



Relationships between dog ownership and physical activity in postmenopausal women[☆]



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ABSTRACT

Background. Positive associations between dog ownership and physical activity in older adults have been previously reported.

Purpose. The objective of this study was to examine cross-sectional associations between dog ownership and physical activity measures in a well-characterized, diverse sample of postmenopausal women.

Methods. Analyses included 36,984 dog owners (mean age: 61.5 years), and 115,645 non-dog owners (mean age: 63.9 years) enrolled in a clinical trial or the observational study of the Women's Health Initiative between 1993 and 1998. Logistic regression models were used to test for associations between dog ownership and physical activity, adjusted for potential confounders.

Results. Owning a dog was associated with a higher likelihood of walking ≥ 150 min/wk (Odds Ratio, 1.14; 95% Confidence Interval, 1.10–1.17) and a lower likelihood of being sedentary ≥ 8 h/day (Odds Ratio, 0.86; 95% Confidence Interval, 0.83–0.89) as compared to not owning a dog. However, dog owners were less likely to meet ≥ 7.5 MET-h/wk of total physical activity as compared to non-dog owners (Odds Ratio, 1.03; 95% Confidence Interval, 1.00–1.07).

Conclusions. Dog ownership is associated with increased physical activity in older women, particularly among women living alone. Health promotion efforts aimed at older adults should highlight the benefits of regular dog walking for both dog owners and non-dog owners.

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Introduction

Regular physical activity can positively affect health outcomes in older adults such as cognitive function, physical function, and quality of life (Benedict et al., 2013; Ip et al., 2013; Phillips et al., 2013). Despite the numerous health benefits, only half of the older adults in the

United States (U.S.) meet the current recommendation of 150 min of moderate-intensity physical activity per week (CDC 2013; Nelson et al., 2007). To address this issue, information regarding factors and barriers associated with physical activity, as well as development of effective strategies to increase physical activity, must be identified.

Dog walking may be a viable strategy to attenuate the declines in physical activity observed with aging (Lim and Taylor, 2005). For instance, favorable positive associations between dog ownership and physical activity in older adults are reported for walking activity, walking frequency, total physical activity, and functional ability (Dembicki and Anderson, 1996; Feng et al., 2014; Gretebeck et al., 2013; Thorpe et al., 2006a; Thorpe et al., 2006b; Toohey et al., 2013). While relationships between dog ownership and physical activity have been

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previously studied in older women, the sample size and population diversity are limited (Enmarker et al., 2012; Harris et al., 2009; Hoerster et al., 2011; Shibata et al., 2012). The purpose of the present study was to expand upon previous research using findings from the well-characterized, diverse sample of over 160,000 postmenopausal women enrolled in the Women's Health Initiative (WHI) observational study and clinical trials (Hays et al., 2003; The WHI Study Group, 1998). The relationships between dog ownership and physical activity were evaluated under the hypothesis that older women who own dogs will demonstrate higher levels of walking and total physical activity as compared to non-dog owners. The relationship between dog ownership and sedentary time was explored given recent evidence that older women who spend greater time in sedentary behavior are at higher risk for chronic disease and mortality (Seguin et al., 2014).

Methods

Study design and sample

The WHI recruited a large, diverse sample of postmenopausal women (50 to 79 years of age) into one or more clinical trials or an observational study between 1993 and 1998 (Hays et al., 2003). All women provided written informed consent and study procedures were approved by the Institutional Review Boards of the 40 U.S. participating clinical centers. Overall, enrollment included 68,132 women in the clinical trials and 93,676 in the observational study. Detailed study information has been published elsewhere (Anderson et al., 2003; Hays et al., 2003; The WHI Study Group, 1998).

