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Understanding perceived park access and physical activity among older adults: A structural equation modeling approach

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ABSTRACT

Parks can provide a low-cost setting for safe physical activity, but older adults are underrepresented among park users in the United States. Using data from a population-representative survey in 2015 and 2018 among adults aged 60 years and older living in Philadelphia, we tested whether perceived access was a mechanism by which objectively-measured park access predicted self-reported physical activity. After controlling for individual-level factors and neighborhood characteristics, we found a statistically significant pathway from overall park area and within-park tree canopy to increased physical activity, mediated by perceived park access. These results highlight the importance of tree canopy for older adult park access and physical activity.

1. Introduction

Maintaining physical activity levels into older adulthood is an important component of healthy aging,(Peel et al., 2005) but urban environments do not always support this. Older adults are more likely than younger adults to have mobility impairments (Ferrucci et al., 2016) and are less likely to drive,(Federal Highway Administration, 2017) and therefore are especially sensitive to neighborhood environmental characteristics (Clarke and Gallagher, 2013; Ghani et al., 2018). Parks can provide infrastructure for older adults to exercise safely and conveniently. However, in the United States, older adults are underrepresented among park users (Evenson et al., 2019), suggesting that neighborhood parks are not adequately serving this population. More evidence is required for planners and policymakers to better design parks for older adult use.

Studies investigating the impact of parks on physical activity among older adults may use either objective or subjective measures of park access, such as proximity to parks (objective) or perceived access to parks (subjective). While objective measures of park access may be more readily translatable to evidence-based policy goals and easier to use in large-scale population health studies, an individual's decision to use a park for exercise is more directly related to their perceived access to parks rather than any external measure (Wan and Shen, 2015). Nor are objective and subjective measurements of park access always closely associated (Boehmer et al., 2006; Larson et al., 2022). Older and lower-income residents can be more likely to have mismatches between perceived and objective environmental measures, (Ball et al., 2008) and residents of deprived neighborhoods that live closer to parks can report less perceived access and less frequent use of parks than do residents of less deprived neighborhoods (Jones et al., 2009). These mismatches may be the result of park characteristics, such as the level of maintenance and the presence of relevant amenities, or neighborhood characteristics, such as greenness and crime. Understanding how park characteristics contribute to perceived access, how perceived access contributes to physical activity levels, and how these relationships operate across different neighborhood contexts, is fundamental to designing interventions to improve park and neighborhood conditions to support physical activity for older adults.

Previous studies have highlighted older adults' park preferences, including the presence and variety of natural features, well-maintained infrastructure and facilities, and the presence of a variety of kinds of parks in the neighborhood (Kou et al., 2021; Wen et al., 2018). Walking paths are frequently cited as important, and older adults may prefer parks that contain a variety of kinds of paths, such as paved and unpaved (Kou et al., 2021) or sloped and flat (Joseph and Zimring, 2007). In addition to park characteristics, neighborhood-level factors including safety and walkability may also influence older adults' decision to walk or engage in other physical activity outside, (Yen et al., 2014) potentially contributing to park visitation. Older adults who live in proximity to parks with supportive features may be expected to be more physically

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active as a result of greater park visitation, but characteristics of the surrounding neighborhood may also play a role in this relationship.

Studying the relationship between park characteristics and perceived access is complicated by within-park spatial variation. Considering a large park with exercise equipment close to its eastern border, a resident living near to the western border of the park will have a different exposure to that equipment as a resident who lives near the eastern border. Investigating the role that individual park features play in perceived access requires exposure assessment based on proximity to features themselves, rather than on proximity to parks that contain those features.

In our study setting of Philadelphia, Pennsylvania, USA, park features are available mapped independently of park boundaries. Detailed data is also available in Philadelphia for neighborhood characteristics relevant for older adults' exercise, including intersection-level crime incidents, the sidewalk network, and the tree canopy. This study spatially links these detailed park and neighborhood data with a subjective measure of perceived park access and self-reported physical activity for a sample of older adults to test the mediational role of perceived park access in the relationship between objective park features and physical activity. We assess whether this relationship varies based on the radius of exposure considered, and test whether model fit is better when considering neighborhood conditions as confounders or as moderators of the relationship between objective park features and perceived park access.

