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论著

# 中国唐山奶农职业性伤害

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**摘　要：目的**　中国的奶牛养殖业与发达国家有显著地差别。本横断面研究旨在探讨中国奶农的职业性伤害及危险因素。**方法**　本研究采用面对面人群调查方法，对唐山地区1 319名奶牛养殖人员在过去12个月中的职业性伤害情况进行问卷调查。**结果**　在1 300名提供了完整问卷的奶牛养殖者中，125人报告发生过导致到医疗机构就医或正常日常活动受限超过半天的职业伤害(伤害发生率为9.61%)。家庭养殖业工作人员的伤害率(每100名工人9.9人受伤)比集体养殖业工作人员的伤害率(每100名工人7.5人受伤)略高。41.5% 的伤害是在工人挤奶时发生的，20.8%的伤害是在工人喂料时发生的。没有1例伤害是机械或拖拉机引起的。接近一半(52.0%)的意外伤害发生在牛舍中，其次为挤奶厅(28.0%)。工人们报告的高危险因素有工作时间长(*OR*：2.27, 95% *CI*：1.09~4.72)及过去12个月全年从事奶牛养殖业(*OR*：3.41, 95% *CI*：1.02~11.39)，低危险因素为非全职从事奶牛养殖业(*OR*：0.58, 95% *CI*：0.38~0.91)。伤害特征与报告的美国奶牛养殖业职业伤害类似。饮酒以及是否接受过安全培训与职业性伤害没有显著性关联。**结论**　本研究报告了中国奶牛养殖业工人的职业伤害的特征与危险因素，中国奶牛养殖业工人职业性伤害与其他职业性疾病需要进一步的研究。

**关键词：**意外伤害；职业伤害；奶牛养殖；中国工人

# Work-related Injuries Sustained by Dairy Workers in Tangshan, China

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**Abstract: Objective**　Dairy farming practices in China differ dramatically from the developed world. This cross sectional study aimed to assess occupational injuries and associated risk factors of dairy farmers in China. **Methods**　Data were collected from face to face interviews in 1 319 dairy farm workers in Tangshang, China. Information about work-related injuries in the past 12 months were self-reported. **Results**　Of the 1 300 farmers who completed the survey, a total of 125 workers self-reported work-related injuries that required professional medical care or restricted the normal daily activities for more than 4 hours (9.61%). Workers of family farms had a slightly higher rate (9.9 per 100 workers) than workers of organized dairy operations (7.5 injured per 100 workers). A total of 41.5% of

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injuries occurred when workers were milking the cow and 20.8% of injuries occurred during feeding activities. None of the 125 injuries was caused by machinery or tractors. About half of these injuries (52.0%) took place in cattle house and 28.0% in the parlor where a milking task was performed. Workers reported a higher risk for injury when working longer work hours (*OR*: 2.27, 95% *CI*: 1.09~4.72) and working all 12 months within the last year (*OR*: 3.41, 95% *CI*: 1.02~11.39) and less risk when working part time (*OR*: 0.58, 95% *CI*: 0.38~0.91). Injuries suffered were similar in nature to United States counterparts. Alcohol consumption and safety training do not have strong associations with injuries. **Conclusion** This pilot study reported characteristics and risk factors of work-related injuries in Chinese dairy farm workers. Work-related injuries and other occupational illnesses in Chinese dairy farmers need to be investigated further.

