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SYMPOSIUM: SEX DIFFERENCES IN MUSCULOSKELETAL DISEASE AND SCIENCE

Do Sex Differences Exist in Rates of Falls and Fractures in Hutterite, Rural, and Nonrural Populations, Aged 20 to 66 Years?

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Abstract

Background Falls and fractures are a major public health concern with an economic impact of more than USD 19 billion per year. Extensive research into the risk of falls and fractures in elderly populations has been performed; however, little is known about fall or fracture risk in younger populations. Additionally, sex- and population-specific (rural versus nonrural) fall and fracture risk may be important in identifying groups most at risk in an effort to develop preventive measures.

Questions/purposes The purpose of this study was to determine whether sex and population (rural versus nonrural) differences exist in fall and fracture rates.

Methods Data from 1256 (538 men) participants of the South Dakota Rural Bone Health Study, a population-based cohort study, including those living a rural lifestyle (n = 349 non-Hutterites and 572 Hutterites) and a nonrural lifestyle (n = 335), were used to address our a priori hypotheses. Health histories, physical activity recall, anthropometric measurements, and dual-energy xray absorptiometry measurements of body composition were obtained longitudinally from participants every 18 months for 7.5 years. Falls and fractures were self-reported and fractures were confirmed through medical record review. Incidence rates were calculated as the number of falls or fractures per 1000 person-years and generalized estimating equations determined the association of sex and population group with fall and fractures rates while accounting for the repeated longitudinal measurements on the same person. All models adjusted for age group, percent time in moderate and vigorous physical activity, lean and fat mass, grip strength, and previous diagnosis of osteoarthritis.

Results Males aged 39 years and younger had a 135% greater fall risk than females in the same age category ($p = 0.03$), but there was no differences between males and females 40 years of age or older ($p = 0.26$; age-by-sex interaction, $p = 0.05$). No sex differences were observed for fracture risk. After controlling for covariates, rural and nonrural individuals fell at higher rates than Hutterites (84% and 50%, respectively, $p < 0.001$). Additionally,

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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rural individuals fractured at a 72% greater rate than Hutterites after controlling for covariates (p = 0.03).
Conclusions Sex differences in fall risk among younger individuals along with population differences in fall and fracture rates suggest that sex and lifestyle factors may have an impact on fall and fracture risk. Future studies focusing on sex- and population-specific risk factors are necessary to develop prevention strategies tailored to specific populations.
Level of Evidence Level III, prospective study.

Introduction

Falls and fractures in aging populations are a major public health concern. In 2000, the estimated annual cost of nonfatal fall-related injuries was USD 19 billion dollars with USD 12 billion related to fractures [14]. This is significant because studies have reported fall-related injury rates as high as 1398 per 100,000 adults aged older than 50 years [5] with a 78% increase in fall-related deaths reported in the last decade [15]. Little is known about sex differences and differences by lifestyle (rural versus nonrural) in fall and fracture rates in younger populations.

Sex differences have been reported in fall incidence with one study reporting rates of 368 and 611 falls per 1000 person-years in community-dwelling men and women older than 70 years of age [7]. Similarly, a study of elderly Japanese people living in Hawaii reported incidence rates of 139 and 276 falls per 1000 person-years for men and women, respectively [1]. More recently, data from the Maintenance of Balance, Independent Living, Intellect and Zest in the Elderly of Boston (MOBILIZE) study indicate that sex differences exist in fall rates for men and women based on whether the fall was indoors or outdoors with men sustaining more outdoor falls and women experiencing more indoor falls [3, 6]. Women also have been reported to be at greater fracture risk than men [4]. Many of the reports on fractures are limited to elderly populations and often include a subset of individuals at increased risk of fracture such as those with osteoporosis. These studies limit the applicability of the findings to a broader population; however, one study of a representative population with a broader age range (35 years and older) reported a greater fracture risk in women than men [9]. Thus, there is a need to investigate falls and fractures in nonelderly populations. Lifestyle also may influence fall and fracture rates among men and women.