2. Methods

2.1. SEPAHHS survey data

The Southeastern Pennsylvania Household Health Survey is an annual phone survey of adults living in a five-county area of Pennsylvania (Bucks, Chester, Delaware, Montgomery, and Philadelphia), administered by the Public Health Management Corporation and conducted by the social science research firm SSRS. Survey methods have been described in detail elsewhere (Turakhia et al., 2019). Briefly, a representative sample is constructed for each survey year based on random digit dialing of landlines and cell phones, voter registration data, and survey re-contact. Participants are surveyed on a variety of domains including health behaviors and outcomes, their perception of risk factors, and demographic information.

For this analysis, we combined data from the two most recent administrations of the SEPAHHS (2015 and 2018) into a single sample and restricted to the older adult population (reported ages 60 and above). The primary outcome for this study was self-reported physical activity, expressed as the number of days per week that participants exercised for 30 min or more. Because of differences in how the physical activity question was operationalized between 2015 and 2018, we dichotomized its responses, with zero or less than one day per week in the first category and one day per week or more in the second category. Perceived park access was assessed as a mediator. This question was asked as whether there is a park or outdoor space in the participant's neighborhood that they feel comfortable visiting during the day. For consistency between years, we dichotomized perceived park access as "yes" or "no." However, the 2018 survey includes multiple negative responses, indicating no park in the neighborhood, or a park is present in the neighborhood but the participant does not feel comfortable visiting it, or the participant does not know. All of these negative responses were combined into the single negative category to correspond with the 2015 survey year.

We included variables describing overall health status, mobility, age, race, and income as individual-level confounders. We dichotomized overall health status as "excellent/very good/good" versus "fair or poor." We dichotomized mobility as "can walk without help" versus "can walk with some help or completely unable to walk." We categorized race as non-Hispanic Black, non-Hispanic White, Hispanic/Latino, and Other. We dichotomized income as above or below 200% of the poverty line.

We linked park and neighborhood data to SEPAHHS participant residential addresses using circular buffers constructed at 250-, 500-, and 1000-m radiuses. These residential buffers formed three different proximity-based exposure areas for each participant to test relationships at multiple spatial scales.

2.2. Park features

We organized a set of mapped park features to objectively characterize parks to predict perceived park access and physical activity for older adults. These features included an *a priori* set of variables based on prior literature (overall park area, tree canopy cover, and the presence of walking trails) as well as an exploratory set of park features based on data availability.

We obtained park boundary data from the Delaware Valley Regional Planning Commission protected open spaces map. (DVRPCa) We calculated park access as the proportion of park area within proximity of participants' residential locations. This measure of access is responsive to the heterogeneity of park sizes in the Philadelphia context, where some neighborhoods have exposure to a single large park and other neighborhoods have exposure to one or several small parks.

We considered individual park features as separate exposures to assess the contribution of each feature type to perceived park access and physical activity. To account for the spatial heterogeneity of parks themselves, objective park feature variables were computed independently for each proximity level for each participant. We obtained data on the features of parks under the management of the Philadelphia Parks and Recreation Department. Park features are available mapped as points, lines, or polygons. The point features we used for this analysis are playgrounds, (Philadelphia Parks and Recreation, 2020a) spraygrounds, (Philadelphia Parks and Recreation, 2014a) hydration stations, (Philadelphia Parks and Recreation, 2019a) adult exercise equipment, (Philadelphia Parks and Recreation, 2019b) swimming pools, (Philadelphia Parks and Recreation, 2019c) tennis courts, (Philadelphia Parks and Recreation, 2019d) picnic sites, (Philadelphia Parks and Recreation, 2019e) recreation centers, (Philadelphia Parks and Recreation, 2022) older adult centers, (Philadelphia Parks and Recreation, 2022) and comfort stations (Philadelphia Parks and Recreation, 2020b). We operationalized these features as separate binary indicators for the presence of each feature within proximity of participants. Point data for boat launches (Philadelphia Parks and Recreation, 2015) and environmental education centers (Philadelphia Parks and Recreation, 2022) was available, but variance was too low for model fit, and we did not include these features in statistical models.

Paved and unpaved walking trails are mapped as separate line features (Philadelphia Parks and Recreation, 2014b). We operationalized trail presence as the total length of paved and unpaved park trails within each proximity level.

