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Correlates of changes in walking during the retirement transition: The Multi-Ethnic Study of Atherosclerosis☆

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ABSTRACT

Retirement from employment involves disruption in daily routines and has been associated with positive and negative changes in physical activity. Walking is the most common physical activity among older Americans. The factors that influence changes in walking after retirement are unknown. The study objective was to identify correlates of within-person change in recreational walking (for leisure) and transport walking (to get places) during the retirement transition among a multi-ethnic cohort of adults (N = 928) from six US communities. Correlates were measured at the individual (e.g., gender), interpersonal (e.g., social support), and community (e.g., density of walking destinations) levels at study exams between 2000 and 2012. Comparing pre- and post-retirement measures (average 4.5 years apart), 50% of participants increased recreational walking by 60 min or more per week, 31% decreased by 60 min or more per week, and 19% maintained their recreational walking. Forty-one percent of participants increased transport walking by 60 min or more per week, 40% decreased by 60 min or more per week, and 19% maintained their transport walking after retirement. Correlates differed for recreational and transport walking and for increases compared to decreases in walking. Self-rated health, chronic conditions, and perceptions of the neighborhood walking environment were associated with changes in both types of walking after retirement. Further, some correlates differed by gender and retirement age. Findings can inform the targeting of interventions to promote walking during the retirement transition.

1. Introduction

Retirement from employment is associated with disruption in daily routines and social networks and increased focus on maintaining health (Felner et al., 1983; Beck et al., 2010; McDonald et al., 2015; Berg et al., 2014). These shifts in routine and focus may provoke positive or negative changes physical activity (Barnett et al., 2012a). Promoting positive changes in physical activity at retirement could help to reduce the burden of chronic disease in later life (Chodzko-Zajko and American College of Sports Medicine Position Stand, 2009; US Department of Health Human Services, 2008; Colditz, 1999).

Better understanding of the correlates of behavior change at retirement is needed to promote physical activity among retirees (Hirvensalo and Lintunen, 2011; Baxter et al., 2016). The most common physical activity among retirement-aged Americans is walking (Centers for Disease Control and Prevention (CDC), 2012). Walking also is among the most accessible physical activities: it requires no special equipment and is available to persons with a wide range of physical abilities (US Department of Health and Human Services, 2015). The correlates of walking may differ depending on its purpose: recreation (for leisure or exercise) or transport (to get places) (Van Holle et al., 2012).

Correlates of walking change at retirement have not been explored. However, the Social Ecological Model and prior research on older adults suggest that correlates exist at multiple levels, including the individual (e.g., gender), interpersonal (e.g., social support), and community levels (e.g., walking environment) (Sallis et al., 2008). Identifying correlates from multiple levels and distinguishing between recreational and transport walking is important because interventions are likely to be more effective when targeted to specific types of activity and addressing correlates at multiple levels (Van Holle et al., 2012; Sallis et al., 2008). We aimed to identify correlates of within-person

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changes in recreational and transport walking at retirement among participants in the Multi-Ethnic Study of Atherosclerosis (MESA), a diverse cohort of United States (US) adults. We describe individual-, interpersonal-, and community-level correlates to inform development of interventions to promote walking among retirees.

2. Methods

2.1. Study population

The MESA is a prospective study of subclinical cardiovascular disease (CVD) (Bild et al., 2002). Briefly, 6814 adults aged 45–84 years and free of clinical CVD were recruited at six sites: Forsyth County, NC; Northern Manhattan and the Bronx, NY; Baltimore City and County, MD; St. Paul, MN; Chicago, IL; and Los Angeles County, CA. This study included MESA participants who were not retired at baseline (2000 − 2002) and retired during follow-up (by 2010–2012, N = 1062). Participants who were missing data on walking (N = 54) or potential correlates (N = 80) were excluded for a final sample size of 928. Excluded participants were more likely non-Hispanic black, low socioeconomic position (SEP), and reported worse health compared to included participants.

2.2. Retirement classification

MESA participants self-reported employment status at five exams. Participants who reported being retired and not working, retired and working, or retired and volunteering were classified as retired.

2.3. Walking

Recreational and transport walking were self-reported by MESA participants at four exams (2000–2002, 2002–2004, 2004–2005, 2010–2012). Walking frequency (days/week) and duration (min/day) for a typical week in the past month were multiplied to estimate min/week of each type of walking. Within-person changes in walking at retirement were calculated as the difference in min/week of walking reported at the last exam prior to retirement and first exam after retirement. Walking measures showed evidence of participants rounding their reports of walking minutes to the nearest 15-minute increment; also, the test-retest reliability of self-reported physical activity is better for categorical compared to continuous measures (Patterson, 2000). Therefore, changes in walking were categorized as “maintaining” (less than 60 min/week difference from pre-retirement), “decreasing” (60 min or more per week less than pre-retirement), or “increasing” (60 min or more per week greater than pre-retirement) for analyses. We explored alternative categorization cut points of 45 min/week and 75 min/week, which yielded similar findings.

2.4. Correlates

Potential correlates were selected based on the Social Ecological Model (Sallis et al., 2008) and existing literature (Saelens and Handy, 2008; Bauman et al., 2012; Engberg et al., 2012; Smith et al., 2015). Correlates were grouped into three levels: individual-, interpersonal-, and community-level (Table 1).

Eleven potential individual-level correlates were identified, of which eight were time-fixed (retirement age, gender, race/ethnicity, SEP, MESA site, car ownership, job type, and occupational physical activity before retirement). Three time-varying individual-level correlates were calculated as the difference between pre- and post-retirement measures: change in self-rated health, number of chronic conditions, and body mass index (BMI, kg/m^2).