Lifestyle differences, in particular urban versus rural lifestyle, have been implicated previously as a potential risk factor for fractures [2, 8]. Previous studies have reported lower fracture risk in elderly rural compared with urban populations in Scandinavia [2, 8], Australia [11], and the United States [9]. A study reported a lower hip fracture rate among old-order Amish in Lancaster County, PA, USA, compared with the general US population [16]. The reasons for the difference in fracture rates are unclear, but we hypothesized that lifestyle factors related to rural and urban lifestyles such as physical activity and presence of osteoarthritis may play important roles in fall and fracture risk.

The purpose of our study was to determine whether fall and fracture rates differed between sexes and among Hutterite, rural, and nonrural populations in eastern South Dakota. As previous investigators have reported, fracture rates are expected to be lower in rural than nonrural populations, but our study was unique in that it included the Hutterite population as well. Hutterites are an Anabaptist population living communally on colonies where they farm, raise livestock, and live a relatively subsistent lifestyle. Their inclusion in this study is unique in that it allows us to compare Hutterites with the other rural individuals to further investigate how lifestyle differences can affect fracture risk. Unique aspects of our study include the definition of rural being defined based on the lifestyle of the individual and not the geographic location in which they reside and the inclusion of younger (39 years and younger) as well as older (40–66 years at enrollment) individuals.

Patients and Methods

The South Dakota Rural Bone Health Study is a 7.5-year population-based longitudinal study of three distinct populations distinguished by lifestyle (Hutterite, rural non-Hutterite [NH], nonrural NH) [13]. Both the Hutterite and rural NH populations live a similar rural farming lifestyle, but their social structure is significantly different (Hutterites have a religion-based communal lifestyle). The non-rural NH population never lived on a working farm and would be expected to have lower levels of physical activity. Participants were enrolled between 2001 and 2004 and were 20 to 66 years of age at the time of enrollment.

Hutterites are an Anabaptist religious group who believe in isolated communal living and self-sufficiency through a technologically advanced agricultural-based rural lifestyle. To be classified as a Hutterite, an individual had to be of Hutterite descent (originating in the Tyrol region of Germany and Austria in the 1500s) and currently residing on a Hutterite colony. Rural and non-rural NH participants were recruited from eight counties in eastern South Dakota that contained at least one participating Hutterite colony. Rural NH participants were individuals who spent at least 75% of their life on a working farm while working less than 1040 hours per year off of the farm. To be considered nonrural the participant could never have lived on a working farm. Methods for recruiting and enrolling participants are described in greater detail elsewhere [13]. Of the 1271 participants, 585 (226 males) were Hutterite, 350 (184 males) were rural NH, and 336 (134 males) had never lived on an active farm (nonrural). Of these participants, 1208 (95%) completed through the third year and 1047 (82%) completed the 7.5 years of followup (82%, 85%, and 80% for Hutterite, rural NH, and nonrural, respectively). For the current analysis, participants were excluded if they had a condition known to significantly affect balance or bone health (cognitive disability, n = 9; Parkinson's disease, n = 2; history of stroke, n = 1; multiple sclerosis, n = 1; muscular dystrophy, n = 1; or rheumatoid arthritis, n = 1). A total of 1256 participants were included in the current analysis. Written informed consent was obtained from all participants and the protocol was approved by South Dakota State University institutional review board.

Procedures

Research staff obtained demographic and medical questionnaires every 18 months along with anthropometric, body composition, and grip strength measurements. Physical activity (7-day) recalls were obtained by research staff quarterly for the first 3 years and every 18 months thereafter, and percent time in moderate plus vigorous activity was calculated using a weighted average of time spent in moderate plus vigorous activity on both weekdays and weekend days. Height was measured in duplicate to the nearest 0.5 cm using a portable stadiometer (Seca, Chino, CA, USA) and weight was measured to the nearest 0.1 kg using a digital scale (Seca). Body composition measurements were obtained using dual-energy xray absorptiometry (QDR 4500A; Hologic, Bedford, MA, USA). Grip strength was measured using a Takei A5401 digital handgrip dynamometer (Takei Scientific Instruments Co, Ltd, Tokyo, Japan).

