Prospective association between physical activity and falls in community-dwelling older women

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ABSTRACT

Objective: To explore associations between physical activity and the risk of falls and fractured bones in community-dwelling older women.

Design, setting and participants: A prospective observational survey with three and six-year follow-ups. The sample included 8188 healthy, community-dwelling women, aged 70–75 years in 1996, who completed surveys as participants in the Australian Longitudinal Study on Women's Health. Women who reported a recent serious injury from falling were excluded. Outcomes were reports of a fall to the ground, injury from a fall, and a fractured bone in 1999 and 2002. The main predictor variable was physical activity level in 1996, categorised on the basis of weekly frequency as none/very low, low, moderate, high and very high. Covariates were demographic and health-related variables. Logistic regression models were computed separately for each outcome in 1999 and 2002.

Main results: In multivariable models, very high physical activity was associated with a decreased risk of reporting a fall in 1999 (odds ratio (OR) 0.67; 95% CI 0.47 to 0.95) and in 2002 (OR 0.64; 95% CI 0.43 to 0.96). High/very high physical activity was associated with a decreased risk of a fractured bone in 2002 (OR 0.53; 95% CI 0.34 to 0.83). No significant association was found between physical activity and injury from a fall.

Conclusions: The results suggest that at least daily moderate to vigorous-intensity physical activity is required for the primary prevention of falls to the ground and fractured bones in women aged 70–75 years.

Falls are a major cause of morbidity among older women and can have serious health and social consequences.[1–8] Up to 49% of community-dwelling women aged 65 years and over will experience at least one fall over a 12-month period,[3] and many of these falls will result in injury, including fracture.[8] Falls are the leading cause of injury-related death and hospitalisation for people aged over 65 years[6 9 10] and can lead to placement in residential care.[7 11 12] Falls are estimated to account for 40% of the lifetime injury costs for women.[13] They may also have psychosocial consequences, such as decreased self-esteem, daily activity and social interaction, which result in isolation and loneliness.[6]

Many physical, psychological and environmental factors are associated with falls.[10 14] Therefore, multifactorial strategies are required to reduce the risk of falls.[15] Physical activity is central to most programmes designed to reduce the risk of falls and may work through the improvement of strength and balance and through other physiological and psychological pathways.[15–17] The role of physical activity in reducing the risk of falls, however, remains controversial.[18] There is concern that physical activity may increase the risk of falls in vulnerable older people,[19] and it has been reported that older people who engage in vigorous-intensity physical activity have a lower falls rate but a higher risk of injuring themselves if they fall.[20]

Although studies have examined risk factors for falls,[21] few[22–24] have recruited large, national samples of healthy, community-dwelling older women. The Australian Longitudinal Study on Women's Health recruited such a sample. The aim of this analysis was to explore prospective associations between physical activity and the risk of falls and fractured bones in this study's cohort of older women.

MATERIALS AND METHODS

Participants

The study sample included 8188 women, aged 70–75 years, who completed mailed surveys for the Australian Longitudinal Study on Women's Health. Surveys were first administered in 1996 with follow-ups in 1999 and 2002. Women were randomly selected from the Medicare national health insurance database, which includes all permanent residents and citizens of Australia.[25 26] Women from rural and remote areas were intentionally oversampled. Women who reported in 1996 that they had had a fall with a serious injury within the previous year were excluded. Respondents in 1996 were reasonably representative of Australian women aged 70–75 years although married women were overrepresented.[26] Written informed consent was obtained from all participants, and the study protocol was approved by the University of Newcastle Ethics Committee.

Assessment of outcome variables

Respondents were asked whether they had experienced "a fall to the ground (does not include stumbles, trips)", "been injured as a result of a fall" or "broken or fractured any bone/s" in the past 12 months. Response options to each item were "yes" and "no". Items were adapted from those developed by the Australian Department of Veterans' Affairs' Preventive Care Trial with adults aged 70 years and older.[27]

Assessment of physical activity

Moderate to vigorous-intensity physical activities were assessed with two items developed by the National Heart Foundation of Australia and Australian Institute of Health[28] and known to have acceptable test–retest reliability.[29] The items asked for the number of times in a normal week