Potential interpersonal-level correlates were change in partnership and caregiving status, and social support. Change in partnership and caregiving status was defined by the participant's status at the pre- and post-retirement exams. Social support was measured using the ENRICHD Social Support Inventory, which has good reliability (Cronbach's alpha 0.86) (Mitchell et al., 2003). The closest pre-retirement measure was used because many participants did not have post-retirement social support scores.

Community-level correlates were 16 measures of the neighborhood environment from the MESA exam closest to each participant's estimated retirement date, which was before retirement for 446 participants and after for 482 participants. Correlates included observed and perceived neighborhood attributes (Diez Roux et al., 2016). Observed attributes were assessed using data from local and federal governments and two commercial sources (National Establishment Time Series and Esri) for ZIP codes where ≥5 MESA participants were living from 2000 to 2010, using participants' geocoded addresses (Hirsch et al., 2014; Evenson and Wen, 2013; Walls and Associates, 2013; Bureau of the Census, US Department of Commerce, 2007). Observed attributes were: density of parks, recreational facilities, walking and social engagement destinations, street connectivity, and population density. Densities were calculated in ArcGIS (Redlands, CA) using a 1-mile radius around participants' homes (Hirsch et al., 2014), and were mean centered and scaled so that a 1-unit increase was equivalent to one standard deviation (Hirsch et al., 2014).

Perceived neighborhood attributes included 13 items grouped into four domains: walking environment, aesthetic quality, safety, and social cohesion (Echeverria et al., 2004). Participants rated each item (strongly agree to strongly disagree) for the area within a 20-minute walk or 1-mile of home. Item responses were grouped as unfavorable/neutral (referent group) or favorable (agree/strongly agree; index group), because favorable perceptions of the neighborhood may facilitate physical activity (Echeverria et al., 2004). Social cohesion was the sum of four items scored so that a higher number corresponded to greater cohesion.

2.5. Analyses

First, we described the distribution of each potential correlate and within-person changes in walking. We compared characteristics of participants who reported some vs. no walking using Chi-square (categorical), ANOVA (mean), or Kruskal-Wallis (median) tests ($\alpha = 0.05$). Next, we assessed collinearity between correlates at each level (individual, interpersonal, community). Densities of recreational facilities, walking destinations, and social engagement destinations were highly correlated. Based on substantive knowledge (Hirsch et al., 2014; Nathan et al., 2012; Sugiyama et al., 2012), only the density of walking destinations was included in multivariable models. No other correlates were strongly correlated ($r > 0.65$).

Next, logistic regression models were constructed to identify correlates of changes in walking at retirement. Recreational and transport walking were modeled separately. Participants who reported zero walking before and after retirement were excluded from the models because maintaining zero walking is qualitatively different from maintaining some level of walking. Separate logistic regression models were used to compare participants who decreased or increased walking after retirement relative to those who maintained walking levels after retirement. Separate logistic regression models were used rather than multinomial models to improve the interpretability of coefficients and to reflect the meaningful ordering of the outcome categories (i.e., benefits of increased walking and risks of decreased walking). A backward selection strategy was applied wherein all potential correlates were included in an initial model then removed sequentially using likelihood ratio tests to compare nested models. A significance threshold of $\alpha = 0.2$ was used to determine which variables to retain in models. All models included nine core variables: gender, retirement age, race/ethnicity, SEP, MESA site, season of both pre- and post-retirement exams, time between pre- and post-retirement exams, and pre-retirement walking tertile. Clustering within US census tracts, as a

Table 1
Potential correlates of change in recreational and transport walking at retirement.

