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Sociodemographic Moderators of Relations of Neighborhood Safety to Physical Activity

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Abstract

Purpose—To investigate gender, race/ethnicity, education and income as moderators of relations of perceived neighborhood crime, pedestrian, and traffic safety to physical activity.

Methods—Participants were from two samples: adults (N=2199, ages 25–65 years) and older adults (N=718, ages 66+ years) from high- and low-walkable neighborhoods in the Washington, DC and Seattle, WA areas. Neighborhood safety and transportation and leisure walking were assessed via survey, and moderate-vigorous physical activity (MVPA) was assessed using accelerometers. Sociodemographic moderators were investigated using interaction terms and follow-up within-group tests from mixed-effects regression models.

Results—Overall direct effects of safety on physical activity were not found, with one exception. Seven interactions were found in each sample. Interactions were found for all physical activity outcomes, though total MVPA was involved in more interactions in adults than older adults. Half of the interactions revealed significant positive relations of pedestrian and traffic safety to physical activity in the more affluent/advantaged group (i.e., high-education, high-income, White non-Hispanic) and null associations in the less affluent/advantaged group. Race/ethnicity was a moderator only in older adults. One third of the interactions involved gender; half of these involved crime safety. Interactions involving crime safety showed nonsignificant positive trends in the more affluent/advantaged group and women, and nonsignificant negative trends in the less affluent/advantaged group and men.

Conclusion—Sociodemographic moderators of neighborhood safety explained some of the variation in adults' and older adults' physical activity. Patterns suggested positive associations between safety and physical activity in participants with more affluent/advantaged sociodemographic characteristics, though some patterns were inconsistent, particularly for gender.

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More refined conceptualizations and measures of safety are needed to understand if and how these constructs influence physical activity.

Keywords

built environment; crime; gender; race/ethnicity; socioeconomic status; traffic; walking

The majority of adults and older adults in the United States do not meet physical activity guidelines (33), resulting in a public health challenge that requires interventions on multiple levels of influence (3). Ecological models are helpful in conceptualizing the factors that can affect physical activity, including levels of influence from individual to social to neighborhood environment and policy factors, with opportunities to intervene at each level (27).

Neighborhood-level safety from traffic and crime and protection for pedestrians are aspects of the social and built environment levels of ecological models. Some studies have found that these safety measures were positively associated with adults' physical activity (2, 11, 32). However, many studies have found inverse or no associations between perceived neighborhood safety and physical activity (11, 15, 17, 34).

One hypothesis that could account for inconsistent results is that the relation of perceived neighborhood safety to physical activity differs systematically by sociodemographic factors, such as gender, race/ethnicity, education, and income (11). This hypothesis is consistent with principles of ecological models which suggest dynamic interactions across levels of influence (27), but cross-level interactions rarely have been examined.

Regarding effect modification of neighborhood safety associations with physical activity, some evidence suggests that perceived safety is positively associated with physical activity in advantaged (e.g., White non-Hispanic, higher education) but not disadvantaged groups (16), and in women but not men (12, 23, 32), although these moderators of associations between safety and physical activity have seldom been investigated. Thus, research is needed to advance understanding of sociodemographic moderators of associations between neighborhood safety and physical activity. If sociodemographic moderators exist, strategies such as built environment changes that improve safety, or social marketing campaigns that increase perceptions of safety, could be targeted in specific areas or groups of people who are most likely to increase their physical activity when perceptions of safety are improved (e.g., 36).

The aim of the present study was to explore whether adults' and older adults' gender, race/ethnicity, education and income moderated the association between perceived neighborhood safety and physical activity. Based on the findings reviewed by Foster and Giles-Corti (11), we hypothesized that men, non-Whites, and socioeconomically disadvantaged groups would be somewhat immune to or less affected by poor neighborhood safety than their counterparts, particularly for transportation physical activity because it may be performed out of necessity. Thus, we expected associations between perceived safety and physical activity to be positive in all participants and stronger in women, White non-Hispanics, and those with higher education and income. We studied this hypothesis in two samples: adults

aged 20–65 years and older adults over age 65. The samples were analyzed separately because the associations between safety and physical activity differed by age group (29) and age-specific findings could lead to age-tailored intervention recommendations.