Medical questionnaires were completed by research staff during an interview with the study participant and included information on any diagnoses made, medications prescribed, or any fractures occurring in the past 1.5 years. All fracture reports were confirmed by reviewing medical records. Information on falls were not obtained during the first 3 years of the study but were added at the 72- and 90-month visits.

Data Analysis

Basic descriptive statistics were used to compare population groups by sex. Analysis of variance was used to compare means with Tukey's honestly significant difference used to adjust for multiple comparisons. Contingency table analyses were used for categorical data. Incidence rates per 1000 person-years and 95% confidence intervals were calculated for falls and fractures and populations were compared after stratifying by sex. For the calculation of incidence rates, each person contributed 1.5 person-years for each visit that was not missed, thereby accounting for missed visits. Age was stratified as less than 40 years or younger or equal to 40 years based on the median age.

Generalized estimating equations with a log link and exchangeable working correlation matrix estimated the association of sex and population group with the rate of fractures and falls while accounting for the repeated longitudinal measurements on the same person. We adjusted for the potential confounding effects of age group, percent time in moderate plus vigorous activity, lean and fat mass, grip strength, and presence of osteoarthritis before the fall or fracture. The significance of the age-by-sex, age-by-population, and sex-by-population interactions also was evaluated. The generalized estimating equations were fit using R statistical software (Version 3.1.2; R Project for Statistical Computing®, Vienna, Austria), whereas all other analyses were done in Stata (Release 12; StataCorp LP, College Station, TX, USA).

Results

There were significant age differences among populations for both females and males (both, $p < 0.001$) (Table 1). Rural NH females were older than Hutterite and nonrural females, whereas Hutterite males were younger than both rural and nonrural males (all, $p < 0.05$). Hutterites of both sexes were shorter than rural and nonrural participants. There also were population differences in grip strength and percent time in moderate plus vigorous activity for both females and males (all, $p < 0.001$). Hutterite females had greater grip strength than nonrural females and Hutterite males had greater grip strength than rural and nonrural males (all, $p < 0.05$ by Tukey's honestly significant difference test). In both females and males, nonrural individuals reported less time in moderate plus vigorous activity than Hutterite and rural NH individuals (all, $p < 0.05$ by Tukey's honestly significant difference test). Additionally, Hutterite females reported less time in moderate plus vigorous activity than rural NH females, whereas Hutterite males reported more time in moderate plus vigorous activity than rural NH males (Table 1; all, $p < 0.05$ by Tukey's honestly significant difference test).

There were significant population differences in the fall rate per person-year followup among females ($p < 0.05$) with Hutterite females having a lower fall rate than rural NH and nonrural females ($p < 0.05$ by Tukey's honestly significant difference test) (Table 1). Significant population differences in fall rates were observed among males ($p < 0.05$) with Hutterite males having lower rates than

Table 1. Population characteristics by sex

Population characteristics	Hutterite	Rural NH	Nonrural	Significance
Females (number)	352	165	201	
Age (years)	38.5 ± 12.8^{A}	47.0 ± 14.0^{AB}	41.2 ± 10.5^{B}	< 0.001
Weight (kg)	74.0 ± 15.8	73.9 ± 14.7	74.3 ± 17.7	NS
Height (cm)	161.9 ± 5.1^{AB}	164.4 ± 6.1^{A}	163.9 ± 6.3^{B}	< 0.001
Grip strength (kg)	32 ± 6^{A}	30 ± 6	29 ± 6^{A}	< 0.001
Lean mass (kg)	45.6 ± 6.4	45.7 ± 6.2	46.1 ± 7.4	NS
Fat mass (kg)	27.2 ± 10.4	27.1 ± 9.7	26.9 ± 11.1	NS
Moderate/vigorous activity (%)	20.2 ± 5.7^{AB}	22.2 ± 7.7^{AC}	17.3 ± 6.8^{BC}	< 0.001
Osteoarthritis (number, %)*	21 (6.0%)	36 (21.8%)	21 (10.5%)	< 0.001
Falls† (number)	97	86	136	
Fall density‡ (number/person)	2.2 ± 1.7	3.2 ± 3.7	2.9 ± 3.8	
Number of fractures§ (%)	18 (5.1%)	13 (7.9%)	15 (7.5%)	
Person-years	2326	1140	1269	
Number of falls/1000 person-years	200 (176–223)^{AB}	373 (326–421)^{A}	389 (343–434)^{B}	< 0.05
Fractures/1000 person-years	7.7 (4.2–11.3)	8.8 (3.3–14.2)	10.2 (4.7–15.8)	NS
Males (number)	220	184	134	
Age (years)	38.3 ± 12.2^{AB}	44.4 ± 13.6^{A}	42.5 ± 11.9^{B}	< 0.001
Weight (kg)	92.8 ± 16.7	94.9 ± 18.0	91.2 ± 18.0	NS
Height (cm)	176.6 ± 5.7^{AB}	178.6 ± 7.8^{A}	179.0 ± 7.4^{B}	0.001
Grip strength (kg)	55 ± 9^{AB}	51 ± 9^{A}	50 ± 9^{B}	< 0.001
Lean mass (kg)	67.6 ± 8.1^{A}	68.8 ± 8.6^{AB}	66.4 ± 9.5^{B}	0.05
Fat mass (kg)	22.3 ± 8.6	23.5 ± 9.6	20.0 ± 9.8	NS
Moderate/vigorous activity (%)	25.8 ± 6.7^{AB}	23.1 ± 8.3^{AC}	16.3 ± 7.3^{BC}	< 0.001
Osteoarthritis (number, %)*	16 (7.3%)	26 (14.1%)	10 (7.5%)	0.05
Falls† (number)	76	91	51	
Fall density‡ (number/person)	3.1 ± 3.8	4.0 ± 4.4	3.9 ± 5.0	
Number of fractures§ (%)	12 (5.4%)	16 (8.7%)	7 (5.2%)	
Person-years (years)	1345	1164	843	
Number of falls/1000 person-years	280 (244–317)^{AB}	555 (497–613)^{AC}	428 (368–488)^{BC}	< 0.05
Fractures/1000 person-years	8.2 (3.3–13.0)	12.9 (6.4–19.4)	8.3 (2.1–14.5)	NS

Significance based on analysis of variance for continuous variables; values with similar superscripts are different by Tukey's honestly significant difference at $p < 0.05$. Incidence rates were compared using incidence rate ratios; 95% confidence intervals that do not contain 1 indicate significance at $p < 0.05$. Falls, fall density, number of fractures, and person-years were included in the calculations of incidence and therefore were not compared. Data are observed means ± SD or (95% confidence intervals); *a previous diagnosis of arthritis at enrollment was not considered osteoarthritis (OA) unless they later stated OA specifically. Numbers (%) are those with an OA diagnosis before their 90-month visit; †the number of individuals who fell during the final 4.5 years of followup; ‡the average number of falls among individuals who fell at least once; §none of the participants had multiple confirmed fractures; NS = nonsignificant.

both rural NH and nonrural males and nonrural males having a lower rate than rural NH males.

Hutterite females experienced 11 lower extremity, five upper extremity, and two other (coccyx and vertebrae) fractures and Hutterite males experienced four lower extremity, five upper extremity, and three other (sacrum, rib, and sesamoid) fractures. Rural NH females experienced three lower extremity, five upper extremity, and five other (rib and phalange) fractures and rural NH males had six lower extremity, six upper extremity, and four other (rib and facial) fractures. Nonrural females had five lower extremity, six upper extremity, and four other (facial, phalange, rib, and vertebrae) fractures, and nonrural males had five lower extremity, one upper extremity, and one other (vertebrae) fracture. There were no population differences in fracture rates per 1000 person-years of followup among either females or males (Table 1).

Sex Differences in Falls and Fractures

Based on the longitudinal analysis controlling for percent time in moderate plus vigorous activity, lean and fat mass, grip strength, and presence of osteoarthritis, males younger than 40 years of age had a 135% significantly greater fall risk than females (Table 2; ratio of means and 95% CI of 2.35 [1.10–5.02], p = 0.03), but there was no difference between males and females 40 years of age or older (1.44 [0.77–2.71], p = 0.26) (Fig. 1A) (age-by-sex interaction significant at p = 0.05).

There was no difference in fracture risk between males and females (ratio = 0.78, 0.31–1.95, p = 0.59) (Table 2; Fig. 1B). This remained nonsignificant when fractures of the phalanges and head were omitted (ratio = 1.27 [0.39–4.12], p = 0.70).

Population Differences in Falls and Fractures

The longitudinal analysis controlling for covariates showed that both rural NH and nonrural individuals fell at higher rates than Hutterites; ratio of means based on longitudinal analysis were 1.84 (1.38–2.46, $p < 0.001$) for rural versus Hutterite and 0.50 (0.36–0.70, $p < 0.001$) for Hutterite versus nonrural populations (Table 2). There was no difference in fall rates between rural NH and nonrural individuals (0.92 [0.64–1.32], p = 0.65). These results are shown graphically (Fig. 2A).

There were no differences in fracture rates between Hutterites and nonrural individuals (0.67 [0.39–1.17], p = 0.16) or rural NH and nonrural individuals (1.16 [0.66–2.03], p = 0.61) (Table 2; Fig. 2B). However, rural NH had a 72% greater fracture rate than Hutterites (ratio of means based on longitudinal analysis: 1.72 [1.05–2.82], p = 0.03) (Fig. 2B). The population differences in fracture rates were consistent between sexes and age groups (< 40 and ≥ 40 years) (sex-by-population and age-by-population interactions not significant at $p > 0.05$). Population differences were attenuated when fractures of the phalanges and head were omitted from the analysis and the ratio of means for the rural NH population compared with the Hutterites was no longer significant (1.46 [0.78–2.73], p = 0.23). However, the ordering of the population