Dog ownership

Participants were identified as a dog owner if at least one of their pets was a dog at baseline. Non-dog owners included women with no pets and women with pets other than dogs. Women with a history of myocardial infarction or stroke within the prior 6 months were excluded, because these diagnoses could lead to changes in activity and limitations in mobility independent of dog ownership. Participants missing data on physical activity measures or dog ownership also were excluded. As a result, the cross-sectional analyses included a total of 36,984 dog owners and 115,645 non-dog owners. Overall, 24.2% of the participants were dog owners. In comparison, estimates of dog ownership in the U.S. among older adults in the mid to late 1980s were 16–17% (Lawton et al., 1984; Marx et al., 1987).

Measurement of physical activity

Walking and total physical activity was assessed using a validated self-reported questionnaire (Meyer et al., 2009; Pettee Gabriel et al., 2009) with data collection detailed elsewhere (Nguyen et al., 2013). A summary variable was calculated for walking (min/wk) including all walking intensities. To incorporate frequency, duration, and intensity, walking casually/strolling (<2 mph), average/normal walking (2–3 mph), fast (3–4 mph), and very fast (>4 mph) were assigned metabolic equivalent (MET) values of 2, 3, 4, and 5.0, respectively (Ainsworth et al., 1993; The WHI Study Group, 1998). Walking (MET-h/wk) was calculated by multiplying the MET level for all walking activities by hours per week and summing values for all activities. Total physical activity (min/wk) included information on all walking and other moderate-, and vigorous-intensity physical activities. MET values were assigned for light-, moderate-, and vigorous-intensity activities as 3, 4.5, and 7 METs, respectively. Total physical activity (MET-h/wk) was calculated by multiplying the MET level for each activity by hours per week and summing values for all of the types of activities. To estimate sedentary time, participants were asked how many hours they spent sitting, including sitting at work, sitting at the table eating, driving or riding in a car or bus, and sitting up watching television or talking. Participants also were asked to estimate total hours spent sleeping or lying down during a usual day and night including time trying to sleep at night, resting or napping, and lying down to watch television. The reported hours of sitting and lying time were combined and then reported hours of sleep were subtracted (Seguin et al., 2014). Hours per day spent sitting or lying was queried only in women in the observational study; therefore, these analyses exclude clinical trial participants.

Covariates

Demographic variables were collected from clinical trial and observational study participants at baseline using a study-specific questionnaire and included self-reported age, race/ethnicity, education (\leq high school, some college, \geq college), income ($<$ \$20 K, \$20–\$75 K, \geq \$75 K), living alone status (no, yes), and smoking status (never, past, current). Height and weight were also measured at baseline for all study participants in local clinics using study-specified protocols; BMI (kg/m^2) was calculated and then categorized according to standard cut-points (NIH, 1998).

History of diabetes mellitus, cancer, and cardiovascular disease were based on self-reported data at baseline. General health was assessed using the General Health Subscale of the Rand SF-36 Item Health Survey (Hays et al., 1993). Self-reported physical function was also assessed using a 10-item subscale from the Rand SF-36 (Ware, 2000). It included 10 items related to ability to engage in moderate-vigorous activities, lifting and carrying groceries, climbing stairs, bending, walking, and bathing/dressing oneself. It was scored from 0 to 100, with a higher score indicative of greater physical function capacity.

Statistical analysis

Baseline characteristics were compared between dog owners and non-dog owners using chi-squared tests. Two-sample *t*-tests were used to compare physical activity levels between dog-ownership categories. Logistic regression models were used to test for associations between dog ownership and physical activity, adjusted for potential confounders. In these models, walking activity was categorized by ≥ 150 min/wk and ≥ 7.5 MET-h/wk (equivalent to 150 min/wk of moderate-intensity physical activity, consistent with the federal guidelines) (CDC 2013; Nelson et al., 2007). Sedentary time was categorized by a cut point used in previous studies (≥ 8 h/day) (Pavey et al., 2012; Seguin et al., 2014). If participant data were missing for any potential confounder, that participant was excluded from the multivariate analyses. Adjusted odds ratios and 95% confidence intervals from logistic regression models are reported. Potential interactions between dog ownership, living alone, and race/ethnicity on each activity outcome were evaluated using likelihood ratio tests. All analyses were conducted between 2013 and 2014 using Stata 13.1 (StataCorp, College Station, TX) and an assumed type 1 error rate of 0.05.

