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Neighborhood Safety, Socioeconomic Status, and Physical Activity in Older Adults

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Abstract

Background—Neighborhood environment can have a substantial influence on the level of physical activity among older adults. Yet, the moderating influence of various measures of SES on the association between perceived neighborhood safety and leisure-time physical activity (LTPA) among older adults remains unknown.

Purpose—The study was designed to investigate the association between perceived neighborhood safety and LTPA in a nationally representative sample of older adults, and to evaluate SES characteristics as potential effect modifiers in the association between perceived neighborhood safety and LTPA.

Methods—Cross-sectional data from the 2004 Health and Retirement Study of older adults aged 50 years were used to examine the association between perceived neighborhood safety and LTPA. Differences in LTPA were evaluated across three measures of SES: education, household income, and household wealth. SES was also evaluated as a potential effect modifier in the association between perceived neighborhood safety and LTPA. The analysis was conducted in 2008.

Results—An SES gradient in LTPA was noted across measures of SES used in this study. After controlling for SES and demographic characteristics and functional limitations, older adults who perceived their neighborhood as safe had an 8% higher mean rate of LTPA compared to older adults who perceived their neighborhood as unsafe. The association was no longer significant when self-rated health was added. Additionally, SES was not a significant effect modifier in the association between perceived neighborhood safety and LTPA.

Conclusions—SES, demographic characteristics, and functional limitations substantially attenuated the positive association between perceived neighborhood safety and LTPA; however, with the inclusion of self-rated health, the association was no longer present. This finding suggests that self-rated health may mediate this association. The lack of significance in the interaction between perceived neighborhood safety and SES suggests that prevention efforts to increase physical activity among older adults should consider perceptions of neighborhood safety as a potential barrier regardless of SES.

Introduction

Physical activity results in numerous benefits to fitness and health for older adults. Specific benefits include decreased risk of hip fracture and decreased risk of cardiovascular disease, diabetes, and some forms of cancer.¹⁻⁴ The American College of Sports Medicine and the American Heart Association recommend that adults aged ≥ 65 years engage in moderate-intensity aerobic physical activity for at least 30 minutes on 5 days each week or vigorous-intensity aerobic activity for at least 20 minutes on 3 days a week.⁵ Yet, prevalence data from the 2005 Behavioral Risk Factor Surveillance System (BRFSS) suggest that 61% of adults aged ≥ 65 years do not meet these recommendations.⁶ Socioeconomic and demographic factors have been investigated to explain the low levels of physical activity among older adults; they suggest a negative association between physical activity and factors such as age,^{7,8} as well as a positive association between physical activity and household income and perceived environmental factors such as neighborhood safety and aesthetics.⁹⁻¹¹

For many older adults, the neighborhood of residence is their predominant environmental context.¹² In particular, the neighborhood can take on a more meaningful role as issues related to declining health and physical impairments increase the likelihood that more time is spent in the neighborhood of residence.¹³ Further, if a neighborhood is deteriorating or deprived of resources, social contact can be reduced and safety compromised, which can then lead to stress, fear, and distrust among neighborhood residents.¹⁴ It is the confluence of these neighborhood problems that can create a sense of social disorder and negatively influence the health behavior of neighborhood residents.¹⁵ It has been found¹⁶ that residents who reported multiple problems in their neighborhood (e.g., traffic, crime, excessive noise, difficulty accessing public transport, inadequate lighting at night, and trash and litter) were more likely to have poor physical and emotional health and to be obese and sedentary at baseline compared to those reporting zero or one neighborhood problem.

The findings from research on the possible association between perceived neighborhood safety and physical activity are inconsistent.^{17,18} For example, in a population-based study of older adults in New South Wales, Australia, it was found¹⁷ that there was no association between perceived neighborhood safety and physical activity. However, data from the BRFSS suggest a positive association between perceived neighborhood safety and physical activity among older adults, even after controlling for race and education.¹⁹ Additionally, some studies have shown a differential effect of perceived neighborhood safety on physical activity across demographic and socioeconomic categories.^{20,21} Yet, among the studies of the relationship between perceived neighborhood safety and leisure-time physical activity (LTPA), few studies have focused exclusively on older adults and even fewer have used population-based probability samples.

