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Associations between Perceived Neighborhood Walkability and Device-Based Physical Activity and Sedentary Behavior Patterns in Older Adults

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Abstract

Neighborhood walkability has been associated with self-reported sedentary behavior (SB), and self-reported and objective physical activity (PA). However, self-report measures of SB are inaccurate and can lead to biased estimates, and few studies have examined how associations differ by gender and age. We examined relationships between perceived neighborhood walkability measured with the Physical Activity Neighborhood Environment Scale (PANES; scored 1.0–4.0) and device-based SB and PA in a cohort of community-dwelling older adults (N=1,077). We fit linear regression models adjusting for device wear time, demographics, self-rated health, and accounting for probability of participation. Higher PANES was associated with higher steps (+676 steps/point on PANES, p=0.001) and sit-to-stand transitions (+2.4 transitions/point, p=0.018). Though not statistically significant, stratified analyses suggest attenuation of effect for those age 85+ and for women. Consistent with previous literature, neighborhood walkability was associated with more steps, though not with PA time. Neighborhood environment may also influence SB.

Keywords

built environment; physical activity; exercise; aging; accelerometer

Background and Objectives:

Older adults, defined in our study as individuals age 65 and older, are the most sedentary and least active segment of the United States (U.S.) population (Matthews et al., 2008) and may be particularly impacted by neighborhood environments, as many older adults have

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limited mobility and may have driving limitations that hamper options to engage in activities outside of their home or neighborhood (King et al., 2011). In the U.S., adults aged 60 and older on average spend 8 hours or more each day on sedentary behaviors (SB) (Harvey, Chastin, & Skelton, 2015) which are defined as any activities expending low energy while sitting, reclining or lying down (Matthews et al., 2008; Tremblay et al., 2017). In older adult populations, high levels of daily SB are associated with numerous sociodemographic factors including male gender and lower educational attainment, and with health status factors including obesity and depression (Diaz et al., 2016; Kelly R. Evenson, Buchner, & Morland, 2012; Owen et al., 2011; Teychenne, Ball, & Salmon, 2010). Less physical activity (PA) and more SB are associated with higher mortality and developing mobility limitations (Biswas et al., 2015; Rillamas-Sun et al., 2018).

Walkable neighborhoods consist of multiple features, such as utilitarian destinations within walking distance, well maintained pedestrian and cycling infrastructure, and pedestrian safety, that can promote PA (Forsyth, 2015). Neighborhood walkability, safety, and a variety of functional and recreational destinations have been associated with increased PA and walking for leisure and purpose among older adults (David W. Barnett et al., 2017; Christman, Wilson-Genderson, Heid, & Pruchno, 2019). By creating environments that encourage more walking, particularly more active transportation, these neighborhood features may also promote reduced sedentary behaviors such as driving and television viewing (Kozo et al., 2012). Neighborhood environments may be a key population-level modifiable target to encourage promoting PA and reducing SB.

While many studies have linked the neighborhood built environment to physical activity in older adults (King et al., 2011; Malambo, Kengne, Lambert, De Villers, & Puoane, 2017; Saelens & Handy, 2008; Sallis et al., 2018), few studies have examined the impact of neighborhood environments on SB patterns in older adult populations. One study found that higher walkability was related to lower self-reported sedentary time among older adults (Oyeyemi et al., 2019) while another found that pedestrian safety and recreational destinations were not associated with self-reported sitting time (Barnett, Cerin, Ching, Johnston, & Lee, 2015). Both studies utilized self-reported measures of SB which are known to correlate poorly with objective measures of SB. Self-reported measures of SB also cannot measure detailed patterns of SB, such as sit-to-stand transitions and mean sitting bout duration (King et al., 2011; LaMonte et al., 2019). There is also limited evidence from hip-worn accelerometers in older adults supporting associations between neighborhood walkability and sedentary time (Amagasa et al., 2019; Compernolle et al., 2017). However, sedentary behavior measures derived from hip-worn accelerometers can underestimate sitting metrics, making postural devices like activPAL more accurate for measuring SB (Barreira, Zderic, Schuna, Hamilton, & Tudor-Locke, 2015; Bellettiere, 2020; Carlson et al., 2019; Lyden, Kozey Keadle, Staudenmayer, & Freedson, 2012). Additionally, none of these studies examined patterns of sitting such as how long prolonged bouts last and the frequency of breaks from sitting. Better understanding the connections between perceived characteristics of the neighborhood environment and PA and SB patterns for older adults may be key to understanding population activity patterns and identifying potential targets for improving these patterns.

Moreover, there is a dearth of evidence exploring how relationships between neighborhood environment and PA and SB metrics in older age vary by important demographic factors including age and gender. PA and SB patterns and locations changes as we age (Portegijs, Tsai, Rantanen, & Rantakokko, 2015). Despite this, very few studies have examined adults over age 85, who may have a more limited life space and venture into their neighborhood less often. Furthermore, men and women interact differently with their environments, particularly as they age (Choi, O'Connor, Mingo, & Mezuk, 2016), but there is little evidence exploring how relationships between neighborhood environment and PA and SB metrics differ by gender, particularly in older adults (Cooney, 2020).

Based on the gaps in the literature, this study explored the relationships between perceived neighborhood walkability among older adults and SB and PA measures from devices (activPAL and ActiGraph). We hypothesized that higher perceived neighborhood walkability would be associated with higher levels of PA, as well as with lower SB and indicators of more interrupted sitting patterns. This study also examined whether these associations differed by age (age over 85 vs. age 65 to 85) or gender, hypothesizing based on literature from younger groups that any noted associations may be attenuated with older age and would not differ significantly by gender.

Research Design and Methods:

Data and sample

This manuscript used data from the ACT Activity Monitoring study, described in detail previously in Rosenberg et al. 2020, which is a sub-study of the Adult Changes in Thought (ACT) cohort. Briefly, ACT is an on-going longitudinal cohort study with continuous enrollment to ensure an active sample size of ~2,000 older adults (age 65+) that began in 1994 to investigate risk factors for development of dementia and has provided the opportunity to study factors of healthy aging more broadly. ACT participants are recruited from the membership panels of Kaiser Permanente Washington, resulting in a cohort that is demographically similar to the older adult population of King County, Washington. Starting in 2016, ACT's data collection protocol added device-based monitoring to better capture the spectrum of SB and PA (ACT Activity Monitor [ACT-AM] study), and current ACT participants were invited to join the sub-study at their biennial study visit. If participants were wheelchair bound, receiving hospice or care for a critical illness, residing in a nursing home, or if memory problems became evident during testing, they were not eligible to participate in the ACT-AM study. In total, 1,885 ACT participants met these eligibility criteria and were approached to participate in the first wave of the ACT-AM study. Those choosing to participate provided full written informed consent to all ACT-AM study procedures. Only data from this initial wave of ACT-AM data collection, from 2016–2018, was included in these analyses. All data collection procedures have been reviewed and approved by the Kaiser Permanente Washington (KPWA) institutional review board.

Measures

Neighborhood walkability—Perceived neighborhood walkability was assessed using the Physical Activity Neighborhood Environment Scale (PANES) at the time of activity monitor wear. The PANES is a validated short self-report measure of key domains of walkable neighborhoods (Sallis et al., 2010). Individual items of the PANES have previously been validated against a widely used tool, the Neighborhood Environment Walkability Scale (NEWS-A). Corresponding walkable neighborhood features from PANES and NEWS-A were highly correlated in general (Spearman correlation coefficients ranged from 0.27 – 0.81) (Ding et al., 2013; Sallis et al., 2010). For brevity and minimized participant burden, the PANES questionnaire administered in the ACT-AM sub-study was modified from the original 17 items to 11 items by limiting domains measured by multiple items in the original instrument to a single item (Ding et al., 2013; Sallis et al., 2010). The modified PANES survey items covered the following domains of perceived walkable neighborhoods: residential density, land use mix, transit, pedestrian infrastructure, cycling infrastructure, recreation facilities, safety (crime, traffic, pedestrian), aesthetics, and sense of community. Each item consisted of a statement describing the participant's neighborhood environment with responses on a scale from 1 (strongly disagree) to 4 (strongly agree). Scores for all items were averaged according to the standard PANES scoring guidelines. The final PANES score has continuous values between 1.0 and 4.0, with higher scores representing higher perceived neighborhood walkability.

Outcomes—Details of the activity monitoring device protocols for the ACT-AM study were described in detail previously (Rosenberg et al., 2020). Briefly, measures of SB and PA were gathered from two devices for these analyses: the activPAL micro (PAL Technologies, Glasgow, Scotland, UK) and the ActiGraph wGT3X+ (ActiGraph LLC, Pensacola, FL, USA). A 24-hour wear protocol was used for both devices over the course of 1 week. Sleep time was captured through a daily sleep log, and this self-reported sleep time was removed from the device data to limit analysis to waking hours. A minimum of 4 days with 10 or more hours of waking wear time, as defined by the presence of valid device data during participant self-reported waking periods, was required to be included in analyses with outcomes from that device. No requirement for number of weekdays vs. weekend days was made.

We used proprietary PAL Technologies software to extract event-level files. Events files were then processed by collapsing consecutive activities of the same activity type and then removing sleep time using a batch processing program in R. Daily summary activPAL-derived measures included: mean daily total sitting time (minutes/day), mean daily total standing time (minutes/day), mean daily total sit-to-stand transitions (number of transitions/day), mean sedentary bout duration (minutes/sedentary bout), and mean daily total steps.

Raw ActiGraph data were collected at 30 Hz and were processed into a proprietary count variable at 15 second epochs using the "normal" filter in ActiLife software (v 6.13.3). Cut-points calibrated for older adults developed in a Women's Health Initiative laboratory study were applied to the data. Specifically, intensity classifications using vector magnitude counts per 15 second epoch were as follows: ≤18 for sedentary time, 19–518 for light-intensity PA (LPA), and >518 for MVPA (K. R. Evenson et al., 2015). Daily summary ActiGraph measures included: mean daily total time engaged in LPA (minutes/day) and mean daily total time engaged in MVPA (minutes/day).

Covariates—Covariates included in regression models described below were: self-reported age (continuous); self-reported gender (male vs. female); self-reported race/ethnicity (non-Hispanic White vs. People of Color); Body Mass Index (BMI) from the ACT measurement visit closest to the activity monitor wear (kg/m^2; continuous); self-reported annual household income collected at the visit closest to the activity monitor wear (<$10,000; $10,000-$19,999; $20,000-$29,999; $30,000-$59,999; $60,000-$99,999; $100,000 or more); and self-rated health (poor, fair, good, very good, excellent).

Analysis

ACT participants consenting to wear devices in the sub-study were generally younger, had better perceived overall health, and had lower burden of chronic conditions (e.g. hypertension, coronary artery disease) than those who did not consent. To account for potential selection bias due to factors related to device-wear consent, we incorporated inverse probability weights in our analyses. Details of the methods used to generate these weights were provided previously (Rosenberg et al., 2020). Briefly, we used logistic regression models for the binary outcome of consent as a function of several demographic, behavioral, and health-related covariates. Separate models were estimated for ActiGraph and activPAL consent, as participants could choose to wear only one device. Predictions from these models were used to construct inverse probability of response (consent) weights which were then incorporated in all outcome models (Little, 2014; Robins, Rotnitzky, & Zhao, 1994).

Primary analyses were conducted by fitting separate multivariable linear regression models for the PANES exposure measure and each previously described activity monitoring device outcome measures (e.g. activPAL mean daily sitting time, ActiGraph mean daily MVPA, etc.). Final models were adjusted for total device wear time (minutes; continuous) and participant characteristics (see Covariates) and were weighted to account for device-wear non-consent as described in the paragraph above. Additionally, to allow for comparisons of the relative magnitudes of associations, we z-transformed all PA and SB outcome measures and re-fit final models to generate standardized beta coefficients.

We were interested in whether associations were similar in adults over and under age 85 and in men and women. We conducted stratified analyses for both factors using our fully adjusted model as described above. Models including an age-PANES interaction term (age over/under 85*PANES score) and, separately, a gender-PANES interaction term (gender*PANES score) were also fit as a formal test of effect modification by age and gender, respectively.

Data processing was done using R, version 3.5.2 (R Foundation for Statistical Computing, Vienna, Austria) and statistical analyses were completed in Stata, version 15.1 (StataCorp LLC, College Station, TX).

Results:

Among the 1885 ACT participants approached to wear devices in the ACT-AM study, 1151 (61%) consented to wear Actigraph and 1135 (60%) consented to wear activPAL. Among these participants that wore devices, at least 4 days of valid data was available for 1088 (95%) Actigraph wearers and 1039 (92%) activPAL wearers. Participants who completed the PANES questionnaire and had valid activPAL (N=961) or ActiGraph (N=1,000) data (total N = 1,077) from the first wave of ACT-AM data collection were included in these analyses. Participant characteristics are described overall and by low (1.0 – 1.99), medium (2.0 – 2.99), and high (3.0–4.0) PANES score in Table 1. Most participants in the sample had a PANES score of 3.0 or higher (66%), and the mean PANES score for the overall sample was 3.1 (SD = 0.5). Most participants (56%) were female and 89% were non-Hispanic White. Approximately 43% of the sample was between the ages of 65 and 74, 41% between 75 and 84, and 16% age 85 or older. Twenty-three percent were obese. The majority reported health status as "excellent" or "very good" (61%) and reported an annual household income of $60,000 or more (57%).