The Philadelphia Parks and Recreation, 2015 tree canopy map uses LiDAR data capture to obtain outlines for all trees in Philadelphia greater than six feet in diameter to provide comprehensive and high-resolution canopy coverage (Intergraph Government Solutions, 2015). We processed this map separately to provide both a measure of tree canopy within parks and a neighborhood-level measure of tree canopy coverage. We computed within-park tree canopy coverage the maximum tree canopy coverage of any single park area contained in a residential buffer.

2.3. Neighborhood characteristics

We considered neighborhood characteristics as potential confounders of the relationship between objective park features and physical activity or as effect measure modifiers of the relationship between objective park features and perceived park access. We used the sidewalk network, crime incidents, and tree canopy coverage as relevant variables based on prior literature demonstrating the importance of walkability and perceived safety for older adult park use and physical activity.

We used the Delaware Valley Regional Planning Commission pedestrian network (DVRPCb) to compute the total length of sidewalk within each proximity level and the previously-described tree canopy map (Intergraph Government Solutions, 2015) to compute the overall proportional canopy coverage for each proximity level.

The Philadelphia Police Department provides crime incident data as a point map with approximately intersection-level resolution. (Philadelphia Police Department) These data include a uniform crime reporting code for each incident (Uniform Crime Reporting Program, 2004). We used this value to restrict to Part I crimes, which are more serious crimes including violent assault, rape, and arson. (Philadelphia Police Department) We used data for the years 2015 and 2018, matching crime year to participant year, and computed the spatial density of Part I crime incidents within each proximity level.

2.4. Statistical analysis

To assess the relationships between objective park and neighborhood features, subjective park perception, and physical activity, we computed structural equation modeling (SEM) path models. This method allows the simultaneous estimation of multiple parameters following a specified structure. The causal structure underlying our analysis is diagrammed in Figs. 1–3.

Mediational Model: To test the mediational role of perceived park access on the relationship between objective park access and physical activity, we computed separate SEM path models at each proximity level. In turn, perceived park access was predicted by each objective park variable (proportion of park area in buffer plus each individual attribute), and self-reported physical activity was predicted by perceived park access as well as the objective park variables, providing estimates for both direct and indirect relationships between park features and physical activity. The model controlled for the neighborhood characteristics of sidewalk length, crime density, and tree canopy cover, as well as the individual characteristics of health status, mobility, race, and income by computing parameter estimates for the relationships between each neighborhood and individual characteristic and the proportional park area in each buffer. This model is illustrated in Fig. 1.

Because data availability for all park and neighborhood data other than park boundaries and the sidewalk network was limited to the Philadelphia area, we restricted the primary analysis to those buffers that fit entirely within the Philadelphia city limits. To account for the risk that this selection could bias our results, we conducted a sensitivity analysis that included all participants but that modeled a reduced set of variables including only park boundary, sidewalk network, and participant response data.

Interaction and Confounding Models: To explore the role of neighborhood-level factors on the relationship between objective and perceived park access, we compared an interaction model (Fig. 2) with a confounding model (Fig. 3). Both models were SEM path models. In both models, we included the park features found to be statistically significant predictors of perceived park access in the mediational model in addition to all neighborhood-level and individual-level variables. In the interaction model, we fit an interaction term between each park feature and each neighborhood characteristic for the relationship between objective park access and perceived park access. In the confounding model, neighborhood-level variables were treated only as confounders of that relationship. We assessed model fit between the interaction and confounding models using the root mean squared error of approximation and the comparative fit index.

3. Results

Descriptive statistics for the analytic sample are presented in Tables 1–3, with separate columns for each assessed proximity level (250m, 500m, and 1 km). Because we constrained the primary analytic sample to participants whose residential buffers did not extend outside of the Philadelphia city limits, the sample size is largest for the 250 m buffers (n = 1958) and smallest for the 1 km buffers (n = 1592). Despite these sample size changes along the borders, demographic and health status characteristics were comparable for all buffer sizes.