Methods

Design

Adult sample—The Neighborhood Quality of Life Study (NQLS) was an observational epidemiologic study designed to examine associations between built environments and physical activity in adults aged 20 to 65 years. The study was conducted in the Baltimore, Maryland-Washington, DC and Seattle-King County, Washington metropolitan areas during 2001–2005. Sixteen neighborhoods were included from each metropolitan area (32 neighborhoods in total), evenly distributed by walkability (high/low) and income (high/low). Neighborhoods were defined as clusters of contiguous census block groups and 219 block groups were included. Details of neighborhood selection, walkability index calculations, and results have been reported previously (13, 28).

Older adults sample—The Senior Neighborhood Quality of Life Study (SNQLS) was based on a similar stratified design and was conducted in the same regions during 2005–2008. The older adult sample was aged 66 years and older. Participants were recruited from 216 census block groups that met criteria for high/low walkability and high/low income; the block groups were not contiguous clusters. The older adult study design and initial results are detailed elsewhere (19).

Participants and Procedures

Adult sample—Participants were 2199 adults recruited from households in the identified neighborhoods, using marketing company mailing lists, and contacted by telephone and mail. Response rate was 26% of those eligible. Eligibility criteria included: being 20–65 years old, residing in a private home (not a group facility), able to complete surveys in English or Spanish, and able to walk independently. Participants signed a consent form and then were mailed an accelerometer. Accelerometers were worn for one week, and participants completed the survey at the end of that week via postal mail.

Older adult sample—Participants were 718 adults over age 65 who lived independently in the general community (not in a group facility). Participants were identified using the method described above. Response rate was 21.4% of those eligible. Eligibility criteria for the older adult sample were similar to the adult sample, with the addition of being able to correctly reiterate the study tasks (i.e., consent comprehension) and walk more than 10 feet without stopping. The data collection protocol was the same as in the adult sample. Both studies were approved by the sponsoring universities' IRBs.

Measures

Sociodemographic Factors—For both samples, age, gender, ethnicity (White non-Hispanic vs. other), education (college degree yes vs. no), number of motor vehicles per adult in household, number of people in household, years at current address, and marital

status (married/cohabitating vs. other) were collected by survey. Block group level neighborhood income was collected from the 2000 US Census. Neighborhood rather than personal income was used because of the expectation that personal income is not a meaningful measure for older adults who are not working but may have considerable assets.

Perceived Safety Measures—Perceived crime, pedestrian, and traffic safety were assessed using the full (adult sample) and abbreviated (older adult sample) versions of the Neighborhood Environment Walkability Survey (NEWS) (7, 25). The NEWS has been shown to have good reliability and validity in multiple studies using various versions (6, 9, 25). The items and internal consistency alphas for scales are presented in Table 1. Scale scores ranged from 1 to 4 (strongly disagree, somewhat disagree, somewhat agree, and strongly agree), with some items being reverse coded so that higher values on scale scores corresponded to better safety. One new item was added to the adult crime safety scale, and six new items pertinent to older adults were added to the older adult pedestrian safety scale.

Total objective physical activity—For both studies, ActiGraph accelerometers (Manufacturing Technology Incorporated, models 7164 and 71256; Pensacola, FL) were used to objectively measure participants' total physical activity. Accelerometers have been shown to have validity for estimating physical activity in adults (35) and older adults (3). The epoch was set at 60-seconds and a valid hour of wear time contained no more than 30 (adults) or 45 (older adults) consecutive minutes of zero counts. Valid wear days were defined as having at least 8 valid hours. Participants without at least 5 valid wear days were asked to rewear the accelerometer for the number of days missing. Data were cleaned and scored using MeterPlus software version 4.0 from Santech, Inc. Minutes/week of moderate to vigorous physical activity (MVPA) was calculated for both samples using previously established cut-points for adults (≥1952 counts/minute) (14).