Measure	Categories or components and data source
Individual level correlates	
Gender	Male, female
Race/ethnicity	Non-Hispanic white, Chinese American, non-Hispanic black, Hispanic
Retirement age	Estimated age at midpoint between pre- and post-retirement exams
MESA site	Forsyth Co., NC; Northern Manhattan and the Bronx, NY; Chicago, IL; Los Angeles Co., CA; St. Paul, MN; Baltimore City and Baltimore Co., MD
Socioeconomic position	Composite index of self-reported education (≤high school, some college but no degree, associates or bachelor's degree, graduate/professional degree), income (< $25,000, $25,000–39,999, $40,000–74,999, ≥$75,000), and ownership of home, car, land/property, and investments (Lemelin et al., 2009). SEP (range 0 to 10) was the sum of scores for education (0–3 from lowest to highest), income (0–3 from lowest to highest), and one point for each wealth indicator. SEP was calculated for the baseline exam
Job type	Employment status at exam prior to retirement: full-time, part-time, or other (homemaker, on-leave from work, or unemployed)
Occupational physical activity prior to retirement	Sum of MET-min/week self-reported frequency and duration of occupational physical activity at four intensity levels prior to retirement. MET values assigned by intensity: sitting 1.5 MET, standing 2.5 MET, moderate effort 3.0 MET, heavy effort 7.0 MET
Change in self-rated health	Difference in pre- and post-retirement self-rated health, categorized as always better than others of the same age, improved after retirement, declined after retirement, never better than others of the same age
Change in number of chronic conditions	Difference in number of chronic conditions before and after retirement, categorized as zero, 1, > 1, increase in number of chronic conditions, or decrease in number of chronic conditions. Chronic conditions were: self-reported asthma, emphysema, arthritis flare up in the past two weeks, measured high cholesterol, hypertension, or diabetes, and kidney disease, cancer, and cardiovascular disease ascertained from medical records and hospital billing claims (Bild et al., 2002; Hirsch et al., 2014)
Change in BMI	Difference in pre- and post-retirement BMI (kg/m^2), measured by standardized protocol
Car ownership	Self-reported ownership of ≥1 car prior to retirement
Pre-retirement walking	Self-reported walking before retirement categorized into tertiles based on the data distribution by type of walking (recreational: ≤90, > 90 to ≤210, > 210 min/week; transport: ≤90, > 90 to ≤300, > 300 min/week)
Interpersonal level correlates	
Change in partnership status	Difference in partnership status before and after retirement, categorized as married/lived with a partner, no partner after retirement, no partner before retirement, or never married/lived with a partner. Partnership status at exam 2 was imputed from the closer of exams 1 or 3 (Hirsch et al., 2014)
Social support	Self-reported ENRICHD Social Support Inventory (Mitchell et al., 2003) (6 items) measured prior to retirement. Scores (range 6–30) set to missing if any items missing and dichotomized as low (score ≤ 12) vs. high (score > 12) (Mezuk et al., 2010)
Change in caregiver status	Difference in caregiver status before and after retirement (always, only before retirement, only after retirement, never). Caregiver status defined as self-reported caring for children or adults ≥150 min/week
Observed community level correlates	
Park density	1-Mile density of public parks excluding walking trails, dog parks, and ornamental parks (source: local government data and Esri) (Evenson and Wen, 2013)
Recreational facility density	1-Mile density of commercial locations for adult physical activity including conditioning, recreational, team/racquet sports, water activities, and instructional facilities based on 114 Standard Industrial Classification codes (source: National Establishment Time Series) (Walls and Associates, 2013; Powell et al., 2006; Gordon-Larsen et al., 2006)
Walking destination density	1-Mile density of postal offices, drug store/pharmacy, banks/credit unions, grocery stores, eating/dining places, and non-alcoholic drinking places based on 137 Standard Industrial Classification codes (source: National Establishment Time Series) (Walls and Associates, 2013; Hoehner and Schootman, 2010)
Social engagement destination density	1-Mile density of barber/beauty shops, performance/participatory/sports entertainment clubs, exercise facilities, gambling, amusement park/carnivals, membership sport/recreation clubs, libraries, museum/art galleries, zoo/aquariums, civil/social/political clubs, religious institutions, eating places, night club/bars based on 430 Standard Industrial Classification codes (source: National Establishment Times Series) (Walls and Associates, 2013; Hoehner and Schootman, 2010)
Street connectivity (network ratio)	Proportion of 1-mile Euclidean buffer covered by 1-mile street network buffer (Hirsch et al., 2014). Higher network ratio indicates greater street connectivity (source: StreetMap and StreetMap Premium for ArcGIS from Esri)
Population density	Population divided by area in miles within 1-mile circular buffer of participants' homes (source: Census 2000 & 2010 Summary File 1) (Bureau of the Census, US Department of Commerce, 2007)
Perceived community level correlates	
Walking environment	Four items, scored from strongly agree (1) to strongly disagree (5) (Echeverria et al., 2004): ● It is pleasant to walk in my neighborhood ● In my neighborhood it is easy to walk places ● I often see other people walking in my neighborhood ● I often see other people exercise in my neighborhood
Aesthetic quality	Three items, scored from strongly agree (1) to strongly disagree (5) (Echeverria et al., 2004): ● There is a lot of noise in my neighborhood ● There is a lot of trash and litter on the streets in my neighborhood ● My neighborhood is attractive
Safety	Two items, scored from strongly agree (1) to strongly disagree (5) (Echeverria et al., 2004): ● I feel safe walking in my neighborhood at day or at night ● Violence is a problem in my neighborhood
Social cohesion scale	Four items, scored from strongly agree (1) to strongly disagree (5). Favorable items reverse-coded and all items summed to create overall score. Categorized as low (0 to 11), moderate (12 to 15), or high (> 15) (Echeverria et al., 2004): ● People around here are willing to help their neighbors ● People in this neighborhood generally do not get along with each other ● People in this neighborhood can be trusted

(*continued on next page*)

Table 1 (*continued*)

Measure	Categories or components and data source
	• People in this neighborhood do not share the same values

Abbreviations: BMI body mass index; ENRICHD Enhancing Recovery in Coronary Heart Disease; MESA Multi-Ethnic Study of Atherosclerosis; MET metabolic equivalent task.

Notes: Correlates at the individual- and interpersonal-levels measured at MESA exams between 2000 and 2012. Community-level correlates measured from external sources (local and federal governments, Esri, and National Establishment Time Series database), or participant perceptions at MESA exams (2000 to 2012).

proxy for neighborhood, was accounted for in final models with an exchangeable correlation structure. Categorical correlates were modeled using dummy indicator coding. Continuous correlates were entered as linear terms or categorized if a non-linear relationship was identified.

2.6. Sensitivity analyses

Changes in physical activity at retirement may vary by SEP, gender, and retirement age (Barnett et al., 2012a; Baxter et al., 2016). To explore variation, interaction terms were added to models after variable selection. Interactions between each correlate and SEP (low, high), gender, and retirement age (< 63, ≥ 63 years) were evaluated in separate models using $\alpha = 0.1$. These models did not account for clustering.

Eight additional sensitivity analyses were related to model specification. First, we replaced the composite SEP measure with the separate components (education, income, home, car, land, and investment ownership). Second, recreational walking models were adjusted for change in transport walking, and vice-versa. Third, analyses were restricted to participants who did not work after retirement (N = 740). Fourth, models were adjusted for population density (Diez Roux et al., 2007). Fifth, we substituted density measures with radii of 1/2-mile or 3-miles for the 1-mile density measures. Sixth, because the relevance of destinations may decline with distance, we used 1-mile kernel density measures in place of simple density measures. Simple and kernel densities were highly correlated (r = 0.98). Seventh, 1-mile density of parks was added to final models for the subset of participants with park data (N = 718 for recreational walking; N = 807 for transport walking). Eighth, we excluded participants (N = 194, 21%) who moved between pre- and post-retirement exams.