Table 1 Characteristics of a national Australian sample of older community-dwelling women who reported "no serious fall with injury in the previous year" in 1996 (whole sample), and of these women, those who reported a fall to the ground, an injury from a fall, or a fractured bone in 1999

Variables	Whole sample n = 8188%	Had fall to ground n = 1427%	Injured in fall n = 975%	Fractured bone n = 394%
Physical activity				
None/very low	23.6	27.0	25.5	25.4
Low	30.4	30.3	29.4	26.1
Moderate	32.8	31.3	32.8	35.0
High	9.3	8.4	8.2	9.4
Very high	3.9	2.9	4.0	4.1
Education				
No secondary	29.2	30.8	29.2	30.5
Some secondary	38.4	37.1	37.2	35.3
Completed secondary	12.3	10.4	12.0	13.5
Trade certificate/university degree	15.9	17.3	16.8	16.5
Missing	4.2	4.3	4.7	4.3
Country of birth				
Australia	74.5	73.7	74.3	74.9
Other English speaking	12.5	11.9	10.6	10.2
Non-English speaking	7.8	9.7	9.4	10.2
Missing	5.2	4.8	5.7	4.8
Medication for nerves				
No	90.3	87.9	88.2	89.8
Yes	8.9	11.4	11.0	9.4
Missing	0.8	0.6	0.8	0.8
Medication for sleep				
No	83.7	80.2	81.1	78.7
Yes	15.4	18.8	18.3	20.8
Missing	0.9	1.1	0.6	0.5
Leaking urine				
Never/rarely	77.4	71.1	72.9	76.4
Sometimes	14.8	18.9	16.3	16.0
Often	5.6	8.0	8.1	5.6
Missing	2.2	2.0	2.7	2.0
Number of stressful life events				
0	31.2	26.6	27.1	30.7
1	28.2	28.0	26.1	26.4
2	19.8	20.5	21.4	18.3
3	11.9	14.2	14.6	14.0
4 or more	8.9	10.7	10.9	10.7
Number of chronic conditions				
0–1	37.5	27.5	28.8	28.9
2	25.0	26.1	25.4	26.6
3	17.7	20.5	20.2	18.5
4	19.6	25.8	25.2	25.9
Missing	0.3	0.2	0.3	0.0
Eyesight problems				
Never	33.6	27.7	26.3	25.4
Rarely	18.7	19.1	20.0	19.5
Sometimes	30.7	32.0	32.8	32.5
Often	13.6	18.6	17.4	19.0
Missing	3.4	2.7	3.5	3.6
Use of hormone replacement therapy				
Never used	76.2	73.3	74.2	75.4
<1 year	7.7	9.1	8.6	7.9
1–4 years	7.6	8.0	7.5	9.9
5–10 years	4.0	4.1	3.8	2.8
>10 years	3.9	4.7	4.9	3.0
Missing	0.6	0.8	1.0	1.0
Alcohol use				
Low risk	62.8	61.0	62.9	61.7
Non drinker	31.1	33.0	30.4	32.0
High risk	3.4	3.2	3.7	3.3
Missing	2.7	2.8	3.1	3.0

Continued

Table 1 Continued

Variables	Whole sample n = 8188%	Had fall to ground n = 1427%	Injured in fall n = 975%	Fractured bone n = 394%
Elder vulnerability score				
0	66.4	60.8	61.0	63.7
1	20.7	23.8	21.7	22.1
2	7.0	8.3	8.7	6.9
3 or more	5.6	6.5	7.9	6.6
Missing	0.3	0.6	0.6	0.8
Body mass index (kg/m^2)				
<20	7.5	6.0	7.7	11.2
⩾20 and <25	44.4	42.3	42.2	44.2
⩾25 and <30	30.7	32.3	33.1	31.0
⩾30	11.9	13.7	11.6	9.4
Missing	5.6	5.7	5.4	4.3

that respondents engaged in vigorous exercise (''which makes you breathe harder or puff and pant'') and in less vigorous exercise (''which does not make you breathe harder or puff and pant'') for at least 20 minutes. Examples were provided. As reported elsewhere,[30] the six response options were recoded (never, 0; once a week, 1; two to three times per week, 2.5; four to six times per week, 5; once a day, 7; more than once a day, 10). In the analysis sample, 21% of the women reported engaging in vigorous exercise at least once a week, and 85.4% reported engaging in non-vigorous exercise at least once a week. A total score was created by weighting the vigorous exercise score by 5.0 (metabolic equivalents) and the less vigorous exercise score by 3.0 (metabolic equivalents) and summing the vigorous and less vigorous scores. With a possible range of zero to 80, scores were categorised as none/very low (<5); low (5 to <15); moderate (15 to <25); high (25 to <40); and very high (⩾40). Respondents in the moderate, high, and very high categories were considered to be meeting US and Australian physical activity recommendations.[31 32]

Assessment of confounders

Variables found in previous studies to be associated with at least one of the outcomes and in initial univariate analyses for this study (data not shown) to be potential confounders of the association between physical activity and at least one of the outcomes were included in the analyses reported here. They included education, country of birth, medication for nerves, medication for sleep, leaking urine, number of stressful life events in the past 12 months (selected from a list of 24 events; eg, death of spouse or partner, death of a child, moving house, being robbed, natural disaster or house fire), number of diagnosed chronic conditions (selected from a standard list), eyesight problems, years of hormone replacement therapy use, alcohol intake, a validated modified version of the Hwalek–Sengstock Elder Abuse Screening Test,[33] body mass index (kg/m^2).

Statistical analysis

Logistic regression models were used to examine associations between physical activity in 1996 and outcomes (fall to the ground, injury as a result of a fall, and a fractured bone) in 1999. Model 1 examined univariate associations between physical activity and each outcome. For model 2, demographic variables were added, and for model 3, health-related variables were added. Model 4, a parsimonious model, included variables from model 3 that were significantly associated with the outcome. Interactions between physical activity and covariates were tested. Odds ratios were computed for all models. Significance was set at $p<0.05$.

For examining associations between physical activity in 1996 and the outcomes in 2001, the first three models were computed as discussed above. Model 4 added a composite of responses to the outcome variables in 1999: having reported a fall, an injury, or a fractured bone (''yes'' or ''no''). Because a previous fall has been identified as a major risk factor for future falls and fractures[34] and altered gait,[35] reporting an outcome in 1999 was hypothesised to play a mediating role between physical activity in 1996 and outcomes in 2001. Model 5 was the parsimonious model.

RESULTS

Table 1 presents characteristics of respondents. Most respondents (n = 4426, 54%) engaged in very low to low physical activity levels, indicating that respondents were insufficiently active to achieve health benefits according to recommendations.[31 32] The proportion of respondents who reported each outcome in 2001 was similar to that in 1999. Of the 2001 sample (n = 6468), 17% (n = 1126) reported a fall, 12% (n = 769) reported an injury and 5% (n = 325) reported a fracture.

Table 2 shows the results of modelling the association between physical activity in 1996 and falls reported in 1999. In model 1, respondents in the low ($p = 0.03$), moderate ($p = 0.01$), high ($p = 0.02$), and very high ($p<0.01$) physical activity categories had lower odds of having a fall than those in the none/very low physical activity category. Results were largely unchanged in model 2. Only respondents in the very high physical activity category had lower odds of reporting a fall in model 3 ($p = 0.03$), and only respondents in the moderate ($p = 0.04$) and very high categories ($p = 0.02$) had lower odds of reporting a fall in model 4. No significant interactions were found between physical activity and any covariate ($p>0.05$).

To examine associations between physical activity and the other outcomes (an injury, a fractured bone), the top two categories of physical activity were collapsed because of small numbers for these events. Univariate logistic regression models indicated that physical activity in 1996 was not associated with reporting an injury ($p = 0.41$) or a fractured bone in 1999 ($p = 0.27$); therefore, no other models were computed for these outcomes in 1996.