Self-reported walking—For adults, self-reported walking was assessed using the International Physical Activity Questionnaire (IPAQ) survey that has evidence of reliability and validity (8). Items assessed frequency and duration of transportation and leisure walking within the past week, from which average minutes/week of the two types of walking were calculated. For older adults, self-reported walking was assessed using two items from the Community Healthy Activities Model Program for Seniors (CHAMPS) survey. One item asked about walking to do errands (i.e., transportation walking) and another about walking for leisure or pleasure. Response options ranged from 1 to 6 (< 1 hour/week; 1–2.5 hours/week; 3–4.5 hours/week; 5–6.5 hours/week; 7–8.5 hours/week, and > 9 hours/week), and values were recoded to derive minutes/week using the midpoint of each category and a value of 540 minutes/week for the highest category. Six-month stability of CHAMPS has been acceptable (ICCs 0.58–0.67), and the survey has been able to discriminate between inactive, somewhat active and active persons (31).

Analysis

For descriptive purposes, mixed effects ANOVAs were used to investigate differences in mean safety scores by sociodemographic factors, and Bonferroni post hoc tests were used for income, which was split into three categories for this descriptive analysis. For the main

analyses, mixed effects regression models were conducted with census block group entered as a random effect variable and participant age, marital status, number of people in household, number of cars per adult in household, years at current address, site (Baltimore vs. Seattle), and neighborhood walkability category (high vs. low) entered as covariates. Main effects for the sociodemographic and safety variables were tested in an initial model and interactions were tested in a subsequent model, for a total of 6 models in each study.

The two adult walking outcomes (transportation and leisure) were natural log transformed to better approximate normality, while the regression coefficients from the respective models were transformed using the following formula so they could be interpreted in their original units: (Exp(coefficient)-1)*intercept. Gender, race/ethnicity, education and dichotomous covariates were dichotomous and centered on 0 (i.e., −.5, .5). The safety scales, neighborhood income and continuous covariates were standardized to have a mean of 0 and standard deviation of 1. A *p*-value of 0.05 was used to interpret significance, with the exception of interactions in older adults, where a *p*-value of 0.10 was used given the smaller sample size as compared to adults. Follow-up mixed effects regression models were conducted for significant interactions, with the association between safety and physical activity being tested at each level of the sociodemographic variable (median split) adjusted for covariates. Charts were created by plotting the effect of the safety variable, using a reference of −1 SD (i.e., “low”) and +1 SD (i.e., “high”). All analyses were conducted using SPSS version 21.0.

Results

Participant demographic characteristics and descriptive statistics for outcomes variables are presented in Table 2 for each study. Final sample size ranged from 2088 to 2163 for adults and 687 to 708 for older adults due to missing data. Table 3 presents differences in safety scores by sociodemographic factors. Participants who were male, White non-Hispanic, college-educated, and living in a higher-income neighborhood generally reported higher neighborhood safety perceptions compared to their peers, with the exception of traffic safety in adults, which was higher in women than men.

Table 4 presents the associations between neighborhood safety and physical activity, as well as moderation of these associations by sociodemographic factors. Across both samples, the only main effect for associations between the safety variables and physical activity outcomes was for pedestrian safety and walking for transportation in adults. Seven significant safety by sociodemographic factor interactions were found in both the adult ($p < 0.05$) and older adult ($p < 0.10$) samples and are plotted in Figures 1 and 2.

In adults, there were no moderators of traffic safety for any of the physical activity outcomes, and race/ethnicity did not moderate any of the safety variables for any outcome. Follow-up tests for the 3 interactions involving crime safety revealed no significant within-group effects (Figures 1a, 1f and 1g). However, there were trends for significance showing negative associations between crime safety and walking for leisure in men and the low-educated group in 2 of these interactions (Figures 1f and 1g). In the interaction involving pedestrian safety and gender, pedestrian safety had a significant positive association with

total MVPA in men and was unassociated with total MVPA in women (Figure 1b). In 2 of the 4 interactions with education or income, pedestrian safety had significant positive associations with total MVPA and walking for transportation in the more affluent/advantaged group and was unassociated with total MVPA and walking for transportation in the less affluent/advantaged group (Figures 1c and 1e). Pedestrian safety was significantly positively associated with total MVPA in the low-income group and unassociated with total MVPA in the high-income group (Figure 1d).