3. Results

Of 928 included MESA participants, 62% retired between MESA exams 3 (2004–2006) and 5 (2010 – 2012), 16% retired between exams 2 (2002–2004) and 3 (2004–2006), and 21% retired between exams 1 (2000–2002) and 2 (2002–2004). On average, pre- and post-retirement exams were 4.5 years apart (standard deviation 2.3 years). Among included participants, 54% were female, 44% were non-Hispanic white, and 28% were of low SEP (Table 2). Prior to retirement, most participants lived with a partner (66%), had ≥1 chronic condition (58%), and walked a median of 90 min/week for recreation and 150 min/week for transport.

Participants who reported zero recreational walking before and after retirement (N = 136) were less likely to be non-Hispanic white and living with a partner, and had lower SEP and higher mean BMI compared to participants who reported some recreational walking. Participants who did not walk for recreation also perceived their neighborhoods to be less cohesive and favorable for walking compared to participants who did walk for recreation.

Participants who reported zero transport walking before and after retirement (N = 41) lived in neighborhoods with lower density of walking destinations and population, and perceived their neighborhoods to be less cohesive and favorable for walking compared to participants who did walk for transportation.

3.1. Recreational walking

Among 792 participants who reported some recreational walking, 247 (31%) decreased, 151 (19%) maintained, and 394 (50%) increased recreational walking after retirement (Table 3). Correlate distributions by category of recreational walking change are shown in Supplemental Table 1.

In multivariable models, six correlates were statistically significantly associated with decreased compared to maintaining recreational walking after retirement (Table 4). The odds of decreased recreational walking were higher for persons with lower SEP, decline in and consistently worse self-rated health, and not perceiving litter in their neighborhood. The odds of decreased recreational walking were lower for persons with a spring post-retirement exam, lower levels of pre-retirement recreational walking, and who perceived it was easy to walk places.

Two correlates were associated with increased compared to maintaining recreational walking after retirement (Table 4). The odds of increased recreational walking were higher for persons with lower SEP and lower levels of pre-retirement recreational walking.

3.2. Transport walking

Among 887 participants who reported some transport walking, 353 (40%) decreased, 172 (19%) maintained, and 362 (41%) increased transport walking after retirement (Table 3). Correlate distributions by category of transport walking change are shown in Supplemental Table 2.

In multivariable models, seven correlates were associated with decreased compared to maintaining transport walking after retirement (Table 5). The odds of decreased transport walking were higher for persons with a fall pre-retirement exam and who saw others walking in their neighborhood, and lower for persons with a summer post-retirement exam, from the CA site, with lower levels of pre-retirement transport walking, higher density of walking destinations, and not perceiving litter in their neighborhood.

Four correlates were associated with increased compared to maintaining transport walking after retirement (Table 5). The odds of increased transport walking were higher for persons with a spring pre-retirement exam, decline in self-rated health, and living with a partner before retirement but not after, and lower for persons from the CA site.

3.3. Sensitivity analyses

There were no significant interactions between SEP and correlates of recreational or transport walking ($p > 0.1$). Although confidence intervals were wide, there were potential interactions with both gender and retirement age.

The correlation between recreational walking and self-rated health and chronic conditions may vary by gender. Higher odds of decreased recreational walking were associated with poor self-rated health among women (OR 4.12, 95% CI: 1.66, 10.26) but not men (OR 0.72, 95% CI: 0.26, 1.98). Lower odds of increased recreational walking were associated with fewer chronic conditions among men (OR 0.24, 95% CI: 0.09, 0.68) but not women (OR 1.89, 95% CI: 0.62, 5.77).

The correlation between walking and neighborhood perceptions

Table 2
Participant characteristics, overall and among participants reporting no walking for recreation or transport.

Characteristic	Overall (N = 928)	No recreational walking (N = 136)[a]	No transport walking (N = 41)[a]
Age (years)	60 (56, 64)	60 (55, 65)	62 (56, 64)
Female gender	501 (54%)	81 (60%)	17 (41%)
Race/ethnicity			
Non-Hispanic White	407 (44%)	46 (34%)	17 (41%)
Non-Hispanic Chinese	101 (11%)	10 (7%)	6 (15%)
Non-Hispanic Black	251 (27%)	57 (42%)	8 (20%)
Hispanic	169 (18%)	23 (17%)	10 (24%)
Socioeconomic position[b]			
Low	263 (28%)	42 (31%)	11 (27%)
Moderate	361 (39%)	66 (49%)	17 (41%)
High	304 (33%)	28 (21%)	13 (32%)
Own ≥1 car	792 (85%)	123 (90%)	39 (95%)
Job type			
Full-time	658 (71%)	103 (76%)	28 (68%)
Part-time	169 (18%)	17 (13%)	6 (15%)
Other[c]	101 (11%)	16 (12%)	7 (17%)
Self-rated health			
Better	532 (57%)	74 (54%)	23 (56%)
Same	351 (38%)	57 (42%)	15 (37%)
Worse	45 (5%)	5 (4%)	3 (7%)
Number of chronic conditions[d]			
0	393 (42%)	46 (34%)	15 (37%)
1	351 (38%)	58 (43%)	16 (39%)
> 1	184 (20%)	32 (24%)	10 (24%)
BMI (kg/m^2)	28 (25, 32)	30 (26, 33)	29 (26, 32)
Married/living with partner	612 (66%)	76 (56%)	32 (78%)
Caregiver	199 (21%)	33 (24%)	4 (10%)
MESA site			
Forsyth Co., NC	178 (19%)	26 (19%)	8 (20%)
New York, NY	156 (17%)	21 (15%)	2 (5%)
Baltimore City and Co., MD	123 (13%)	30 (22%)	6 (15%)
St. Paul, MN	176 (19%)	28 (21%)	14 (34%)
Chicago, IL	190 (20%)	16 (12%)	7 (17%)
Los Angeles Co., CA	105 (11%)	15 (11%)	4 (10%)
Recreational walking (min/week)	90 (0, 240)	0 (0, 0)	0 (0, 225)
Transport walking (min/week)	150 (45, 360)	122 (40, 240)	0 (0, 0)
Aesthetic quality			
Little trash on the street	773 (83%)	111 (82%)	33 (80%)
Little noise in neighborhood	585 (63%)	86 (63%)	27 (66%)
Neighborhood is attractive	761 (82%)	106 (78%)	34 (83%)
Safety			
Feel safe walking	701 (76%)	97 (71%)	29 (71%)
Violence is not a problem	698 (75%)	103 (76%)	29 (71%)
Walking environment			
Pleasant to walk	805 (87%)	108 (79%)	31 (76%)
Easy to walk places	724 (78%)	92 (68%)	27 (66%)
See others walking	827 (89%)	115 (85%)	35 (85%)
See others exercising	708 (76%)	87 (64%)	24 (59%)
Low social cohesion	72 (8%)	19 (14%)	9 (22%)
Density of walking destinations	55.3 ± 79.7	46.9 ± 73.4	24.8 ± 35.1
Network ratio	0.4 ± 0.2	0.4 ± 0.2	0.4 ± 0.2
Population density per mi^2	14,207 ± 19,055	13,777 ± 19,659	5,975 ± 5,886