**Key words:** Unintentional injury; Work-related injuries; Dairy farm; Chinese workers

## 1 Introduction:

In the United States, agriculture remains a dangerous industry prone to non-fatal work-related injuries. Although the total number of US farmers has decreased from 6 170 940 in 2001 to 5 294 912 in 2004, the injury rate has increased from 12.3 injuries per 1 000 adult workers to 13.4 respectively[1]. In 2010, the injury rate for agriculture workers was 4.8 injuries per 100 workers,while all other workers rate was 3.81[2]. Previous studies have attributed non-fatal injuries to characteristics of the farmer and the features of the farm.[3-17] Studies have shown characteristics such as younger age, female sex, higher education, alcohol consumption, longer work hours, previous injury, poor self-perceived health, depressive symptoms, health problems that limit work and being US born have been attributed to increased injury[3-5,7-9,12-17]. One common risk factor of the farm involved in many injuries was the presence of livestock or farm animals, which has directly or indirectly caused a high proportion of animal-related injuries[1,6,7,10-14,18-23] .The risk runs high especially in dairy farms where workers are constantly exposed to animals[6,7,10,11,21-28]. Due to the physical contact from operational activities such as milking, feeding and cleaning, cattle are a major source of work-related injuries in dairy farms[6,10,11].

The dairy industry is an important agricultural sector for the US and a focus toward injury prevention is vital in preserving dairy farms. In 2010, the United States' dairy industry produced 87 461 300 metric tons of cow milk which was valued to be the second highest commodity of the US in the same year[29]. The US also leads the world in the production of cow milk with India and China following behind[30]. However, farming practice in the developing world is vastly different from the western developed world due to differences in culture, settings and technology. China is a large developing agricultural country and little is known about the risks involved in dairy farming there. Previous studies have shown that risk factors for agricultural injuries in China including low income, low levels of schooling, tensions with neighbors, stress as well as alcohol[31,32]. No studies have investigated work-related injuries in Chinese dairy farmers and their associated risk factors. Injuries in China have been deemed a serious public health problem, but further research is needed to specify the risks in the dairy industry[33].

The purpose of this study is to assess work-related injuries and associated risk factors in dairy farmers in Tangshan China, focusing on (1) animal exposure variables, (2) the nature of injury, and (3) alcohol consumption.

## 2 Methods

### 2.1 Design

This study was approved by the Institutional Review Board of the Tongji Medical College and Colorado State University. Data was collected using cluster sampling to select 3 single family dairy breeding villages, 10 large communities and 2 centralized breeding farms in Tangshan, a city in the Hebei province of northern China. Dairy farmers were interviewed face-to-face by trained teachers and students from the North Coal Medical College

Department of Preventive Medicine in August 2010. Based on previously reported injury rate in famers (16.6%), a minimum sample size for our study to collect data from enough number of injured farmers was estimated to be 858 farmers. We increased the sample size to 1 300 farmers to accommodate potential nonresponse and incomplete survey. In the actual survey, a total of 1 319 workers were interviewed and 19 workers were eliminated due to incomplete responses (98.5% response rate). The Questionnaire was divided into five sections; (1) demographic information, (2) health status, (3) dairy farming activities, (4) safety education, and (5) injury event. Demographic information questions included age, sex, education, income and marital status. Health status questions included current health, back pain, and alcohol consumption. If alcohol was consumed, further questions about amount, drinking history, time of day of drinking, dizziness experience and if work was continued after drinking were asked. Dairy farming activity questions included experience, prior 12 month work time, average work hours, type of dairy farm, ownership, number of cows, and whether the work was full time. Safety education information was obtained by asking whether the worker received safety training. Injury questions included treatment, work day loss, location of injury, work description during injury, alcohol consumption, body part injured, nature of injury and severity of injury. Only workers who answered, "Yes" to a question about a prior injury in the last 12 months and who either sought medical treatment, were limited for 4 hours or more of daily activities, or both, were asked to answer the injury event questions. A total of 173 workers reported that they had suffered injuries in the 12 months prior to the interview.

### 2.2 Injury definition and study variables

Injuries were defined as unintentional work-related injuries that either received medical treatment, limited normal activities for 4 hours or more, or both. Due to the restrictions based on the definition, 48 of 173 injured farmers were eliminated, leaving 125 injured farmers for our study. Multiple injuries were accounted for with a total of 131 unique injury events. Risk factors were grouped into demographics, animal exposure variables, safety training and alcohol consumption. Animal exposure variables included work experience, working time in the last 12 months, average work hours, type of farm, number of cows and type of occupation. Injury pattern variables included activity when injured, location and severity of injury, work day missed, body part injured, nature of injury, and whether alcohol was consumed 4 hours prior to the injury event. Alcohol consumption variables included amount, drinking years, self-reported dizziness after drinking, and work after drinking. The severity of the injury was self-reported and was classified into the following three categories: mild injury - injury did not result in hospitalization; moderate - injury resulted in hospitalization but no disability; and severe - injury resulted in hospitalization and disability.

### 2.3 Statistical analysis

Data was analyzed using SAS 9.3.[34]. First, the demographical characteristics of interviewed workers including gender, age, marital status, income and education were described. Second, Chi-square tests ($\chi^2$) tests with the associated p-value were used to compare injury rates in workers with regard to demographic information, animal exposure variables, safety training and alcohol consumption variables. Third, characteristics of the 131 work-related injury eventsincluding activity when injured, location, severity, work day missed, injured body part, nature of injury, and alcohol consumption 4 hours prior were analyzed. Finally, 3 logistic regression models were used to calculate odds ratios with 95% confidence interval (*CI*) of work-related injuries. Demographic information, exposure variables, safety training and alcohol consumption were used as independent variables with injury as the dependent variable. Model 1 showed the odds and 95% *CI* based only on demographic information. Model 2 added exposure variables and Model 3 included all four groups of variables.

### 2.4 Quality control

The same questionnaire was repeated to 130 workers who participated in the face-to-face interview to assess the quality of our survey data. Answers of 124 workers matched in both surveys but some of the answers of 6 workers did not match; thus the accuracy rate in our study was 95.4%.

## 3 Results

Out of 1 300 workers who provided complete survey, 125 reported an injury (9.61%) that resulted in medical care or limited the worker's normal activities for more than 4 hours and 375 reported alcohol consumption (28.8%). The highest proportion of workers were male (57.5%), >50 years of age (40.7%), married (96.3%), income <10 000 Yuan per year (72.5%) and have a middle school education (41.5%). (Table 1)

**Table 1 Demographic Characteristics of Interviewed Dairy Farmers in Tangshan China, 2010.**

| | | Sample N | % |
|---|---|---|---|
| Total | | 1 300 | |
| Gender | Male | 748 | 57.5 |
| | Female | 552 | 42.5 |
| Age(year) | <40 | 327 | 25.2 |
| | 40~50 | 444 | 34.2 |
| | >50 | 529 | 40.7 |
| Marriage | Married | 1 252 | 96.3 |
| | Never married/divorced | 48 | 3.7 |
| Income (Yuan/year) | <10 000 | 943 | 72.5 |
| | 10 000~19 999 | 117 | 9 |
| | 20 000~34 999 | 130 | 10 |
| | ≥35 000 | 110 | 8.5 |
| Education | Illiterate | 151 | 11.6 |
| | Elementary school | 434 | 33.4 |
| | Middle school | 540 | 41.5 |
| | High school or higher | 175 | 13.5 |

Male workers had a lower injury rate than female workers (8.69% and 10.87%, respectively). (Table 2) Among the age groups, similar rates were present. Workers in the age group >50 years of age had an injury rate of 9.83% compared to 40~50 years of age of 10.36% and <40 years of age of 8.26%. The majority of workers was married and had an injury rate of 9.66% while unmarried workers had a rate of 8.33%. Injury rates generally increased as income increased, as grouped in <10 000 Yuan, 10 000~19 999 Yuan, 20 000~34 999 Yuan, ≥ 35 000 Yuan (9.33%, 9.40%, 6.92%, and 15.45% respectively). Injury rates also increased as education increased, from illiterate, elementary school, middle school and high school or higher (6.62%, 10.14%, 9.81%, and 10.29% respectively). However, Chi-square tests showed no significant differences in the injury rate ($P$>0.05) by gender, age, marriage, income and education. (Table 2)