In older adults, 4 of the 7 interactions involved traffic safety, 2 involved pedestrian safety and 1 involved crime safety. Follow-up tests revealed significant within-group safety effects for 3 of the interactions and trends for significance for an additional 3 interactions. Follow-up tests for the interaction involving crime safety revealed no significant within-group effects (Figure 2f). In the 2 interactions involving total MVPA, traffic safety (trend for significance) and pedestrian safety (significant) were positively associated with total MVPA in the high-education and high-income groups, and unassociated with total MVPA in the low-education and low-income groups (Figures 2a and 2b). Similarly, pedestrian safety and traffic safety had significant positive associations with walking for transportation and walking for leisure in the White non-Hispanic and high education groups, and were unassociated with walking for transportation and walking for leisure in the less affluent/advantaged groups (Figures 2d and 2g). Traffic safety was significantly negatively associated with walking for transportation in women and unassociated with walking for transportation in men (Figure 2c). Traffic safety was positively associated (trend for significance) with walking for leisure in men and unassociated with walking for leisure in women (Figure 2e).

The magnitude of these interactions, gauged by differences in minutes of weekly physical activity, ranged in size. For example, for total MVPA in adults, the strongest interactions found were between pedestrian safety and gender and pedestrian safety and income, where high vs. low pedestrian safety was associated with 35 more minutes/week of MVPA in men (as opposed to 8 fewer minutes/week of MVPA in women) and 35 more minutes/week of MVPA in the low-income group (as opposed to 5 fewer minutes/week of MVPA in the high-income group; see Figures 1b and 1d). In older adults, the strongest interaction found was between traffic safety and education in explaining walking for leisure, where high vs. low traffic safety was associated with 34 more minutes/week of walking for leisure in the high-education group (as opposed to 22 fewer minutes/week of walking for leisure in the low-education group; see Figure 2g).

Discussion

The hypothesis was that examining sociodemographic moderators of the association between neighborhood safety and physical activity would help explain some of the inconsistent results in the literature. Similar to other studies (15, 16), the present study found only one of the 18 direct associations tested between various perceived safety measures and diverse physical activity metrics to be significant. The present study found about 20% of the tested interactions between sociodemographic factors and perceived neighborhood safety in relation to adults' and older adults' physical activity were significant (though $p < 0.10$ for

older adults), suggesting there is moderation by sociodemographic subgroups and supporting the ecological principle of interactions across levels of influence. Though it appears sociodemographic factors are important in understanding neighborhood safety and physical activity, there is still inconsistency, suggesting a greater complexity than can be explained by sociodemographic differences alone.

There was some consistency in the patterns of the interactions found, where 6 of the 9 interactions involving race/ethnicity, education, or income revealed positive associations (significant or trend for significance) between safety and physical activity in the more affluent/advantaged group and null associations in the less affluent/advantaged group. This pattern was seen in both the older adult (4 of 5 interactions) and adult samples (2 of 4 interactions). These results provided some support for study hypotheses and suggested that White non-Hispanics and more socioeconomically advantaged individuals may be impacted more than their counterparts by neighborhood safety in regard to physical activity. Thus, in older adults, improvements in neighborhood safety may provide the greatest benefit to more advantaged populations. This result is similar to that of Hooker et al., who found that perceived safety was positively associated with physical activity in White non-Hispanics but unassociated with physical activity in Blacks (16). One possible explanation for safety being positively associated with physical activity in the more affluent/advantaged groups but not the less affluent/advantaged groups is that safety may be most influential at the more-favorable end of the scale. For example, a small difference in safety may be influential for affluent/advantaged people who live in mostly-safe areas, whereas a small difference in people who already feel unsafe may not be as perceptible and thus may be less influential on physical activity.