Table 3 shows results of the analysis of physical activity in 1996 and falls reported in 2001. In model 1, only respondents in the very high ($p = 0.02$) physical activity category had decreased odds of having a fall compared with those in the none/very low

Table 2 The association between physical activity in 1996 and reporting in 1999 a fall to the ground within the previous 12 months among a sample of older Australian women (n = 8188)

	Model 1 Univariate model	Model 2* Demographic model	Model 3† Confounders model	Model 4‡ Parsimonious model
Variable	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**
Physical activity				
None/very low	1.00	1.00	1.00	1.00
Low	0.84 (0.72 to 0.98)	0.85 (0.73 to 0.99)	0.89 (0.76 to 1.05)	0.88 (0.75 to 1.03)
Moderate	0.80 (0.69 to 0.93)	0.81 (0.69 to 0.94)	0.87 (0.75 to 1.02)	0.85 (0.73 to 0.99)
High	0.76 (0.60 to 0.95)	0.76 (0.60 to 0.95)	0.84 (0.67 to 1.06)	0.82 (0.65 to 1.03)
Very high	0.61 (0.43 to 0.86)	0.60 (0.42 to 0.84)	0.69 (0.48 to 0.97)	0.67 (0.47 to 0.95)

The sample size was the same for all models. Odds ratios and 95% CI are adjusted for area of residence to account for oversampling of women from rural and remote areas.
*Odds ratios and 95% CI also adjusted for education and country of birth.
†Odds ratios and 95% CI also adjusted for education, country of birth, use of medication for nerves, use of medication for sleep, leaking urine, number of stressful life events, number of chronic conditions, eyesight problems, use of hormone replacement therapy, alcohol use, elder vulnerability score, and body mass index.
‡Odds ratios and 95% CI also adjusted for country of birth, leaking urine, number of stressful life events, number of chronic conditions, eyesight problems, and elder vulnerability score. Odds ratios and 95% CI for these covariates are presented in table 1 published online only on the journal's website.

physical activity category. The strength of association was slightly changed in model 2, and respondents in the high ($p = 0.03$) and very high ($p = 0.01$) physical activity categories had decreased odds of having a fall. In model 3, the strength of association was weaker, and there was a trend towards an association between the very high physical activity category and decreased odds of having a fall ($p = 0.05$). The odds were lower only among respondents in the very high physical activity category in models 4 ($p = 0.04$) and 5 ($p = 0.03$). No significant interactions were found between physical activity and any covariate ($p>0.05$).

As found in the examination of the association between physical activity in 1996 and reports of an injury from a fall in 1999, physical activity in 1996 was not associated with reporting an injury in 2001 ($p = 0.31$) in model 1; therefore, no other models were computed for this outcome.

In model 1 of the analysis of the association between physical activity and a fractured bone in 2001 (table 4), respondents in the high/very high physical activity category had decreased odds of reporting a fractured bone compared with those in the none/very low physical activity category ($p<0.01$). As shown in table 4, the significance and strength of this association remained almost unchanged in models 2 ($p<0.01$), 3 ($p = 0.01$), 4 ($p = 0.01$), and 5 ($p = 0.01$). No significant interactions were found between physical activity and any covariate ($p>0.05$).

DISCUSSION

Our findings indicate that older women who reported a very high level of physical activity (more than daily vigorous-intensity physical activity for at least 20 minutes or almost twice daily moderate-intensity physical activity for at least 20 minutes) had decreased odds of reporting a fall both three and six years later compared with women reporting no or very low levels of physical activity (one or less 20-minute session of vigorous-intensity physical activity per week or two or less 20-minute sessions of moderate-intensity physical activity per week). At the three-year follow-up, the odds for women in the very high physical activity category were reduced by 33% and at the six-year follow-up by 36%. We also found that the women reporting a moderate level of physical activity (three to five sessions of vigorous-intensity physical activity per week or five to eight sessions of moderate-intensity physical activity per week, at least 20 minutes per session) had a 15% reduced risk of reporting a fall to the ground three years later. This reduction in the risk of falls is similar in magnitude to that found for interventions developed to reduce the risk of falls (18%) by tailoring strategies on the basis of individuals' personal risk assessment profiles.[36] The association between a moderate level of physical activity and the risk of falls in our study was not, however, found at the six-year follow-up.