Approximately half of participants in the sample reported park access. As the size of residential buffers increased, the mean proportion of residential buffers covered by protected open space increased from 4.6% to 7.3%, and the average maximum tree canopy coverage of park areas within buffers increased from 11% to 56.5%. However, the mean

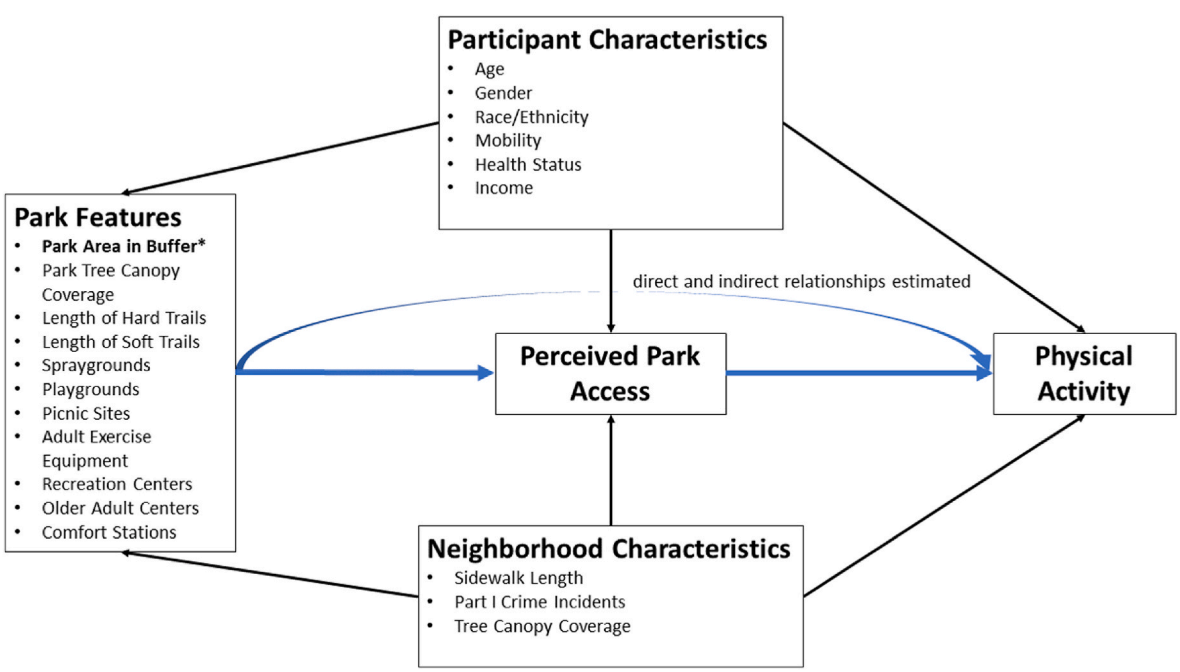

Fig. 1. Mediation model.