The aim of this study was to investigate the association between perceived neighborhood safety and LTPA in a nationally representative sample of older adults, and to evaluate SES characteristics as potential effect modifiers in the relationship between perceived neighborhood safety and LTPA. It was hypothesized that the level of LTPA would be significantly higher in those living in neighborhoods perceived as safe compared to that in those living in neighborhoods perceived as unsafe even after adjusting for demographic, SES, and health characteristics. It was also hypothesized that socioeconomic characteristics, such as education, household annual income, and household wealth would be effect modifiers in the relationship between perceived neighborhood safety and LTPA. In particular, it was hypothesized that the association between perceived neighborhood safety and LTPA would be different across categories of SES with greater differences in the level

of LTPA along categories of SES among respondents living in neighborhoods perceived as unsafe compared to those perceived as safe.

Methods

Data Source

The Health and Retirement Study (HRS) is a national longitudinal study of the economic, health, marital, family status, and public/private support systems of older Americans funded by the National Institute on Aging (grant number NIA U01AG009740) and the Social Security Administration and conducted by the Institute for Social Research Survey Research Center at the University of Michigan.²² The HRS uses a national multistage area probability sample of households in the U.S., with oversamples of blacks, Hispanics, and residents from the state of Florida. The details of the HRS are described elsewhere.²³ For this study, cross-sectional data from the 2004 HRS were used. The 2004 HRS consisted of 20,129 respondents, and the response rate was 88%. The 2004 HRS consisted of 20,129 respondents. For the present study, respondents were excluded if they were dead; institutionalized; aged <50 years ($n=1544$); or missing data on LTPA ($n=25$), neighborhood safety ($n=138$), or socioeconomic ($n=41$) or demographic ($n=11$) characteristics. Thus, the sample available for analysis was $n=18,370$. The analysis for the present study was conducted in 2008.

Measures

Outcome variable—Three levels of self-reported physical activity were measured in the HRS in 2004: vigorous, moderate, and mild. These levels of physical activity were assessed by the following questions, respectively: *How often do you take part in sports or activities that are vigorous, such as running or jogging, swimming, cycling, aerobics or gym workout, tennis, or digging with a spade or shovel?*; *How often do you take part in sports or activities that are moderately energetic such as gardening, cleaning the car, walking at a moderate pace, dancing, floor or stretching exercises?*; and *How often do you take part in sports or activities that are mildly energetic, such as vacuuming, laundry, home repairs?* Following a method previously described,²⁴ an index of LTPA was created by combining the responses to the vigorous and moderate physical activity questions. The responses for the vigorous activity questions were coded as follows: 0=hardly ever or never; 2=one to three times a month; 6=once a week; and 12=more than once a week. The responses for the moderate activity questions were coded as half of the vigorous codes (i.e., 0, 1, 3, and 6, respectively).²⁴ The index was created by the sum of the responses to the vigorous and moderate physical activity questions, and the index ranged from 0 to 18.

Independent Variables

Primary exposure variable—Perceived neighborhood safety was measured by a single question in the 2004 HRS. Respondents were asked to rate the safety of their neighborhood as excellent, very good, good, fair, or poor. This variable was dichotomized with responses of excellent, very good, and good coded as safe, and responses of fair and poor coded as unsafe for ease of interpretation.

Demographic characteristics—Demographic characteristics used in this study include age; gender; race (white/nonwhite); ethnicity (Hispanic/non-Hispanic); and marital status (married/unmarried). Age was categorized into tertiles: aged 50–64, 65–74, and >75 years for univariate and bivariate analysis. Age was used as a continuous variable in multivariable analysis.

Socioeconomic variables—Educational attainment was grouped into the following categories for univariate and bivariate analysis: less than high school, high school diploma/GED, some college/college graduate, and graduate/professional degree. Years of schooling was used to operationalize educational attainment as a continuous variable for multivariable analysis. Household annual income was calculated by summing the respondents' self-reported wage/salary income, bonuses/overtime, pay/commissions/tips, second job or military reserve earnings, and professional practice or trade income. Household wealth was calculated by summing self-reported household assets such as cash; real estate (excluding primary residence); vehicles; businesses owned; and total financial securities less household debt. Household annual income and household wealth variables were calculated by the RAND Corporation's Center for the Study of Aging.²⁵ Tertiles (low, moderate, high) were created of annual income and household wealth for univariate and bivariate analysis. Household annual income and household wealth were used as continuous variables in multivariable analysis. In order to retain the respondents reporting negative wealth, the negative wealth values were replaced with zero prior to log transformation. In addition, in order to retain those reporting zero income or wealth, a constant (+1) was added to these variables prior to log transformation.

Health characteristics—Functional limitations were measured by a count of the number of activities the respondents reported having difficulty participating in, such as walking several blocks, getting up from a chair, lifting or carrying objects weighing >10 pounds, and climbing one flight of stairs (range: 0–10). Self-rated health was measured by the following question, with the coding level in parentheses: *Would you say your health is excellent (1), very good (2), good (3), fair (4), or poor (5)?*

Statistical Analysis

In order to test the association between perceived neighborhood safety and LTPA, bivariate and multivariable tests were performed. LTPA was positively, continuously distributed, but no assumptions were made regarding the shape of the distribution of LTPA in this population; thus, nonparametric tests were selected for bivariate analysis. Bivariate analyses using Wilcoxon-Mann-Whitney tests were conducted to determine differences across demographic categories on LTPA; Kruskal-Wallis tests were conducted to determine differences across SES categories on LTPA in the unweighted sample. Spearman correlation analysis was performed among the continuously measured SES and demographic variables and LTPA. Weighted regression models were calculated to determine the unadjusted and adjusted association between perceived neighborhood safety and LTPA. In subsequent models, interaction terms were entered individually for socioeconomic characteristics to determine if the association between perceived neighborhood safety and LTPA was modified by SES. Additionally, to determine if the effect of age on LTPA increases with age, a quadratic term for age was tested.

Estimation

Population-averaged estimates and inferences to the general population of older adults were of interest; therefore, all models estimated were marginal models (i.e., generalized estimating equations [GEE]). It has been suggested²⁶ that GEEs may give equivocal variance estimates in a stratified cluster sample. For this reason, a weighted GEE was used that incorporates sampling weights to account for the probability of selection and nonresponse, as well as adjustments for the multistage stratified cluster sampling in the HRS. A two-stage procedure²⁶ was followed to obtain consistent parameter and robust variance estimates.²⁶ In so doing, weighted GEEs with a normal distribution, a log link function, and an exchangeable correlation structure were computed. The GEE regression with log link was chosen to ensure a positive predicted outcome. All models were estimated

in SAS version 9.2. Proc GENMOD was used with a weight statement to obtain a consistent estimate of β by GEEs. The parameter estimates obtained were then used to create pseudo-outcomes and pseudo-covariates, which were then used in SAS Survey procedures to obtain consistent robust variance estimates.

Results

Table 1 lists the descriptive statistics. The weighted mean age was 65 years (unweighted mean age=67 years; range=50–108 years). The weighted mean LTPA in the sample was 7.56 (unweighted mean=7.06; un-weighted median=6.0). Univariate analyses revealed that men reported more LTPA than women; white respondents reported more LTPA than nonwhite respondents; non-Hispanic respondents reported more LTPA than Hispanic respondents; and married individuals reported more LTPA than unmarried individuals. Across all SES variables (education, annual household income, and household wealth), a gradient in average LTPA was noted. Additionally, the weighted mean functional limitation was 2.28, and weighted average self-rated health was 2.79. Bivariate analyses revealed significant differences in mean LTPA across the categories of all demographic and SES variables ($p<0.001$; Table 1). In addition, Spearman correlation analysis showed positive correlations between LTPA and SES (educational attainment, household annual income, and household wealth), and between LTPA and self-rated health; a negative correlation was found between age and LTPA, and between functional limitations and LTPA (Table 2).

