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Injurious Falls Are Associated with Lower Household but Higher Recreational Physical Activities in Community-Dwelling Older Male Veterans

Dawn P. Gill[a] G.Y. Zou[b, c] Gareth R. Jones[d] Mark Speechley[b]

[a]Graduate Program in Epidemiology and Biostatistics, and [b]Department of Epidemiology and Biostatistics, Schulich School of Medicine and Dentistry, University of Western Ontario, London, Ont., [c]Robarts Clinical Trials, Robarts Research Institute, and [d]Human Kinetics, Faculty of Health and Social Development, University of British Columbia – Okanagan, Kelowna, BC, Canada

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Motor activity · Accidental falls · Injuries · Veterans

Abstract
Background: Physical activity (PA) and exercise have numerous beneficial effects in older adults. The effect of sustaining an injury from a fall on subsequent PA levels has received little research attention, even though about a quarter of older adults who fall sustain a serious injury. Even less is known about the effect of injurious falls on different PA categorizations. ***Objective:*** To examine the role of injurious falls on subsequent household and recreational PA levels in older community-dwelling males who were all Canadian veterans of World War II and the Korean War. ***Methods:*** Data from a fall risk-factor modification trial were used for the present study. Falls and related injuries were ascertained prospectively using fall calendars. A brief, valid and reliable PA interview for older adults (Phone-FITT) measured household and recreational PA approximately 1 year later. Covariates were measured as part of the screening questionnaire administered at the start of the study. Multiple linear regression models were computed using household and recreational PA as dependent variables. ***Results:*** The present study included 200 males with a mean age 81 years (SD = 3.8). Half of the participants fell at least once and about one third reported at least one injury resulting from a fall. Multivariable analyses indicated that household PA scores were 3.1 points lower (95% CI = –5.8 to –0.3, p = 0.03) and recreational PA scores were 3.4 points higher (95% CI = 0.1 to 6.7, p = 0.04) among persons who had one or more falls leading to injury compared to those who did not fall or had one or more falls without injury. Analyses were adjusted for age, baseline PA, self-rated health, foot problems, balance problems, inability to stand without using armrests, vision and memory. ***Conclusion:*** Categorization of PA type (household vs. recreational) suggests distinct differences in PA response following an injurious fall. Use of an overall PA measure would obscure this finding. Following further research, the results from this study may help in the design of preventive strategies to maximize physical activity in those who have sustained an injurious fall.

Introduction

Physical activity (PA) and exercise have beneficial effects in older adults, including enhanced physiological capacity, improvements in overall physical functioning and reduced morbidity and mortality [1]. The maintenance of physiological capacity can keep older adults living independently above critical performance thresholds required for successful completion of many daily func-

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Dawn P. Gill, Department of Epidemiology and Biostatistics
Schulich School of Medicine and Dentistry, University of Western Ontario
Kresge Building, Room 201, London, ON, N6A 5C1 (Canada)
Tel. +1 519 661 2111, ext. 86266, Fax +1 519 661 3766
E-Mail Dawn.Gill@schulich.uwo.ca

tional activities [2]. Despite these benefits, many older adults are inactive. According to the Healthy People 2010 report, by age 75, one in three males and one in two females do not engage in regular PA [3].

Previous studies have examined risk factors associated with low PA in older adults. A number of these studies have considered some aspect of unintentional falls (e.g. recent fall history, fall-related injuries or fear of falling) as important risk factors for low PA. Four recent studies found some aspect of fall status (multiple falls, injurious falls or more recent falls) to be independently associated with PA restriction specifically due to fear of falling [4–7]. Tinetti and Williams [8] found that experiencing at least one injurious fall was associated with a decline in PA 3 years later. Other studies have failed to find a recent history of falls as a risk factor of either activity curtailment due to fear of falling or actual leisure-time PA cessation [9, 10]. Fear of falling, however, was found to be a risk factor for low recreational PA and cessation of recreational PA in two recently published studies [10, 11].

There are many methodological explanations for this heterogeneity of published findings. Study designs, participant samples and the conceptualization of falls and PA have varied greatly across studies. Falls and fall-related injuries were ascertained in a number of studies retrospectively over a range of time periods (e.g. past 90 days, past 3 months, past year) and fewer studies measured these events prospectively throughout the study period. Measures of PA have also ranged from restriction of PA due to fear of falling to measures of basic and instrumental activities of daily living (ADL, IADL), recreational PA, and other general PA measures. The majority of published studies have been cross-sectional, have used retrospective measures of falls and have focused primarily on activity restriction due to fear of falling as the measure of PA.