Results

Baseline characteristics of study participants

A total of 152,629 women (36,984 dog owners and 115,645 non-dog owners) were included in the final analytical sample (Table 1). The mean age of dog owners was 61.5 years compared to 63.9 years in non-dog owners ($P < 0.001$). Dog owners were more likely to live with others than non-dog owners (79.0% versus 67.3%; $P < 0.001$). Furthermore, dog owners had higher average BMI (28.4 kg/m^2 versus 27.8 kg/m^2) and were more likely to currently smoke (8.5% versus 6.4%) than non-dog owners ($P < 0.001$). Significant differences between dog owners and non-dog owners also were observed for education, income, physical function, general health, history of diabetes mellitus, and history of cardiovascular disease ($P < 0.05$).

Dog ownership and physical activity

Total minutes of walking was not significantly different between dog owners and non-dog owners ($P = 0.683$) (Table 2). However, measures of intensity indicated dog owners expended less MET-h/wk walking ($P = 0.002$). Total physical activity (min/wk and MET-h/wk) was also lower in dog owners compared to non-dog owners ($P < 0.001$). To examine if dog ownership was associated with a greater likelihood of achieving physical activity guidelines (≥ 150 min/wk and ≥ 7.5 MET-h/wk), physical activity measures were compared by dog ownership status (Table 3). After adjusting for possible confounders, dog ownership was associated with a 14% greater odds of walking more than 150 min/wk as compared to non-dog owners (OR, 1.14; 95% CI, 1.10–1.17). However, dog ownership was not associated with walking ≥ 7.5 MET-h/wk (OR, 1.03; 95% CI, 1.00–1.07) or achieving

Table 1
Baseline characteristics of women according to dog ownership status (%) (Women's Health Initiative, United States, 1993–1998).

Characteristics	Non-dog owners (n = 115,645)	Dog owners (n = 36,984)	Total (n = 152,629)	P
Age (years)				<0.001
<60	29.6	42.4	32.7	
60–69	45.9	42.3	45.1	
≥70	24.5	15.3	22.3	
Race/ethnicity				<0.001
Non-Hispanic White	82.3	83.1	82.5	
Black	9.79	6.79	9.06	
Hispanic	3.52	5.20	3.93	
Other/unknown	4.41	4.94	4.54	
Education				<0.001
≤High school	22.4	22.5	22.4	
Some college	37.0	40.6	37.8	
≥College	40.6	36.9	39.7	
Income				<0.001
<\$20 K	17.0	15.6	16.7	
\$20 to <\$75 K	64.6	64.5	64.6	
≥\$75 K	18.4	20.0	18.8	
BMI (kg/m ²)				<0.001
<25	36.5	32.2	35.4	
25–29.9	34.6	34.7	34.6	
≥30	29.0	33.2	30.0	
Smoking status				<0.001
Never	51.6	49.0	51.0	
Past	42.0	42.5	42.1	
Current	6.41	8.54	6.93	
Living alone				<0.001
No	67.3	79.0	70.1	
Yes	32.7	21.0	29.9	
General health				0.007
Tertile 1 (0 to 70)	41.3	41.0	41.2	
Tertile 2 (75 to 85)	34.2	33.7	34.1	
Tertile 3 (90 to 100)	24.5	25.3	24.7	
Physical function				<0.001
Tertile 1 (0 to 80)	39.2	36.5	38.4	
Tertile 2 (85 to 95)	43.4	43.8	43.0	
Tertile 3 (100)	17.4	19.7	18.6	
History of diabetes mellitus				0.031
No	95.6	95.4	95.6	
Yes	4.39	4.65	4.45	
History of cancer				0.304
No	90.5	90.6	90.5	
Yes	4.39	4.65	4.45	
History of cardiovascular disease				0.002
No	82.0	82.8	82.2	
Yes	18.0	17.3	17.8	

The P values were obtained using chi-squared tests between non-dog owners and dog owners.