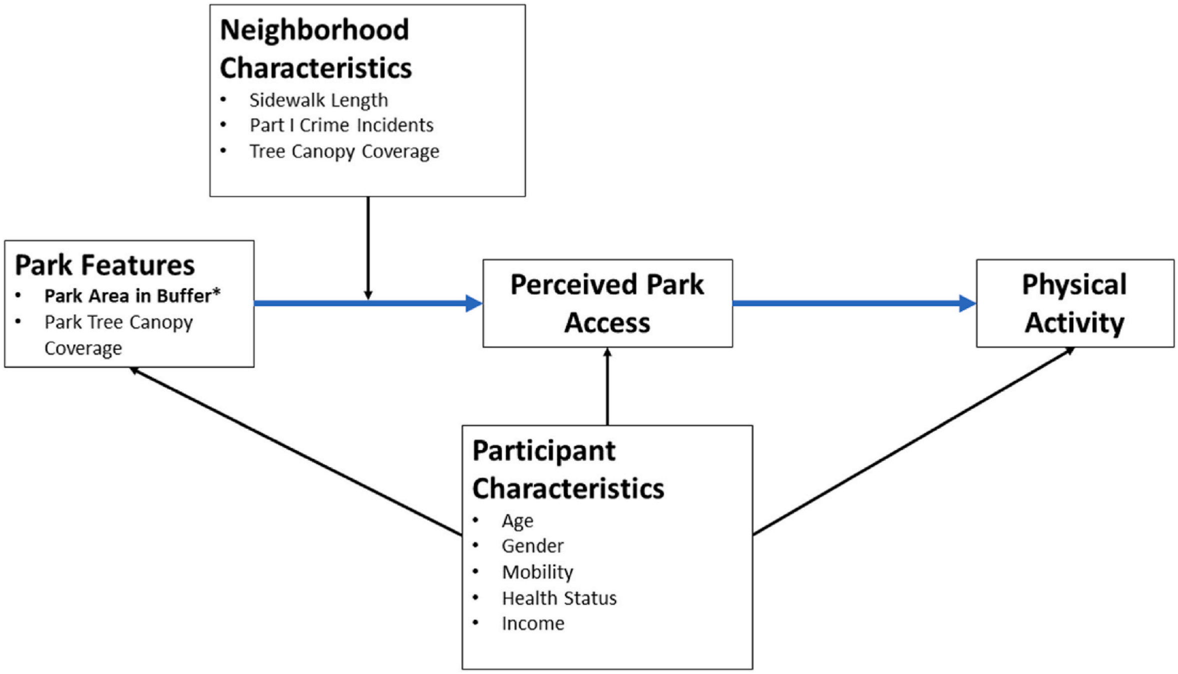

Fig. 2. Interaction model.

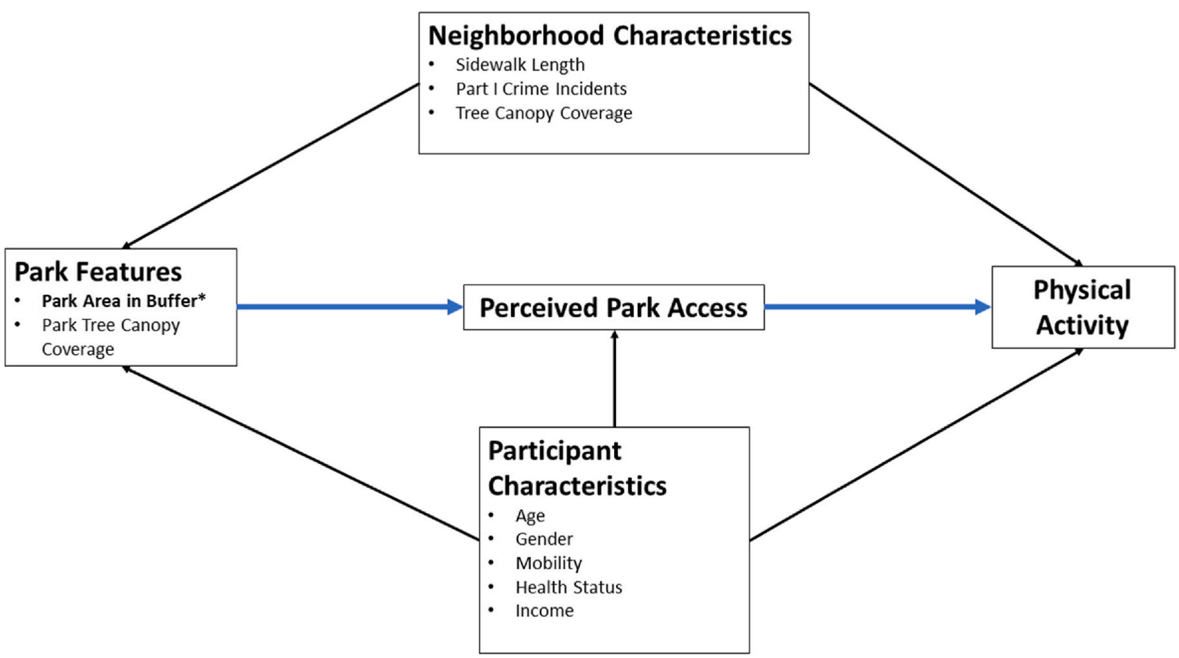

Fig. 3. Confounding model.

neighborhood-level tree canopy coverage was 17% across all buffer sizes.

3.1. Mediational model

Table 4 presents parameter estimates for path regression models estimating park access and physical activity levels from park and neighborhood characteristics in each buffer size. Because of the large number of parameters estimated, Table 4 presents a reduced set of variables corresponding with our *a priori* park features, and a complete table of all parameters is available as supplementary data.

In 250- and 500-m buffers, both total park coverage and the maximum tree canopy of proximate parks were positively and significantly associated with perceived park access. In turn, perceived park access was positively and significantly associated with physical activity for models in all buffer sizes. Therefore, in the two smaller buffer sizes, we found a mediational pathway from objective park characteristics to increased physical activity through increased perceived park access for the characteristics of total land coverage and tree canopy coverage, but not for any other park characteristics.

Results for other estimated parameters, including individual-level factors and other park features are shown in supplementary material. Age was negatively associated with perceived park access in the 250- and 500-m buffer models, and females perceived lower park access than

Table 1
Characteristics of SEPHHS participants, aged 60+, 2015 and 2018 Waves (count and (percent).