Abbreviations: BMI body mass index; MESA Multi-Ethnic Study of Atherosclerosis.
Most characteristics were measured at the last MESA exam prior to retirement for each participant (2000–2007), excepting SEP (measured at baseline) and community correlates (measured at the MESA exam closest to retirement for each participant). Values are N (%), mean ± standard deviation, or median (first quartile, third quartile).

[a] Persons reporting no recreational and transport walking before and after retirement are not mutually exclusive (N = 9 in both columns).

[b] Composite index of education, income, and four indicators of wealth (ownership of home, land/property, car, investments) categorized as low (0–4), moderate (5–7), or high (8–10) (Mezuk et al., 2010).

[c] Includes homemaker, on-leave from work, or unemployed at the exam prior to retirement.

[d] Includes asthma, emphysema, arthritis flare up in the past two weeks, high cholesterol, hypertension, diabetes, kidney disease, cancer, and cardiovascular disease.

may vary by retirement age (< 63 vs. ≥63 years). Higher odds of decreased recreational walking were associated with not perceiving litter in the neighborhood among older (OR 4.84, 95% CI: 1.72, 13.65) but not younger retirees (OR 0.96, 95% CI: 0.35, 2.68), whereas lower odds of decreased recreational walking were associated with ease of walking places among younger (OR 0.15, 95% CI: 0.05, 0.48) but not older retirees (OR 1.12, 95% CI: 0.45, 2.77). On the other hand, lower odds of increased recreational walking were associated with living in an attractive neighborhood among younger (OR 0.14, 95% CI: 0.04, 0.51) but not older retirees (OR 1.50, 95% CI: 0.66, 3.39). The odds of decreased transport walking were higher among older (OR 2.59, 95% CI: 1.13, 5.94) but not younger retirees (OR 0.65, 95% CI: 0.24, 1.74) who did not identify violence as a neighborhood problem.

When the composite SEP measure was replaced with component variables, there were three statistically significant associations: lower income was associated with higher odds of decreased recreational

Table 3
Recreational and transport walking before and after retirement.

Walking domain	N (%)	Median (Q1, Q3) walking (min/week)		
		Before retirement	After retirement	Change
Recreational walking				
Overall	792	120 (30, 270)	210 (60, 420)	45 (−90, 225)
Decrease (≤ −60 min/week)	247 (31%)	270 (150, 420)	15 (0, 180)	−180 (−330, −90)
Maintain (within 60 min/week)	151 (19%)	105 (30, 240)	120 (45, 240)	0 (−20, 30)
Increase (≥60 min/week)	394 (50%)	60 (0, 150)	360 (210, 600)	225 (120, 420)
Transport walking				
Overall	887	180 (60, 420)	180 (60, 420)	0 (−165, 195)
Decrease (≤ −60 min/week)	353 (40%)	360 (210, 630)	90 (0, 210)	−210 (−390, −120)
Maintain (within 60 min/week)	172 (19%)	75 (35, 135)	82 (27, 142)	0 (−30, 15)
Increase (≥60 min/week)	362 (41%)	90 (30, 210)	420 (225, 750)	270 (145, 510)

Abbreviations: Q1 first quartile; Q3 third quartile; MESA Multi-Ethnic Study of Atherosclerosis.
Median (first quartile, third quartile) recreational and transport walking before and after retirement among participants reporting > 0 min/week walking before or after retirement (recreational walking N = 792; transport walking N = 887). Change in walking is difference in post-minus pre-retirement walking, categorized as decrease (≤ −60 min/week), maintain (within 60 min/week), or increase (≥60 min/week). Frequency and duration of walking self-reported at MESA exams between 2000 and 2012.

walking after retirement, less education was associated with higher odds of decreased transport walking after retirement, and owning a home was associated with higher odds of increased transport walking after retirement.

Findings were consistent when: 1) models for recreational walking were adjusted for change in transport walking and vice-versa; 2) restricted to participants who did not work after retirement (N = 740); 3) adjusted for population density; and, 4) 1-mile density of walking destinations was replaced with 0.5-mile density or 1-mile kernel density (data not shown). When the 1-mile density of walking destinations was replaced with the 3-mile density, the odds ratio for decreased transport walking was closer to one. Where data were available (N = 836 participants), the 1-mile density of parks was not statistically significantly associated with changes in walking. Excluding participants who moved between the pre- and post-retirement exams primarily affected coefficients related to MESA site (Supplemental Tables 3 and 4 compared to Tables 4 and 5).