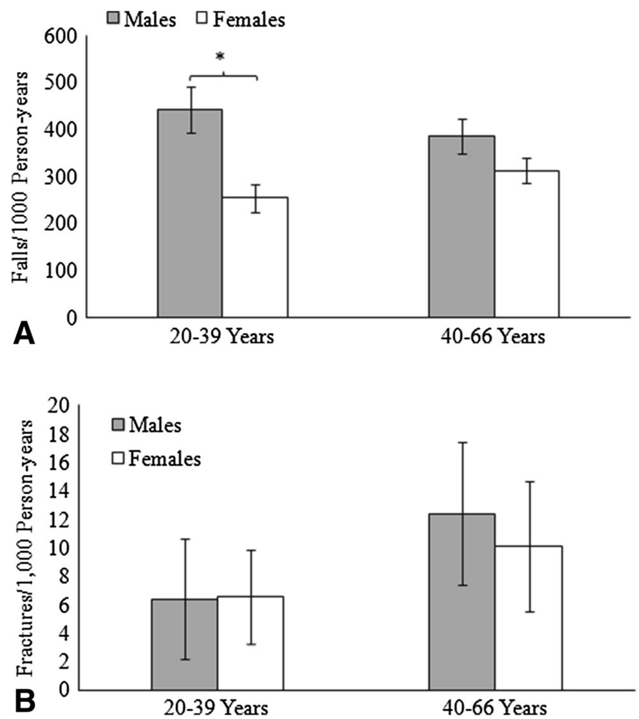

Fig. 1A–B Sex differences in fall and fracture rates are shown. (**A**) Males younger than 40 years of age had a greater fall rate than females (p = 0.03), but this difference was not apparent in males and females aged 40 years or older (p = 0.26) (age-by-sex interaction, p = 0.05). (**B**) There were no sex differences in fracture rates, and fracture rates were greater among individuals aged 40 years and older at enrollment compared with individuals 20 to 39 years of age (younger than 40 years versus 40 years and older: 0.52 [0.31–0.86, p = 0.01]). Covariates included in longitudinal analyses include age group, percent time in moderate plus vigorous activity, lean and fat mass, grip strength, and presence of osteoarthritis before the fall or fracture.

Table 2. Multiplicative effects from longitudinal analysis*

Outcome	Independent variable	Ratio of means (95% confidence interval)	P value
Falls	Males versus females (< 40 years)	2.35 (1.10–5.02)	0.03
	Males versus females (> 40 years)	1.44 (0.77–2.71)	0.26
	Hutterites versus nonrural	0.50 (0.36–0.70)	< 0.001
	Rural versus nonrural	0.92 (0.64–1.32)	0.65
	Rural versus Hutterites	1.84 (1.38–2.46)	< 0.001
Fractures	Males versus females	0.78 (0.31–1.95)	0.59
	Hutterites versus nonrural	0.67 (0.39–1.17)	0.16
	Rural versus nonrural	1.16 (0.66–2.03)	0.61
	Rural versus Hutterites	1.72 (1.05–2.82)	0.03

* Longitudinal analysis was used with generalized estimating equations with a log link (ie, Poisson regression) and an exchangeable working correlation matrix. Covariates included were age group (positive association with fractures, 0.52 [0.31–0.86, p = 0.01]), percent time in moderate plus vigorous activity (positive association with falls, p = 0.006), lean and fat mass, grip strength, and presence of osteoarthritis before the fall or fracture (borderline positive relationship with fractures, 1.73 [0.95–3.15, p = 0.07]).

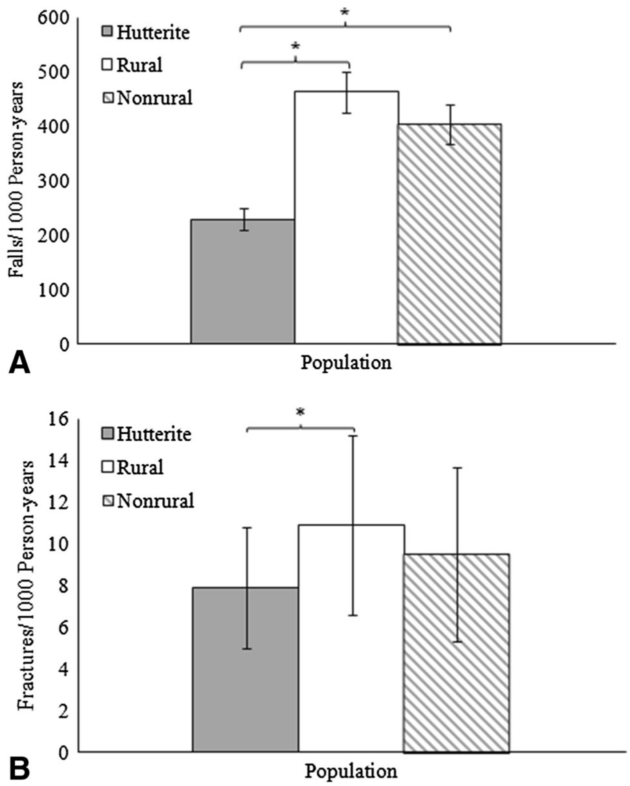

Fig. 2A–B Population differences in fall and fracture rates are shown. (**A**) Hutterites had lower fall rates than both rural NH and nonrural individuals (both, $p < 0.001$), and (**B**) fracture rates were higher in the rural NH population than in the Hutterite population ($p = 0.03$). Covariates included in longitudinal analyses include age group, percent time in moderate plus vigorous activity, lean and fat mass, grip strength, and presence of osteoarthritis before the fall or fracture.

fracture rates was similar (lowest to highest): Hutterite, nonrural, and rural NH.

Discussion

Falls and fractures are a major public health concern with a large economic impact and an even greater impact on quality of life for those who are affected. Previous studies have investigated risk factors and sex differences for falls and fractures in elderly populations, but little is known about risk factors and sex differences for falls and fractures in the nonelderly. The purpose of this study was to compare fall and fracture rates between sexes and among two populations representing differing rural lifestyles and a nonrural population.

Our study has a number of limitations. First, all data regarding falls were self-reported and therefore prone to recall bias. Fall data were collected every 18 months, and infrequent data collection could have led to underreporting, especially in the case of minor falls where no injuries occurred. We do not believe that the underreporting biased the results because underreporting is likely to occur to the same extent in males versus females and among populations. Therefore, even if there was underreporting of falls, it is unlikely that it would impact any sex or population differences we observed. Second, medical records were only reviewed for individuals reporting a fracture. It is therefore possible that fractures were underreported; however, our fracture rates were similar to those previously published elsewhere in similar populations [9] and if underreporting were an issue, we would have expected our fracture rate to be lower than what other studies have reported.

A problem that is often seen with longitudinal studies is a significant loss to followup. Our retention rates of 95% through the third year and 82% through 7.5 years of followup are excellent and not often obtained in longitudinal studies of this length. In addition, the followup rates were fairly constant among the three populations so it is unlikely that there is a bias among groups as to who was followed (82%, 85%, and 80% for Hutterite, rural NH, and nonrural, respectively). Another source of potential bias that could result, especially in studies of healthy individuals, is a selection bias if enrollment is based on public announcements and word of mouth. We tried to address this in the design of the study by conducting a population-based sampling of individuals who were randomly identified by their lifestyle.

In our study, sex differences for falls only existed among individuals younger than 40 years of age with men falling more than women. These differences among younger individuals is likely explained by differing daily activities in which males spend more time at risk for falls than females. This is supported by studies that have found location specific (indoor versus outdoor) differences in fall rates between males and females. Data from the MOBLIZE Boston study indicate that women experience far more indoor falls, whereas men actually experience far more outdoor falls [6]. As stated earlier, this may be explained by differing sex roles, in which women are working inside the home and men are working outside, and hence, their time spent at risk in those locations is different. The lack of sex differences we observed for falls in older individuals was somewhat surprising given that two previous studies reported fall rates in women to be almost double that of men [1, 7]. One reason for the difference in results could be that previous studies focused primarily on relatively small and typically elderly populations. Further study into sex-specific risk factors associated with falls throughout the life cycle is necessary to develop fall prevention protocols tailored specifically to specific subsets within a population.

A difference in work tasks in a communal setting may explain why Hutterites experienced a lower fall rate than the rural and nonrural populations. The Hutterites live communally and work is spread among many individuals, whereas in a noncommunal living arrangement, fewer individuals carry out the same tasks. Another explanation could be the higher grip strength among Hutterites compared with rural and nonrural participants. Grip strength has previously been associated with overall physical function [12] and maximal oxygen consumption [10]. Based on these findings, we postulate that Hutterites may have a higher level of physical function and overall fitness and therefore may be at a lower risk of falling. However, significant population differences existed when we statistically controlled for grip strength in our analysis.

Our finding that rural individuals have a greater fracture risk than Hutterites but not nonrural individuals was surprising given previous studies reporting higher fracture rates among individuals residing in rural areas compared with urban areas [2, 8, 9, 11]. Our finding of no population difference in fracture risk when phalangeal and facial fractures were removed suggests that the high fracture rate among rural individuals may be a result of work-related injuries.