Table 2 displays unstandardized and standardized adjusted model estimates of the associations between PANES score and each activity outcome of interest. Higher PANES score (meaning higher perceived neighborhood walkability) was associated with more total daily steps, but not with other measures of PA. A 1–point increment on the PANES scale was associated with 676 (95% Confidence Interval [CI]: 286, 1,067) more activPAL-measured steps/d, on average. Higher PANES scores, indicating more neighborhood walkability, were also associated with patterns indicative of more interruptions in sitting. In fully adjusted models, a 1-point higher PANES score was associated with an additional 2.4 (95% CI: 0.4, 4.5) sit-to-stand transitions per day. Differences in average sitting bout duration showed 2.2 (95% CI: −4.5, 0.1) minutes lower average sitting bout duration associated with each 1-point higher PANES score ($p = 0.06$). As indicated in Table 2, other activity measures (total sitting time, total standing time, number of sitting bouts of 30 minutes or more, total LPA, and total MVPA) were not significantly associated with PANES scores.

Tables 3a and 3b show results from stratified analyses alongside p-values for tests of interaction by age and gender. Examining point estimates in Table 3a from analyses of associations between PANES score and the various activity outcomes of interest stratified by age group (under age 85 vs. age 85+) suggest attenuated associations for most measures in the age 85+ group, though the age*PANES interaction terms were non-significant in all interaction models. Similarly, point estimates from gender-stratified analyses in Table 3b suggest possible attenuation of associations for women compared to men, but confidence intervals are wide. All gender interaction models had non-significant p-values for the gender*PANES interaction terms.

Discussion:

Overall in our sample of community-dwelling older adults, we observed associations between the perceived neighborhood walkability and daily PA as measured by the activPAL mean daily steps. These findings suggest that neighborhoods that are perceived as more walkable are associated with more daily walking: nearly 700 more steps per day with each point higher in the PANES walkability index. This supports the existing literature which has previously established associations between both perceived and objective neighborhood walkability and higher levels of both self-reported walking and objective PA measures in older adult populations (David W. Barnett et al., 2017). However, we note that there were no significant associations with mean daily time in LPA or MVPA, as measured by the ActiGraph in our sample.

In addition to these findings for daily steps, a novel element of this study was the inclusion of activPAL-measured patterns of SB and their association with perceived walkable neighborhoods for older adults. A 2016 study by Fleig and colleagues, using hip-worn Actigraph data sampled from 174 older adults in Vancouver, BC, Canada, found an inverse association between total SB time and both perceived street connectivity and land use mixture (Fleig et al., 2016). In the current findings, there was no association between perceived neighborhood walkability and total time spent in sitting or standing time, but we do note associations with measures of SB patterns, or the way that total SB time is broken up throughout the day. In the current study, a 1-point higher PANES perceived walkability score was associated with approximately 2.5 more transitions from sitting to standing and, while not statistically significant at the $p = 0.05$ level ($p = 0.063$), just over 2 minutes lower mean sitting bout duration. When considered relative to the overall sample's average values for these measures, these difference estimates represent a roughly 6% difference in number of sit-to-stand transitions and 14% difference in mean sitting bout duration.

When interpreting all these current findings, it is important to consider that a 1-point difference in PANES score represents a large difference in neighborhood environment. In this sample, a 1-point difference in PANES score is approximately two standard deviations. Given this, it is unclear if these small differences in sitting pattern metrics detected with a 1-point PANES score difference would translate to differences of practical significance. In short, these results suggest only modest associations between one's perceived neighborhood environment and steps and the way sitting and other sedentary behaviors are broken up and spread throughout the day, which the literature suggests may also be important for health (Chastin & Granat, 2010).