The results from the simple and multivariable regression analyses using GEE to investigate the association between perceived neighborhood safety and LTPA are shown in Table 3. The SE estimates reported are robust SEs. The exponentiated parameter estimates represent the risk ratio of the mean outcome for those living in a neighborhood perceived as safe compared to those living in a neighborhood perceived as unsafe. The simple regression revealed that living in a neighborhood perceived as safe was associated with a 35% higher mean LTPA than living in a neighborhood perceived as unsafe (Table 3; $\beta=0.30$; $\exp(\beta)=1.35$; CI=1.24, 1.46; $p<0.001$). After controlling for demographic characteristics (Table 3, Model 2), the mean LTPA for those living in a neighborhood perceived as safe compared to those living in a neighborhood perceived as unsafe was reduced to a 29% higher mean LTPA, but it remained significant ($\beta=0.26$; $\exp(\beta)=1.29$; CI=1.20, 1.39; $p<0.001$). After controlling for SES (Model 3), the association between neighborhood safety and LTPA was attenuated but remained significant ($\beta=0.11$; $\exp(\beta)=1.12$; CI=1.04, 1.19; $p<0.001$). Lastly, the association between neighborhood safety and LTPA was attenuated when functional limitations was added ($\beta=0.08$; $\exp(\beta)=1.08$; CI=1.01, 1.16; $p<0.05$), but the association was no longer significant when self-rated health was added (Table 3).

Interaction terms for perceived neighborhood safety and each of the SES variables (educational attainment, annual income, and household wealth) were then entered individually. Tests for interactions revealed no significant associations. The quadratic term for age was then entered and revealed a significant association (Model 6) for this interaction term (Table 3).

Discussion

The findings from this study revealed a gradient in LTPA across all measures of SES among older adults, with a higher average mean LTPA among those with higher SES compared to those with lower SES. The results of this study also revealed that older adults who perceived their neighborhood environment as safe have a significantly higher mean LTPA compared to older adults who perceive their neighborhood environment as unsafe; however, after controlling for demographic and SES characteristics and functional limitations, the

differences in LTPA by perception of neighborhood safety were substantially attenuated. Nevertheless, the results from the adjusted models revealed that the mean LTPA remained lower among those living in neighborhoods perceived as unsafe compared to those living in neighborhoods perceived as safe even after accounting for demographic, SES, and functional limitations differences. Although the noted effect was small, these findings suggest that over and above the influence of SES, demographic, and functional limitation variations in LTPA, perceived neighborhood safety exerts an influence over LTPA behavior among older adults. However, this influence appears to be mediated by self-rated health.

Surprisingly, the tests of interactions between neighborhood safety and the SES variables revealed no significant associations. This finding suggests that the association between LTPA and perceived neighborhood safety does not differ significantly across the various categories of the SES variables measured in this study among older adults. Yet, the significant positive association of the quadratic term for age suggests that the negative association between age and LTPA increases as age increases. It should be noted that the inclusion of the quadratic term for age did not substantially change the parameter estimate for perceived neighborhood safety, suggesting that the nonlinear association between LTPA and age may not influence the relationship between perceived neighborhood safety and LTPA among older adults.

Several studies have shown an association between perceived neighborhood safety and physical activity behavior among adults in general²⁷ and older adults in particular.^{28,29} The findings here are consistent with these studies. In particular, the present study provides additional evidence of the positive association between the perception of neighborhood safety and LTPA. Additionally, the substantial attenuation of the association between perceived neighborhood safety and LTPA when SES was included in the models is consistent with studies showing the strong influence of SES on physical activity behavior.^{30,31} What distinguishes the present study from other studies in this area is that the present study investigated the relationship between neighborhood safety and LTPA in a national probability sample of older adults, and the results are generalizable to the population of older adults aged >50 years in the U.S. In addition, although it proved to be an insignificant finding, the present study investigated SES as a potential effect modifier in the relationship between perceived neighborhood safety and LTPA among older adults. The findings here are in contrast to those found in a study¹⁷ in which neighborhood safety was not associated with physical activity among older adults; however, inconsistencies may in part be a result of different operationalizations of neighborhood safety and physical activity between the two studies.³²