Missing data: education (n = 1162; 0.8%), income (n = 10,318; 6.8%), BMI (n = 1381; 0.9%), smoking (n = 1604; 1.1%), living alone (n = 16,526; 10.8%), general health construct (n = 1669; 1.1%), physical functioning construct (n = 2476; 1.6%), history of diabetes (n = 141; 0.1%), history of cancer (n = 845; 0.6%), and history of cardiovascular disease (n = 2029; 1.3%).

150 min/wk of total physical activity (OR, 0.99; 95% CI, 0.96–1.01). Furthermore, dog owners were less likely to meet ≥7.5 MET-h/wk of total physical activity than non-dog owners (OR, 0.93; 95% CI,

0.90–0.96). Finally, using a cut point of ≥8 h/day, dog owners were 14% less likely to be sedentary as compared to non-dog owners (OR, 0.86; 95% CI, 0.83–0.89) (Table 3).

Effect modification by living alone and race/ethnicity

Significant interactions were detected between dog ownership and living alone or living with others, adjusted for potential confounders (Table 4). Among women who reported living alone, dog owners were more likely to walk ≥150 min/wk, walk ≥7.5 MET-h/wk, and achieve ≥150 min/wk of total physical activity than non-dog owners (OR, 1.29; 95% CI, 1.21–1.37; OR, 1.13; 95% CI, 1.06–1.21; and OR, 1.14; 95% CI, 1.07–1.20; respectively; $P_{\text{interaction}} < 0.01$). Furthermore, dog owners who lived alone were 23% less likely to be sedentary ≥8 h/day (OR, 0.77, 95% CI, 0.71–0.83; $P_{\text{interaction}} = 0.004$) compared to non-dog owners. There was no significant relationship between dog owners and non-dog owners for achieving total physical activity ≥7.5 MET-h/wk (OR, 1.03, 95% CI, 0.97–1.09; $P_{\text{interaction}} < 0.001$). These relationships were attenuated in dog owners living with others as compared to non-dog owners living with others (Table 4).

Relationships between dog ownership and physical activity showed effect modification by race/ethnicity such that non-Hispanic White (NHW) dog owners were 19% more likely to walk ≥150 min/wk (OR, 1.19, 95% CI, 1.15–1.23) than NHW non-dog owners, whereas Hispanic dog owners were 18% less likely to walk ≥150 min/wk (OR, 0.82; 95% CI, 0.71–0.95; $P_{\text{interaction}} < 0.001$) than Hispanic non-dog owners (Table 5). Both NHW and Hispanic dog owners were less likely to achieve 7.5 MET-h/wk of total physical activity than their non-dog owning counterparts (OR, 0.93; 95% CI, 0.90–0.96; OR, 0.82; 95% CI, 0.71–0.95; respectively; $P_{\text{interaction}} = 0.055$). Further, dog ownership was associated with a lower likelihood of being sedentary ≥8 h/day in all racial/ethnic groups examined (NHW, Black, and Hispanic), although this relationship was non-significant in Hispanics. Differences in these relationships between racial/ethnic groups were more pronounced after restricting to women who live alone (Fig. 1). NHW dog owners who live alone were 36% more likely to walk greater than ≥150 min/wk (OR, 1.36, 95% CI, 1.27–1.45; $P_{\text{interaction}} < 0.001$) and 24% less likely to be sedentary ≥8 h/day (OR, 0.76, 95% CI, 0.70–0.83; $P_{\text{interaction}} = 0.827$) than NHW non-dog owners who live alone.