$\chi^2$ tests showed significant differences in the proportion of injured workers ($P$<0.05) in exposure variables including experience in farm, months worked 12 months prior, average work hours, number of cows, type of occupation and safety training. (Table 2) Working with 5~10 years of experience had the highest injury rate of 13.33%. If the farmer worked all 12 months within the last year, the injury rate was 10.22% while farmers worked less than 12 months had an injury rate of 2.83%. Injury rates increased as work hours increased, as grouped in 1~4 hours, 5~7 hours, 8 hours or more (5.26%, 9.41%, and 11.69% respectively). Owning 1~5 cows had an injury rate of 7.11%, while owning 6~20 cows had a rate 12.42% and owning 20 cows or more had a rate 9.23%. Working full time had a higher injury rate compared to working part time (13.39% and 8.14% respectively). The type of farm did not significantly affect injury rate as working on a family farm had an injury rate of 9.95%, while working on a company farm had an injury rate of 7.47%. Safety training did not affect injury rate as being trained had an injury rate of 11.43% and being untrained had an injury rate of 9.19%.

The use of alcohol had little effect on injury and the differences in injury groups were only significant ($P$<0.05) for workers who continued working after drinking. (Table 3) Consumers of alcohol had similar injury rate compared to abstainers with an injury rate of 9.9% and 9.5% respectively. Drinking 50g of alcohol had a higher injury rate than drinking 100g or more with rates of 10.5% and 7.7% respectively while drinking years did not significantly affect injury rate. Workers who experienced dizziness after drinking had a higher injury rate of 12.5% compared to workers who didn't experience any dizziness with a rate of 9.6%. Workers who continued working after drinking had a lower injury rate than those who stopped working after drinking (7.8% and 14.5% respectively).

**Table 2 Frequency and Percentage of Injuries across Demographic and Animal Exposure Variables among Interviewed Dairy Farmers in Tangshan China, 2010**

| | | Sample N | Injured N (%) | P–value |
|---|---|---|---|---|
| Gender | Male | 748 | 65 (8.69%) | 0.187 |
| | Female | 552 | 60 (10.87%) | |
| Age | <40 | 327 | 27 (8.26%) | 0.604 |
| | 40~50 | 444 | 46 (10.36%) | |
| | >50 | 529 | 52 (9.83%) | |
| Marriage | Married | 1 252 | 121 (9.66%) | 0.198* |
| | Never married/divorced | 48 | 4 (8.33%) | |
| Income (yuan/year) | <10 000 | 943 | 88 (9.33%) | 0.139 |
| | 10 000 ~ 19 999 | 117 | 11 (9.40%) | |
| | 20 000 ~ 34 999 | 130 | 9 (6.92%) | |
| | ⩾35 000 | 110 | 17 (15.45%) | |
| Education | Illiterate | 151 | 10 (6.62%) | 0.613 |
| | Elementary school | 434 | 44 (10.14%) | |
| | Middle school | 540 | 53 (9.81%) | |
| | High school or higher | 175 | 18 (10.29%) | |
| Experience in dairy farming | < 5 years | 438 | 35 (7.99%) | 0.047 |
| | 5~9 years | 285 | 38 (13.33%) | |
| | 10 years or more | 577 | 52 (9.01%) | |
| Work time 12 months prior | < 12 months | 106 | 3 (2.83%) | 0.013 |
| | 12 months | 1 194 | 122 (10.22%) | |
| Average work hours | 1~4 hours | 190 | 10 (5.26%) | 0.04 |
| | 5~7 hours | 648 | 61 (9.41%) | |
| | 8 hours or more | 462 | 54 (11.69%) | |
| Type of farm | Family | 1 126 | 112 (9.95%) | 0.303 |
| | Company farm | 174 | 13 (7.47%) | |
| Number of cows | 1~5 cows | 492 | 35 (7.11%) | 0.019 |
| | 6~19 cows | 483 | 60 (12.42%) | |
| | 20 cows or more | 325 | 30 (9.23%) | |
| Type of occupation | Full time | 366 | 49 (13.39%) | 0.004 |
| | Part time | 934 | 76 (8.14%) | |
| Safety training | Yes | 245 | 28 (11.43%) | 0.285 |
| | No | 1 055 | 97 (9.19%) | |