The strengths of the present study include the use of a large national probability sample (N=18,370), which allows the results to be generalized to non-institutionalized adults in the U.S. aged >50 years. In addition, the present study is one of the first to test for effect modification of SES in the association between perceived neighborhood safety and LTPA among older adults. There are several limitations to this study. The study is cross-sectional and cannot provide evidence for a causal relationship between perceived neighborhood safety and LTPA. In addition, although similar questions used to assess LTPA and perceived neighborhood safety in this study have been examined for validity and reliability, the index created in this study has not been. In addition, in the present study, physical activity is measured by two questions related to vigorous and moderate activity, and perceived neighborhood safety is measured with only one question. These measures neither capture the multidimensionality of these constructs nor the associations among the various dimensions of neighborhood safety and LTPA. Lastly, all data used from the HRS were self-reported and therefore subject to recall bias.

Conclusion

Although the benefits of physical activity have been well documented, the rates of participation remain relatively low among older adults.³³ Socioeconomic and demographic characteristics have shown great influence on the physical activity behavior of older adults.^{34,35} Additionally, the neighborhood environment has been shown to be associated with the physical activity behavior of older adults.³⁶ The findings of the present study suggest that over and above the influence of socioeconomic and demographic characteristics and functional limitations, perceived neighborhood safety can have an influence on the level of physical activity among older adults. In addition, the lack of significance for the SES and perceived neighborhood safety interaction terms suggests that the influence of perceived neighborhood safety on LTPA does not differ across levels of SES. The implications of the findings here suggest that health promotion efforts to increase LTPA among older adults should take into account residents' perceptions of neighborhood safety as a potential barrier to physical activity behavior, regardless of SES. Lastly, the fact that the association between LTPA and perceived neighborhood safety disappears with the inclusion of self-rated health suggests that self-rated health may function as a mediator in this association and as an important predictor of LTPA among older adults.

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Table 1
 Frequency distributions across levels of neighborhood safety, the weighted mean of LTPA, and bivariate *p*-values

Variable	<i>n</i>	Weighted %	Neighborhood safety ^a =0	Neighborhood safety ^a =1	Weighted mean LTPA	<i>p</i> -value ^b
Full sample	18,370		1,728	16,642	7.56	
DEMOGRAPHICS						
Gender						
Male	7,898	45.95	693	7,205	8.46	<i>p</i> <0.0001
Female	10,472	54.05	1,035	9,437	6.79	
Race						
Nonwhite	3,518	14.35	809	2,709	6.29	<i>p</i> <0.0001
White	14,852	85.65	919	13,933	7.77	
Ethnicity						
Non-Hispanic	16,662	93.08	1,360	15,302	7.62	<i>p</i> <0.0001
Hispanic	1,708	6.92	368	1,340	6.73	
Age (years)						
50–64	7,499	55.18	804	6,695	8.43	<i>p</i> <0.0001
65–74	6,050	23.26	572	5,478	7.55	
75	4,821	21.56	352	4,469	5.35	
Marital status						
Unmarried	6,734	36.94	902	826	6.46	<i>p</i> <0.0001
Married	11,636	63.06	5,832	10,810	8.20	
SOCIOECONOMIC VARIABLES						
Educational Attainment						
Less than high school	4,593	20.17	821	3,772	5.36	<i>p</i> <0.0001
GED/high school diploma	6,145	32.91	503	5,642	6.90	
2–4 years of college	5,646	34.14	333	5,313	8.43	
Postcollege/professional degree	1,986	12.78	71	1,915	10.38	
Annual household income						
Low	6,087	28.91	986	5,101	5.45	<i>p</i> <0.0001
Moderate	6,126	31.17	492	5,634	7.34	
High	6,157	39.91	250	5,907	9.26	

Variable	<i>n</i>	Weighted %	Neighborhood safety ^a =0	Neighborhood safety ^a =1	Weighted mean LTPA	<i>p</i> -value ^b
Household wealth						
Low	6,086	30.22	1,172	4,914	5.50	<i>p</i> <0.0001
Moderate	6,128	34.31	392	5,736	7.62	
High	6,156	35.47	164	5,992	9.25	