The findings of an inverse association between very high levels of physical activity and the risk of falls to the ground support those from several prospective observational studies showing

Table 3 The association between physical activity in 1996 and reporting in 2001 a fall to the ground within the previous 12 months among a sample of older Australian women (n = 6468)

	Model 1 Univariate model	Model 2* Demographic model	Model 3† Confounders model	Model 4‡ Mediator model	Model 5§ Parsimonious model
Variable	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**
Physical activity					
None/very low	1.00	1.00	1.00	1.00	1.00
Low	0.88 (0.74 to 1.06)	0.87 (0.73 to 1.04)	0.91 (0.76 to 1.09)	0.91 (0.75 to 1.09)	0.89 (0.75 to 1.07)
Moderate	0.92 (0.77 to 1.09)	0.89 (0.75 to 1.06)	0.95 (0.79 to 1.13)	0.94 (0.78 to 1.12)	0.92 (0.77 to 1.11)
High	0.78 (0.61 to 1.01)	0.76 (0.59 to 0.98)	0.81 (0.63 to 1.06)	0.81 (0.62 to 1.05)	0.80 (0.62 to 1.04)
Very high	0.63 (0.42 to 0.94)	0.61 (0.41 to 0.91)	0.67 (0.45 to 1.00)	0.65 (0.43 to 0.97)	0.64 (0.43 to 0.96)

The sample size was the same for all models. Odds ratios and 95% CI are adjusted for area of residence to account for oversampling of women from rural and remote areas.
*Odds ratios and 95% CI also adjusted for education and country of birth.
†Odds ratios and 95% CI also adjusted for education, country of birth, use of medication for nerves, use of medication for sleep, leaking urine, number of stressful life events, number of chronic conditions, eyesight problems, use of hormone replacement therapy, alcohol intake, elder vulnerability score, and body mass index.
‡Odds ratios and 95% CI also adjusted for education, country of birth, use of medication for nerves, use of medication for sleep, leaking urine, number of stressful life events, number of chronic conditions, eyesight problems, use of hormone replacement therapy, alcohol use, elder vulnerability score, body mass index, and previous fall, injury from fall or fractured bone at S2.
§Odds ratios and 95% CI also adjusted for education, use of medication for nerves, leaking urine, number of chronic conditions, eyesight problems, elder vulnerability score, and previous fall, injury from fall or fractured bone at S2. Odds ratios and 95% CI for these covariates are presented in table 2 published online only on the journal's website.

Table 4 The association between physical activity in 1996 and reporting in 2001 a fracture within the previous 12 months among a sample of older Australian women (n = 6468)

	Model 1 Univariate model	Model 2* Demographic model	Model 3† Confounders model	Model 4‡ Mediator model	Model 5§ Parsimonious model
Variable	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**	**Odds ratio (95% CI)**
Physical activity					
None/very low	1.00	1.00	1.00	1.00	1.00
Low	0.82 (0.61 to 1.11)	0.83 (0.62 to 1.13)	0.85 (0.63 to 1.16)	0.85 (0.63 to 1.16)	0.84 (0.62 to 1.13)
Moderate	0.87 (0.65 to 1.16)	0.89 (0.66 to 1.19)	0.92 (0.68 to 1.24)	0.91 (0.68 to 1.23)	0.88 (0.66 to 1.19)
High/very high	0.50 (0.32 to 0.78)	0.52 (0.34 to 0.82)	0.55 (0.35 to 0.87)	0.55 (0.35 to 0.86)	0.53 (0.34 to 0.83)

The sample size was the same for all models. Odds ratios and 95% CI are adjusted for area of residence to account for oversampling of women from rural and remote areas.
*Odds ratios and 95% CI also adjusted for education and country of birth.
†Odds ratios and 95% CI also adjusted for education, country of birth, use of medication for nerves, use of medication for sleep, leaking urine, number of stressful life events, number of chronic conditions, eyesight problems, use of hormone replacement therapy, alcohol intake, elder vulnerability score and body mass index.
‡Odds ratios and 95% CI also adjusted for education, country of birth, use of medication for nerves, use of medication for sleep, leaking urine, number of stressful life events, number of chronic conditions, eyesight problems, use of hormone replacement therapy, alcohol use, elder vulnerability score, body mass index, and previous fall, injury from fall or fractured bone at S2.
§Odds ratios and 95% CI also adjusted for country of birth, number of chronic conditions, eyesight problems, body mass index, and previous fall, injury from fall or fractured bone at S2. Odds ratios and 95% CI for these covariates are presented in table 3 published online only on the journal's website.

physical activity to be associated with significant reductions in the risk of falls.[18] Other studies, in contrast, indicate that both high and low levels of physical activity put older adults at a high risk of falls,[18 21] and the results from physical activity intervention trials have been mixed. Some have found significant reductions in the risk of falls among participants, whereas others have found no significant differences between intervention and control groups in the risk of falls.[15 18 37 38]

Physical activity was not associated with having an injury as a result of a fall in this study. This finding supports those from another large prospective study of community-dwelling older adults,[14] which found no significant association between physical activity and the risk of injury. Two small prospective studies have, however, shown a significantly increased risk of injury among community-dwelling older adults participating in high levels of physical activity compared with those participating in low levels.[20 39] Given the conflicting results, more investigation of these associations is needed.

Our analyses also indicated that women in the high/very high physical activity categories had a 47% decreased odds of reporting a fractured bone six years later compared with those in the none/very low physical activity category. As in our study, Albrand *et al*[40] found in their prospective cohort study that older women who were moderately to vigorously active had decreased odds of fragility fractures compared with sedentary and lightly active women. Although we did not have information about the site of fracture, our results support findings from prospective and case–control studies showing significant reductions in hip or vertebral fractures among women who were physically active compared with those who were sedentary.[22 24 41 42]

Strengths

A major strength of this study was the use of a large, national sample of community-dwelling, relatively healthy adults. This is in contrast with most previous studies in this area,[22–24] which have tended to be in defined populations of women.[22 24] Using a cohort of older women allowed us to focus on a population that is growing in size as the population as a whole ages and that is at a high risk of falls and fractured bones.

Limitations

We did not assess mechanisms by which physical activity influences risks of the injuries examined. Although results from intervention studies suggest that physical activity may protect against fractures by preventing bone loss, the effects of physical activity on bone mineral density in older adults are small and are not likely to be biologically significant.[42] Other ways by which physical activity may decrease the risk of falls and subsequently fractured bones are by improving balance, coordination, muscle strength, reaction time and mobility.[18]

Other limitations include the use of self-report data, which are prone to recall bias, and the limited generalisability of the findings. Respondents whose data were included in these analyses were community-dwelling women, aged 70–75 years in 1996, who had not reported a fall resulting in serious injury within the previous year. Ideally, our findings should be tested in other populations. Furthermore, although respondents were fairly representative of Australian women at the first survey, those who continued in the study were healthier and of higher socioeconomic status than the general population and than respondents who dropped out,[43] suggesting that our prevalence estimates may be low. By limiting our analyses to women who reported that they had not had a serious injury from falling within the previous year, we introduced selection bias. In a sensitivity analysis, however, we also included women who had reported having had a recent fall and found the main findings to hold true (the main findings of this analysis are available in this

What is already known on this subject

- Falls are a major cause of morbidity among older women
- Physical activity is central to many interventions designed to decrease the risk of falls
- Concerns about the role of physical activity in reducing the risk of falls remain because physical activity has been shown to increase the risk of falls in some older adults

What this paper adds

- For older women who have not had a recent fall resulting in injury, only the highest level of physical activity decreased the risk of falls to the ground. Moderate levels of physical activity may reduce the risk of such falls but the decrease in risk is much smaller
- For these older women, the highest levels of physical activity also decreased the risk of a fractured bone

Policy implications

The results indicate that for the primary prevention of falls, healthy older women who are able should be encouraged to engage in moderate-intensity physical activities for 20 minutes twice a day

paper's web supplement on the journal's website). The major differences between the results reported here and those from the sensitivity analysis were that a moderate level of physical activity was not associated with a decreased risk of falls to the ground in the next three years in the sensitivity analysis, and the inverse association between a high/very high level of physical activity and risk of fractured bones six years later was stronger in the findings reported here than in the results from the sensitivity analysis. It should be noted that the measure of physical activity did not allow for computations of total time each week in all physical activities.

CONCLUSIONS

Our findings indicate that very high levels of physical activity (more than daily vigorous-intensity physical activity for at least 20 minutes or almost twice daily moderate-intensity physical activity for at least 20 minutes) are associated with reduced odds of falls among community-dwelling older women aged 70–75 years. The highest levels of physical activity are also associated with reduced odds of a fractured bone among these older women. Together, these findings suggest that the highest levels of moderate and vigorous-intensity physical activity reduce the risk of falls to the ground and fractured bones in women aged 70–75 years. Only 9% of the women in this sample were, however, engaging in high levels and another 4% were engaging in very high levels, suggesting that these levels may not be obtainable for most women in this age range.

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