The underlying cause of associations between SB patterns and perceived neighborhood walkability is not yet clear. Interestingly, we note associations both with total steps and with indicators of more interrupted sitting patterns (more sit-to-stand transitions and shorter mean sitting bout duration), while simultaneously seeing no association with measures of total sitting or standing time, or with direct measures of time in LPA or MVPA. This pattern of findings suggests the possibility that walkable neighborhoods may encourage more interruptions to sitting bouts with short bouts of additional stepping, but do not necessarily discourage sitting or lead to an appreciable increase in total PA. Furthermore, the PA and SB metrics assessed here are not limited to activities in the participants' neighborhood environment, but rather represent a summary of all activity throughout the day, in all contexts the individual spends time (e.g. movement at home, in their neighborhood, and beyond their neighborhood). Individuals in perceived walkable neighborhoods may be inclined to step more in their neighborhood to get from place to place throughout the day, but the environments may still support sitting at their destinations and in their homes, such that total sitting time doesn't substantially differ, even though they are stepping more and breaking up their sitting bouts more frequently.

Furthermore, it is curious that higher PANES score was associated with more daily steps but not with direct measures of LPA or MVPA. While unadjusted mean MVPA (Table 1) tends to be higher with increasing PANES score, these associations were not significant in fully adjusted models. This may suggest that, for older adults in particular, steps may capture walking outdoors in their neighborhood environment (e.g. active transportation) more than other types of activity, whereas MVPA may represent indoor physical activities (e.g. household chores, cleaning, etc.) that may be physically taxing but do not involve many steps and that are less likely to be influenced by neighborhood characteristics. It is also possible that the additional stepping that might be encouraged by a walkable neighborhood environment may be done at a very low intensity that does not meet the threshold for Actigraph-measured LPA. Further study with detailed assessment of types and context of activities throughout the day (e.g. household chores, recreational walking, reading, etc.) may be helpful in interpreting and replicating these observed activity patterns.

Though no statistically significant interactions were observed by age groups, we do note an overall pattern of attenuation of associations for most outcomes in the age 85+ group. Sample size was limited for this group, which impacts power to detect significant differences. Some evidence in the literature suggests that for individuals age 85+, who are less likely to walk in contexts outside the home (Collia, Sharp, & Giesbrecht, 2003; Portegijs et al., 2015; Simonsick, Guralnik, Volpato, Balfour, & Fried, 2005), activity patterns are more strongly influenced by other factors, such as overall health and social context, connectivity, and social support, than by the characteristics of the neighborhood in which they live (Asiamah, Kouveliotis, Petersen, & Eduafo, 2019; Chaudhury, Campo, Michael, & Mahmood, 2016; Josey & Moore, 2018). To our knowledge, no previous studies have looked at associations between perceived neighborhood walkability and PA and SB patterns in adults over age 85 or compared them to younger older adult group. While we reported null findings here, more study is needed including larger samples of adults age 85+ and measures of social connectivity and isolation in order to better understand if this complex relationship between neighborhood environment and PA and SB patterns changes as we age.

For most PA and SB metrics, point estimates were slightly attenuated for women, compared to men, but none had statistically significant interaction terms. Though not statistically significant, this attenuation could indicate that the neighborhood environment may be more supportive for older men than women, but the absolute magnitude of the differences in point estimates between men and women is small and unlikely to represent a clinically or practically significant difference. Unlike with the age sub-groups, sample size was more balanced between groups for these analyses. Overall, we see no evidence in these findings to support a conclusion that associations between perceived neighborhood walkability and the measured PA or SB metrics differ by gender, though replication in future studies should be sought.

This study had several limitations. First, the cross-sectional nature of these current data meant that we were unable to assess causality or temporal relationships. Further follow-up in the ACT cohort will allow for longitudinal assessment of these questions in the future. Second, the demographic distributions on our sample, which is largely Non-Hispanic white and highly educated, limit generalizability to the broader US population. The assessment of neighborhood walkability relies on self-report measures of perceived neighborhood characteristics, rather than objective measurements like a calculated walk score based on geographic proximity of various destinations or other neighborhood features. While the use of objective measures of true neighborhood activity-promoting features would better inform potential policy and/or intervention strategies for physical changes to the built environment, evidence suggests that perceptions of a built environment correlate reasonably with objective measures and may, in fact, be independently important drivers of PA and SB (Gebel, Bauman, & Owen, 2009; Hinckson et al., 2017). Future studies should explore objective approaches to walkability measurement and how these associations compare with those observed with perceived measures. Furthermore, the perceived neighborhood walkability measure used here, PANES, was validated in a general adult population, so may not include some neighborhood features, such as availability of places to rest and good street lighting (D. W. Barnett et al., 2017; Bonaccorsi et al., 2020). The PANES instrument is also designed to measure features promoting PA and is not designed to measure SB promoting or discouraging features in neighborhoods, and our study lacked a measure of home or work environments that might be more impactful on SB. Also due to the self-report nature of the neighborhood environment data available for this study, we were unable to examine neighborhood-level factors, such as neighborhood socioeconomic status (SES), which could moderate the relationship between perceived neighborhood walkability and activity. Due to the exploratory nature of our investigations we did not adjust any analyses for testing multiple hypotheses, meaning the possibility remains that some observed associations may be due to type I error. We did note though that the difference in steps associated with differences in perceived walkability would survive even the most conservative Bonferroni correction.

