



## Socio-environmental risk factors for medically-attended agricultural injuries in Wisconsin dairy farmers



Jeffrey J. VanWormer<sup>a,\*</sup>, Kathrine L. Barnes<sup>b</sup>, Stephen C. Waring<sup>c</sup>, Matthew C. Keifer<sup>d</sup>

<sup>a</sup> Center for Clinical Epidemiology and Population Health, Marshfield Clinic Research Foundation, United States

<sup>b</sup> National Farm Medicine Center, Marshfield Clinic Research Foundation, United States

<sup>c</sup> Division of Research, Essentia Institute of Rural Health, United States

<sup>d</sup> Department of Medicine and Public Health, University of Washington and Veterans Administration Puget Sound Health Care System, United States

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### ABSTRACT

**Background:** Accidents are common in the agricultural industry, particularly among dairy farmers. How said farmers get hurt is well established, but far less is known about how distal, socio-environmental factors influence injuries. This study examined associations between medically-attended agricultural injuries and: (1) personal sociodemographic characteristics, and (2) farm environment features and general safety practices.

**Methods:** A cross-sectional survey was implemented with linked data from electronic health records on prior agricultural injuries that occurred between 01/01/2002–12/31/2015. The sample included adult dairy producers who resided in north-central Wisconsin (USA) and were medically-homed to the Marshfield Clinic Health System. Multiple logistic regression was used to analyze associations between socio-environmental characteristics and agricultural injuries.

**Results:** There were 620 dairy farmers in the analytical sample, with 50 medically-attended agricultural injuries observed during the 14-year study time period (5.7 injuries per 1000 dairy farmers per year). In the multivariable model, the odds of agricultural injury were significantly greater among farmers who have private individually-purchased health insurance (OR = 4.25; 95% CI: 1.31, 13.84), do not live at their dairy operation (OR = 2.91; CI: 1.27, 6.67), and do not provide safety training to their workers (OR = 4.27; CI: 1.00, 18.21).

**Conclusions:** Dairy farmers in this analysis who did not live at their dairy operation, did not provide safety training to all their workers, or had individually-purchased health insurance were more apt to get injured, but more research is needed to confirm these findings in prospectively designed studies. How these factors can be directly addressed or otherwise used to better focus farm injury prevention initiatives should also be explored.

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### Introduction

With an annual fatality rate of 27 per 100,000 workers, farming is the sixth deadliest occupation in the U.S., second only to sales/delivery transportation in the absolute number of occupational deaths [1]. Rates of non-fatal agricultural injuries are much higher than severe injuries, but all injuries combined can generally be expected to impact about 10% of farm workers each year [2,3]. Precise injury estimates are complicated by how injury data is

collected, as farmers are known to delay medical care, save for the most acute health events [4,5]. Health hazards are unequally distributed across farming types/operations. For example, Pratt et al. [6] found that, after controlling for age and numbers of work hours, dairy farm owners appeared to be at particularly high risk with about 17 injuries per 100 dairy farm owners per year. Other studies have indicated farmers in dairy production are at somewhat lower risk compared to those in other agricultural areas, such as beef production [7].

How dairy farmers get injured has been examined in several prior studies. Use of heavy equipment remains the most common cause of fatal or disabling injury (e.g., tractor rollover, rotating shaft entanglement) [8]. Less severe dairy farm injuries are usually the result of falls and interactions with animals [9,10]. Other causes of injuries include chemical exposures, confined space (e.g., manure

\* Corresponding author at: Center for Clinical Epidemiology and Population Health, Marshfield Clinic Research Foundation, 1000 North Oak Ave, Marshfield, WI 54449, United States.

E-mail address: [vanwormer.jeffrey@mcrf.mfldclin.edu](mailto:vanwormer.jeffrey@mcrf.mfldclin.edu) (J.J. VanWormer).

lagoons), and use of motorized equipment (e.g., all-terrain vehicles [ATV]) and power tools without personal protective equipment. Ways in which distal factors, including characteristics of the farm environment and farmers' sociodemographic profile, might also influence dairy injuries are not well known. A recent meta-analysis of 32 studies, focused on all agricultural operations from around the world, found that males, full-time farmers, farm owners, those with a history of prior injury, hearing loss, regular medication use, and stress/depression were associated with ~1.5–2.0 higher odds of agricultural injury (usually self-reported) [11].

While nearly all agricultural injuries are theoretically preventable, identifying the modifiable factors that can reduce injury risk in dairy operations is a challenge. Developing a better understanding of injury determinants may be particularly important for dairy farmers due to the unique, technologically dynamic environment in which they work. Minimal research has been conducted on dairy injury antecedents beyond the most proximal causes (e.g., tractor rollover, animal assault). Methods that combine primary and passive data collection, via linking survey data on general dairy farm exposures to injury documentation in electronic health records (EHR), may offer advantages in terms of minimizing respondent burden and negating injury recall biases. There are burgeoning models of the secondary use of EHR data to capture various disease events and certain types of injuries [12,13], but such methods have only recently been tested to augment farm injury surveillance [14]. The purpose of this study was to examine associations between medically-attended agricultural injuries and: (1) personal sociodemographic characteristics, and (2) farm environment features and general safety practices. This was an exploratory study designed to inform future agricultural injury

prevention research and safety initiatives, thus analyses were conducted without a priori hypotheses.

## Materials and methods

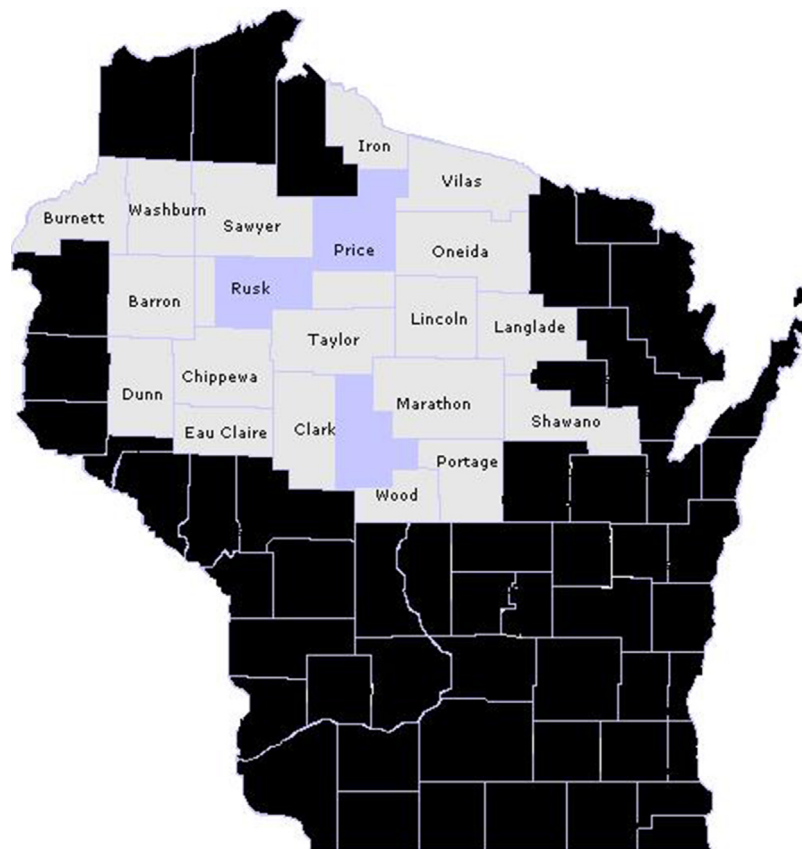
### Design and setting

This was a cross-sectional survey with linked participant EHR data on agricultural injuries that occurred over a prior 14-year period (01/01/2002–12/31/2015). The target population included adult dairy producers from north-central Wisconsin, and for whom there was a reasonable expectation of complete capture of their medical care by Marshfield Clinic Health System's (MCHS) electronic data repository. MCHS is a large integrated care system serving a predominantly rural area of north-central Wisconsin.

### Sampling frame

Survey inclusion criteria were, as of December 2015: (1) listed on the register of licensed dairy producers from Wisconsin's Department of Agriculture, Trade and Consumer Protection, (2) dairy production operation address listed within the targeted 20-county region (as outlined in Fig. 1), and (3) complete capture of medical care within MCHS data systems, as evidenced by at least one of the following:

- Member of MCHS's Virtual Data Warehouse population – The Virtual Data Warehouse is a defined medical research population used as part of the broader Health Care Systems Research Network [15]. It includes individuals who are members of an



**Fig. 1.** Source population, including individuals with a dairy production address in the outlined 20-county region of Wisconsin (lighter shaded 20 counties) and who were: (1) members of Marshfield Clinic Health System's Virtual Data Warehouse population (i.e., members of Security Health Plan of Wisconsin and/or residents of the Marshfield Epidemiologic Study Area [24 darker shaded postal code areas]), or (2) medically-homed to the Marshfield Clinic Health System (i.e., primary care provider assigned to them, or with a preponderance of primary care visits having occurred at a Marshfield Clinic Health System center over the past three years).

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