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# Identifying and mitigating risks for agricultural injury associated with obesity

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ABSTRACT

In some occupational contexts overweight and obesity have been identified as risk factors for injury. The purpose of this study was to examine this hypothesis within farm work environments and then to identify specific opportunities for environmental modification as a preventive strategy. Data on farm-related injuries, height and weight used to calculate body mass index (BMI), and demographic characteristics were from the Phase 2 baseline survey of the Saskatchewan Farm Injury Cohort; a large cross-sectional mail-based survey conducted in Saskatchewan, Canada from January through May 2013. Multivariable logistic regression was used to examine associations between BMI and injury. Injury narratives were explored qualitatively. Findings were inconsistent and differed according to gender. Among women ($n = 927$), having overweight (adjusted OR: 2.94; 95% CI: 1.29 to 6.70) but not obesity (1.10; 95% CI: 0.35 to 3.43) was associated with an increased odds of incurring a farm-related injury. No strong or statistically significant effects were observed for men ($n = 1406$) with overweight or obesity. While injury-related challenges associated with obesity have been addressed in other occupational settings via modification of the worksite, such strategies are challenging to implement in farm settings because of the diversity of work tasks and associated hazards. We conclude that the acute effects of overweight in terms of injury do require consideration in agricultural populations, but these should also be viewed with a differentiation based on gender.
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## 1. Introduction

Overweight and obesity are known risk factors for occupational injury (Janssen et al., 2011; Ostbye et al., 2007; Pollack et al., 2007). High prevalence levels of overweight and obesity have been reported for rural populations in Saskatchewan (Chen et al., 2009; Pickett et al., 2015). Biological mechanisms that may underlie such effects include the influence of altered gait and balance, increased forces involved in falls, higher rates of sleep apnea and fatigue, and increased susceptibility to musculoskeletal damage due to comorbidities (e.g., osteoarthritis) (Janssen et al., 2011). Additionally, excessive body weight can create physical challenges in manual work situations. Mechanistically, these occur during lifting, bending, reaching, and pushing/pulling, and through poor mobility, reduced grip strength, and poor anthropometric fit (Jensen, 2005).

Historically, occupational interventions for overweight and obesity, such as workplace wellness programs (Osilla et al., 2012), have attempted to address physical activity and dietary behaviours in the workforce. These initiatives have had little impact on body weight over the long-term (Anderson et al., 2009). Furthermore, while behavioural-based wellness programs are practical for large workplaces, they are more challenging for small, independently operated farm operations. Obesity can be managed in the workplace by addressing the physical barriers that restrict the quantity and quality of participation in work by persons affected by obesity (Forhan and Gill, 2013). This could potentially be achieved by environmental modification to mitigate risks for occupational injury. In farm work contexts, this could include modifications to machine design and configuration, clothing design, ergonomic modifications, and optimization of structures and other aspects of the physical environment to reduce hazardous exposures (Helander, 2005; Pheasant and Haslegrave, 2006; Marras et al., 2000; Carrivick et al., 2005). Obesity-related risks could also be addressed through modification to work roles and practices performed by obese workers.

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We had the opportunity to explore relationships between weight and risk for injury in a large cross-sectional analysis of farmers and their families. Our specific objectives were as follows: (1) to examine the association between body mass index (BMI) and occupational injury in a farm population known to be vulnerable to both obesity (Pickett et al., 2015) and occupational injury (Canadian Agricultural Injury Surveillance Program, 2003); and (2) through review of case injury reports involving farm people affected by overweight and obesity, to identify specific opportunities to modify the farm work environment as a preventive strategy.

## 2. Methods

### 2.1. Study design and population

This study used reports compiled in January to May, 2013 during a Phase 2 baseline cross-sectional health survey of the Saskatchewan Farm Injury Cohort (Pickett et al., 2008). In Phase 1 of this study, survey procedures in this cohort were tested via a pilot randomized trial (Day et al., 2008) and are described in detail elsewhere (Pickett et al., 2008). The Dillman total design method for mailed-based surveys was employed in both study phases (Dillman, 2000). The Phase 2 sampling frame was built by augmenting the sample that remained at the end of the Phase 1 cohort, and this included 74 rural municipalities (the 50 original plus 24 additional), selected proportionally by soil zone to provide a large and heterogeneous sample of Saskatchewan farm operations. In Phase 2, participation rates were 93% at the rural municipality level and 48% at the farm level. Questionnaires were completed by a single informant on each farm. Informed consent was indicated through completion and return of the questionnaire. The study protocol was approved by the Behavioural Research Ethics Board of the University of Saskatchewan.

### 2.2. Key study variables

Body mass index (BMI) values were calculated using self-reported height and weight (mass (kg)) divided by height squared ($m^2$), and used to create non-overweight (BMI < 25 $kg/m^2$), overweight (BMI 25–29.9 $kg/m^2$), and obese (BMI ≥ 30 $kg/m^2$) categories. Participants with an underweight BMI ($n = 18$) were included in the non-overweight study group, and for children aged 7 to 17, internationally accepted age and sex-specific thresholds were used for the three BMI categories (Cole et al., 2000).

Farm-related injuries were defined as "… injuries that occurred in a farm environment whether you were working or not. This includes injuries that occurred off-farm but involved farm work (e.g., driving a tractor on a public road). This also includes being poisoned or burned." We asked respondents to recall injury events in the prior calendar year (2012). Additionally, for their one most serious injury, respondents provided a structured narrative that included information on what they were doing, where and how it happened, what went wrong, and the nature and anatomical site of injury experienced.

Individual level factors that were potential confounders between BMI and injury included the following: age in years, sex, relationship to the farm owner-operator ('primary owner-operator', 'spouse', 'parent, child, or other relative'), highest level of education completed ('less than high school', 'completed high school', 'completed post-secondary'), binge drinking as reported by the consumption of 5 or more alcoholic drinks at one sitting ('never', 'at most once a month', 'at most once a week', 'more than once a week'), current smoker ('yes' or 'no'), number of doctor-diagnosed comorbidities ('0', '1', '2 or more' of the following: sleep apnea, rheumatoid arthritis, osteoarthritis, high blood pressure, heart disease, diabetes, stomach or intestinal problems, asthma or other lung conditions, dementia, hearing loss, depression, chronic pain, incontinence/urinary problem), typical sleep duration ('>7 h', '6 to 7 h', '<6 h'), excessive daytime sleepiness (Epworth Sleepiness score ≥ 11) (Johns and Hocking, 1997), and hours of farm (hours per week, averaged over the full year) and off-farm work ('part-time' (<30 h/week), 'full-time' (≥30 h/week)). Sex was also examined as a potential effect modifier (Janssen et al., 2011).

Farm (area) – level factors considered as confounders included commodities produced, total farm acreage ('0–500', '501–1500', '1501–2500', '>2500' acres), and farm safety conditions/practices ("Would you say the safety conditions and practices on your farm are:" 'Excellent', 'Good', 'Fair' or 'Poor'). In addition, a socioeconomic index was created from three items; frequency that cash flow shortages and also debt were sources of worry on the farm ('every day', 'at least once a week', 'at least once a month', 'less than once a month', 'never'), and farm operation income at the end of the most recent fiscal year ('large deficit', 'small deficit', 'break even', 'small surplus', 'large surplus'). These items were internally consistent (Cronbach's alpha = 0.82) and were summed and grouped into an overall socio-economic index that was subsequently divided into tertiles.

Work task exposures. We assessed time engaged in the following work tasks (days per year or hours per week) over the previous year: operating tractors and combines, tractor and combine maintenance, chores with large and small animals, herd maintenance and veterinary activities, lifting, lowering, or carrying heavy objects, using a shovel or pitchfork, working with hands over shoulder height, operating power tools. Origins and testing of these items is described elsewhere (Pickett et al., 2008).

### 2.3. Statistical analysis

SAS version 9.4 (SAS Institute, Cary, NC, 2010) was used for all analyses. Following initial descriptive analyses, multivariable logistic regression using the SAS procedure PROC GLIMMIX was utilized to examine associations between BMI categories and farm injury, adjusting for clustering by farm using a random effect statement. Guided by previous study findings (Janssen et al., 2011) we examined whether sex was an effect modifier in the association between BMI status (the primary exposure) and injury through inclusion of a two-way interaction term; subsequent modeling was then stratified by sex. Potential confounders were identified through backwards elimination ($p < 0.15$) and change in estimate approaches (>10%) (Rothman et al., 2008). Any covariate identified as a confounder was included in each of the sex-stratified models. The final analysis was restricted to participants with valid responses to items included in the regression models ($n = 2333$ (1406 males and 927 females)). For the overweight and obesity exposures this study was 80% powered to detect modest injury effects in men (OR: 1.8 to 2.0) and in women (OR: 2.1 to 3.3) at an alpha level of 0.05, 2-sided. For the other categorical exposures, the study was similarly powered to detect modest to large effects (OR 1.9 to 4.6).

Further analyses were conducted to complement the regression findings and inform prevention strategies. Time reported engaging in specific farm work tasks was examined descriptively by sex and BMI status to identify work exposure patterns. Following the quantitative analysis, we also explored qualitatively the narratives associated with individual injury events. For the subset of injuries reported by farm women, thematic coding was performed, and common themes were extracted in the areas of incident cause, work task involved, and how weight may have influenced risk. Based on the identified themes we referred to published literature and the expertise of our research team to make suggestions for common environmental or behavioural strategies that could be used to address overweight and obesity as a potential cause of farm-related injury.

## 3. Results

Overall, 39% (95% CI: 37% to 41%) of individuals in the farm cohort were classified with an overweight BMI, and 26% (95% CI: 24% to 28%) were classified as having obesity, with prevalence levels higher

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