The specific relationship between sustaining an injury from a fall and subsequent PA levels has received less research attention, even though about a quarter of older adults who fall sustain a serious injury [12]. As well, there is an absence of literature examining the effect of injurious falls measured prospectively on different PA categorizations. Physical activity can be conceptualized broadly into two classifications; household activities (ADL, IADL) required for independent living and recreational/fitness activities that may engender a health and fitness benefit (walking, gardening) but are not immediately required for day-to-day activities that support functional independence. The objective of the present study was to examine prospectively, the effects of injurious falls on subsequent household and recreational PA levels in community-dwelling Canadian male veterans of World War II (WWII) and the Korean War.

Methods

Participants

The present study is based on data from the Project to Prevent Falls in Veterans (PPFV), a fall risk-factor screening and modification trial. The PPFV was approved by the Research Ethics Board for Health Sciences Research Involving Human Subjects at the University of Western Ontario. Written informed consent was obtained from all participants.

Design

The PPFV began with a baseline screening package mailed to three random samples of addresses of 1,000 Canadian veterans of WWII and the Korean War living in south-west Ontario. To be eligible for the study persons had to be Canadian veterans of WWII and the Korean War, living independently in the community, and able to understand and provide responses to a questionnaire. Initial eligibility was determined by Veterans Affairs Canada, who generated the simple random samples from their clients' lists. Instructions listed on the cover page of the questionnaire attempted to screen out those unable to complete the questionnaire for major health reasons such as Alzheimer-related dementia or stroke. Additional details of the sampling procedure and inclusion criteria for this phase are presented elsewhere [13].

Two of the three regions continued past the screening phase. Participants from the screening phase who consented to be recontacted and who had self-reported at least one modifiable risk factor for falling were randomized to either the Specialized Geriatric Services (SGS) group or the Family Physician (FP) group. Participants in the SGS arm received a comprehensive geriatric assessment and were provided with individual recommendations for fall risk factor reduction. Participants in the FP arm were sent a letter summarizing the risk factors that they reported on the screening questionnaire; a similar letter was sent to the participants' family physician. Any treatment was left to the discretion of the physician. Those with no reported modifiable risk factors for falling (Zero Mod group) formed an open arm in the study that received educational materials on fall prevention and healthy living. All participants were asked to send in monthly fall calendars to track their fall status for the duration of the study. The study concluded with a telephone interview which included a PA interview schedule, administered approximately 1 year after the start of the falls measurement period. For the present study, male veterans were the participants of interest.

Outcome Measures: Household PA and Recreational PA

At the end of the PPFV, participants were telephone-administered the Phone-FITT, a brief, valid and reliable PA interview designed specifically for community-dwelling older adults [14]. The Phone-FITT measures frequency and duration of household and recreational (including exercise-based) PAs performed indoors during a typical week in the past month. Physical activities dependent on weather, such as golf and gardening were measured with-

in the past year. Frequency was measured as the number of times PA was typically performed per week. Usual duration of each reported PA was measured in categories of 0–15, 16–30, 31–60 or 60+ min and coded from 1–4 for scoring purposes. Continuous summary scores incorporating frequency and duration can be calculated for household, recreational and total PA by adding the frequency and duration scores for each activity and then summing these for all activities in the given category (e.g. all activities classified as household PA). Higher scores represent higher PA levels and should be interpreted relative to scores in a given sample. The household PA summary score can theoretically range from 0 to 66 whereas the recreational PA summary score can range from 0 to 154. Household PA includes: light housework, meal preparation/clean-up, shopping, heavy housework, home maintenance (e.g. yard work, home repairs) and caregiving. Recreational PA includes: arm strengthening, leg strengthening, stretching and balance exercises, walking for exercise, dancing, swimming, bicycling, golf, and gardening as well as up to three other PAs.

From our previous work, test-retest reliability was demonstrated for both household and recreational summary scores in a convenience sample from the PPFV (n = 43, 79.4 ± 2.9 years, 51% male). Participants had the Phone-FITT administered to them, two times by the same interviewer, 7 days apart. Intraclass correlation coefficients and 95% CIs were 0.84 (0.73 to 0.91) for the household score and 0.88 (0.8–0.94) for the recreational score. Validity of the Phone-FITT was established in a random sample of individuals in older adult exercise programs (n = 48, 77.4 ± 4.7 years, 25% male). The comparison of Phone-FITT scores with accelerometer activity counts provided evidence for criterion-related validity. Spearman rho correlations and 95% CIs were 0.29 (0.01–0.53) for the household score and 0.46 (0.2–0.66) for the recreational score, which are similar in magnitude to other existing PA measures for older adults. In the validity study sample, evidence of known-groups and construct validity was also demonstrated and the mean time-to-complete the Phone-FITT was 10 min [14].

