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Dog walking among adolescents: Correlates and contribution to physical activity

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ABSTRACT

Purpose. To assess the association of dog walking with adolescents' moderate-to-vigorous physical activity (MVPA) and body mass index (BMI), and identify correlates of dog walking.

Methods/design. Participants were 12–17 year-olds (n = 925) from the Baltimore, MD and Seattle, WA regions. Differences in accelerometer-assessed minutes/day of MVPA and self-reported BMI (percentile) were compared among adolescents (1) without a dog (n = 441) and those with a dog who (2) did (≥1 days/week, n = 300) or (3) did not (n = 184) walk it. Correlates of (1) dog walking (any vs. none) among adolescents with dogs (n = 484), and (2) days/week of dog walking among dog walkers (n = 300) were investigated. Potential correlates included: demographic, psychosocial, home environment, perceived neighborhood environment, and objective neighborhood environment factors.

Results. 52% of adolescents lived in a household with a dog, and 62% of those reported dog walking ≥1 day/week. Dog walkers had 4–5 more minutes/day of MVPA than non-dog-walkers and non-dog-owners. BMI was not associated with dog walking or ownership. Among households with dogs, adolescents who lived in objectively walkable neighborhoods were 12% more likely to walk their dog than those in less walkable neighborhoods. Among dog walkers, having a multi-family home, college-educated parent, lower perceived traffic safety, higher street connectivity and less mixed use were related to more days/week of dog walking.

Conclusions. Dog walkers had 7–8% more minutes/day of MVPA than non-dog walkers, and correlates of dog walking were found at multiple levels of influence. Results suggest multilevel interventions that include both environmental and psychosocial components to increase dog walking should be evaluated.
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Background

The National Health and Nutrition Examination Survey (NHANES) found that only 8% of US adolescents met the recommended 60 min of physical activity a day, based on objective measures (Troiano et al., 2008). While 84% of adolescents reported walking as a source of physical activity (Brener et al., 2013), GPS-measured minutes of walking in this population appear low (Carlson et al., 2015). Therefore, walking may be a promising approach to increase adolescents' physical activity.

Because nearly half of US households have a dog (American Pet Products Manufacturers Association, 2012), dog walking could be an important contributor to physical activity, but many adult and adolescent dog owners report little or no dog walking (Christian et al., 2013a; Salmon et al., 2010; Timperio et al., 2008). A meta-analysis of 17 studies found that dog ownership and dog walking were associated with greater overall physical activity. Only 4 studies used objective measures of physical activity, and few studied adolescents or children (Christian et al., 2013b). A review of 9 dog walking studies among adults calculated the odds of meeting moderate intensity physical activity guidelines and concluded that dog walkers were 2.5 times more likely to meet the guidelines (Soares et al., 2015). Identifying factors, like motivators and barriers, related to dog walking is important because results can inform interventions to increase dog walking (Cutt et al., 2008).

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Multiple levels of correlates should be examined, because ecological models posit that variables at individual, social, community environment, and policy levels influence behaviors (Sallis and Owen, in press). Correlates of dog walking in previous studies included those at the individual level (i.e., race/ethnicity, income, illness), social level (i.e., social support, walking as a family, neighborhood social cohesion), perceived environment level (i.e., perceived crime) and objective environment level (i.e., weather and neighborhood walkability) (Salmon et al., 2010; Toohey et al., 2013; Coleman et al., 2008). Few studies applied principles of ecological models by examining multiple levels and interactions (i.e. moderators) across levels.

A systematic review of dog walking studies found only 2 studies examined children or adolescents (Christian et al., 2013a), and 18% of youth aged 10–12 years walked their dogs at least 3 times per week (Salmon et al., 2010; Timperio et al., 2008). One of the studies found owning a dog was associated with 29 additional minutes of moderate to vigorous physical activity (MVPA) per day among younger female children, yet no effects for males or older females (Salmon et al., 2010). Children who lived in households with dogs were 49% more likely to achieve physical activity recommendations (Christian et al., 2012). The current study filled gaps in the literature by quantifying the contribution of dog walking to objectively-measured total physical activity in adolescents and investigating a broader range of correlates of dog walking at multiple levels.

The first objective of the present paper was to quantify the difference in MVPA and weight status (i.e. BMI) between adolescents living in households 1) without dogs, 2) with a dog but did not walk it, and 3) who reported any dog walking. A second objective was to explore the subsample of dog owners to assess ecological correlates of walking the dog at all versus none. A third objective was to assess correlates of dog walking frequency (days/week) among dog walkers. A final objective was to explore cross-level interactions in both dog household subsamples (i.e. dog owners and dog walkers) to identify moderators of associations.