*Fisher's Exact Test

The frequency and percentage of the injury pattern were described in Table 4. Most injuries occurred during the activity of milking (41.22%) and feeding (20.61%) and occurred in the shed (51.15%). Most injuries were mild (77.86%) and resulted in either 8~30 work day loss (32.28%) or 2~7 work day loss (30.71%). The most injured body part was the trunk (43.51%) with the upper limb (23.66%) and lower limb (23.66%) following. The nature of the injury included superficial injuries (21.37%), fractures (19.84%), open wounds (12.98%), sprain (15.27%) and muscle and tendon injury (24.43%).

In logistic regression model 1, using only

**Table 3 Alcohol Consumption and Work-related Injuries in Interviewed Dairy Farmers in Tangshan China, 2010**

| | | Sample N | Injured N (%) | P-value |
|---|---|---|---|---|
| Alcohol consumption | Yes | 375 | 37 (9.9%) | 0.845 |
| | No | 925 | 88 (9.5%) | |
| Average amount | 50g | 284 | 30 (10.5%) | 0.424 |
| | 100g or more | 91 | 7 (7.7%) | |
| Drinking years | 5 years or less | 71 | 5 (7.0%) | 0.23 |
| | 6~19 years | 121 | 9 (7.4%) | |
| | 20 years or more | 183 | 23 (12.6%) | |
| Dizziness after drinking | Yes | 32 | 4 (12.5%) | 0.194* |
| | No | 343 | 33 (9.6%) | |
| Work after drinking | Yes | 258 | 20 (7.8%) | 0.041 |
| | No | 117 | 17 (14.5%) | |

*Fisher's Exact Test

demographic information, no significant differences in the odds of injury were found by gender, age, marital status and education with the exception of income. (Table 5) Having ≥ 35 000 Yuan of income (*OR*: 1.83, 95%*CI*: 1.02~3.25) significantly increased the odds of injury. Model 2 adjusted for animal exposure variables with demographic information and lowered the odds for all demographic variables except marital status and income variable. Working all 12 months (*OR*: 3.51, 95%*CI*: 1.05~11.70) and working 8 hours or more a day (*OR*: 2.28, 95%*CI*: 1.10~4.72) both significantly increased the odds of suffering an injury. Working in a company farm (*OR*: 0.66, 95%*CI*: 0.31~1.39) decreased the odds of injury while working part time (*OR*: 0.58, 95%*CI*: 0.38~0.91) significantly decreased the odds. Model 3 adjusted for all four groups of variables. Being female increased the odds of injury modestly (*OR*: 1.57, 95%*CI*: 0.99~2.50) and having an income of ≥35 000 Yuan of income lowered the odds of injury (*OR*: 1.54, 95%*CI*: 0.84~2.85) to an insignificant level when adjusted for alcohol consumption and safety training. The odds of injury for demographic information and animal exposure variables stayed similar to Model 2. The odds of injury for working all 12 months (*OR*: 3.41, 95%*CI*: 1.02~11.39), 8 hours of more a day (*OR*: 2.27, 95%*CI*: 1.09~4.72) and part time (*OR*: 0.58, 95%*CI*: 0.38~0.91) stayed significant. Workers who consumed alcohol were at a slightly higher odds of injury (*OR*: 1.23, 95%*CI*: 0.74~2.02), but the association was not statistically significant.

## 4 Discussion

Our study indicated that 9.61% of dairy farmers in our sample suffered injuries in the past 12 months. Dairy farmers in the US suffering from animal-related occupational injuries that required medical care had an injury rate of 12.42 injuries per 1 000 person-years compared to the non-dairy injury rate of 5.5 per 1 000 person-years [35]. Another study with a similar injury definition had an injury rate of 31.8 animal-related injuries per 1 000 persons-years, however, animals included dairy cows, beef, horses and other animals [36]. The injury rate of US dairy farmers is slightly higher than the injury rate in Chinese dairy farmers that we reported in this paper. Among dairy farmers in Tangshan, China, demographic variables showed little association with injury with the exception of gender and income, while animal exposure variables showed a significant association. Neither safety training nor alcohol consumption had a significant association with injury. Most injuries were mild, occurred while milking in the shed or milking hall and resulted in 8~30 days of work loss. These injuries often affected the trunk of the body and were mostly defined as a muscle or tendon injury.