^aNeighborhood safety=0 represents neighborhood perceived as unsafe; neighborhood safety=1 represents neighborhood perceived as safe

^b*p*-value results from the Wilcoxon-Mann-Whitney tests and the Kruskal-Wallis tests LTPA, leisure-time physical activity

Table 2

Spearman correlation among continuously measured variables

	Leisure-time physical activity	Age	Education attainment ^a	Household annual income ^b	Household wealth ^b	Functional limitations ^c	Self-rated health ^d
LTPA	1.00						
Age	-0.196*	1.00					
Education attainment ^a	0.234*	-0.188*	1.00				
Household annual income ^b	0.279*	-0.331*	0.476*	1.00			
Household wealth ^b	0.235*	0.001	0.407*	0.528*	1.00		
Functional limitations	-0.432*	0.261*	-0.255*	-0.349*	0.228*	1.00	
Self-rated health	-0.396*	0.142*	-0.320*	-0.349*	0.286*	0.542*	1.00

^aEducation attainment measured as years of schooling

^bVariables were log-transformed

^cCount of the number of activities in which the respondents reported having difficulty participating (range: 0–10)

^dMeasured by the following question, with the coding level in parentheses: *Would you say your health is excellent (1), very good (2), good (3), fair (4), or poor (5)?*^a

* $p < 0.001$

Table 3
 Estimates for models of the association between perceived neighborhood safety and leisure-time physical activity

PARAMETER	Model 1 ^a	Model 2 ^b	Model 3 ^c	Model 4 ^d	Model 5 ^e	Model 6 ^{f,e}
Neighborhood safety						
Neighborhood perceived as safe	0.30 *** (0.040)	0.26 *** (0.037)	0.11 ** (0.042)	0.08 * (0.038)	0.05 (0.040)	0.04 (0.042)
Gender						
Male	0.17 *** (0.013)	0.14 *** (0.013)	0.08 *** (0.012)	0.105 *** (0.012)	0.104 *** (0.013)	0.104 *** (0.013)
Age	-0.016 *** (0.006)	-0.014 *** (0.0008)	-0.007 *** (0.0008)	-0.007 *** (0.0008)	-0.007 *** (0.008)	0.044 *** (0.009)
Marital status						
Unmarried	-0.11 *** (0.019)	0.022 (0.021)	0.010 (0.021)	0.010 (0.021)	0.002 (0.021)	0.010 (0.022)
Race						
Nonwhite	-0.16 *** (0.023)	-0.058 * (0.025)	-0.072 ** (0.025)	-0.049 * (0.034)	-0.064 * (0.033)	-0.070 * (0.036)
Ethnicity						
Non-Hispanic	0.08 ** (0.031)	-0.075 * (0.036)	0.031 *** (0.004)	0.021 *** (0.003)	0.015 *** (0.003)	0.016 *** (0.003)
Educational attainment						
Annual income (log)		0.031 *** (0.011)	0.004 (0.010)	0.004 (0.010)	-0.003 (0.010)	-0.002 (0.011)
Household wealth (log)						
Household wealth (log)		0.043 *** (0.004)	0.028 *** (0.004)	0.022 *** (0.004)	0.022 *** (0.004)	0.022 *** (0.004)
Functional limitations						
Self-rated health		-0.123 *** (0.003)	-0.123 *** (0.003)	-0.090 *** (0.003)	-0.090 *** (0.003)	-0.090 *** (0.003)
Interaction						
Age 3 age interaction					-0.143 *** (0.007)	-0.144 *** (0.007)
						-0.0004 *** (0.00007)

^a Simple model testing the association between perceived neighborhood safety and LTPA

^b Adjusted model controlling for demographic characteristics (gender, age, marital status, race, and ethnicity)

^c Adjusted model controlling for demographic characteristics and SES (years of schooling, annual income, and household wealth)

^d Adjusted model controlling for demographic characteristics, SES and functional limitations

^e Adjusted model controlling for demographic characteristics, SES, functional limitations, and self-rated health

^f Adjusted model controlling for demographic and SES characteristics and includes an age × age interaction term

* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$; numbers in parentheses are robust SEs