Methods

Study design and participants

The present study used data from the Teen Environment and Neighborhood (TEAN) observational study (Carlson et al., 2014, 2015). Participants were adolescents aged 12–17 living in the Seattle, WA or Baltimore, MD regions in 2009–2011 (n = 925). Participants were one adolescent and one parent/guardian selected from neighborhoods (i.e., census block groups) defined by high or low walkability (based on GIS measures of built environment factors) and stratified by high or low income (based on Census 2000 data), similar to methods described previously (Frank et al., 2010). Households with adolescents in selected block groups were identified from a marketing company and recruited by mail and telephone. Overall participation rate was 36% and did not vary by quadrant. Compared to Census demographics, the study sample had somewhat higher education and household income. Adolescents and parents each completed a survey to assess demographics, psychosocial characteristics and perceived neighborhood environment (available at http://sallis.ucsd.edu/Documents/Measures_documents/TEAN%20Survey%20ADOL%20FINAL%20010509.pdf). Adolescents wore an accelerometer for one week to determine daily minutes of MVPA. The Institutional Review Board of San Diego State University approved the study, parents/guardians signed informed consents, and adolescents signed assent forms.

Measures

Dog ownership and dog walking (survey data)

Adolescents were asked if their family owned a dog (yes/no). If yes, the adolescent was asked how many days a week he/she walked the dog (0 to 7 days).

Psychosocial and perceived environment variables (survey data)

Self-efficacy for physical activity was determined by asking the adolescents 6 items that assessed confidence in doing physical activity despite barriers (e.g., "do physical activity even when the weather is bad, or when sad or stressed"). Response options ranged from 1 = "I'm sure I can't" to 5 = "I'm sure I can" and were averaged to create a scale (Cronbach's alpha = .76; test–retest intraclass correlation coefficient (ICC) = .71) (Norman et al., 2005).

Decisional balance for physical activity was assessed with 5 "pro" items (Cronbach's alpha = .81; test–retest ICC = .74) and 5 "con" items (Cronbach's alpha = .53; test–retest ICC = .86) where each item was rated from 1 = strongly disagree to 4 = strongly agree (Norman et al., 2005). "Pro" items focused on benefits of physical activity (e.g., would have fun) and the "con" items focused on negatives of physical activity (e.g., time away from being with friends). Decisional balance was measured by subtracting the mean for the 5 "cons" items from the mean of the 5 "pros" items, resulting in a variable ranging from −5 to 5.

Enjoyment was measured with 1 item asking whether the adolescent enjoyed doing physical activity, with response options ranging from 1 = "strongly disagree," to 5 = "strongly agree."

Rules were measured by having adolescents report on 13 rules (yes/no) their parent(s) enforced regarding physical activity (e.g. "come in before dark," "do not go places alone") (Cronbach's alpha = .87; test–retest ICC = .68; unpublished data) with items summed to create an index.

Adolescents were asked whether they owned 4 types of portable electronics (e.g., cell phone, iPod/MP3 player), yielding a summed score ranging from 0 to 4. Participants reported which of 6 electronic devices were in their bedroom (e.g. TV, computer), yielding a summed score ranging from 0 to 6 (test–retest ICC ≥ .60 for both scales) (Rosenberg et al., 2010).

A subset of the Neighborhood Environment Walkability Scale for Youth (NEWS-Y) was completed by both the adolescent and parent. Parent sections included neighborhood aesthetics with 4 items (e.g. interesting things to look at), traffic safety with 3 items (e.g. most drive above the speed limit), pedestrian safety with 3 items (e.g. crosswalks and signals present), crime safety with 1 item (high crime rate), and stranger danger with 4 items (e.g. afraid of my child being taken or hurt by stranger). Response options ranged from 1 (strongly disagree) to 4 (strongly agree) where larger numbers represented more favorable conditions for physical activity. The adolescent sections of the NEWS-Y included traffic safety, pedestrian safety, crime safety and stranger danger. Means of item values were calculated for multiple item sections. Test–retest ICCs for subscores ranged from 0.61 to 0.78 for adolescents and parents (Rosenberg et al., 2009).

Weight status (survey data)

In the survey, adolescents were provided instructions on how to accurately measure and record their weight and height. BMI percentiles were based on CDC BMI-for-age growth charts (Kuczmarski et al., 2000).

Objective built environment (GIS data)

Built environment features were derived from county tax assessor data, regional land use at the parcel level, and street networks and integrated into GIS. Variables were calculated for 1 kilometer street network buffers around participants' homes (Frank et al., 2010). A walkability index was created by summing the sample z-scores for each of 4 built environment measures: (1) housing units per residential land area, (2) intersection density, (3) retail floor area ratio, and (4) mixed use including residential, retail, food and entertainment, and office land use

Table 1
Overall sample characteristics of adolescents (N = 925), living in households without dogs (n = 441), households with dogs but do not walk the dogs (n = 184) or households with dogs and walk the dogs ≥1 day per week (n = 300) in the Seattle and Baltimore regions.

Variables of interest within ecological model levels	Total sample characteristics (N = 925) Mean (SD) or n (%)	Households without dogs (n = 441) Mean (SD) or n (%)	Households with dogs non-dog walkers (n = 184) Mean (SD) or n (%)	Households with dogs walkers (n = 300) Mean (SD) or n (%)
Individual characteristics				
Adolescent age	14.09 (1.40)	14.12 (1.37)	14.16 (1.45)	14.02 (1.39)
Adolescent gender (male)	460 (49.6%)	230 (52.2%)	91 (49.5%)	137 (45.7%)
Adolescent White Non-Hispanic	611 (66.3%)	258 (58.9%)	135 (73.8%)	217 (72.8%)
Parent married/living with a partner	774 (83.9%)	363 (83.1%)	159 (86.9%)	251 (84.0%)
Parent with college degree	695 (75.4%)	334 (76.3%)	132 (72.1%)	227 (75.9%)
House type (single family)	835 (90.5%)	388 (88.8%)	171 (93.4%)	275 (91.7%)
Psychosocial characteristics				
Confidence in ability to do PA (self-efficacy) [1–5]	3.53 (1.00)	3.44 (1.01)	3.46 (0.97)	3.72 (0.98)
Decisional balance: (pros of PA − cons of PA) [−5 to 5]	2.01 (0.78)	1.95 (0.78)	1.98 (0.76)	2.12 (0.79)
Enjoyment of PA [1–5]	4.27 (0.98)	4.22 (1.00)	4.16 (1.06)	4.41 (0.87)
Home environment				
Portable electronics ownership index [0–4]	2.91 (0.95)	2.85 (1.00)	2.85 (0.95)	3.04 (0.86)
Electronic items/things in bedroom index [0–6]	2.61 (1.70)	2.50 (1.61)	2.65 (1.70)	2.75 (1.81)
Activity rules index [0–14]	8.72 (3.10)	8.73 (3.08)	8.74 (3.08)	8.68 (3.12)
Perceived neighborhood environment (NEWS)				
Parents NEWS				
Esthetics [1–4]	3.12 (0.64)	3.11 (0.62)	3.03 (0.64)	3.16 (0.65)
Traffic safety [1–4]	2.58 (0.88)	2.59 (0.57)	2.53 (0.59)	2.60 (0.60)
Pedestrian safety [1–4]	2.83 (0.65)	2.84 (0.65)	2.79 (0.68)	2.85 (0.64)
Low crime risk [1–4]	3.09 (0.88)	3.07 (0.87)	3.14 (0.89)	3.11 (0.90)
Low stranger dangers [1–4]	3.01 (0.73)	2.96 (0.74)	3.07 (0.72)	3.04 (0.72)
Adolescent NEWS				
Traffic safety [1–4]	2.73 (0.61)	2.74 (0.59)	2.72 (0.67)	2.73 (0.61)
Pedestrian safety [1–4]	3.10 (0.52)	3.11 (0.51)	3.06 (0.52)	3.12 (0.53)
Low crime risk [1–4]	3.21 (0.91)	3.21 (0.91)	3.17 (0.89)	3.24 (0.92)
Low stranger dangers [1–4]	3.38 (0.74)	3.35 (0.74)	3.39 (0.76)	3.41 (0.73)
Built environment characteristics				
Number parks [parks/km^2]	1.46 (1.65)	1.50 (0.17)	1.24 (1.49)	1.52 (1.72)
Residential density [housing units/parcel]	6.27 (8.68)	6.99 (11.47)	5.34 (4.84)	5.70 (4.86)
Street Connectivity [intersections/km^2]	73.37 (21.57)	74.60 (20.90)	70.01 (20.96)	73.41 (22.64)
Retail floor area ratio [building:parcel ft^2]	0.16 (0.19)	0.16 (0.19)	0.13 (0.16)	0.17 (0.20)
Mixed use [0 = single 1 = mixed]	0.18 (0.22)	0.18 (0.22)	0.13 (0.18)	0.20 (0.23)
Walkability index	−0.03 (2.85)	0.14 (3.03)	−0.67 (2.52)	0.07 (2.71)

(Frank et al., 2010). Higher index values represented more walkable neighborhoods.

Overall physical activity (accelerometer data)

Enrolled adolescents were mailed an Actigraph accelerometer (models 7164/71256 or GT1M/GT3X with Normal filter) with instructions to wear the device for 1 week. Participants wore the accelerometer on a belt at their left iliac crest with acceleration captured at 30-second epochs. Minutes/day of MVPA were scored using the Freedson 3-MET age-based cut points (Freedson et al., 1998; Trost et al., 2011). Days were removed from the scoring if the participant did not wear the accelerometer for at least 10 valid hours (range 0–17 valid days in present analyses). Strings of >60 sequential 30-second epochs within an hour with no movement (i.e. count = 0) were considered not valid.

Statistical analyses

All models utilized mixed effects regression in SPSS V.22.0 to adjust for nesting of participants within block groups. Participant characteristics, potential dog walking correlates, and overall daily MVPA and BMI percentile were compared across adolescents in households without dogs (n = 441), adolescents who had a dog but did not walk it (n = 184), and those who reported any dog walking (≥1 day/week) (n = 300). In dog owners, total MVPA was also regressed on days/week of dog walking to assess the contribution of each additional day of dog walking. Models were adjusted

Table 2
Comparing MVPA minutes per day and BMI age adjusted percentiles of adolescents by those who live in households with dogs and walk them ≥1 day/week or don't walk them or live in households without dogs (N = 928) in the Seattle and Baltimore regions.

	N	Mean (95% CI) MVPA minutes/day[a,b]	P value	Mean (95% CI) CDC Age adjusted BMI percentiles[a,b]	P value
A. Adolescents who don't own a dog	441	61.99 (59.02, 64.95)	Vs. B, P = .816 Vs. C, P = .025	66.53 (63.48, 69.57)	Vs. B, P = .516 Vs. C, P = .481
B. Adolescents who own a dog but do not walk it	184	61.45 (57.76, 65.41)	Vs. A, P = .816 Vs. C, P = .044	64.86 (59.15, 68.90)	Vs. A, P = .516 Vs. C, P = .890
C. Adolescents who own a dog and walk it ≥ 1 day per week[c]	300	66.41 (62.96, 69.86)	Vs. A, P = .025 Vs. B, P = .044	65.21 (61.64, 68.77)	Vs. A, P = .481 Vs. B, P = .890

[a] Separate models were run in SPSS to compare the categorical variables with each other.
[b] All models controlled for adolescent age, gender, race/ethnicity, parent marital status, parent education and house type.
[c] The P-values are repeated contrasts from above but in different orders (i.e. A vs. C and C vs. A, B vs. C and C vs. B).

Table 3
Ecological analyses of correlates of dog walking among adolescents who live in households with dogs and walk the dog ≥1 day/week vs do not walk the dog in the Seattle and Baltimore regions. Ecological analyses of correlates of dog walking among adolescents who walk the dog ≥1 day a week.

	Walk at all (≥1 day/week) vs. none (n = 484)			Number of days/week walking dog (1–7) (n = 300)		
	OR	95% CI	P	B	95% CI	P
Intercept (with centered variables):	1.85	1.25, 2.72	–	3.47	3.15, 3.99	–
Demographic characteristics (Model 1)						
Adolescent age (years)	1.15	0.79, 1.67	.473	−0.07	−0.23, 0.09	.390
Adolescent gender (male)	0.92	0.81, 1.06	.239	0.02	−0.41, 0.46	.923
Adolescent White Non-Hispanic	1.01	0.66, 1.56	.963	−0.24	−0.76, 0.28	.362
Parent married/living with a partner	0.80	0.45, 1.40	.423	−0.46	−1.08, 0.16	.148
Parent with college degree	1.27	0.82, 1.97	.518	0.69	0.16, 1.22	.012
House type (single family)	0.77	0.36, 1.69	.518	−1.44	−2.27, −0.60	.001
Psychosocial characteristics (Model 2)[a]						
Confidence in ability to do PA (self-efficacy) [1–5]	1.19	0.93, 1.52	.171	0.11	−0.16, 0.38	.430
Decisional balance: (pros of PA − cons of PA) [−1, −3]	0.99	0.73, 1.34	.939	−0.08	−0.41, 0.25	.640
Enjoyment of PA [1−5]	0.17	0.92, 1.60	.166	0.06	−0.28, 0.40	.737
Home environment (Model 3)[a]						
Portable electronics ownership index [0–4]	1.34	1.07, 1.67	.011	0.04	−0.23, 0.34	.712
Electronic items/things in bedroom index [0–6]	1.01	0.90, 1.14	.861	0.004	−0.13, 0.14	.957
Activity rules index [0–14]	0.99	0.92, 1.05	.663	−0.03	−0.11, 0.04	.411
Perceived neighborhood environment (Models 4–5)[a]						
Model 4: Parents NEWS						
Esthetics [1–4]	1.31	0.95, 1.80	.095	0.26	−0.11, 0.63	.169
Traffic safety [1–4]	1.20	0.83, 1.73	.326	0.08	−0.32, 0.49	.683
Pedestrian safety [1–4]	1.05	0.77, 1.42	.766	−0.03	−0.09, 0.47	.888
Low crime risk [1–4]	0.95	0.75, 1.21	.690	0.19	−0.09, 0.47	.186
Low stranger dangers [1–4]	0.91	0.67, 1.23	.518	−0.10	−0.45, 0.24	.559
Model 5: Adolescent NEWS						
Traffic safety [1–4]	0.91	0.65, 1.27	.581	−0.32	−0.71, 0.07	.107
Pedestrian safety [1–4]	1.16	0.79, 1.70	.447	0.13	−0.31, 0.57	.550
Low crime risk [1–4]	1.07	0.84, 1.37	.588	0.005	−0.27, 0.28	.973
Low stranger dangers [1–4]	1.08	0.79, 1.49	.629	−0.11	−0.47, 0.26	.568
Objective neighborhood environment (Models 6–7)[a]						
Model 6: Built environment characteristics						
Number parks [parks/km^2]	1.03	0.90, 1.18	.659	−0.06	−0.20, 0.09	.426
Residential density [housing units/ parcel]	0.96	0.91, 1.01	.109	0.01	−0.05, 0.07	.788
Street connectivity [intersections/km^2]	1.01	1.0, 1.02	.221	0.01	0, 0.02	.038
Retail floor area ratio [building:parcel ft^2]	2.13	0.54, 8.42	.279	−0.24	−1.68, 1.20	.745
Mixed use [0 = single 1 = mixed]	4.20	1.33, 13.23	.014	−1.29	−2.41, −0.17	.024
Model 7: Walkability						
Walkability index	1.11	1.03, 1.20	.009	−0.01	−0.10, 0.07	.794

[a] Models 2-7 controlled for adolescent age, gender, race/ethnicity, parent marital status, parent education and house type B denotes unstandardized regression coefficient.

for demographic covariates (adolescent age, gender, White Non-Hispanic race/ethnicity, parent married/living with a partner, parent with college degree, house type [e.g. apartment, single family]).

Table 4
Final cross-level ecological model of correlates of dog walking (any vs. none) among adolescents who own a dog (N = 484) in the Seattle and Baltimore regions. Significant (P < .10) interactions are shown in Fig. 1: A–E.

	Walk at all (≥1 day/week) vs. none (n = 484)		
	OR	95% CI	P
Intercept (with centered variables):	1.89	1.25, 2.87	–
Final ecological model			
Adolescent age	0.89	0.77, 1.03	.112
Adolescent gender (male)	1.03	0.69, 1.54	.892
Adolescent White Non-Hispanic	1.03	0.64, 1.63	.916
Parent married/living with a partner	0.88	0.48, 1.60	.668
Parent with college degree	1.25	0.76, 2.06	.385
House type (single family)	0.72	0.31, 1.68	.916
Portable electronics ownership index	1.24	0.84, 1.82	.278
Perceived esthetics (Parents NEWS)	1.20	0.83, 1.73	.326
Walkability index	1.12	1.03, 1.21	.006
Age * Perceived esthetics	0.74	0.59, 0.92	.007
Race * Perceived esthetics	1.88	0.91, 3.87	.090
Age * Portable electronics ownership	0.85	0.72, 1.01	.062
Parent with college degree * Portable electronics ownership	0.29	0.15, 0.55	<.001
House type * Portable electronics ownership	2.64	1.10, 6.31	.029

Correlates of dog walking were investigated in (1) all adolescents who lived in households with a dog (n = 484) and (2) adolescents who walked their dog at least one day a week (n = 300). In the subsample of adolescents in households with dogs, the dependent variable was walking the dog at all vs. no walking. In the smaller subsample of only those who walked their dog (at all), the number of days per week (1–7) the adolescent walked the dog was the dependent variable. Independent variables/correlates were first analyzed in 6 separate models based on levels of ecological models and source of data: (1) demographic, (2) psychosocial, (3) home environment, (4) parent's perceived neighborhood environment and (5) adolescent's perceived neighborhood environment, and (6) objective neighborhood built environment. All subsequent models were adjusted for the demographic factors tested in the initial model. Independent variables with P < 0.15 were entered into a final, cross-level model. All potential cross-level interactions were tested using a backwards stepwise approach, where interaction terms were removed one at a time until only terms with P < 0.1 remained. The independent variables were grand mean centered to create orthogonal interaction terms so the intercept would approximate the sample mean for dog walking days/week in the subsample of dog walkers. Interaction visuals were plotted using one standard deviation above and below the mean for continuous variables to represent high and low supportiveness of dog walking. Unstandardized regression coefficients (B) are reported and can be interpreted as the change in the dependent variable for a 1-unit change in the independent variable. In the final model, standardized regression coefficients are also reported so effects can be compared across variables.

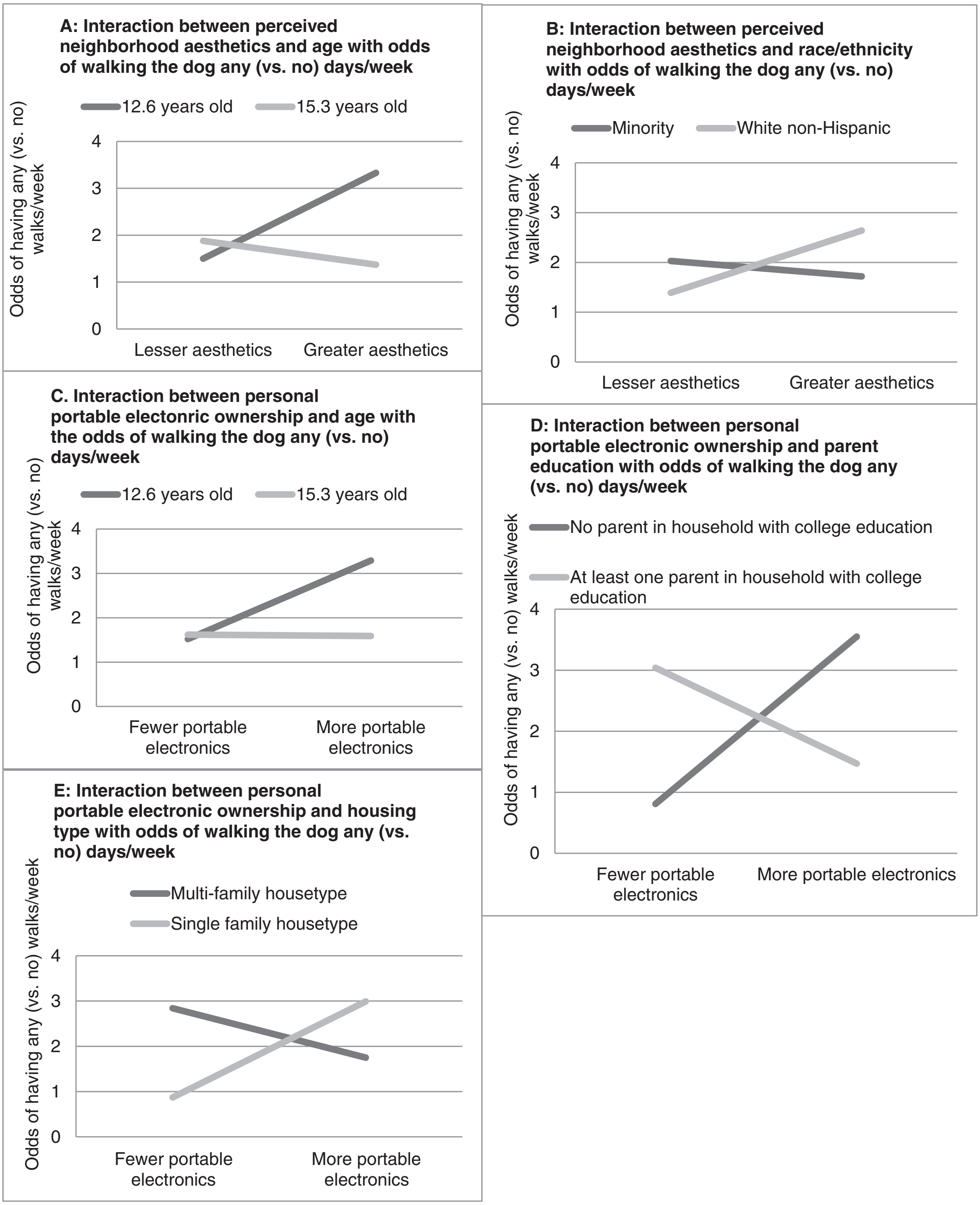

Fig. 1. Interactions with the odds of adolescents walking the dog at least one day a week (versus no days a week) in the Seattle and Baltimore regions.

Results

Sample characteristics

The study sample was composed of adolescents with a mean age of 14 and was almost equally split between males and females. About two thirds of participants were White Non-Hispanic, and over 80% lived in a household with a parent who was married or living with a partner and in a single-family home (Table 1). The only significant difference in demographic characteristics was that households with dogs (regardless if they walked the dog or not) had a greater proportion of White Non-Hispanic adolescents (73%) compared to households without dogs (59%) ($P < 0.001$; Table 1).

Dog walking and overall physical activity and BMI

Table 2 shows that average daily MVPA was about 62 min for adolescents who lived in households without a dog as well as those who had a dog but did not walk it. Adolescents who walked their dog at least one day a week performed over 66 min of MVPA per day, which was significantly more than those in the other two groups (by 4–5 min), for an overall difference of 7–8% in MVPA time (P = 0.044 and 0.025). Additionally, each day of dog walking was associated with 1.57 more minutes of total MVPA among dog owners (P = 0.005). Dog ownership and dog walking were not associated with the adolescents' BMI percentiles (Table 2).

Correlates of dog walking at all versus none among adolescents with dogs

No demographic factors were associated with dog walking at all versus none, though all demographic variables were included as covariates in subsequent models (Table 3). In the subsequent 5 models, portable electronics ownership, parent's perceived neighborhood esthetics, mixed use, and the walkability index had positive associations with any dog walking at P < 0.15, and residential density had a negative association with walking the dog at all at P < 0.15, which met the criterion for inclusion in the final cross-level model (Table 4).