4. Discussion

In this diverse cohort of US adults, we identified correlates from multiple levels associated with within-person changes in recreational and transport walking after retirement. Interpersonal- and community-level correlates were not investigated in most studies of physical activity at retirement (Van Dyck et al., 2017) and to our knowledge none have focused on changes in walking. In this study, changes in recreational and transport walking after retirement were associated with individual-level correlates, including health, and community-level correlates, such as aesthetic quality and walking environment. Further, correlates differed by type of walking.

Worse self-rated health and a greater number of chronic conditions were associated with decreased recreational walking after retirement. Chronic conditions may prompt retirement and limit one's ability to walk (National Institute on Aging, 2007). However, walking also can contribute to secondary prevention and control of chronic conditions (US Department of Health and Human Services, 2015). Surprisingly, declining self-rated health was associated with higher odds of increased transport walking after retirement. Possible explanations include that health may be a stronger motivator for behavior change among people who are sick than those who are well (Baxter et al., 2016) and increased prioritization of health after retirement (Beck et al., 2010). Thus, targeting interventions to persons who retire due to ill health and including health promotion as a motivation for walking are approaches that could be explored further.

Low SEP also may be an important factor in targeting interventions at the retirement transition. Lower SEP was linked to decreased overall physical activity after retirement (Jones et al., 2018) and higher odds of changes (increased or decreased) in recreational walking after retirement. Decreased walking after retirement among persons of low SEP may be linked to poor health. The prevalence of chronic conditions was higher among MESA participants of lower SEP and persons of lower SEP are more likely to retire due to illness in the US (Henretta et al., 1992; Lytle et al., 2015). On the other hand, among persons who become more active after retirement, persons of lower SEP may walk because it requires few resources, whereas persons of higher SEP may choose non-walking activities (e.g., tennis). Retirement was associated with increased non-walking leisure physical activity among MESA participants of high but not low SEP (Jones et al., 2018).

Changes in walking also were correlated with pre-retirement walking, caregiving, and partnership status. The influence of earlier life experience on later behavior is a key Life Course Theory principle (Elder et al., 2003). Workplace wellness programs that promote walking before retirement may contribute to higher prevalence of walking after retirement (Morrow-Howell et al., 2014). However, changes in other life domains concurrent with retirement, such as becoming a caregiver, may reduce time and energy for walking (Jones et al., under review). Interventions could be targeted to retirees who become caregivers or are widowed. Such interventions could include increased social support, which facilitated physical activity among retired women (Barnett et al., 2012b; Barnett et al., 2013; Kosteli et al., 2016). Surprisingly, social support was not correlated with walking changes in this sample, perhaps because the MESA social support index was not specific to walking.

Community-level correlates of walking are important given the potential for wide-scale impact of environmental changes (Community Preventive Services Taskforce, 2016). Community Preventive Services Task Force recommendations identified street connectivity, pedestrian infrastructure, and proximity to destinations as effective for promoting physical activity (Community Preventive Services Taskforce, 2016). However, changes to physical characteristics influence but do not determine perceptions of the environment (Arvidsson et al., 2012). Perceived measures of the environment were more strongly associated with changes in walking compared to objective measures in this sample. Qualitative and experimental studies may provide insights on whether environmental improvements are sufficient to change perceptions and support behavior change (Moran et al., 2014; Ward Thompson et al., 2014).

The association between changes in walking and community-level correlates may vary by retirement age. In MESA, the SEP of younger retirees averaged higher than that of older retirees. Younger retirees

Table 4
Correlates associated with changes in recreational walking after retirement.

Correlate level Correlate	Decrease vs. maintain	Increase vs. maintain
	OR (95% CI)	OR (95% CI)
Core variables		
Gender		
Male	0.94 (0.56, 1.62)	1.08 (0.70, 1.67)
Female	1 (ref)	1 (ref)
Socioeconomic position[a]		
Low	**3.12 (1.46, 6.67)***	**2.31 (1.30, 4.12)***
Moderate	1.60 (0.84, 3.04)	1.32 (0.82, 2.13)
High	1 (ref)	1 (ref)
Race/ethnicity		
Chinese American	1.06 (0.38, 2.99)	1.24 (0.54, 2.84)
Non-Hispanic black	1.73 (0.88, 3.42)	1.17 (0.71, 1.95)
Hispanic	1.02 (0.51, 2.01)	0.71 (0.38, 1.33)
Non-Hispanic white	1 (ref)	1 (ref)
Retirement age (1-year difference)	0.99 (0.95, 1.03)	0.98 (0.95, 1.02)
Time between exams (1-year difference)	1.06 (0.94, 1.19)	1.07 (0.96, 1.19)
Season of pre-retirement exam		
Spring	1.76 (0.88, 3.53)	1.32 (0.75, 2.31)
Summer	1.49 (0.76, 2.95)	1.26 (0.71, 2.23)
Fall	0.76 (0.37, 1.59)	1.11 (0.63, 1.97)
Winter	1 (ref)	1 (ref)
Season of post-retirement exam		
Spring	**0.50 (0.25, 0.99)***	1.18 (0.63, 2.21)
Summer	0.70 (0.35, 1.42)	1.71 (0.91, 3.21)
Fall	0.97 (0.46, 2.04)	1.48 (0.86, 2.56)
Winter	1 (ref)	1 (ref)
MESA site		
Forsyth Co., NC	1.02 (0.45, 2.34)	1.00 (0.51, 1.94)
New York, NY	1.61 (0.60, 4.30)	1.18 (0.53, 2.63)
Baltimore City and Co., MD	0.91 (0.35, 2.35)	0.53 (0.24, 1.18)
St. Paul, MN	0.99 (0.38, 2.62)	0.53 (0.21, 1.32)
Los Angeles Co., CA	0.91 (0.28, 2.94)	0.82 (0.37, 1.84)
Chicago, IL	1 (ref)	1 (ref)
Recreational walking before retirement		
≤90 min/week	**0.09 (0.04, 0.18)***	**2.13 (1.19, 3.81)***
> 90 to ≤210 min/week	**0.48 (0.26, 0.90)***	**1.84 (1.06, 3.19)***
> 210 min/week	1 (ref)	1 (ref)
Individual-level		
Change in self-rated health relative to others		
Improved after retirement	1.59 (0.76, 3.34)	
Declined after retirement	**2.96 (1.46, 6.01)***	
Always “same”/“worse”	**2.05 (1.07, 3.95)***	
Always “better”	1 (ref)	
Change in number of chronic conditions[b]		
Fewer after retirement		0.67 (0.33, 1.39)
More after retirement		0.96 (0.55, 1.66)
1 chronic condition		1.32 (0.70, 2.51)
> 1 condition		0.55 (0.28, 1.06)
No chronic conditions		1 (ref)
Job type before retirement		
Part-time		0.84 (0.49, 1.41)
Other[c]		0.54 (0.28, 1.03)
Full-time		1 (ref)
Community-level		
Aesthetic quality: there is a lot of trash on the street		
Disagree	**2.21 (1.16, 4.23)***	
Agree	1 (ref)	
Aesthetic quality: my neighborhood is attractive		
Agree		0.58 (0.30, 1.09)
Disagree		1 (ref)
Walking environment: it is easy to walk places		
Agree	**0.50 (0.26, 0.97)***	0.62 (0.34, 1.11)
Disagree	1 (ref)	1 (ref)
Walking environment: I see others exercise		
Agree	0.57 (0.28, 1.2)	
Disagree	1 (ref)	