**Table 4 Characteristics of Work-related Injuries in Interviewed Dairy Farmers in Tangshan China, 2010**

| | | Sample N = 131 | % |
|---|---|---|---|
| Activity when injured | Tagging | 2 | 1.53 |
| | Silage | 1 | 0.76 |
| | Foraging | 3 | 2.29 |
| | Feeding | 27 | 20.61 |
| | Milking | 54 | 41.22 |
| | Vaccination | 6 | 4.58 |
| | Confinements | 1 | 0.76 |
| | Cleanup stool | 5 | 3.82 |
| | Other | 32 | 24.43 |
| Location | Shed | 67 | 51.15 |
| | Milking hall | 37 | 28.24 |
| | Outdoor | 27 | 20.61 |
| Severity | Mild | 102 | 77.86 |
| | Moderate | 24 | 18.32 |
| | Severe | 5 | 3.82 |
| Work day missed* | 0 days | 15 | 11.81 |
| | 1 day | 12 | 9.45 |
| | 2~7 days | 39 | 30.71 |
| | 8~30 days | 41 | 32.28 |
| | more than 30 days | 20 | 15.75 |
| Injured body part | Head and neck | 12 | 9.16 |
| | Trunk | 57 | 43.51 |
| | Upper limb | 31 | 23.66 |
| | Lower limb | 31 | 23.66 |
| Nature of injury | Superficial skin injury | 28 | 21.37 |
| | Fracture | 26 | 19.84 |
| | Open wounds | 17 | 12.98 |
| | Dislocation/sprain | 20 | 15.27 |
| | Muscle and tendon injury | 32 | 24.43 |
| | Other | 8 | 6.11 |
| Alcohol consumption 4 hours prior | Yes | 8 | 6.11 |
| | No | 123 | 93.89 |

*Sample N =127

Exposure to animals has been shown to be a significant risk factor for injury in both the United States and China. Our results indicate a significant increase in injury rate and odds of injury when working 8 hours or more a day. This finding is consistent with studies in the US conducted in dairy and non-dairy farms [6-8,13-15,36]. Farmers working full time are more likely to have more exposure time which is also attributed to a higher risk for injury than part time workers [9,20,24]. A previous study of dairy farms in Eastern Ontario showed a relative risk of 2.5 for working full time compared to working part time (>35 hours a week), which is consistent with our data when comparing part-time workers to full-time workers [26]. Similarly, farmers in the US who spent 12 or more weeks working off the farm were less likely to suffer an injury (*OR*: 0.46, 95% *CI*: 0.25~0.84) [36]. Our