In the final adjusted multi-level model, the significant main effect indicated that for every one-unit increase in neighborhood walkability, there was a 12% increase in the odds of walking the dog at all (P = 0.006, Table 4). Residential density and mixed use were not included in this model because they were components of the walkability index. Five of 30 tested interactions were significant at P < 0.1. Perceived esthetics had significant interactions with adolescent age (P = 0.007, Fig. 1A) and adolescent race/ethnicity (P = 0.090, Fig. 1B). Portable electronics interacted significantly with adolescent age (P = 0.062, Fig. 1C), parental education (P < 0.001, Fig. 1D), and housing type (P = 0.029, Fig. 1E) in explaining the odds of walking the dog at all.

Correlates of dog walking frequency among adolescents who walked their dogs

Adolescent dog walkers reported walking their dogs 2.96 days/week (SD = 1.97). Having a parent with a college degree was associated with more dog walking (P = 0.012), and living in a single-family home was associated with less dog walking (P = 0.001) (Table 3). Having a two-parent/guardian household, mixed use neighborhoods, and adolescent-perceived traffic safety were negatively associated, and objective street connectivity was positively associated with days of walking the dog at P < 0.15, which met the criterion for inclusion in the final cross-level model (Table 5).

Table 5
Final cross-level ecological model of correlates of dog walking frequency among adolescents who reported walking the dog at least 1 day/week (N = 300) in the Seattle and Baltimore regions. Significant (P < .10) interactions are shown in Fig. 2.

	Number of days/week walking dog (1–7) (n = 300)			
	β	B	95% CI	P
Intercept (with centered variables):	2.94	3.48	3.07, 3.90	–
Final ecological model				
Adolescent age (years)	−0.13	−0.09	−0.25, 0.07	.273
Adolescent gender (male)	0.02	0.03	−0.39, 0.46	.879
Adolescent White Non-Hispanic	−0.11	−0.25	−0.76, 0.25	.325
Parent married/living with a partner (marital status)	−0.15	−0.42	−1.03, 1.26	.177
Parent with college degree	0.32	0.74	0.22, 1.26	.006
Housing type (single family)	−0.36	−1.30	−2.13, −0.48	.002
Traffic safety (adolescent NEWS)	−0.22	−0.36	−0.71, 0	.048
Street connectivity [intersections/sq km]	0.32	0.02	0.01, 0.04	.006
Mixed use [0 = single 1 = mixed]	−0.33	−1.45	−2.44, −0.46	.004
Marital status ∗ street connectivity	−0.24	−0.03	−0.06, 0	.083

B denotes unstandardized regression coefficient.
β denotes standardized Beta.

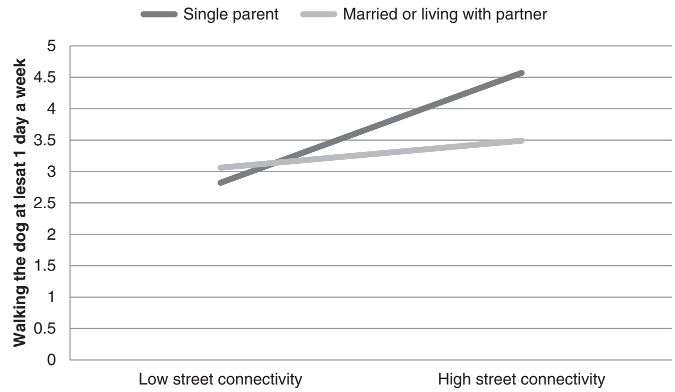

Fig. 2. Interaction between parent marital status and neighborhood street connectivity with increased number of days of dog walking.

In the final adjusted multi-level model, living in a household where a parent had a college degree was associated with 0.74 more days/week of dog walking (P = 0.006), and 10 more intersections per sq km (street connectivity) was associated with 2 more days/week of dog walking (P = 0.006) (Table 5). Living in a single-family home was associated with 1.3 fewer days/week of dog walking (P = 0.002), each unit increase in perceived traffic safety was associated with 0.36 fewer days/week of dog walking (P = 0.048), and mixed use was associated with 1.45 fewer days/week of dog walking (compared to single use) (P = 0.004). Only 1 of the 18 tested interactions was significant at P < 0.1; marital status and street connectivity (P = 0.083) (Fig. 2).

Discussion

Adolescents who walked their dogs at all obtained 4 to 5 min more MVPA per day than dog owners who did not walk their dogs. Those who walked their dogs 5 days a week had almost 8 min more of total MVPA/week than those not walking their dog. These findings are consistent with previous findings that dog walking contributes to more total physical activity among adults and adolescents (Christian et al., 2012, 2013a,b; Salmon et al., 2010; Timperio et al., 2008; Soares et al., 2015; Coleman et al., 2008). The relatively modest impact of dog walking on total MVPA minutes may be due to short dog walks or most dog walking being below the moderate-intensity threshold that would be captured in the accelerometer scores. Several demographic and environmental variables were related to dog walking. Youth living in more walkable neighborhoods and those with more portable electronics were more likely to walk their dogs. Supporting adolescents to walk their dogs regularly among households with dogs is a potential approach for interventions to increase total physical activity, but such interventions remain to be evaluated with adolescents.

There were no associations between dog walking and adolescent weight status. Previous dog walking studies found mixed associations between BMI and dog walking. Coleman et al. reported a significant inverse association among adults (Coleman et al., 2008). Timperio et al. found the association between dog walking and adolescent weight varied by the type of dog owned, length of ownership and manner of interaction with the dog (Timperio et al., 2008). Further studies of dog walking and BMI are needed to answer questions related to adolescent dog-walking patterns.

Correlates of any dog walking

The current study identified correlates at multiple levels of walking the dog at all. In the final model of any dog walking, neighborhood walkability emerged as the only significant main effect. Adolescents who lived in objectively more walkable neighborhoods were 12%

more likely to walk their dogs in this study, consistent with a similar study of adults (Coleman et al., 2008). A likely explanation is that people in single family homes with backyards do not perceive the need to walk their dogs for biological relief.

Ecological models predict cross-level interactions (Sallis and Owen, in press), and 5 such significant interactions were found in the final model for any dog walking by adolescents. A commonality among the interactions was that demographic factors moderated relations of perceived esthetics and personal portable electronic ownership to dog walking. Esthetics was positively related to dog walking in both younger and White Non-Hispanic adolescents. It is possible that better esthetics may lead parents to feel more comfortable letting their younger adolescents outside. In higher-minority neighborhoods, it is possible that esthetics have a less influential role because other barriers to walking may be more salient (e.g. traffic or crime safety). Portable electronics were related to more dog walking among younger participants and those living in single-family and less-educated households. It is possible that portable electronics improve perceptions of safety or make dog walking more enjoyable, but this warrants further research.

Correlates of dog walking frequency

Several main effects were found for correlates of the frequency of adolescent dog walking. Adolescents who lived in single-family homes, had better perceived traffic safety, and lived in neighborhoods with objectively more mixed use walked their dogs less frequently. The present study examined housing type, with the hypothesis that dog owners in single-family homes would have less need to walk their dog because dogs could get both exercise and relieve themselves in private yards. This hypothesis was supported, as adolescents who lived in single-family homes walked their dogs about one day less per week than those who lived in multi-family homes or apartments. Cutt et al. found that an important reason dog owners overcame barriers to walk their dog was by recognizing the need to take their dog outside; (Cutt et al., 2008) having a yard may reduce this motivation. It was unexpected that better safety from traffic and more land use mix were associated with less dog walking, particularly because overall walkability was associated with the likelihood of walking the dog at all. These findings seem somewhat contradictory and could be due to confounding, but the authors could not identify a promising explanation.

Among adolescent dog walkers, those living in households with a college-educated parent and in neighborhoods with objectively higher street connectivity reported walking their dogs more frequently. Perhaps highly educated parents better understand the benefits of physical activity and are more likely to encourage their adolescents to walk dogs more. Higher street connectivity is an indicator of walkable neighborhoods, which was an important correlate of any dog walking. Because there was only one significant interaction related to frequency of dog walking, there is not strong evidence of moderation.

Strengths and limitations

Present findings support the utility of ecological models because significant correlates were found at multiple levels of influence. It is noteworthy that though no psychosocial correlates were significant in the final models, both reported and objectively measured environmental variables were significantly related to both dog walking outcomes. The cross-sectional design of the present study limits interpretation about causal pathways. The sample was intended to capture an even distribution of high and low walkable neighborhoods but not intended to be representative of the regions studied. Dog walking was self-reported by adolescents and potentially susceptible to social desirability bias. Though the short one-week recall of dog walking may reduce recall bias, this short time frame may limit representativeness of the dog walking measures. Frequency of dog walking was assessed, but it would be useful to obtain reports of usual duration of dog walking and if they walked with other people. Future studies could assess duration using improved measures such as the combination of GPS and accelerometry.

Conclusion

Because dog walkers had 7–8% more daily MVPA than non-dog-walkers, dog walking is a potential way to increase physical activity among adolescents with dogs. Present findings suggest intervention approaches that could be evaluated, particularly interventions that target multiple levels of the ecological model including walkability. Enhancing esthetics of the neighborhood, such as more street trees, repainted buildings, and landscaping, might facilitate dog walking. Owning portable electronics could potentially increase dog walking because the adolescent can use these devices for entertainment or security. Less dog walking among those living in low-walkable neighborhoods and less frequent dog walking among those living in single-family homes seems to be an unanticipated consequence of current zoning laws. Present findings provide additional rationale for adoption of zoning laws that favor walkable neighborhood designs to limit barriers to walking, including dog walking.

Conflict of interest statement

The authors declare that there are no conflicts of interests.

Transparency document

The Transparency document associated with this article can be found, in online version.

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