Discussion

In a large, ethnically diverse cohort of postmenopausal women, dog owners were more likely to walk ≥150 min/wk and less likely to be sedentary than non-dog owners. These relationships were more pronounced for older women who were living alone. While the differences between dog owners and non-dog owners were modest, these findings are important because increasing walking activity and reducing sedentary time are associated with improved quality of life and higher levels of physical function in older adults (Balboa-Castillo et al., 2011; Heesch et al., 2012; Santos et al., 2012; Seguin et al., 2014). Further, decreased sedentary time and walking, regardless of pace, is associated with lower coronary heart disease rates and mortality among older women (Lee et al., 2001; Seguin et al., 2014).

Table 2
Comparisons of physical activity measures by dog ownership status (Women's Health Initiative, United States, 1993–1998).

Outcome measure	Non-dog owners (mean ± s.d.)	Dog owners (mean ± s.d.)	Total (mean ± s.d.)	P
Walking (min/wk)	87.2 ± 99.9	87.5 ± 100.7	87.3 ± 100.1	0.683
Walking (MET-h/wk)	4.71 ± 6.03	4.60 ± 5.92	4.68 ± 6.00	0.002
Total physical activity (min/wk)	182.8 ± 178.9	176.8 ± 182.7	181.3 ± 179.9	<0.001
Total physical activity (MET-h/wk)	12.6 ± 13.7	11.9 ± 13.8	12.4 ± 13.7	<0.001

s.d. = standard deviation.

The P values were obtained using t-tests between non-dog owners and dog owners.

Table 3

Associations between dog ownership and physical activity and sedentary time (Women's Health Initiative, United States, 1993–1998).

Outcome measure	Non-dog owners, n (%)	Dog owners, n (%)	OR (95% CI) ^a unadjusted	OR (95% CI) ^a adjusted ^b
Walking (≥ 150 min/wk)	30,458 (26.3)	9971 (27.0)	1.03 (1.01–1.06)	1.14 (1.10–1.17)
Walking (≥ 7.5 MET-h/wk)	30,780 (26.6)	9515 (25.7)	0.96 (0.93–0.98)	1.03 (1.00–1.07)
Total physical activity (≥ 150 min/wk)	57,838 (50.0)	17,521 (47.4)	0.90 (0.88–0.92)	0.99 (0.96–1.01)
Total physical activity (≥ 7.5 MET-h/wk)	63,626 (55.0)	18,918 (51.2)	0.86 (0.84–0.88)	0.93 (0.90–0.96)
Sedentary (≥ 8 h/day) ^c	39,199 (56.1)	11,038 (53.6)	0.91 (0.88–0.93)	0.86 (0.83–0.89)

OR, odds ratio; CI, confidence interval.

^a Dog owners as compared to non-dog owners.^b Adjusted for age, race/ethnicity, education, income, BMI, smoking status, living alone, general health, physical function, history of cardiovascular disease and history of diabetes mellitus.^c Data on sedentary time available only in OS participants; non-dog owners (n = 69,935) and dog owners (n = 20,591).

An association was not seen between dog ownership and walking to meet physical activity guidelines (≥ 7.5 MET-h/wk), possibly related to the differential walking intensity performed. Dog owners were *more* likely to engage in casual strolling/walking and *less* likely to walk fairly fast or very fast than non-dog owners (data not shown). Perhaps dogs facilitate social interactions among older adults which may slow down walking speed (Rogers et al., 1993; Wood et al., 2007). Additionally, older women may be hesitant to walk their dog at higher intensity levels to avoid musculoskeletal injury as a result of being pulled over by the dog (Willmott et al., 2012). Interestingly, using an objective measure of physical activity, Richards et al. (2014) recently found that young adult dog owners spent a majority of time walking their dog at moderate–vigorous intensity levels and in bouts greater than 10 min. Further, Feng et al. (2014) demonstrated that older dog owners (≥ 65 years of age) were 12% more active than non-dog owners when physical activity was assessed objectively by accelerometry counts. While 75% of dog owners in the study reported dog walking, the study did not identify the intensities of activities performed. Efforts to characterize the frequency, duration, and intensity of activities older dog owners perform are still needed.