The original Phone-FITT also measured intensity of each activity by asking respondents whether on average when performing the activity, they were breathing normally, slightly out of breath, or too out of breath to carry on a conversation. The addition of intensity resulted in little or no improvement in validity or reliability. For the present study, household and recreational scores incorporating frequency and duration were the outcome variables of interest (hereafter referred to as household PA and recreational PA).

Primary Explanatory Variable: Injurious Fall Events

At the start of the intervention trial, participants were given a fall calendar and were asked to keep track of any falls daily by circling the days of the month when (and if) a fall occurred. A fall was defined as 'unintentionally coming to rest on the floor or ground'. This definition was printed on the inside of each calendar. The straightforward definition is similar to that recommended in a recently published consensus statement for fall injury prevention trials [15]. Due to the definition selected, falls reported can include those that are a result of a major intrinsic event such as syncope. At the end of each month, participants detached and mailed to the study office their calendar pages that were postage-paid and pre-addressed on the reverse side. Participants who did not return a calendar page for the previous month and those who reported any falls were telephoned. Those reporting any falls were interviewed to ensure that the reported fall met the study definition (e.g. near falls and falls caused by an external force such as a vehicle were excluded), and in order to gather additional details related to the fall(s), including whether any injuries were sustained. Injurious falls were defined as falls that resulted in contusions (bruises), abrasions (scrapes), lacerations (cuts), sprains or strains, back pain, fractures, head injuries and other unspecified injuries. This definition of an injurious fall is similar to the definition used in two recently published fall prevention trials [16, 17].

For the present study, the exposure of primary interest was having sustained an injury as a result of a fall, resulting in persons classified as either: (a) those who sustained one or more injurious falls (injurious fallers), or (b) those who did not fall (nonfallers) or those who sustained one or more falls without injury (non-injurious fallers). This conceptualization of injurious falls follows the logic of other prospective studies that assign those with hip fracture to the exposure group and assign anyone without hip fracture to the unexposed control without regard to whether or not they had fallen [18, 19], including those with previous fractures to bones other than the hip [18].

Covariates

The covariates tested for inclusion in the multivariable analyses were all measured as part of the screening questionnaire [13]. Age in years was categorized as 65–74, 75–84, and 85–99, corresponding to definitions that distinguish older adults as young-old, old and old-old [20]. Financial strain was measured by asking participants how their finances usually work out at the end of the month: (a) usually end up with some money left over, (b) have just enough to make ends meet, and (c) not enough money to make ends meet. Participants self-rated their health using five response options ranging from poor to excellent, and also self-rated their memory compared to 5 years earlier, using five response options ranging from much worse to much better. A global self-report question of PA asked participants to rate their PA level compared to their peers using response options ranging from much less to much more active, providing a baseline measure of overall PA. Open-ended questions assessed the number of family physician visits in the past month, number of days in a typical week that more than two alcoholic beverages were consumed, and number of current prescription medications. The potential for poor vision was assessed by asking participants to indicate the last time that they had their eyesight checked using four response options ranging from the past year to more than 5 years ago. The potential for high PA as a result of living in a multi-level residence was assessed by asking participants whether the rooms in which they slept and ate were on different levels. Balance problems were measured with the question:

Sometimes people get dizzy or light-headed, and lose their balance. Other people report a loss of balance in their legs. Do you ever feel that you are losing your balance other than when you feel dizzy or light-headed? By that we mean do you feel the problem is in your legs rather than in your head?

Lower-extremity strength was measured by asking participants if they were able to get up from a chair without using the armrests. Foot pathology was assessed with the question, 'Do you have serious problems with your feet (such as bunions, corns or

persistent foot pain)?' Study group assignment, a nominal variable with three categories (SGS group, FP group, Zero Mod group), was also tested for inclusion in the multivariable models to control for potential effects of the intervention on PA levels.

Statistical Analyses

Data quality was examined using frequency tables for categorical variables, and descriptive statistics and plots for continuous variables. Although missing values were less than seven percentage points for all covariates, in order to preserve the sample size by reducing loss of cases resulting from list-wise deletion in multiple regression, cold-deck imputation, in particular overall mean or median imputation, was employed [21]. Imputation was not employed for the injurious falls variable. For the dependent variables, household PA and recreational PA, overall mean or median imputation was performed for components of these summary scores following a priori counting rules. Briefly, if either frequency or duration is missing for a particular activity, then the subscore for that activity becomes missing and participation in that activity will no longer contribute to the summary score even though the activity was performed. As an example, if a participant reported that in a typical week in the past month, she performed light housework activities three times per week (frequency) but did not know typically how long she did this on each occasion (duration), then the activity sub-score for light housework would be calculated as missing and as a result, this activity would not be counted in the household PA summary score. Imputation was indicated for activity-specific frequency and duration variables if: (a) The variable had missing values of less than 10%, and (b) the subject reported participation in the activity of interest and had a valid response for either frequency or duration.

Bivariate analyses were conducted using the independent samples t test to examine differences in mean household PA and recreational PA between injurious fallers and nonfallers/noninjurious fallers. For multivariable analyses, two multiple linear regression models were performed using epidemiological model building techniques [22]. Ordinal-level covariates were treated as continuous variables by ordering responses from lowest to highest. Indicator variables were created for the SGS and FP groups, with the Zero Mod group as the reference category. Model building proceeded as follows:

(1) To test for effect modification, the injurious falls variable and all covariates were forced into the model and interaction terms (injurious falls × each covariate) were tested for removal using the backward elimination stepwise algorithm set at an alpha level of 0.05. Any covariates identified as effect modifiers were forced into subsequent models along with their interaction terms.
(2) Covariates deemed to be potential confounders based on the literature were forced into the model. Remaining covariates were tested as operational confounders of the association between injurious falls and household PA or recreational PA. Operational confounders were identified by removing each covariate from the model one at a time and subsequently examining the ± percentage change in the regression coefficient for injurious falls. It was determined a priori that if the change in the coefficient was at least 10%, then the covariate was declared an operational confounder and forced into subsequent models, along with any effect modifiers, interaction terms, and literature confounders. This approach has been suggested to be appropriate by others [23] and the 10% criterion is considered to be meaningful in epidemiological statistical analyses [24].
(3) Remaining covariates were tested to determine if any should remain in subsequent models in order to help better explain household PA or recreational PA, using a backward elimination stepwise algorithm with an alpha level set to 0.1, as recommended by Kennedy and Bancroft [25].

Following model building, regression diagnostics were performed to ensure that the data fit the proposed models. Specifically, failure in model fit was examined by looking for multicollinearity among the explanatory variables, influential outliers, non-normality of the residuals and nonlinear effects [23]. Unless otherwise indicated, an alpha value of 0.05 was used for all statistical tests. Data management and statistical analyses were performed using SAS v. 9.1.3.

Results

The flow of participants from the start of the PPFV to those included in the present study is detailed in figure 1. The risk factor screening phase of the PPFV started with 1913 Canadian veterans of WWII and the Korean War. Of these, 241 were eligible and agreed to enrol in the risk factor modification trial, and an additional 56 respondents with no identified modifiable risk factors for falling agreed to take part in the open arm of the trial. Reasons for the decrease in sample size for the present study include withdrawal, long-term care, illness, lost to follow-up and death. As well, exclusions based on the objectives of the present study and to reduce bias, resulted in a further slight decrease in sample size. These exclusions were: (a) female gender (total of 6 participants), (b) injurious falls data collection of 80 days or less (total of 3 participants) and, (c) date of the Phone-FITT interview preceded date of first injurious fall in the database and the discrepancy could not be resolved (total of 2 participants). A total of 267 male veterans (55 in Zero Mod group, 117 in SGS group, and 95 in FP group) had complete prospective fall data. Loss of cases following collection of fall data was due to missing data on the Phone-FITT (i.e. did not complete follow-up interview or missingness on the Phone-FITT was in excess of pre-specified criteria to allow for data imputation). The resultant sample size for the present study was 200 male veterans.

Characteristics of the Sample

Participant characteristics are described in table 1. Male veterans had a mean age of 81 years (SD = 3.8). About one third of participants reported serious foot problems, a slightly higher percentage reported balance

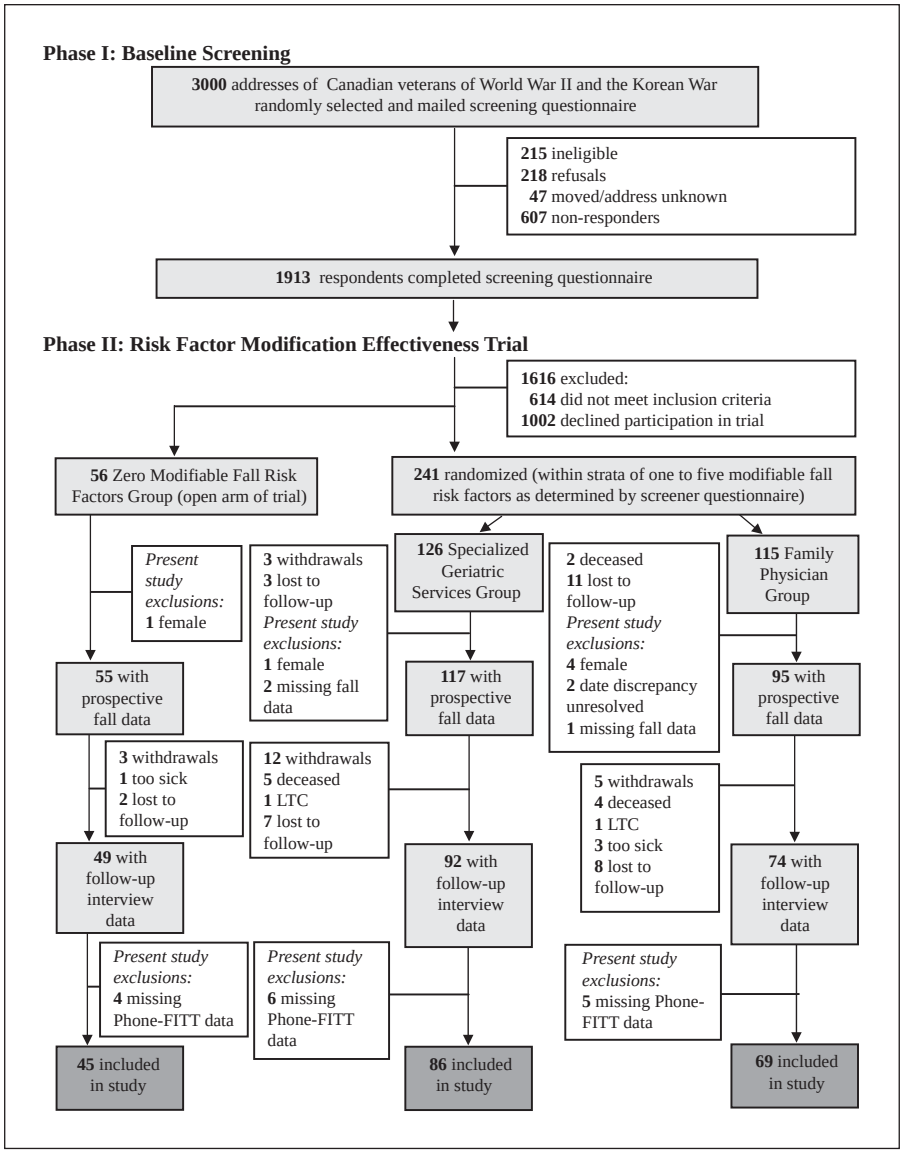

Fig. 1. Overview of participants included in the present study. LTC = Long-term care.

problems in their legs, 43% reported being unable to stand up without using armrests and close to half reported currently taking four or more prescription medications. Fair or poor health was indicated by 37% of participants, 13% reported being less active than their peers and 40% reported that their memory was worse than it was 5 years earlier. One half of participants reported falling and one third of participants reported at least one injury resulting from a fall. We compared the 200 with complete data with 67 individuals who would have been eligible but did not have complete Phone-FITT data, with the following results: injurious falls ($p = 0.88$), age ($p = 0.62$), baseline PA ($p = 0.001$), self-rated health ($p = 0.002$), leg weakness ($p = 0.09$), last vision check ($p = 0.27$), memory compared to 5 years ago ($p = 0.32$), foot problems ($p = 0.76$), and balance problems in the legs ($p = 0.31$). Therefore, the only statistically significant differences were that those who did not complete the Phone-FITT interview, self-reported worse health and less baseline PA than those who were included in the analysis for the present study.

In our sample of 200 participants, 64 were classified as injurious fallers and therefore reported at least one fall that led to injury. The worst injury sustained per injurious faller was examined with the following results: 6 (9.4%) suffered serious injuries (three head injuries, one

hip fracture and two fractures other than the hip), 19 (29.7%) suffered strains or sprains, 9 (14.1%) had falls resulting in lacerations, 27 (42.2%) had falls resulting in contusions and abrasions, and 3 (4.7%) individuals sustained other, unspecified injuries as a result of a fall.

Effect of Injurious Falls on Household PA and Recreational PA

Descriptive statistics of household PA and recreational PA and bivariate analyses are presented in table 2. In the present study, the minimum score for either household PA or recreational PA was zero, corresponding to no reported PA. The maximum scores were fairly close between household PA and recreational PA, despite the fact that more recreational PAs are measured during the interview. Mean household PA was slightly higher than recreational PA, reflecting the important contribution of household PAs to overall PA in this sample of older male veterans. Injurious fallers had lower subsequent household PA compared to nonfallers/noninjurious fallers; although not statistically significant, the difference between these two groups reversed when recreational PA was examined. In analyses not presented, the mean difference of total PA between these two groups was also examined. The measure of total PA is a combination of the household PA and recreational PA summary scores derived from the Phone-FITT. The independent samples t test was used to obtain a mean difference of total PA between the two groups of 0.6 (–4.5 to 5.6), p = 0.82. These results show that the effects seen on household PA and recreational PA are washed out when a general measure of PA is used.