The interactions involving gender were less consistent, and some results were contrary to expectations. For example, pedestrian safety was positively associated with total MVPA in adult men, whereas crime safety was negatively associated with walking for leisure in adult men. Furthermore, the two interactions involving gender in older adults were opposite to the expected direction. These results are difficult to explain because we expected women to be more sensitive to safety perceptions, which was only the case in 1 of the 5 gender interactions found. Some of the inconsistencies across safety variables suggest that gender differences in the influence of safety on physical activity differs by type of safety and type of physical activity. For example, crime safety may be more influential of physical activity in women than men, but not pedestrian and traffic safety.

Results of the interactions involving transportation and leisure walking were generally consistent and intuitive, with the associations between neighborhood safety and walking being positive in participants of higher income and higher education, and in White non-Hispanics. The exceptions were the findings with gender, as described above. By contrast, in the adults, the results involving total MVPA were contradictory for similar socioeconomic variables. For example, the association between pedestrian safety and total MVPA was positive in the high education group but also in the low-income group. Some of these apparently contradictory findings could be explained by the fact that MVPA includes occupational and household activities that may not be related to neighborhood attributes but may introduce confounding effects.

It is unclear why there would be a negative association between perceived neighborhood safety and physical activity in any group, which was found through follow-up tests of 3 interactions. The analyses adjusted for macro-level neighborhood walkability, and previous studies found positive rather than negative associations between pedestrian safety and macro-level measures of walkability (25). Thus, it is not likely differences in macro-level walkability accounted for the present results. One possibility is that people who do more walking in their neighborhood are more aware of threats to their safety, and that this phenomenon is stronger in people with disadvantaged sociodemographic characteristics. There may be additional factors influencing the association between safety and physical activity that were not accounted for in the present analyses. Examples of additional factors worth exploring are social networks that support physical activity, avoidance of specific routes or places for physical activity, and/or obligatory conditions under which participants may have safety concerns but have to be physically active outdoors, such as when walking is the only available method of transportation.

The evidence of sociodemographic moderators of neighborhood safety and physical activity was more compelling for pedestrian safety and traffic safety than for crime safety. For the one crime safety interaction found in older adults, and one of the 3 found in adults, follow-up tests revealed no significant within-group effects. The other 2 crime safety interactions found in adults were difficult to interpret because the significant effect (or trend for significance) was negative. Interestingly, there were no significant interaction effects involving traffic safety and physical activity in the adult sample. Ethnicity was a moderator only in the older adults, and only one of the 2 ethnicity interactions had a significant within-group effect. The interactions appeared to be distributed across physical activity outcomes, rather than appearing for only one or 2 of the outcomes. A prudent interpretation of the present results is that they supported the principle of moderation of neighborhood safety-physical activity associations, but the results were not strong or consistent enough to lead to firm conclusions or suggest specific intervention approaches.

It is possible that the safety items used here lacked adequate specificity and sensitivity, which could have contributed to some of the counterintuitive results. For example, survey questions asked about perceptions of neighborhood safety but did not ask about perceptions of personal risk of victimization or whether safety concerns were deterrents from being active outside. Future studies should consider incorporating key concepts from sociology and criminology that, to date, have not been systematically used in studies of physical activity (11). Examples could include making the distinction between fear (emotionally-based) and perceived risk (cognitively-based) (10, 20) and examining the role that personal experiences with victimization may play in determining responses to crime and general perceived safety (30). Behavioral adaptations (e.g., taking actions to protect oneself; avoiding certain routes, places or times of day; being active despite concerns or out of necessity) may be a response to crime/disorder, instead of fear (5), and may moderate the association between cognitive and emotional responses to crime and outdoor physical activity.