Our findings are consistent with previous literature in some regards, but not others. In a recent cross-sectional analysis of 884 adults aged 50 years or more (Toohey et al., 2013), 27% of dog owners achieved ≥ 150 min/wk of recreational walking as compared to non-dog owners, similar to our study population. In addition, Dembicki and Anderson (1996) demonstrated that dog owners aged 60 or above walked more than non-dog owners. One study examined this relationship exclusively in younger women and suggested, similar to our sample of older women, that dog ownership was positively associated with more leisure-time walking (Ball et al., 2007). In contrast, Thorpe et al. (2006a) found that dog owners (70–79 years of age) were more likely to engage in any activity and non-exercise related walking compared to non-dog owners. Yet no differences were observed for exercise walking or vigorous activity. Further, a recent meta-analysis of 17 studies that examined the relationship between dog ownership and physical activity found that

dog owners reported *more* minutes per week of walking and physical activity than non-dog owners (Christian et al., 2013). Future research is needed to probe additional factors such as companionship, social interactions, and health outcomes informing on the relationship between dog ownership and physical activity. Importantly, this may help to identify barriers and strategies for dog owners who are not physically active.

While prior reports have evaluated relationships between dog ownership and physical activity, the role of dogs in facilitating physical activity among racial/ethnic groups is unclear. In our study population, NHW dog owners were more likely than non-dog owners to walk ≥ 150 min/wk, whereas Hispanic dog owners were less likely; there was no significant relationship for Black dog owners. Further, NHW and Black dog owners were less likely to be sedentary ≥ 8 h/day as compared to non-dog owners, but this relationship was not observed in Hispanics. Johnson and Meadows (2002) found older Latino dog owners (50–83 years of age) view their dogs as valuable companions and family members similar to NHW. However, this perception was not associated with physical activity behaviors. One potential explanation is that dog and dog owner behaviors influence shared social and physical environments, which may affect physical activity patterns (Toohey and Rock, 2011). For example, dog litter in public places such as parks or sidewalks and stray/uncontrolled dogs is associated with lower physical activity for dog owners and non-dog owners (Cutt et al., 2008; Toohey and Rock, 2011). In fact, older adults, women, and racial/ethnic minorities appear to be the most vulnerable to experiencing other people's uncontrolled dogs as barriers to being physically active (Toohey and Rock, 2011). The differential associations we observed should be further evaluated to determine if they can be replicated in other cohorts.

Living alone substantially modified relationships between dog ownership and physical activity outcomes particularly for walking and sedentary time. This may suggest that women living alone may rely on their dog as a source of social support and safety for walking outside (Knight and Edwards, 2008). Alternately, women living alone may be more emotionally attached to their dogs (Poresky and Daniels, 1998) and more likely to take on owner responsibilities (bathing, grooming, and play) and dog walking (Cutt et al., 2008) compared to women living with others who share responsibility. Notably, living alone was not associated with meeting ≥ 7.5 MET-h/wk of total physical activity. This suggests that time spent walking the dog, as well as competing demands on time more generally, may reduce time spent performing physical activity at higher intensity levels. However, participation in light-mild intensity activity is associated with lower mortality among older adults (Hamer et al., 2014). Further, dog ownership promotes aspects of healthy aging such as social well-being and mental health among older women living alone, independent of physical activity (Knight and Edwards, 2008).

Limitations and strengths

There are limitations to this investigation which should be acknowledged. Dog ownership does not necessarily translate to dog walking,

Table 4

Associations between dog ownership and physical activity, stratified by living alone versus living with others (Women's Health Initiative, United States, 1993–1998).

Outcome measure	Living alone (95% CI) ^a	Living with others OR (95% CI) ^a	P _{interaction}
Walking (≥ 150 min/wk)	1.29 (1.21–1.37)	1.09 (1.05–1.13)	<0.001
Walking (≥ 7.5 MET h/wk)	1.13 (1.06–1.21)	1.01 (0.97–1.04)	0.002
Total physical activity (≥ 150 min/wk)	1.14 (1.07–1.20)	0.95 (0.92–0.98)	<0.001
Total physical activity (≥ 7.5 MET h/wk)	1.03 (0.97–1.09)	0.90 (0.87–0.93)	<0.001
Sedentary (≥ 8 h/day) ^b	0.77 (0.71–0.83)	0.90 (0.86–0.94)	0.004

OR, odds ratio; CI, confidence interval.

^a Dog owners as compared to non-dog owners, adjusted for age, race/ethnicity, education, income, BMI, smoking status, general health, physical function, history of cardiovascular disease and history of diabetes mellitus.^b Data on sedentary time available only in OS participants.

Table 5

Associations between dog ownership and physical activity, stratified by race/ethnicity (Women's Health Initiative, United States, 1993–1998).

Outcome measure	Non-Hispanic White OR (95% CI) ^a	Black OR (95% CI) ^a	Hispanic OR (95% CI) ^a	P _{interaction}
Walking (≥150 min/wk)	1.19 (1.15–1.23)	0.94 (0.83–1.07)	0.82 (0.70–0.96)	<0.001
Walking (≥7.5 MET h/wk)	1.07 (1.10–1.26)	0.89 (0.78–1.02)	0.76 (0.53–1.09)	<0.001
Total physical activity (≥150 min/wk)	1.00 (0.97–1.04)	0.96 (0.86–1.07)	0.83 (0.72–0.96)	0.016
Total physical activity (≥7.5 MET h/wk)	0.93 (0.90–0.96)	0.99 (0.89–1.10)	0.82 (0.71–0.95)	0.055
Sedentary (≥8 h/day) ^b	0.87 (0.84–0.90)	0.85 (0.73–0.98)	0.89 (0.73–1.08)	0.972

OR, odds ratio; CI, confidence interval.

^a Dog owners as compared to non-dog owners, adjusted for age, race/ethnicity, education, income, BMI, smoking status, general health, physical function, history of cardiovascular disease and history of diabetes mellitus.^b Data on sedentary time available only in OS participants.

particularly among dog owners living with others who take on the dog walking responsibility (Christian et al., 2013; Thorpe et al., 2006b). However, Serpell (1991) found that new dog owners demonstrated an increase in the frequency and duration of recreational walking. In our sample, information on duration of dog ownership was not collected. Additionally, information about dog characteristics such as size, type/

breed, age, sex, health/ability, weight status, behaviors (sniffing), and behavioral problems (aggressiveness), which impact dog walking behaviors was not collected (Toohey and Rock, 2011; Westgarth et al., 2014; Westgarth et al., 2010). Further, this study was not able to consider how physical environments may affect dog walking behaviors for older adult dog owners (Toohey and Rock, 2011; Westgarth et al., 2014). The study population included postmenopausal women participating in a longitudinal study, and this may limit broad generalizability of our findings. It also is possible that dog walkers who are non-dog owners are included in our study population (Johnson and Meadows, 2010). While our data can provide insight into the relationships between dog ownership and physical activity among postmenopausal women, this analysis does not allow for the assessment of temporal relationships. Therefore, we cannot determine if those who were more physically active prior to the study were more likely to be dog owners. Lastly, the physical activity data were based on self-report which are subject to significant bias (Blair et al., 1991), although the measures performed reasonably when validated against objective assessment (Neuhouser et al., 2013). Strengths of our study include one of the largest and most diverse study samples to examine these relationships in older women. Additionally, our sample is well characterized in relation to demographic, clinical, and lifestyle variables.