Despite these limitations, this study had several key strengths. We employed device-based measures of SB and PA using two devices that allowed quantification of numerous activity pattern metrics (e.g. mean sitting bout duration, sit-to-stand transitions, etc.) not accurately captured through self-report. Our sample was from a large cohort of community-dwelling U.S. older men and women that is demographically representative of King County, WA. Inverse probability weighting was used to account for selection bias in the ACT-AM sample, making these results generalizable to the larger ACT cohort. We also leveraged the well-characterized ACT cohort which includes data on several potential confounding factors, allowing for adjustment for these factors in analyses.

In conclusion, we found that living in a neighborhood perceived to be highly walkable was associated with higher daily steps and more frequent interruptions in sedentary behaviors throughout the day, but not with total sitting time. These associations did not differ significantly by older age (age 85+) or gender. Overall, these findings suggest that, for older adults, living in a neighborhood they perceive as walkable may help support an active lifestyle with more interrupted patterns of sitting, which may, in turn, support a healthy aging process.

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Table 1

Study Sample Characteristics by Level of Perceived Neighborhood Walkability

		PANES Index Category		
	Overall Sample	**Low PANES (1–1.99)**	**Medium PANES (2.0–2.99)**	**High PANES (3.0–4.0)**
	N (%)	**N (%)**	**N (%)**	**N (%)**
Overall	1,077 (−)	21 (1.9)	345 (32.0)	711 (66.0)
Age category				
65–74	461 (42.8)	3 (14.2)	119 (34.5)	339 (47.7)
75–84	441 (41.0)	7 (33.3)	155 (44.9)	279 (39.2)
85+	175 (16.3)	11 (52.4)	71 (20.6))	93 (13.1)
Sex				
Female	607 (56.4)	16 (76.2)	207 (60.0)	384 (54.0)
Male	470 (43.6)	5 (23.8)	138 (40.0)	327 (46.0)
Race/ethnicity				
Hispanic or non-white	121 (11.3)	7 (33.3)	47 (13.7)	67 (9.5)
Non-Hispanic white	950 (88.7)	14 (66.7)	295 (86.3)	641 (90.5)
BMI				
Underweight (BMI < 18.5) (ref)	11 (1.0)	0 (0)	4 (1.2)	7 (1.0)
Normal weight (BMI 18.5 – <25)	391 (37.0)	6 (28.6)	98 (29.2)	287 (40.9)
Overweight (BMI 25 – < 30)	408 (38.6)	7 (33.3)	136 (40.5)	265 (37.8)
Obese (BMI 30+)	248 (23.4)	8 (38.1)	98 (29.2)	142 (20.3)
Income				
Under $19,999	46 (5.0)	1 (5.9)	13 (4.7)	32 (5.1)
$20,000 – $29,999	68 (7.3)	5 (29.4)	29 (10.4)	34 (5.4)
$30,000 – $59,999	281 (30.3)	8 (47.1)	91 (32.6))	182 (28.8)
$60,000 – $99,999	279 (30.0)	2 (11.8)	80 (28.7)	197 (31.1)
$100,000 or more	255 (27.4)	1 (5.88)	66 (23.7)	188 (29.7)
Self-Rated Overall Health				
Poor	8 (0.7)	1 (4.8)	3 (0.9)	4 (0.6)
Fair	79 (7.3)	7 (33.3)	37 (10.7)	35 (4.9)
Good	336 (31.2)	7 (33.3)	121 (35.1)	208 (29.3)
Very Good	455 (42.3)	6 (28.6)	135 (39.1)	314 (44.2)
Excellent	199 (18.5)	0 (0)	49 (14.2)	150 (21.1)
Housing Type				
Detached, single family home	642 (60.7)	8 (53.3)	201 (58.6)	433 (62.0)
Townhouse/rowhouse/2–3 story apartment	51 (4.8)	1 (6.7)	13 (3.8)	37 (5.3)
Mix single-family, townhouses	280 (26.5)	3 (20.0)	95 (27.7)	182 (26.0)
Apartment/condo of 4 or more stories	84 (8.0)	3 (20.0)	32 (9.9)	47 (6.7)
Retirement Community				
Yes	117 (11.5)	7 (38.9)	47 (14.3)	63 (9.4)
No	901 (88.5)	11 (61.1)	281 (85.7)	609 (90.6)

	Overall Sample	PANES Index Category		
		Low PANES (1–1.99)	**Medium PANES (2.0–2.99)**	**High PANES (3.0–4.0)**
	N (%)	**N (%)**	**N (%)**	**N (%)**
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
PANES Walkability Index	3.1 (0.5)	1.7 (0.2)	2.6 (0.3)	3.4 (0.3)
activPAL Measures [a]				
Total sitting time (avg min/day)	600.9 (118.5)	643.1 (108.9)	604.6 (130.3)	598.0 (112.9)
Total Standing time (avg min/day)	240.9 (95.7)	212.4 (110.6)	244.9 (104.5)	239.9 (90.8)
Total Steps (avg #/day)	6,783 (3,514)	3,390 (1,410)	5,965 (3,100)	7,262 (3,614)
Mean Sitting Bout Duration (min/bout)	16.0 (8.7)	20.6 (9.0)	17.2 (11.5)	15.2 (7.0)
Sit-to-Stand Transitions (mean #/day)	43.7 (13.3)	36.4 (9.9)	42.6 (13.7)	44.5 (13.0)
Number of sitting Bouts >30mins (avg #/day)	5.8 (1.7)	6.3 (1.6)	5.7 (1.8)	5.8 (1.7)
Actigraph Measures [b]				
Total LPA (avg min/day)	275.9 (76.2)	249.0 (96.1)	273.5 (81.2)	277.9 (73.0)
Total MVPA (avg min/day)	68.2 (43.9)	26.3 (22.8)	61.4 (42.3)	72.5 (44.1)

Note. Summaries include participants with valid activPAL OR Actigraph data (N = 1,077). Totals across characteristics of interest presented in the table deviate due to missingness of the covariate. N (%) missing for each covariate: Race 6 (0.6%), BMI 19 (1.8%), income 148 (13.7%), PANES 9 (0.8%), housing type 20 (1.9%), retirement community residence 59 (5.5%). Covariates not included in this list have complete capture for the sample. PANES = Physical Activity Neighborhood Environment Scale; SD = standard deviation; LPA = light-intensity physical activity; MVPA = moderate-to-vigorous intensity physical activity.

[a] Totals for activPAL measurements are N=961.

[b] Totals for Actigraph Measurements are N=1,000.

Table 2

Estimated associations between PANES score and activity metrics

Outcome	Estimate[a]	95% CI	Standardized Estimate[b]	95% CI	p-value
activPAL (N=810)					
Sitting time (avg mins/day)	6.9	(−9.8, 23.7)	0.06	(−0.08, 0.20)	0.417
Standing time (avg mins/day)	−12.4	(−26.6, 1.73)	−0.13	(−0.28, 0.02)	0.085
Steps (avg steps/day)‡	676 *	(286, 1067)	0.19 *	(0.08, 0.30)	0.001
Sit to stand transitions (avg #/day)‡	2.4 *	(0.4, 4.5)	0.18 *	(0.03, 0.34)	0.018
Average Bout Duration (mins/bout)	−2.2	(−4.5, 0.1)	−0.24	(−0.50, 0.01)	0.063
Sitting bouts of at least 30+ min (avg bouts/day)	0.3	(−0.0, 0.5)	0.15	(−0.01, 0.31)	0.061
Actigraph (N=839)					
Total LPA (avg mins/day)	1.3	(−9.5, 12.1)	0.02	(−0.12, 0.16)	0.813
Total MVPA (avg mins/day)	3.8	(−1.0, 8.6)	0.09	(−0.02, 0.19)	0.125

Note. Each row (outcome/predictor pair) corresponds to a separate linear regression model. All models adjust for total device wear time, age, gender, race, education, income, self-rated health and incorporate weighting to account for selection due to device-wear consent. Complete case analyses were performed. Sample sizes included in analyses deviates due to missingness of included covariates. N(%) missing for each covariate included in the model: Race 6 (0.6%), BMI 19 (1.8%), income 148 (13.7%). Covariates not included in this list have complete capture for the sample. PANES = Physical Activity Neighborhood Environment Scale; CI = confidence interval; LPA = light-intensity physical activity; MVPA = moderate-to-vigorous intensity physical activity.

[a]Estimates presented represent a difference in means for each PA and SB measure associated with a 1-unit difference in PANES score.

[b]Standardized estimates represent a difference in zscore for each PA and SB measure associated with a 1-unit difference in PANES score.

*p< .05

Table 3a

Age-stratified linear regression model results predicting differences in activity metrics based on PANES[*] score for individuals under age 85 and age 85+

Outcome	Age Group	Estimate[a]	95% CI	p-interaction
activPAL (age <85 N=703; age 85+ N=107)				
Sitting time (avg mins/day)	Under 85	−4.0	(−22.3, 14.4)	0.280
	85+	34.3	(−2.1, 70.7)	
Standing time (avg mins/day)	Under 85	−4.1	(−19.5, 11.2)	0.249
	85+	−32.6	(−65.4, 0.1)	
Steps (avg steps/day)	Under 85	893[*]	(423, 1363)	0.867
	85+	52	(−597, 701)	
Sit to stand transitions (avg #/day)	Under 85	2.7[*]	(0.6, 4.8)	0.178
	85+	1.6	(−3.8, 6.9)	
Average Bout Duration (mins/bout)	Under 85	−2.2[*]	(−3.7, −0.8)	0.477
	85+	−1.2	(−7.6, 5.3)	
Sitting bouts of at least 30+ min (avg bouts/day)	Under 85	0.1	(−0.2, 0.4)	0.982
	85+	0.6	(−0.1, 1.2)	
Actigraph (age <85 N=734; age 85+ N=105)				
Total LPA (avg mins/day)	Under 85	5.7	(−5.5, 16.9)	0.450
	85+	−9.9	(−32.3, 12.4)	
Total MVPA (avg mins/day)	Under 85	4.7	(−1.2, 10.7)	0.842
	85+	0.7	(−6.6, 8.1)	

Note. Each row (outcome/predictor pair) corresponds to a separate linear regression model. All models adjust for total device wear time, age, gender, race, education, income and account for sample weighting using the standard adjustors developed for the ACT-AM sample. Complete case analyses were performed. PANES = Physical Activity Neighborhood Environment Scale; CI = confidence interval; LPA = light-intensity physical activity; MVPA = moderate-to-vigorous intensity physical activity.

[a]Estimates presented represent a difference in means for each PA and SB measure associated with a 1-unit difference in PANES score.

[*]$p < .05$

Table 3b

Sex-stratified linear regression model results predicting differences in activity metrics based on PANES* score for male vs. female individuals

Outcome	Gender	Estimate[a]	95% CI	p-interaction
activPAL (male N=375; female N=435)				
Sitting time (avg mins/day)	Men	6.7	(−15.8, 29.2)	0.932
	Women	3.1	(−20.8, 27.1)	
Standing time (avg mins/day)	Men	−13.4	(−32.1, 5.3)	0.811
	Women	−8.0	(−28.7, 12.7)	
Steps (avg steps/day)	Men	747*	(156, 1,339)	0.333
	Women	649*	(125, 1,172)	
Sit to stand transitions (avg #/day)	Men	3.6*	(0.4, 6.9)	0.346
	Women	1.4	(−1.1, 3.9)	
Average Bout Duration (mins/bout)	Men	−3.7*	(−7.2, −0.2)	0.117
	Women	−0.4	(−2.0, 1.1)	
Sitting bouts of at least 30+ min (avg bouts/day)	Men	0.3	(−0.1, 0.6)	0.270
	Women	0.2	(−0.2, 0.5)	
Actigraph (male N=390; female N=449)				
Total LPA (avg mins/day)	Men	−0.4	(−14.5, 13.8)	0.743
	Women	4.0	(−11.9, 19.9)	
Total MVPA (avg mins/day)	Men	4.6	(−2.3, 11.4)	0.592
	Women	3.9	(−3.1, 10.9)	

Note. Each row (outcome/predictor pair) corresponds to a separate linear regression model. All models adjust for total device wear time, age, gender, race, education, income and account for sample weighting using the standard adjustors developed for the ACT-AM sample. Complete case analyses were performed. PANES = Physical Activity Neighborhood Environment Scale; CI = confidence interval; LPA = light-intensity physical activity; MVPA = moderate-to-vigorous intensity physical activity.

[a]Estimates presented represent a difference in means for each PA and SB measure associated with a 1-unit difference in PANES score.

*p< .05