Strengths of the present study included examination of two age groups that were selected in similar ways, multiple indicators of neighborhood safety, multiple physical activity

outcomes, and multiple sociodemographic variables. Limitations included the smaller sample size of older adults relative to adults that necessitated using a more liberal alpha value and lack of more objective safety variables such as crime records and traffic volume. The relatively low recruitment rates were likely due to the demands of wearing accelerometers and completing lengthy surveys on two occasions, but a critical finding was that response rates did not differ by walkability X income study design quadrants (19, 29). This suggests there was little differential bias across neighborhood types. The current analyses focused on perceptions of neighborhood safety, yet locations of physical activity were not assessed so the amount of physical activity that occurred in their neighborhoods was unknown. Thus, future studies may be improved by considering locations of physical activity and location-specific safety measures. Including objective measures of crime may provide insight into concordance between perceptions and reality to highlight where educational campaigns may be beneficial.

In conclusion, new evidence emerged showing positive associations between neighborhood safety and physical activity in demographically and socioeconomically affluent/advantaged participants and negative or null associations among less advantaged subgroups. However, because some inconsistent patterns were found, particularly for gender, the present study of moderators suggests a greater complexity than can be explained by sociodemographic differences alone. Both conceptual and methodological improvements, ideally based on collaborations with criminologists, may be needed to substantially advance this field of study. There are likely multiple levels of influence that need to be targeted, in addition to safety, to increase physical activity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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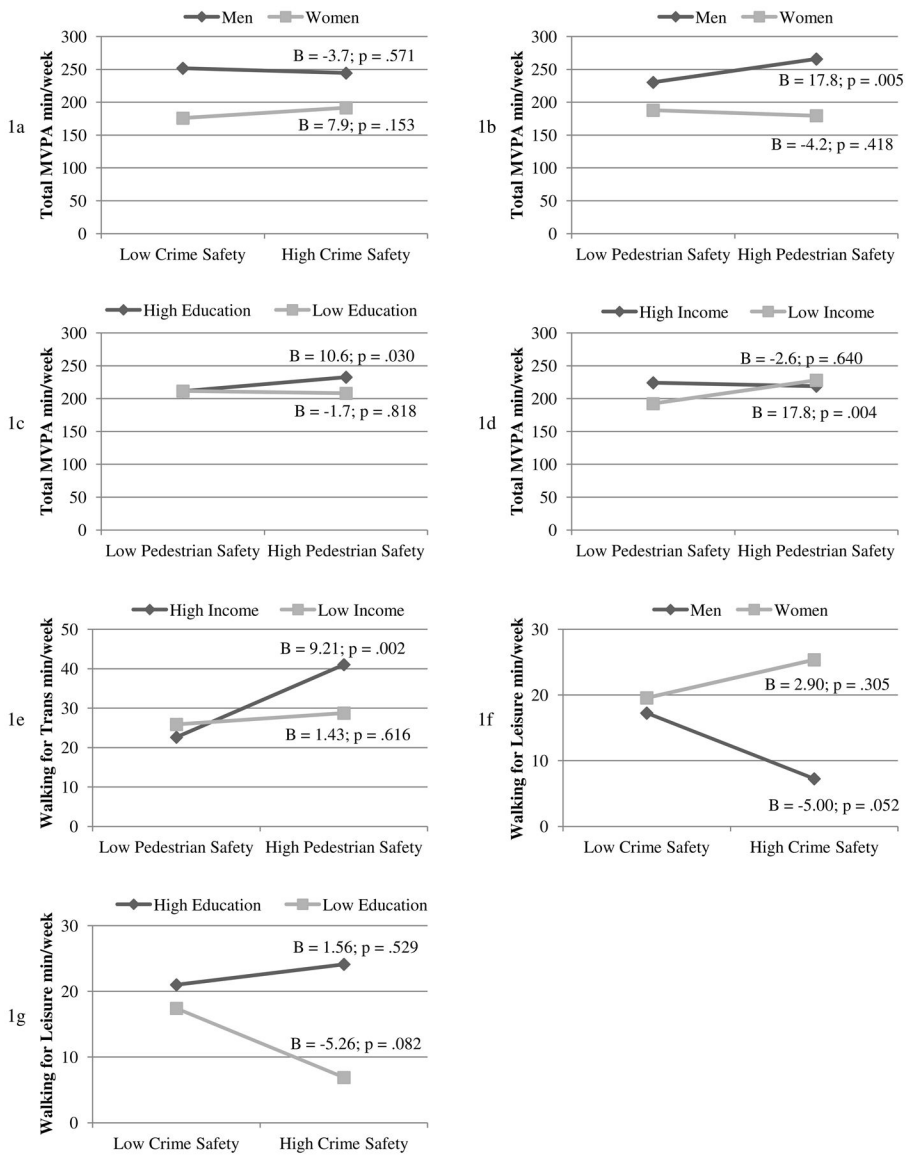