		Buffer Size		
		250 m *n=1958*	**500 m** *n=1848*	**1 km** *n=1592*
Age	60–64	492 (25.1%)	471 (25.5%)	399 (25.1%)
	65–74	817 (41.7%)	769 (41.6%)	652 (41%)
	75 or older	649 (33.1%)	608 (32.9%)	541 (34%)
Gender	Male	697 (35.6%)	661 (35.8%)	570 (35.8%)
	Female	1261 (64.4%)	1187 (64.23%)	1022 (64.2%)
Race	Non-Hispanic White	889 (45.4%)	840 (45.5%)	725 (45.5%)
	Non-Hispanic Black	830 (42.4%)	780 (42.2%)	660 (41.5%)
	Other	239 (12.2%)	228 (12.3%)	207 (13%)
Mobility	Can walk without help	1719 (87.8%)	1618 (87.6%)	1382 (86.8%)
	Trouble walking	241 (12.3%)	232 (12.6%)	212 (13.3%)
Health Status	Excellent, very good, or good	1371 (70%)	1291 (69.9%)	1100 (69.1%)
	Fair or poor	594 (30.3%)	564 (30.5%)	499 (31.3%)
Income	≥200% of the poverty line	1031 (52.7%)	970 (52.5%)	822 (51.6%)
	<200% of the poverty line	928 (47.4%)	879 (47.6%)	771 (48.4%)
Perceived Park Access	Yes	968 (49.4%)	912 (49.4%)	787 (49.4%)
	No, don't know, or refused	990 (50.6%)	936 (50.6%)	805 (50.6%)
Exercise >30 min	Less than once per week	564 (28.8%)	530 (28.7%)	463 (29.1%)
	Once per week or more	1424 (72.7%)	1345 (72.8%)	1154 (72.5%)

did males in all models. Participants with poor health status also reported lower perceived park access in the 250- and 500-m buffer models, and participants with income at or above 200% of the poverty line reported higher perceived park access in all models.

Several specific park features were associated with either park access or physical activity in only one model. In 250-m buffers, the presence of comfort stations in parks was negatively associated with perceived park access, and the presence of pools was negatively associated with physical activity. In 500-m buffers, the presence of picnic sites was negatively associated with physical activity. In 1000-m buffers, the total length of paved trails in parks was positively associated with perceived park access.

Finally, in the sensitivity analysis of a reduced model for all surveyed participants in the southeastern Pennsylvania area, the total proportion of park area within proximity to residence was positively associated with perceived park access at the 250-m level, but not for the larger buffer sizes, potentially reflecting lower pedestrian accessibility in the suburban portions of the study area. Perceived park access was positively associated with an increased probability of exercising one day per week or more at all proximity levels, consistent with the main analysis.

Despite these significant findings, overall model fit was poor across all three buffer sizes (root mean square error of approximation (RMSEA) of 0.255, 0.365, and 0.327 for the 250m, 500m, and 1 km buffers, respectively). The next section describes fitting improved models based on the findings from the mediational models.

Table 2
Descriptive statistics of Park features within 250, 500 and 1000m residential buffers.

		Buffer Size		
		250 m	500 m	1 km
		n = 1958	n = 1848	n = 1592
Park Area %	Mean (SD)	4.6% (9.1%)	6% (9%)	7.3% (8.4%)
Max Park Tree Canopy %	Mean (SD)	11% (19.7%)	29.5% (26.8%)	56.5% (24.1%)
Length of Hard Trails (m)	Mean (SD)	15.7 (98.7)	116.3 (485.1)	691.3 (1596.5)
Length of Soft Trails (m)	Mean (SD)	16.5 (109.6)	109.7 (486.6)	594.2 (1886.1)
Pools	Yes	108 (5.5%)	461 (24.9%)	1103 (69.3%)
	No	1850 (94.5%)	1387 (75.1%)	489 (30.7%)
Spraygrounds	Yes	158 (8.1%)	601 (32.5%)	1166 (73.2%)
	No	1800 (91.9%)	1247 (67.5%)	426 (26.8%)
Playgrounds	Yes	472 (24.1%)	1216 (65.8%)	1520 (95.5%)
	No	1486 (75.9)	632 (34.2%)	72 (4.5%)
Picnic Sites	Yes	202 (10.3%)	632 (34.2%)	1203 (75.6%)
	No	1756 (89.7%)	1216 (65.8%)	389 (24.4%)
Adult Exercise Equipment	Yes	59 (3.0%)	169 (9.1%)	438 (27.5%)
	No	1899 (97.0%)	1679 (90.9%)	1154 (72.5%)
Recreation Centers	Yes	323 (16.5%)	994 (53.8%)	1464 (92%)
	No	1635 (83.5%)	854 (46.2%)	128 (8.0%)
Older Adult Centers	Yes	9 (0.5%)	52 (2.8%)	154 (9.7%)
	No	1949 (99.5%)	1796 (97.2%)	1438 (90.3%)
Comfort Stations	Yes	19 (1.0%)	109 (5.9%)	380 (23.9%)
	No	1939 (99.0%)	1739 (94.1%)	1212 (76.1%)