The multivariable regression models of household PA and recreational PA on injurious falls are presented in table 3. None of the interaction terms tested in the models remained significant. A number of covariates (age, baseline PA, self-rated health, foot problems, balance problems, inability to stand without using armrests, vision and memory) were deemed possible confounding variables and were forced into each model. Remaining variables (financial strain, alcohol, prescription medications, general physician visits, one-level residence, group status) did not remain in either model following testing as operational confounders or other important covariates according to prespecified criteria.

Compared to nonfallers/noninjurious fallers, injurious fallers had a household PA score that was 3.1 points lower (with a range of plausible values of 5.8–0.3 points lower) and a recreational PA score that was 3.4 points higher (with a range of 0.1–6.7 points higher), after ad-

Table 1. Participant characteristics (n = 200)

Characteristic	n (%)
Age	
65–74 years	10 (5)
75–84 years	159 (79.5)
85–99 years	31 (15.5)
Finances at end of month	
Not enough money	1 (0.5)
Just enough money	49 (24.5)
Money left over	150 (75)
1+ falls over approximately one year	99 (49.5)
1+ injurious falls over approximately one year	64 (32)
Foot problems	62 (31)
Balance problems in legs	74 (37)
Unable to stand up without using armrests	85 (42.5)
Last vision examination	
5+ years ago	6 (3)
3–5 years ago	4 (2)
1–3 years ago	37 (18.5)
Within past year	153 (76.5)
Number of prescription medications	
0	21 (10.5)
1	22 (11)
2	36 (18)
3	32 (16)
4+	89 (44.5)
Days per week >2 alcoholic drinks consumed	
0	158 (79)
1	19 (9.5)
2	8 (4)
3+	15 (7.5)
Eat and sleep on same level	156 (78)
Number of visits to general physician within past month	
0	63 (31.5)
1	98 (49)
2	27 (13.5)
3+	12 (6)
Self-rated health	
Poor	9 (4.5)
Fair	65 (32.5)
Good	91 (45.5)
Very good	33 (16.5)
Excellent	2 (1)
Activity level compared to peers	
Much less active	3 (1.5)
Less active	23 (11.5)
About as active	84 (42)
More active	78 (39)
Much more active	12 (6)
Memory compared to 5 years earlier	
Much worse	3 (1.5)
Worse	77 (38.5)
About the same	118 (59)
Better	1 (0.5)
Much better	1 (0.5)
Study group	
Zero modifiable risk factors group	45 (22.5)
Family physician group	69 (34.5)
Specialized geriatric services group	86 (43)

Table 2. Mean household and recreational physical activity scores by injurious falls status

Physical activity score	Total sample (n = 200)			1+ falls, any injury (n = 64)			No falls or 1+ falls, no injury (n = 136)			Difference between two groups[1]			
	mean	SD	range	mean	SD	range	mean	SD	range	mean	SE	95% CI	p
Household	18.1	9.6	0 to 44.0	15.9	10.5	0 to 44.0	19.2	9.0	0 to 40	3.3	1.5	0.5 to 6.2	0.03
Recreational	15.8	11.4	0 to 48.3	17.6	11.6	0 to 46.2	14.9	11.3	0 to 48.3	–2.7	1.7	–6.1 to 0.7	0.12

[1] Determined from the independent samples t test under the assumption of unequal variances.

Table 3. Multivariable linear regressions of household and recreational physical activity on injurious falls (n = 200)

Characteristic	Household physical activity				Recreational physical activity			
	b	SE	95% CI	p value	b	SE	95% CI	p value
1+ injurious falls	–3.06	1.38	–5.78 to –0.33	0.03	3.43	1.67	0.13 to 6.73	0.04
Age[1]	–1.25	1.46	–4.12 to 1.62	0.39	–2.68	1.76	–6.16 to 0.79	0.13
Activity compared to peers	–1.33	0.91	–3.13 to 0.47	0.15	0.70	1.10	–1.48 to 2.88	0.53
Self-rated health	1.92	0.95	0.05 to 3.79	0.04	3.44	1.15	1.18 to 5.71	0.003
Foot problems	2.77	1.54	–0.26 to 5.80	0.07	–2.34	1.86	–6.01 to 1.32	0.21
Balance problems in legs	–3.92	1.49	–6.85 to –0.98	0.009	–1.24	1.80	–4.79 to 2.32	0.49
Inability to stand without using armrests	–4.37	1.58	–7.50 to –1.25	0.006	–1.06	1.92	–4.84 to 2.73	0.58
Last vision examination	2.27	0.97	0.37 to 4.18	0.02	1.54	1.17	–0.77 to 3.85	0.19
Memory compared to 5 years ago	0.01	1.17	–2.29 to 2.32	0.99	0.19	1.42	–2.60 to 2.99	0.89
Adjusted R^2	0.15				0.12			

Response categories for all ordinal variables were ordered from lowest to highest (e.g. activity compared to peers: 1 = much less active and 5 = much more active). All covariates listed in the table were forced into the models along with the primary explanatory variable (injurious falls) in order to control for possible confounding, if they were not statistically significant. Other covariates tested for inclusion in models were: financial strain, alcohol intake, prescription medications, family physician visits, one-level residence and group status. Interaction terms of each covariate by injurious falls were also tested for inclusion in the models. b = Regression coefficient.

[1] Age categories (1 = 65–74, 2 = 75–84, 3 = 85–99) were entered for model fitting purposes.

justing for age, baseline PA, self-rated health, foot problems, balance problems, inability to stand without using armrests, vision and memory. The covariates included in both models were identical and the direction of the coefficients for these covariates was consistent with hypothesized relationships. A differential influence of injurious falls on household PA and recreational PA was observed, following the trend seen in the bivariate analyses. Statistical significance was reached in the recreational PA multivariable model even though this did not occur in the simple bivariate analyses. Imputed covariate data were used to maximize the sample size and statistical power available for analyses. When the models were re-run using non-imputed forms of covariates the basic finding was maintained: household PA is lower and recreational PA is higher among injurious fallers (n = 185 in both models). The household PA beta coefficient was slightly weaker (–2.77 vs. –3.06), with an absolute change of 0.29 points and borderline statistically significant (p = 0.06), due to a smaller sample size. The beta coefficient for recreational PA score was slightly stronger (3.87 vs. 3.43), with an absolute change of 0.44 points and in this model, statistical significance did not change.

Regression diagnostics for the household PA model revealed no problems with data fit to the linear regression model. For the recreational PA model, possible heteroscedasticity was identified but upon further testing, the model proved to be robust and it was determined that the usual tests of the regression parameters were appropriate. Although both household PA and recreational PA dem-

onstrated slight positive skewness (0.18 and 0.66), the studentized-deleted residuals (for both variables) were approximately normally distributed. Due to variable numbers of injurious falls, and times between these falls and assessment of PA, supplementary regression models were computed. Neither the number of injurious falls or time from most recent injurious fall to PA assessment was statistically significant in predicting either type of PA (household PA: $p = 0.22$ or 0.16; recreational PA: $p = 0.96$ or 0.11).

Discussion

The present study prospectively examined the effect of sustaining an injurious fall on physical activity in older community-dwelling males. Injurious falls were associated with lower subsequent household PA but higher recreational PA after adjusting for age, baseline PA, self-rated health, foot problems, balance problems, inability to stand without using armrests, vision, and memory. These findings would have been obscured had a general measure of PA (e.g. total PA) been used instead. Household PAs are everyday lifestyle habits that comprise a portion of nonexercise activity [26, 27]. They include PAs that must be performed as part of independent living, as reflected in the overlap between them and measures of ADL and IADL. Most older adults undertake household PAs but fewer participate in recreational PAs, also commonly referred to as leisure-time PA or a form of this [28]. Recreational PAs do not include essential PAs and their performance requires functional abilities, interest, and perceived ability to participate in these PAs, among other factors [28].

The effect of sustaining an injurious fall on different categorizations of PA in older adults has received little research attention. Studies have looked more generally at fall history, fear of falling, and general measures of PA. Nevertheless, some similarities exist with published studies. Tinetti et al. [29] examined fear of falling and fall-related efficacy in relation to functioning and included number of falls as a covariate in their multivariable models. When a measure of overall PA was used as the dependent variable and fall-related efficacy rather than fear of falling was included in the model, their results indicated that PA levels increased as the number of falls increased, after adjusting for the other variables in the model. Their PA measure was a relative scale derived from a modification of the Yale Physical Activity Survey (YPAS) [30] and included both household and recreational PAs. Tinetti and Williams [8] reported that falling was associated with a decline in ADL and IADL 1 year later and 3 years later, and decline was greatest in those who reported one or more falls with serious injury. The measure of ADL-IADL includes some of the same activities that are included in the household PA score derived from the Phone-FITT such as shopping, housework and home maintenance activities (including yard work and home repairs).

Our findings are inconsistent, however, with some previous results. In the study by Tinetti and Williams [8], no significant effect of fall status on a general PA measure was found after 1 year. After 3 years, an effect of one or more seriously injurious falls on decline in PA was detected. Their PA measure was also a modification of the YPAS; however, this modification was a scale based on estimated kilocalories expended from the number of blocks walked and the number of flights of stairs climbed per day. In a recent cross-sectional study, one or more falls were associated with lower levels of PA in people 85 years of age and above, when hypothesized mediating variables of perceived control and optimism were not included in the model [31]. Their PA measure consisted of a sum of two items that asked participants to rate both their PA compared to peers and their PA in the last few months.