Conclusions

Public health guidance suggests Americans should be physically active daily yet many fail to meet this goal. Our study suggests dog ownership is associated with walking as well as lower sedentary time in older women, particularly among women living alone. In order to more fully realize the potential of dogs as a strategy to meet physical activity guidelines, health promotion efforts aimed at older adults should highlight the benefits of regular dog walking for both dog owners and non-dog owners.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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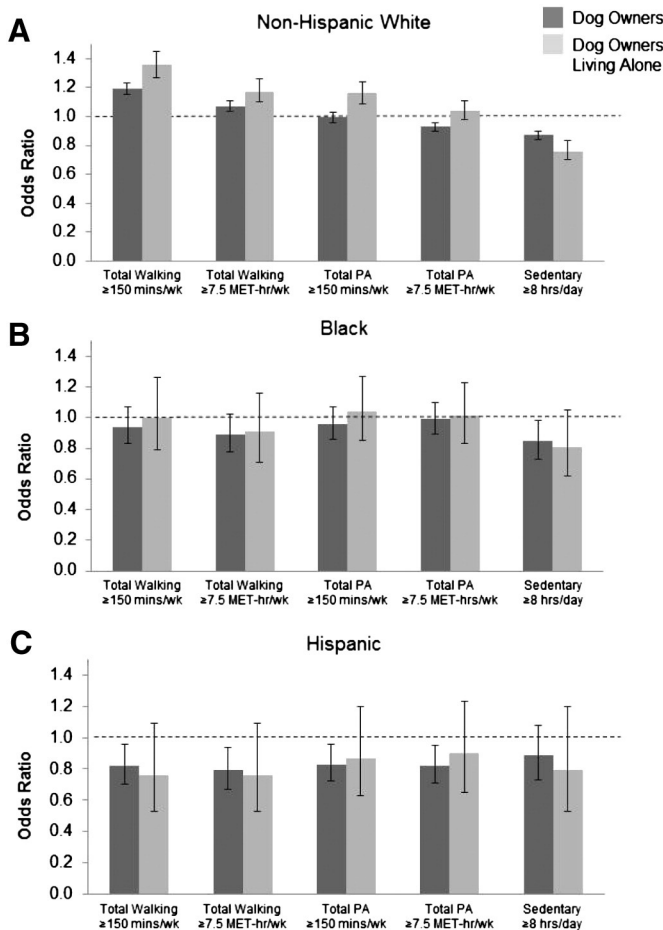


Fig. 1. Associations between dog ownership and physical activity stratified by race/ethnicity (A) Non-Hispanic White, (B) Black, and (C) Hispanic (Women's Health Initiative, United States, 1993–1998). Models are adjusted for age, education, income, BMI, smoking status, living alone, general health, physical function, history of cardiovascular disease, and history of diabetes. Odds ratios were calculated using non-dog owners as the reference group (OR = 1.0; horizontal dashed lines). Vertical bars represent 95% CIs. Results from a sensitivity analysis in which the population was restricted to women living alone are presented as light gray bars. Likelihood ratio test for interaction between dog ownership and race/ethnicity on each outcome: walking (≥150 min/wk), $P < 0.001$; walking (≥7.5 MET-h/wk), $P < 0.001$; total PA (≥150 min/wk), $P = 0.016$; total PA (≥7.5 MET-h/wk), $P = 0.055$; and sedentary (≥8 h/day), $P = 0.972$. Likelihood ratio test for interaction between dog ownership and race/ethnicity on each outcome and restricted to women living alone: walking (≥150 min/wk), $P < 0.001$; walking (≥7.5 MET-h/wk), $P = 0.008$; total PA (≥150 min/wk), $P = 0.101$; total PA (≥7.5 MET-h/wk), $P = 0.515$; and sedentary (≥8 h/day), $P = 0.827$.

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