Values for the point-mapped park features (pools, spraygrounds, playgrounds, picnic sites, adult exercise equipment, recreation centers, older adult centers, and comfort stations) are expressed as the number and percentage of participants whose buffer contains one or more of those features.

Table 3
Descriptive statistics of neighborhood characteristics within 250, 500 and 1000m residential buffers.

		Buffer Size		
		250 m	500 m	1 km
		n = 1958	n = 1848	n = 1592
Sidewalk Length (km)	Mean (SD)	6.8 (2.3)	26 (9)	99.9 (32.8)
Part I Crime (per sq. km)	Mean (SD)	778.2 (811.7)	777.8 (723.5)	781.6 (586.8)
Tree Canopy Coverage	Mean (SD)	17% (10.3%)	17.2% (10%)	17.1% (9.7%)

3.2. Neighborhood characteristics: confounding vs. interaction

We found a mediational pathway from objective park characteristics to physical activity only in 250- and 500-m buffer sizes, so we ran SEM path models comparing interaction and confounding causal structures for the role of neighborhood characteristics only for these two buffer sizes. We included only park land area coverage and park tree canopy coverage in these models, as these were the only two park features found

Table 4
Regression estimates of perceived Park access and physical activity from mediational model.

Response Variable	Predictor Variable	250-m buffers Estimate	250-m buffers P-value	500-m buffers Estimate	500-m buffers P-value	1 km buffers Estimate	1 km buffers P-value
Perceived Park Access	Park Area %	1.518[a]	0.004	2.308[a]	<0.001	0.359	0.715
	Max Park Tree Canopy %	0.656[a]	0.002	0.681[a]	<0.001	0.318	0.121
	Length of Paved Trails	0.606	0.145	0.145	0.087	0.057[a]	0.036
	Length of Unpaved Trails	−0.312	0.363	−0.043	0.651	−0.038	0.211
Physical Activity	Perceived Park Access	0.124[a]	0.016	0.119[a]	0.026	0.153[a]	0.007

[a] Statistically significant at $p < 0.05$.

to have a significant relationship with perceived park access. We also removed race as an individual-level covariate because we found that it was not statistically associated with park access in the mediational models. In a comparison of models in which neighborhood characteristics (tree canopy coverage, crime incidents, and sidewalk network length) were treated as effect measure modifiers of the relationship between objective park characteristics and perceived park access, or as confounders of the association between objective park characteristics and physical activity, we found that the confounding model at both exposure distances had better fit statistics (in the 250m buffer, RMSEA was 0.105 for confounding vs. 0.653 for interaction; in the 500m buffer, RMSEA was 0.038 for confounding vs. 0.735 for interaction). This indicates that the model using neighborhood characteristics as confounders was a better fit to these data than was a model using neighborhood characteristics as effect measure modifiers. However, the comparative fit index for all models was estimated at 0, suggesting that a small amount of available variance may be explained by the variables in this analysis.

4. Discussion

Based on this survey of older adults in southeastern Pennsylvania, perceived access to parks was higher with greater total park area in proximity to participants and with more tree cover in those nearby parks. We also found that self-reported level of physical activity was higher with improved perception of park access. Other measured park characteristics were not associated with increased perceptions of park access or physical activity levels. Our results suggest that objectively-measured park access and within-park tree canopy levels may be associated with increased physical activity levels of older adults, mediated by their perceptions of park access. Interventions to increase older adults' access to parks may be expected to result in increased physical activity levels. Further, we find that a model treating neighborhood characteristics as confounders of the relationship between park features and physical activity provided a better fit to these data than did a model treating neighborhood characteristics as effect measure modifiers, although this analysis does not confirm or preclude any causal relationships.