Lower household PA among injurious fallers in our study as compared to nonfallers/noninjurious fallers, may have been a direct result of the injury itself, or could have occurred indirectly via fear of falling or instructions from a health care provider [32]. In contrast, higher recreational PA is surprising. It could reflect higher baseline PA since we were unable to look at change in PA, although our inclusion of a simple baseline PA measure was not significant in the model. Those who injured themselves may have been more active on average prior to the fall, and the recreational PA may itself have been a factor in the injurious fall. Their higher postinjurious fall recreational PA could reflect that of advice of health care providers, family members or friends, in an attempt to prevent future falls from occurring, most likely among those who suffered only minor injuries. Following further research, our results may contribute to evidence for the importance of the preventing injurious falls, particularly among older men for whom household PA comprises a substantial part of their overall PA. While some work has been done, more research is required on the benefits of these types of PA in comparison to traditional exercise regimens. A study by Brach et al. [33] showed that while lifestyle activities (including

activities such as household chores) may not confer as much protection against functional limitations as specific exercise regimens, they are more beneficial than no activity at all. Another recent study has shown that health benefits in older women, such as reduced risk for early mortality, can be obtained not only by exercise but also by an active lifestyle including nonexercise behaviors [26].

Our results indicated that 50% of male veterans reported at least one fall and 32% reported at least one injurious fall, prospectively over the study period of 1 year. The most commonly cited estimates of 1-year fall risk from large prospective studies are 33% in community-dwelling people aged 75 or older [12] and 35% in those aged 70 years or older from both community and residential homes for the aged [34]. In another prospective study, a 57% annual fall risk was reported in people aged 60 years and older, but an inclusion criteria for this sample was that they had fallen at least once in the past year [35]. Additionally, prospective results have shown that 24% of those who fall experience serious injury [12]. While our estimates are higher in comparison, they are consistent with higher estimates that we have observed previously in this sample when falling was measured retrospectively over the past year (1-year fall risk of 40% and 1-year injurious fall risk of 34%) [13]. Other explanations for our higher fall risk estimates may be the use of broad definitions for falls and injurious falls, the older age of our sample, and possibly a reflection of changes in older adult cohorts.

Strengths of the present study include its prospective nature, the ascertainment of falls and injuries using prospective measures and the measurement of household and recreational PA using a valid and reliable interview specifically developed for older adults. Limitations of the present study also exist. The follow-up group, although not different on some fall risk factors or injurious fall frequency, were more active and had higher self-rated health at baseline, compared to individuals not included in the final study sample. Even though these variables were controlled in the analysis of those with complete data, it is possible that the findings observed here would be different in the absence of missing data. While measurement of PA using the Phone-FITT was a strength of the study, inherent limitations of self-reported PA exist, including social desirability effects and possible overestimation of true PA levels [36]. Since the Phone-FITT was administered only at the end of the study, we were unable to look at changes in PA. Therefore, we cannot know for sure that individual PA levels decreased or increased from their baseline levels as a result of injurious falls.

Another limitation of our study is that all of the covariates included in our models were obtained by self-report. It is possible that residual confounding may remain for certain variables, such as those meant to represent physical functioning or performance. Although the self-reported nature of the covariates is a limitation in this study, the fact that our models accounted for 15 and 12% of the variance in household and recreational PA demonstrates that these simple measures are capturing aspects of the specific characteristic being controlled for in the models. Tinetti and Williams [8] had 16 covariates (including a number of variables measured objectively by an assessor), and still only explained 19% of the variance in their outcome of ADL-IADL change over the period of one year. Also, we were unable to adjust our analyses for any psychological-type variables, such as depression and anxiety. A limitation relating to our ascertainment of injurious falls is that injuries resulting from falls were self-reported over the telephone and were not corroborated by any other source (e.g. examination by a study nurse, hospital records, etc.). As with any self-report measure, the possibility exists that injurious falls were over-reported; however, we may have reduced the amount of misclassification by examining fall status in terms of injurious fallers, since there were 118 injurious falls among the 64 injurious fallers in the present study. As well, previous reports have indicated that most injuries self-reported by participants (66%) were observed upon subsequent nurse examination [37].

Future research should investigate the effect of injurious falls on change in household and recreational PA in samples of both men and women. As well, future research could improve upon our study by controlling for covariates that have been objectively measured. Additionally, it would be informative to test for the mediating effect of fear of falling or fall-related efficacy in order to determine whether injurious falls have a direct effect on these different classifications of PA. The results from the present study suggest that the effect of injurious falls on not only overall PA levels be examined, but also by different classifications of PA. Combined with what is already known about the positive effects of PA, and the negative psychological consequences of falling, the results from this study may help in the design of preventive strategies to maximize physical activity in those who have sustained an injurious fall.

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