Abbreviations: CI confidence interval; MESA Multi-Ethnic Study of Atherosclerosis; OR odds ratio.
Individual-, interpersonal-, and community-level correlates associated with decreased (≤ −60 min/week; N = 247) or increased (≥60 min/week; N = 394) recreational walking after retirement compared to maintaining recreational walking after retirement (within 60 min/week; N = 151) among MESA participants reporting > 0 min/week recreational walking before or after retirement (data collected 2000 to 2012). Odds ratios (95% CI) from separate multivariable logistic regression models comparing decreased vs. maintained and increased vs. maintained categories. All models adjusted for nine core variables, other variables selected via backward selection using likelihood ratio tests to compare nested models (α = 0.2). Final models estimated using generalized estimating equations with exchangeable correlation structure.

[a] Composite index of education, income, and four indicators of wealth (ownership of home, land/property, car, investments).

[b] Chronic conditions included asthma, emphysema, arthritis flare up in the past two weeks, high cholesterol, hypertension, diabetes, kidney disease, cancer, and cardiovascular disease.

[c] Includes homemaking, unemployment, and on-leave from work at the exam prior to retirement.

* p-Value < 0.05.

may be motivated to walk for enjoyment, making neighborhood attractiveness and ease of walking to destinations more important to this group. Thus, interventions may need to be tailored to the age of retirees.

4.1. Strengths and limitations

Strengths of this work include exploration of multi-level correlates, including the neighborhood environment, and a focus on walking, the most prevalent physical activity among older Americans (Centers for Disease Control and Prevention (CDC), 2012). Although some potentially important factors were not measured (e.g., attitudes towards aging) (Van Dyck et al., 2017), understanding the role of environmental correlates is important given their population-level reach and sustainability (Community Preventive Services Taskforce, 2016). Further, correlates of changes in transport and recreational walking differed, emphasizing the importance of specificity in physical activity measures when studying behavioral correlates. Also, the MESA is diverse, which is important as the population of minority older Americans is projected to increase from 6.3 million (18% of older Americans) in 2003 to 21.1 million (28%) in 2030 (Administration for Community Living, 2014).

One limitation of this work is reliance on self-reported measures of walking, which typically overestimate walking relative to accelerometer measures (Prince et al., 2008). To address over-reporting, we categorized changes in walking. Recalling walking also may be more difficult after retirement without the regular structure of work, evidenced by the stronger correlation found between self-reported and accelerometer measures among employed vs. non-employed women (Jones et al., 2015). However, self-reported measures continue to be important to identify correlates of specific domains of walking (Heath

Table 5

Correlates associated with changes in transport walking after retirement.

Correlate level Correlate	Decrease vs. maintain	Increase vs. maintain
	OR (95% CI)	OR (95% CI)
Core variables		
Gender		
Male	1.46 (0.85, 2.52)	1.06 (0.67, 1.68)
Female	1 (ref)	1 (ref)
Socioeconomic position[a]		
Low	2.06 (0.95, 4.48)	0.98 (0.56, 1.70)
Moderate	1.67 (0.94, 2.98)	1.10 (0.69, 1.76)
High	1 (ref)	1 (ref)
Race/ethnicity		
Chinese American	2.81 (0.99, 8.02)	1.03 (0.50, 2.10)
Non-Hispanic black	0.81 (0.43, 1.52)	0.73 (0.43, 1.24)
Hispanic	1.94 (0.73, 5.17)	1.42 (0.67, 3.02)
Non-Hispanic white	1 (ref)	1 (ref)
Retirement age (1-year difference)	0.98 (0.93, 1.02)	0.98 (0.95, 1.01)
Time between exams (1-year difference)	1.07 (0.95, 1.21)	1.10 (0.99, 1.20)
Season of pre-retirement exam		
Spring	1.68 (0.81, 3.51)	**1.65 (1.01, 2.71)***
Summer	1.99 (0.91, 4.38)	1.37 (0.77, 2.47)
Fall	**2.41 (1.11, 5.22)***	1.48 (0.84, 2.60)
Winter	1 (ref)	1 (ref)
Season of post-retirement exam		
Spring	0.65 (0.31, 1.35)	0.72 (0.41, 1.25)
Summer	**0.34 (0.15, 0.76)***	0.64 (0.35, 1.16)
Fall	0.88 (0.38, 2.05)	1.13 (0.60, 2.13)
Winter	1 (ref)	1 (ref)
MESA site		
Forsyth Co., NC	0.77 (0.31, 1.90)	0.62 (0.33, 1.16)
New York, NY	3.06 (0.96, 9.77)	2.06 (0.90, 4.72)
Baltimore City and Co., MD	1.08 (0.39, 3.02)	1.19 (0.56, 2.53)
St. Paul, MN	1.15 (0.47, 2.81)	0.66 (0.37, 1.17)
Los Angeles Co., CA	**0.30 (0.11, 0.86)***	**0.24 (0.12, 0.48)***
Chicago, IL	1 (ref)	1 (ref)
Pre-retirement transport walking		
≤90 min/week	**0.01 (0.01, 0.03)***	0.86 (0.48, 1.57)
> 90 to ≤300 min/week	**0.19 (0.10, 0.34)***	0.87 (0.48, 1.58)
> 300 min/week	1 (ref)	1 (ref)
Individual-level		
Self-rated health relative to others		
Improved after retirement		1.33 (0.70, 2.53)
Declined after retirement		**2.02 (1.11, 3.70)***
Always "same"/"worse"		0.64 (0.35, 1.14)
Always "better"		1 (ref)
Interpersonal-level		
Change in partnership status		
Never married/lived with partner	1.38 (0.75, 2.51)	1.09 (0.62, 1.89)
Married/lived with partner before retirement	3.63 (0.89, 14.79)	**2.90 (1.10, 7.68)***
Married/lived with partner after retirement	2.91 (0.51, 16.73)	0.92 (0.27, 3.11)
Always married/lived with partner	1 (ref)	1 (ref)
Change in caregiver status[b]		
Caregiver before retirement	0.68 (0.31, 1.52)	
Caregiver after retirement	0.52 (0.26, 1.05)	
Always a caregiver	2.26 (0.87, 5.86)	
Never a caregiver	1 (ref)	
Community-level		
Density of walking destinations (1-SD unit increase)	**0.65 (0.45, 0.95)***	
Aesthetic quality: there is a lot of trash on the street		
Disagree	**0.46 (0.23, 0.91)***	
Agree	1 (ref)	
Aesthetic quality: my neighborhood is attractive		
Agree		0.69 (0.41, 1.16)
Disagree		1 (ref)
Safety: violence is a problem in my neighborhood		
Disagree	1.57 (0.81, 3.05)	
Agree	1 (ref)	
Walking environment: it is easy to walk places		
Agree	0.53 (0.25, 1.15)	
Disagree	1 (ref)	
Walking environment: I see others walking		
Agree	**2.38 (1.02, 5.53)***	1.59 (0.85, 2.98)
Disagree	1 (ref)	1 (ref)

Abbreviations: CI confidence interval; MESA Multi-Ethnic Study of Atherosclerosis; OR odds ratio; SD standard deviation.

Individual-, interpersonal-, and community-level correlates associated with decreased (≤ −60 min/week; N = 353) or increased (≥60 min/week; N = 362) transport walking after retirement compared to maintaining transport walking after retirement (within 60 min/week; N = 172) among MESA participants reporting > 0 min/week transport walking before or after retirement (data collected 2000 to 2012). Odds ratios (95% CI) from separate multivariable logistic regression models comparing decreased vs. maintained and increased vs. maintained categories. All models adjusted for nine core variables, other variables selected via backward selection using likelihood ratio tests to compare nested models ($\alpha = 0.2$). Final models estimated using generalized estimating equations with exchangeable correlation structure.

[a] Composite index of education, income, and four indicators of wealth (ownership of home, land/property, car, investments).

[b] Caregiver defined as reporting ≥150 min/week of caregiving physical activity to children or adults.

* p-Value < 0.05.

et al., 2012).

The correlates in this study also are subject to limitations. For example, retirement age was estimated as the mid-point between exams because it was not directly measured by MESA. Also, some time-varying correlates were not measured repeatedly (e.g., car ownership, SEP, social support), so changes in these correlates after retirement were not captured. Neighborhood measures were attributed for the exam closest to retirement. Many environmental features change slowly over time, and environmental measures were highly correlated at pre- and post-retirement exams (correlation coefficient range 0.56 to 0.92). Moreover, findings were similar after excluding people who moved between pre- and post-retirement exams. Associations of walking with environmental features also may vary depending on the size and composition of the area over which measures are aggregated (Houston, 2014). Because the relevant areal unit for walking was unknown, circular buffers were used. MESA participants reported being active within 1-mile of home (Diez Roux et al., 2007), and findings were robust using a half-mile buffer or 1-mile kernel density, as in a previous study of older adults (Villanueva et al., 2014). However, the relevant areal unit may differ by location, walking purpose, or individual characteristics (Houston, 2014; Villanueva et al., 2014). Also, this study may over-represent healthier persons who experienced favorable transitions to retirement. MESA participants were healthy at baseline (Bild et al., 2002), and participants who were sicker or less satisfied with retirement may have been more likely to drop out of the study.

5. Conclusion

The population of older Americans is projected to grow to 72 million by 2030 (Administration for Community Living, 2014; National Center for Chronic Disease Prevention and Health Promotion, 2013). Older adults suffer a large burden of chronic disease, making health promotion in this age group a public health priority (Administration for Community Living, 2014; Frank et al., 2010). Retirement is a potentially critical window for health promotion in later life when peoples' roles, relationships, and ecological contexts are changing (Hirvensalo and Lintunen, 2011; Kelly et al., 2016). Our findings suggest that various strategies may help to promote positive changes in walking after retirement, including targeting retirees of lower SEP or those with chronic conditions and improving walking environments.

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Conflict of interest

The authors declare that there are no conflicts of interest. The funders had no part in the study design, analysis, interpretation, reporting, or decision to publish.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2018.07.002.

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