Physical activity mediates the relationship between perceived crime safety and obesity

Barbara B. Brown[a]

Carol M. Werner[b]

Ken R. Smith[c]

Calvin P. Tribby[d]

Harvey J. Miller[d]

[a] Department of Family and Consumer Studies; Cancer Control and Population Sciences, Huntsman Cancer Institute, 225 S 1400 E RM 228, University of Utah, Salt Lake City, UT

[b] Professor, Department of Psychology, 380 S. 1530 E., RM 502 BSB, University of Utah, Salt Lake City, UT
[c] Professor, Department of Family & Consumer Studies; Cancer Control and Population Sciences, Huntsman Cancer Institute; 225 S 1400 E RM 228, University of Utah, Salt Lake City, UT.
[d] Department of Geography; University of Utah. Present address 1036 Derby Hall, 154 N. Oval Mall, The Ohio State University, Columbus, OH, USA
[e] Department of Family & Consumer Studies, 225 S 1400 E RM 228, University of Utah, Salt Lake City, UT.

Funding. The project described was supported (in part) by grant number CA157509 from the National Cancer Institute at the National Institutes of Health and the Robert Wood Johnson Foundation.

Conflict of Interest. The authors declare there is no conflict of interest.

Word count text: 2781 (of 2800)

Word count abstract: 199 (of 200)

UU IR Author Manuscript

Physical activity mediates the relationship between perceived crime safety and obesity

Abstract

Objective. The current cross-sectional study tests whether low perceived crime safety is associated with body mass index (BMI) and obesity risk and whether less moderate-to-vigorous physical activity (MVPA) accounts for part of this relationship.

Method. Adults (n=864) from a relatively low-income and ethnically mixed neighborhood in Salt Lake City UT (2012) were assessed for perceived crime safety, objective physical activity, and BMI measures.

Results. This neighborhood had lower perceived safety than for other published studies utilizing this safety measure. In a mediation test, lower perceived crime safety was significantly associated with higher BMI and greater risk of obesity, net of control variables. Residents with lower perceived safety had less MVPA. Lower MVPA partially explained the relationship between less safety and both elevated BMI and higher obesity risk, suggesting that perceiving less crime safety limits MVPA which, in turn, increases weight.

Conclusion. In this neighborhood, with relatively low perceived safety from crime, residents' low perceived safety related to more obesity and higher BMI; lower MVPA among residents explained part of this relationship. If residents are to become more active in their neighborhood it may be important to address perceived crime safety as part of broader efforts to enhance active living.

UU IR Author Manuscript

UU IR Author Manuscript

1. Introduction

Does low perceived safety from crime relate to lower physical activity and greater obesity risk? Although past research has focused on perceived safety from crime and self-reported physical activity, few studies have examined objective levels of physical activity. Furthermore, few studies test whether low perceived safety might relate to lower objectively measured physical activity, a known obesity risk.

The idea that low perceived crime safety might reduce one's activities in the neighborhood was proposed long ago (Skogan and Maxfield, 1981), but the research evidence is surprisingly inconclusive. One review found that more perceived personal safety related to more walking in six studies, but no such relationship was found in ten studies (Saelens and Handy, 2008). A more comprehensive review of the relationship between safety and constrained physical activity revealed 41 published papers by mid-2007 (Foster and Giles-Corti, 2008). The authors concluded that "there is insufficient evidence to conclude that crime-related safety influences PA" (p. 249). Specifically, they reported that, in 17 studies of adults, higher perceptions of crime problems (e.g., fear, risk) were associated with lower levels of reported PA (Booth et al., 2000; Carnegie et al., 2002; De Bourdeaudhuij et al., 2003; Eyler et al., 2003; Foster et al., 2004; Giles-Corti and Donovan, 2002; Harrison et al., 2007; Hooker et al., 2005; Li et al., 2005; Mota et al., 2007; Piro et al., 2006; Ross, 2000; Shenassa et al., 2006; Vest and AM, 2005; Weinstein et al., 1999; Wilbur et al., 2003a; Wilcox et al., 2003). However, no significant relationships were reported in 16 studies (Ainsworth et al., 2003; Ball et al., 2007; Brownson et al., 2001; Duncan and Mummery, 2005; Evenson et al., 2003; Hoehner et al., 2005; Huston et al., 2003; King et al., 2000; Lim and Taylor, 2005; Parks et al., 2003; Sallis et al., 1997; Troped et al., 2003; Voorhees and Young, 2003; Wilbur et al., 2003b; Wilcox et al., 2000; Young and Voorhees, 2003). The remaining eight studies were not relevant due to the use of multi-item composites that conflated crime concern with other concepts, such as perceived traffic problems, or due to the use of objective measures of crime, not perceived crime safety. Foster and Giles-Corti and others (Loukaitou-Sideris, 2006) recommended that PA researchers should avoid measures that specify broader safety concerns and employ measures that specify that low perceived crime safety discourages walking. The current study follows this recommendation by measuring perceived crime safety concerns that discourage walking in one's neighborhood, given that most adults achieve much of their healthy physical activity through neighborhood walks (Giles-Corti and Donovan, 2003; Mathews et al., 2009).