**Table 5 Odds Ratios (OR) and 95% CI of Work~related Injuries in Interviewed Dairy Farmers in Tangshan China, 2010.**

| | | Model 1*OR* (95% *CI*) | Model 2 *OR* (95% *CI*) | Model 3 *OR* (95% *CI*) |
|---|---|---|---|---|
| Gender | Male | 1.00 (Reference) | 1.00 (Reference) | 1.00 (Reference) |
| | Female | 1.45 (0.97 ~ 2.15) | 1.43 (0.96 ~ 2.14) | 1.57 (0.99 ~ 2.50) |
| Age | <40 | 1.00 (Reference) | 1.00 (Reference) | 1.00 (Reference) |
| | 40~50 | 1.32 (0.79 ~ 2.20) | 1.21 (0.72 ~ 2.05) | 1.21 (0.72 ~ 2.04) |
| | >50 | 1.52 (0.88 ~ 2.62) | 1.48 (0.85 ~ 2.59) | 1.46 (0.84~ 2.56) |
| Marriage | Married | 1.00 (Reference) | 1.00 (Reference) | 1.00 (Reference) |
| | Never married/divorced | 0.92 (0.31 ~ 2.72) | 1.03 (0.34 ~ 3.11) | 1.05 (0.35 ~ 3.16) |
| Income (yuan/year) | <10 000 | 1.00 (Reference) | 1.00 (Reference) | 1.00 (Reference) |
| | 10 000 ~ 19 999 | 1.00 (0.51 ~ 1.94) | 1.03 (0.52 ~ 2.05) | 1.01 (0.51 ~ 2.02) |
| | 20 000 ~ 34 999 | 0.71 (0.34 ~ 1.46) | 0.67 (0.31 ~ 1.41) | 0.64 (0.30 ~ 1.35) |
| | ⩾35 000 | 1.83 (1.02 ~ 3.25) | 1.64 (0.90 ~ 3.00) | 1.54 (0.84 ~ 2.85) |
| Education | Illiterate | 1.00 (Reference) | 1.00 (Reference) | 1.00 (Reference) |
| | Elementary School | 1.70 (0.82 ~ 3.52) | 1.60 (0.76 ~3.36) | 1.56 (0.74 ~ 3.28) |
| | Middle School | 1.79 (0.85 ~ 3.80) | 1.59 (0.74 ~ 3.41) | 1.57 (0.73 ~ 3.37) |
| | High School or higher | 1.97 (0.84 ~ 4.62) | 1.73 (0.73 ~ 4.09) | 1.65 (0.69 ~ 3.94) |
| Experience in dairy farming | < 5 years | | 1.00 (Reference) | 1.00 (Reference) |
| | 5~9 years | | 1.42 (0.85 ~ 2.38) | 1.43 (0.85 ~ 2.40) |
| | 10 years or more | | 0.91 (0.56 ~ 1.48) | 0.90 (0.55 ~ 1.48) |
| Work time 12 months prior | < 12 months | | 1.00 (Reference) | 1.00 (Reference) |
| | 12 months | | 3.51 (1.05 ~ 11.70) | 3.41 (1.02 ~ 11.39) |
| Average work hours | 1~4 hours | | 1.00 (Reference) | 1.00 (Reference) |
| | 5~7 hours | | 1.67 (0.83 ~ 3.39) | 1.69 (0.84 ~ 3.43) |
| | 8 hours or more | | 2.28 (1.10 ~ 4.72) | 2.27 ( 1.09 ~ 4.72) |
| Type of farm | Family | | 1.00 (Reference) | 1.00 (Reference) |
| | Company farm | | 0.66 (0.31 ~ 1.39) | 0.61 (0.28 ~ 1.33) |
| Number of cows | 1~5 cows | | 1.00 (Reference) | 1.00 (Reference) |
| | 6~19 cows | | 1.53 (0.96 ~ 2.42) | 1.52 (0.95 ~ 2.41) |
| | 20 cows or more | | 1.04 (0.54 ~ 2.02) | 1.03 (0.53 ~ 2.00) |
| Type of occupation | Full time | | 1.00 (Reference) | 1.00 (Reference) |
| | Part time | | 0.58 (0.38 ~ .91) | 0.58 (0.38 ~ 0.91) |
| Safety Training | Yes | | | 1.00 (Reference) |
| | No | | | 0.78 (0.47 ~ 1.29) |
| Alcohol consumption | No | | | 1.00 (Reference) |
| | Yes | | | 1.23 (0.74 ~ 2.02) |

results show that farmers in China who worked all 12 months in the past 12 months were more likely to suffer dairy farm–related injury. This may be a universal risk factor as an increase in working hours increases exposure time for all farmers working with animals.

Reports of the injuries conducted in US dairy farms showed that injuries occurred while milking, herding, moving and feeding with an emphasis on milking [6,10,11]. A study in Colorado showed 47.9% of injuries to have been caused by milking, 14.0% by moving and 5.2% by herding [11]. Our study shows that Chinese dairy farmers mostly suffer from injuries when also performing milking

and feeding activities. Injuries were reported to be suffered at both the upper and lower extremities [26,27,35,36]. In our study, a high proportion of body parts injured included the upper and lower limbs; however, the highest proportion of injuries was located in the trunk. Based on studies of animal-related injuries, injuries were usually sprains, fractures, lacerations and contusions [11,26,35,36]. A study on injuries from dairy cattle activities showed 27% of injuries were contusions, 26% were sprains, 17% were fractures and 12% were lacerations [10]. Our results were consistent with previous studies, but a large proportion of Chinese dairy farmers suffered from superficial skin, muscle and tendon injuries rather than lacerations and contusions.

Alcohol consumption did not have a significant association with injuries. This finding is consistent with reports associated with animal-related injuries [24,36]. A study among Iowa livestock farmers showed no increase in the odds of injury for alcohol consumption when comparing injured farmers and non-injured farmers [36]. Dairy and beef farms in Ontario also found no association between injury rate and the use of drinking [24]. On the other hand, there were reports that alcohol is a major risk factor for agricultural farm-related injuries in the United States and in China [5,32,37]. A study in Colorado showed farmers who drank more than 3 times a week had a higher injury incidence rate compared to abstainers (3.35 injuries per 10 000 person-days of observation and 1.94 injuries per 10 000 respectively)[5]. In China, agricultural farmers who drank within the past month were at an increased risk for injury [32]. The differences in risk may be associated in the differences between the practices of dairy and agricultural farm processes as well as the presence of animals. In our study, the average amount, drinking years and dizziness after drinking were not associated with injuries. However, there was a significant difference in the injury rates in farmers who worked after drinking. Our study showed that farmers who do not work after drinking have a higher injury rate than farmers who work after drinking. However, continuing work after drinking should not lower the risk of injury and the higher injury rate of farmers who do not work after drinking may have been the result of potential under-reported responses due to thestigma of working after drinking.

Although this is the first study from China that assessed work-related injuries in dairy farmers, our results should be interpreted in the context of our study limitations. Our study is based on a self-reported questionnaire with a small sample size that is not representative of all dairy farmers in China. Data was collected from only one city, Tangshan of Northern China. Injuries were self-recalled on a 12 month basis that may have been under-represented as not all injuries may have been reported. Alcohol consumption may have been under-reported due to the cultural stigma of drinking especially for farmers who continue work after drinking.

## 5 Conclusion

In summary, there is little research on the injury risk of dairy farmers in China. Our study shows a significant association between a longer exposure time to animals and injuries. Injuries suffered by Chinese dairy farmers are similar with respect to the nature of the injury, injury activity and body part injured to its US counterparts. Our study also shows that safety training and alcohol consumption do not have a significant impact on rates of animal-related injuries. While differences in dairy farming methods exist between China and the United States, the industry still remains a dangerous sector for both countries. Since this study is the first to assess work-related injuries in dairy farmers in China, further research is needed to evaluate the important risk factors stressed in this study. Methods to increase awareness and prevent injury need to be developed to address this serious public health issue.

## 6 Contributions

Kevin Li: At the time of this study, Mr. Li was a research intern in the Center for Injury Research and Policy at Nationwide Children's Hospital, The Ohio State University College of Medicine. Mr. Li conducted the statistical analysis under the supervision of Dr. Huiyun Xiang, interpreted results, wrote the first draft of manuscript, reviewed comments by coauthors and revised

the manuscript, and approved the final manuscript as submitted. Ling Xue: Dr. Xue was the local principal investigator of this pilot study. She conceptualized and designed the study, supervised the data collection, and critically reviewed the manuscript. Shulan Pang and Weijun Guan: Drs. Pang and Guan participated in the study design and field data collection and critically reviewed the manuscript. Lorann Stallones and Huiyun Xiang: Drs Stallones and Xiang helped Dr Xue designed the study, and critically reviewed the manuscript. All authors approved the final manuscript as submitted.

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