In conclusion, males younger than 40 years of age had higher fall rates than females of similar age, but this difference did not exist in individual 40 years of age or older. The reason for the lower fall rate among Hutterites compared with the rural and nonrural populations and the lower fracture rate among Hutterites compared with rural populations are not known but may be related to their communal lifestyle and distribution of work-related tasks. Further investigation into identifying the factors that could explain lower fall and fracture rates among Hutterites could lead to interventions that may be beneficial in reducing fall and fracture risk in other populations.

References

1. Davis JW, Ross PD, Nevitt MC, Wasnich RD. Incidence rates of falls among Japanese men and women living in Hawaii. *J Clin Epidemiol.* 1997;50:589–594.
2. Diamantopoulos AP, Rohde G, Johnsrud I, Skoie IM, Hochberg M, Haugeberg G. The epidemiology of low- and high-energy distal radius fracture in middle-aged and elderly men and women in southern Norway. *PLoS One.* 2012;7:e43367.
3. Duckham RL, Procter-Gray E, Hannan MT, Leveille SG, Lipsitz LA, Li W. Sex differences in circumstances and consequences of outdoor and indoor falls in older adults in the MOBILIZE Boston cohort study. *BMC Geriatr.* 2013;13:133.
4. Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int.* 2006;17:1726–1733.
5. Kannus P, Parkkari J, Koskinen S, Niemi S, Palvanen M, Jarvinen M, Vuori I. Fall-induced injuries and deaths among older adults. *JAMA.* 1999;281:1895–1899.
6. Kelsey JL, Berry SD, Procter-Gray E, Quach L, Nguyen US, Li W, Kiel DP, Lipsitz LA, Hannan MT. Indoor and outdoor falls in older adults are different: the maintenance of balance, independent living, intellect, and Zest in the Elderly of Boston Study. *J Am Geriatr Soc.* 2010;58:2135–2141.
7. Luukinen H, Koski K, Hiltunen L, Kivela SL. Incidence rate of falls in an aged population in northern Finland. *J Clin Epidemiol.* 1994;47:843–850.
8. Mannius S, Mellstrom D, Oden A, Rundgren A, Zetterberg C. Incidence of hip fracture in western Sweden 1974–1982. Comparison of rural and urban populations. *Acta Orthop Scand.* 1987;58:38–42.
9. Melton LJ 3rd, Crowson CS, O'Fallon WM. Fracture incidence in Olmsted County, Minnesota: comparison of urban with rural rates and changes in urban rates over time. *Osteoporos Int.* 1999;9:29–37.
10. Mroszczyk-McDonald A, Savage PD, Ades PA. Handgrip strength in cardiac rehabilitation: normative values, interaction with physical function, and response to training. *J Cardiopulm Rehabil Prev.* 2007;27:298–302.
11. Sanders KM, Nicholson GC, Ugoni AM, Seeman E, Pasco JA, Kotowicz MA. Fracture rates lower in rural than urban communities: the Geelong Osteoporosis Study. *J Epidemiol Community Health.* 2002;56:466–470.
12. Shechtman O, Mann WC, Justiss MD, Tomita M. Grip strength in the frail elderly. *Am J Phys Med Rehabil.* 2004;83:819–826.
13. Specker B, Binkley T, Fahrenwald N. Rural versus nonrural differences in BMC, volumetric BMD, and bone size: a population-based cross-sectional study. *Bone.* 2004;35:1389–1398.
14. Stevens JA, Corso PS, Finkelstein EA, Miller TR. The costs of fatal and non-fatal falls among older adults. *Inj Prev.* 2006;12:290–295.
15. Stevens JA, Rudd RA. Circumstances and contributing causes of fall deaths among persons aged 65 and older: United States, 2010. *J Am Geriatr Soc.* 2014;62:470–475.
16. Streeten EA, McBride DJ, Lodge AL, Pollin TI, Stinchcomb DG, Agarwala R, Schaffer AA, Shapiro JR, Shuldiner AR, Mitchell BD. Reduced incidence of hip fracture in the Old Order Amish. *J Bone Miner Res.* 2004;19:308–313.