Few studies of crime safety and walking include objective PA measures. Recent research has shown that self-reports of achieving sufficient physical activity are ten times as high as accelerometer-measures of sufficient physical activity (Troiano et al., 2008). Thus it is also important to use objective accelerometer measures of MVPA, which two recent studies do. A study of Shanghai parents found no relationship between perceived crime safety and MVPA (Zhou et al., 2013). A study of older adults (mean age 64) in Wisconsin also showed no significant relations between perceived crime safety and accelerometer-measured PA (Strath et al., 2012). These limited findings may not generalize to other adult populations in the US.

Although the implicit assumption behind many studies is that low perceived crime safety will discourage MVPA, which will relate to increased obesity risk, few studies test whether safety relates to obesity or whether MVPA mediates the relationship between safety and obesity. Some studies find a direct relationship between low perceived crime safety and obesity (Burdette and Hill, 2008; Christian et al., 2011) and some do not (Roman et al., 2009).

A few tests of mediation that rely on self-reported PA have yielded mixed results. A large study of English adults reported that both fewer perceived social nuisances (e.g., teens hanging out and graffiti)

and more self-reported walking related to lower self-reported obesity risk, but walking did not mediate the nuisance-to-obesity relationship (Poortinga, 2006). Contrary to expectations, adults who perceived vandalism, graffiti, and damage to property in the neighborhood were *more* likely to report achieving recommended PA (≥30 minutes of activity, 5 days/week), perhaps because they were more aware of nuisances (Duncan and Mummery, 2005). Obesity levels were fairly low by US standards (20.4%), suggesting a need to test these relationships for other samples. In contrast, a study of Chicago adults revealed no direct relationship between fear of walking and self-reported obesity, nor any evidence of mediation through self-reported PA (Roman et al., 2009). A study in Nigeria found that self-reported "sufficient" walking (i.e., >150 minutes/week), sufficient MVPA, and total physical activity mediated the relationship between perceived low safety for walking at night and measured BMI; however, mediation was insignificant for perceived safety of walking during the day (Oyeyemi et al., 2012). A study of residents from Scotland and England showed perceived neighborhood disorder was unrelated to objectively measured BMI, but that disorder was linked to BMI through higher area-level (not individual-level) sports participation (Stafford et al., 2007). In light of the absence of objective MVPA, the scarcity of BMI measures, the relatively low rates of overweight/obesity in Nigeria and England, the use of general perceived safety measures that are not tied to walking, and other unique features of these samples, more testing of potential mediational relationships in US samples is warranted.

The current study addresses possible mediation for the perceived crime safety subscale from the Neighborhood Environment Walkability Scale (NEWS). This subscale is designed to measure crime safety conditions relevant to walking and thereby may overcome the limitations noted by Foster and Giles-Corti (2008). Furthermore, both BMI and MVPA are objectively measured. The expectation is that lower perceived safety from crime relates to higher weight outcomes and that lower amounts of MVPA mediate this relationship.

2. Methods

2.1 Area and participants.

Participants were sampled from those living Near (<1k) and Far (1-2km) from an impending Complete Street renovation that entailed new light rail, sidewalks, and bike paths. These alterations were planned for the center of the 2km by 4.5km target neighborhood, which had 11,197 addresses. This area included a range of housing—downtown condos, apartment complexes, mobile home communities, and generally modest single family detached housing—as well as a number of businesses; it includes a relatively low-income and ethnically diverse population. Census data (2010) and American Community Survey (2012) data from the three zip codes that encompass most of the study area show between 52% and 89% white, 7% and 52% Hispanic, and with median household incomes between $39,002 and $51,047 (U.S. median was $53,046 in 2012).

Participants received letters inviting them to the study and research assistants (RAs) followed up with door-to-door recruitment, where allowed. Community outreach events and media efforts were held to familiarize the neighborhood with the study; a number of residents volunteered to be in the study from these efforts and were accepted if their address had been selected to be in the sample. Within-household selection of participants was random if one or two adults were eligible. If three or more adults were eligible, RAs prioritized selection to invite first the youngest eligible male then, if needed, the oldest available female (Hill et al., 1999). Some participants (21.3%) volunteered when the within household selection method did not select them; they were accepted into the study but were coded as alternates in keeping with practices in similar studies (Oakes et al., 2008). Alternates were more likely to be female (61.50% vs. 51.90%), younger (37.64 vs. 40.45 years), and married (53.57% vs. 38.13%) than randomly selected within household residents (logistic regression predicting alternates: Nagelkerke $R^2 = .045$).

UU IR Author Manuscript

Eligible participants were Spanish or English speakers, aged ≥18, who were not pregnant and who planned to reside within their target neighborhood for another year. They needed to be able to walk a few blocks, complete surveys, and wear accelerometers and GPS loggers. Accelerometer wear requirements were ≥3 days of ≥10-hours per day (Trost et al., 2005). Among the 1015 participants who completed some or all of the introductory survey, 41 dropped out without wearing the accelerometers and 62 had insufficient accelerometer wear time; 2 others were withdrawn for technical and eligibility problems during the participation week. Specifically, 43.1% of non-completers (from N=102 reporting) had up to high school graduate levels compared with 32.9% of those with sufficient wear times, χ^2 (1, *N*=1027) = 4.33, *p* = .04. The resulting 910 completions yielded a 28.9% response rate based on the universe of all addresses that could be recruited (using American Association of Public Opinion Researchers response rate formula 3; this improves to 30.9% if all survey completers are included), which compares favorably to comparable studies (Oakes et al., 2008; Saelens et al., 2003).

2.2 Sampling street segments. Sampling of street segments (i.e., both sides of a block between intersections) in Near and Far areas was stratified according to the number of residences per block, given that multifamily apartment complexes might represent more walkable areas. Within strata, street segments were randomly selected.

2.3 Measures

Crime safety. The Neighborhood Environment Walkability Survey (NEWS) abbreviated scale (Cerin et al., 2009) provided three crime safety items (coefficient alpha = .77), rated on 4-point agreement scales, where high values indicate low safety. Items include: "There is a high crime rate in my neighborhood;" "The crime rate in my neighborhood makes it unsafe to go on walks during the day;" and "at night."

Control variables. Female gender (1=female, 0 = male), age (in years), white race (1= yes, 0 = else), and children in the household (1 = yes, 0 = no children in household) were the socio-demographic controls (Scarborough et al., 2010). Crime indicator cues, from a walkability audit of the respondent's home block street segment (interrater *r* = .67), were adapted from the Irvine Minnesota Inventory (Boarnet et al., 2006) subscale on crime cues. The 19-item audit subscale includes items such as abandoned buildings, bars on windows, graffiti, and litter; it augmented the original subscale by adding two global questions for auditors to see how safe they would feel walking on the segment during the day and at night; subscale scores were Winsorized z-scores (with subscale means ranging from -.78 to .55, with higher values indicating more safety cues).

Physical activity. Accelerometers (Actigraph GT3X+) measured moderate-to-vigorous physical activity, using a 2020 counts per minute threshold (Troiano et al., 2008) and calculated for MVPA minutes per 10-hours of accelerometer wear.

Weight measures. Height and weight were measured during interviews using stadiometers and calibrated scales (Road Rod and Healthometer349, respectively). BMI was calculated as weight (lb) / inches^2 x 703 and obesity as >30 BMI. Underweight (<18.5 BMI) individuals (n= 17) were excluded. Listwise deletion was used for missing data, because of low levels of missing data (n=29); the final sample size was 864.

2.4 Statistical analyses

Regression tests of BMI and logistic regressions on obesity were conducted with SAS 9.3, using stratification weights. Mediation tests used the Freedman and Schatzkin test of differences in coefficients produced when MVPA was added to the model (Freedman and Schatzkin, 1992; MacKinnon

et al., 2002). Preliminary analyses demonstrated that controls for clustering by census block and for random selection within household did not alter significant relationships; thus, the simpler models are presented. In addition, we explored the possibility that gender might moderate the effects, given that women sometimes report greater fear of crime associated with outdoor walking (Roman and Chalfin, 2008), but no moderation tests were significant.

3. Results

As shown in Table 1, participants averaged 21 MVPA minutes for each 10 hours they wore the accelerometer. Body mass index averaged 29, which is in the overweight category, and 37% of the sample was obese.

The test of mediation involves two essential steps. Step 1 estimates the relationship between perceived crime safety and obesity, net of control variables. Step 2 estimates whether the Step 1 relationships diminish significantly after adding the proposed mediator, MVPA, to the model. Although a significant direct relationship between perceived safety and MVPA is not required for mediation to exist (Hayes, 2008), the relationship was significant in this model (Pearson r = -.10, p = .002).

The results of the mediation test were significant. For the BMI outcome, higher BMIs were associated with higher fear of crime, as shown in Step 1 of Table 2. The coefficient for perceived safety diminished significantly when MVPA was added to the equation in Step 2; Freedman-Schatzkin t (862) = 2.32, p = .02. The control variables from Step 1 demonstrated that older individuals and those with children in the home had higher BMIs.

In Table 3, with obesity as the outcome, the coefficient for perceived crime safety diminished significantly when MVPA was added to the equation in Step 2; Freedman-Schatzkin t (862) = 3.29, p = .001. The control variables from Step 1 showed that older individuals and females were more likely to be obese and that white individuals were less likely to be obese.

4. Discussion

As hypothesized, less perceived safety from crime related to higher risks of obesity and higher levels of BMI. In both models MVPA partially and significantly mediated the relationship between perceived safety and obesity. The results were consistent with the conceptual model that posits low perceived safety from crime to be associated with lower MVPA, which in turn relates to BMI and obesity risk.

These results emerged even after controlling for crime cues visible at the block segment level. That is, the indicators of graffiti and unkempt conditions that were audited on residents' street segments did not relate significantly to either MVPA or weight outcomes. Nevertheless, residents with lower perceived safety lived on blocks with more crime cues, r = -.10, p = .003. This demonstrates that lower perceived safety was associated with objectively measured physical conditions in the neighborhood (e.g., graffiti). Actions to enhance perceived safety in the neighborhood might involve interventions that deal with perceived safety, actual neighborhood conditions, and crime itself. Perceived safety may be addressed directly with interventions that enhance neighborhood cohesion and trust (Lorenc et al., 2012); physical improvements, such as neighborhood upkeep and defensible space (Brown and Altman, 1983; Brown et al., 2004; Lorenc et al., 2013) or walkability supports (Foster et al., 2010).

Past research has shown mixed relationships between perceived crime safety and physical activity and few studies have used objective accelerometer data or tested the relationship between perceived safety and obesity. The significant relationships in the current study may derive from the use of objective

measures as well as the relevance of safety in the target neighborhood. The average score on the NEWS crime safety measure of 2.15 (SD .75 on a 1-4 scale, where 4= low perceived safety) indicates less perceived crime safety than the same measures reported for adult samples in Seattle, Baltimore, Adelaide, and Ghent (Ms = .6, .6, 1.0, and .9, respectively; with higher scores representing lower perceived safety) (Van Dyck et al., 2012). Perceived safety may be more important to decisions to be active in this particular neighborhood than in neighborhoods where safety is not as salient. Residents of low-income neighborhoods walk more for transportation purposes (Hoehner et al., 2005) and engage in more active transportation (Yang et al., 2011). Thus it will be important in future research to examine whether low-income areas with low perceived safety have lower levels of physical activity, such as was found in the present study. In a social ecological model of walking, a sense of safety, along with accessibility and feasibility of walking, are considered to be more important prerequisites for walking than perceptions of comfort and pleasantness (Alfonzo, 2005).

Study strengths and limitations. Although linkages among perceived safety from crime, physical activity, and BMI are often hypothesized, few studies test mediation models with objective measures. However, the study is limited by the reliance on cross-sectional data; longitudinal data would provide more conclusive results. Finally, the data set provided few potential mediators, beyond MVPA, that might explain the relationship between safety and weight outcomes. Perhaps stress or stress-related overeating might be worth exploring in the future as additional mediators (Burdette and Hill, 2008; Stafford et al., 2007).

5. Conclusion

Crime safety deserves research attention as it relates to both MVPA and obesity. The target neighborhood had lower levels of perceived crime safety than reported in other studies that used the same measures. It is possible that the relatively low levels of perceived crime safety in the target neighborhood yielded relatively strong relationships among perceived crime safety, MVPA, and BMI. For health outcomes in neighborhoods with high levels of obesity and low perceived crime safety, interventions to increase physical activity may have to address ways to increase perceived crime safety.

UU IR Author Manuscript

References

Ainsworth, B.E., Wilcox, S., Thompson, W.W., Richter, D.L., Henderson, K.A., 2003. Personal, social, and physical environmental correlates of physical activity in African-American women in South Carolina. American Journal of Preventive Medicine 25:23-29.
Alfonzo, M.A., 2005. To walk or not to walk? The hierarchy of walking needs. Environ. Beha. 37:808-36.
Ball, K., Timperio, A., Salmon, J., Giles-Corti, B., Roberts, R., Crawford, D., 2007. Personal, social and environmental determinants of educational inequalities in walking: A multilevel study. Journal of Epidemiology and Community Health 61:108-14.
Boarnet, M.G., Day, K., Alfonzo, M., Forsyth, A., Oakes, M., 2006. The Irvine-Minnesota Inventory to measure built environments: Reliability tests. Am. J. Prev. Med. 30:153-59.
Booth, M.L., Owen, N., Bauman, A., Clavisi, O., Leslie, E., 2000. Social-cognitive and perceived environment influences associated with physical activity in older Australians. Preventive Medicine 31:15-22.
Brown, B.B., Altman, I., 1983. Territoriality, defensible space and residential burglary: An environmental analysis. J. Environ. Psychol. 3:203-20.
Brown, B.B., Perkins, D.D., Brown, G., 2004. Crime, new housing, and housing incivilities in a first-ring suburb: Multilevel relationships across time. Hous. Policy Debate 15:301-45.
Brownson, R.C., Baker, E.A., Housemann, R.A., Brennan, L.K., Bacak, S.J., 2001. Environmental and policy determinants of physical activity in the United States. American Journal of Public Health 91:1995-2003.
Burdette, A.M., Hill, T.D., 2008. An examination of processes linking perceived neighborhood disorder and obesity. Soc. Sci. Med. 67:38-46.
Carnegie, M.A., Bauman, A., Marshall, A.L., Mohsin, M., Westley-Wise, V., Booth, M.L., 2002. Perceptions of the physical environment, stage of change for physical activity, and walking among Australian adults. Research Quarterly for Exercise and Sport 73:146-55.
Cerin, E., Conway, T.L., Saelens, B.E., Frank, L.D., Sallis, J.F., 2009. Cross-validation of the factorial structure of the Neighborhood Environment Walkability Scale (NEWS) and its abbreviated form (NEWS-A). Int J Behav Nutr Phys Act 6:32.
Christian, H., Giles-Corti, B., Knuiman, M., Timperio, A., Foster, S., 2011. The influence of the built environment, social environment and health behaviors on body mass index. Results from RESIDE. Preventive Medicine 53:57-60.
De Bourdeaudhuij, I., Sallis, J.F., Saelens, B.E., 2003. Environmental correlates of physical activity in a sample of Belgian adults. American Journal of Health Promotion 18:83-92.
Duncan, M., Mummery, K., 2005. Psychosocial and environmental factors associated with physical activity among city dwellers in regional Queensland. Preventive Medicine 40:363-72.
Evenson, K.R., Sarmiento, O.L., Tawney, K.W., Macon, M.L., Ammerman, A.S., 2003. Personal, social, and environmental correlates of physical activity in North Carolina Latina immigrants. American Journal of Preventive Medicine 25:77-85.
Eyler, A.A., Brownson, R.C., Bacak, S.J., Housemann, R.A., 2003. The epidemiology of walking for physical activity in the United States. Medicine and Science in Sports and Exercise 35:1529-36.
Foster, C., Hillsdon, M., Thorogood, M., 2004. Environmental perceptions and walking in English adults. Journal of Epidemiology and Community Health 58:924-28.
Foster, S., Giles-Corti, B., 2008. The built environment, neighborhood crime and constrained physical activity: An exploration of inconsistent findings. Preventive Medicine 47:241-51.
Foster, S., Giles-Corti, B., Knuiman, M., 2010. Neighbourhood design and fear of crime: A social-ecological examination of the correlates of residents' fear in new suburban housing developments. Health and Place 16:1156-65.

Freedman, L.S., Schatzkin, A., 1992. Sample size for studying intermediate endpoints within intervention trails or observational studies. Am. J. Epidemiol. 136:1149-59.
Giles-Corti, B., Donovan, R.J., 2002. Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. Preventive Medicine 35:601-11.
Giles-Corti, B., Donovan, R.J., 2003. Relative influences of individual, social environmental, and physical environmental correlates of walking. American Journal of Public Health 93:1583-89.
Harrison, R.A., Gemmell, I., