

Odds ratios and 95% CIs of agricultural machinery injuries among 1921 operators in northern China, 2008–2009.

Variables	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
<i>Gender</i>		
Male	2.68(1.44, 5.01) *	3.58(1.56, 8.23) *
Female	1.00	1.00
<i>Education</i>		
College or above	5.63(0.68, 46.84)	4.95(0.55, 44.91)
Senior high school	4.21(0.56, 31.76)	3.45(0.43, 27.42)
Junior high school	3.14(0.42, 23.39)	2.16(0.28, 16.95)
Primary school	2.73(0.36, 20.78)	1.84(0.23, 14.79)
Illiterate	1.00	1.00
<i>Average annual income per family member (Yuan)</i>		
<1000	2.77(1.92, 4.01) *	2.09(1.27, 3.45) *
1000–2000	1.48(1.10, 1.99) *	1.59(1.12, 2.24) *
>2000	1.00	1.00
<i>Hearing</i>		
Poor	1.96(0.41, 9.50)	3.25(2.08, 5.09) *
Fair	1.50(0.29, 7.70)	2.24(0.22, 22.67)
Good	1.00	1.00
<i>Difficulty falling sleep</i>		
Always	2.01(1.18, 3.42) *	1.40(0.65, 2.98)
Sometimes	1.42(0.81, 2.46)	1.36(0.64, 2.91)
Never	1.00	1.00
<i>Daytime sleepiness</i>		
Always	2.54(1.56, 4.14) *	1.37(0.72, 2.60)
Sometimes	1.68(1.04, 2.69) *	0.94(0.65, 1.37)
Never	1.00	1.00
<i>Chronic diseases^a</i>		
Yes	1.62 (1.21, 2.17) *	1.32(0.92, 1.90)
No	1.00	1.00
<i>Smoking during machine use</i>		
Yes	1.42(1.08, 1.85) *	1.08(0.79, 1.49)
No	1.00	1.00
<i>Alcohol use</i>		
Yes	1.37(1.04, 1.81) *	1.13(0.79, 1.62)
No	1.00	1.00
<i>Satisfied with income</i>		
Unsatisfied	1.67(1.09, 2.56) *	1.49(0.87, 2.57)

Variables	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Satisfied	1.81(1.11, 2.94)*	1.44(0.78, 2.65)
Very satisfied	1.00	1.00
<i>Current debt</i>		
Yes	2.21(1.66, 2.95)*	2.10(1.45, 3.04)*
No	1.00	1.00
<i>Self-reported stress</i>		
A lot	2.59(1.52, 4.39)*	2.20(1.15, 4.23)*
Some	1.61(1.05, 2.46)*	0.88(0.53, 1.48)
A little	1.21(0.78, 1.89)	0.70(0.41, 1.20)
None	1.00	1.00
<i>CES-D 10 score</i>		
10	1.37(1.02, 1.84)*	0.95(0.66, 1.37)
<10	1.00	1.00

^aChronic diseases refer to arthritis, rheumatism, heart disease, hypertension, or asthma that machinery operators suffered.

* $P < 0.05$.

Table 5

Characteristics of agricultural machinery injuries ($n = 251$) among operators in northern China, 2008–2009.

Characteristics	<i>n</i>	%
<i>Location injury occurred</i>		
Farmland	117	46.6
Road	66	26.3
Farm buildings	14	5.6
Around house	44	17.5
Forgot or unknown	10	4.0
<i>External cause of injury</i>		
Stuck by stationary object	55	21.9
Fall from stationary vehicle	31	12.4
Struck by falling object	28	11.2
Caught in moving part of equipment/machinery ^a	18	7.2
Crushed by equipment/machinery	16	6.4
Slashed/stabbed by sharp object	35	13.9
Burned by equipment/machinery	13	5.2
Electricity	0	0.0
Other	55	21.9
<i>Month injury occurred</i>		
January–March	35	14.6
April–June	123	51.5
July–September	59	24.7
October–November	22	9.2
<i>Treatment after injury</i>		
None	16	6.4
Self-administered/family member	83	33.1
Village clinic treatment	61	24.3
Outpatient treatment	51	20.3
Hospitalisation	33	13.2
Unknown	7	2.7

^a Machinery or equipment includes: (1) tractor; (2) harvester; (3) thresher (4) cultivator; (5) transplanter; (6) cutting machine; (7) mechanical facilities used in irrigation and drainage; (8) stockbreeding machine; (9) transportation machinery; (10) other powered equipment.