While our results highlight the role of within-park tree canopy levels for increasing perceived park access, other types of interventions that we did not test may also be effective at improving park access. These interventions may benefit from considering individual attributes of park users as well as contextual attributes of parks and neighborhoods: our findings suggest that, among our older-adult sample, those in the oldest age category, those with reduced health status, and those with lower incomes all report lower perceived park access, and that females report lower perceived park access than do males. Future research may evaluate the effectiveness of park access interventions on improving physical activity in older adults.

Prior studies have found that older adults prefer parks that incorporate vegetation and natural surroundings (Kou et al., 2021; Van Puyvelde et al., 2023). Our finding that tree canopy coverage in parks was positively associated with perceived park access supports the importance of greenery for park use by older adults. Further, urban greenspaces have been associated with higher levels of physical activity among older adults (Gong et al., 2014) as well as slower declines in physical activity over time (Dalton et al., 2016). Our results indicate a potential mediational pathway from tree canopy in parks through perceived park access and leading to physical activity, which may help to further explain the relationships between urban greenspace, park preferences, and physical activity in older adults.

Other prior studies have also highlighted park walking paths as important for older adult physical activity (Joseph and Zimring, 2007; Van Puyvelde et al., 2023). While we found a significant relationship between the length of paved park paths and perceived park access at the 1 km buffer size, no other relationships with paved or unpaved paths were significant in any buffer size, so the previously-described importance of this feature was not replicated in our study. Potentially this is because we could not distinguish physical activity that occurred within parks from physical activity in other settings. Our finding of the mediational pathway from park characteristics to physical activity only in the 250- and 500-m buffer sizes is not consistent with some other relevant work indicating that larger buffer sizes better predict health outcomes associated with greenness (Browning and Lee, 2017) or that neighborhood characteristics associated with walkability have similar impacts on walking behavior across spatial scales (Villanueva et al., 2014).

This study had several important limitations. First, the cross-sectional design of this study limits our ability to draw causal inferences from the associations presented here. Further, we are approximating this cross-sectional design based on two years of a survey, in which some questions were phrased differently between years; this could have impacted how participants interpreted and responded to these questions. In particular, participants responded differentially to the park access question in the two survey years, with most 2015 participants reporting access, and most 2018 participants reporting a lack of access. However, the addition of an indicator for survey year did not substantively impact our modeled results. Second, while we were able to assess older adult perceptions of park access and self-reported physical activity, we did not have information about park visitation for these participants or location of physical activity. However, even if participants did not visit or enter neighborhood parks, the presence of parks could still potentially increase physical activity levels if the parks contributed to more pleasant neighborhood conditions that encourage outdoor activity or promote mental health. A lack of data availability outside of the city of Philadelphia and the risk of edge effects resulting from buffers extending outside of Philadelphia limited our sample and reduced its representativeness only to urban residents, despite the SEPAHHS's study area including suburban and semirural areas. In addition, employing a uniform 0.05 p-value cutoff in reducing our model could have eliminated relevant features that may have been statistically significant in a different analysis. Finally, there are several park characteristics that prior studies have found to be important for older adult park perceptions and park use but for which we did not have available measurements in the full set of parks in Philadelphia. These factors include park upkeep and maintenance, the presence of litter, and social incivilities. Our study relied on park attribute data distributed by the municipal government, and thereby sacrificed measurement detail for spatial comprehensiveness.

Despite these limitations, the large sample size of the SEPAHHS data and its linkage with residential locations enabled a large-scale spatial analysis that can assess the independent role of specific park features in promoting perceived park access and physical activity. This study contributes to an ongoing body of literature to understand how parks can be designed and managed to promote older adult use and physical activity. Our results support prior findings of the importance of natural spaces for public health by demonstrating a mediational pathway from tree canopy in parks through perceived park access to physical activity. Increasing the availability of public land with high levels of tree canopy coverage and other natural vegetation may increase levels of physical activity and improve health outcomes for older adult populations.

CRediT authorship contribution statement

Dustin Fry: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Russell K. McIntire:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Michelle C. Kondo:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Conceptualization.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2024.103258.

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