Figure 1.

Follow up tests for interactions between demographic factors and perceived safety explaining physical activity (adults). [The “low” category was plotted at -1 standard deviation from the mean and the “high” category was plotted at +1 standard deviation from mean for each independent variable. Unstandardized coefficients (Bs) represent minutes/day of physical activity for a 1 standard deviation change in the independent variable (i.e., multiplying the B by two provides the difference in minutes/day of physical activity between the low and high categories).]

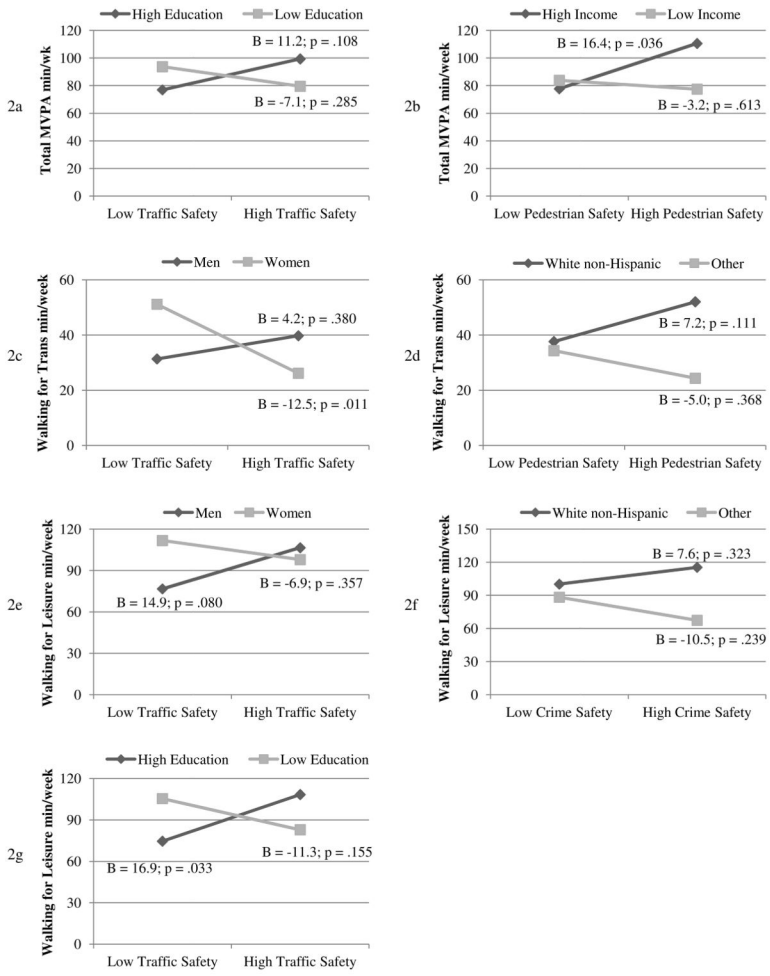

Figure 2.

Follow up tests for interactions between demographic factors and perceived safety explaining physical activity (older adults). [The “low” category was plotted at −1 standard deviation from the mean and the “high” category was plotted at +1 standard deviation from mean for each independent variable. Unstandardized coefficients (Bs) represent minutes/day of physical activity for a 1 standard deviation change in the independent variable (i.e., multiplying the B by two provides the difference in minutes/day of physical activity between the low and high categories).]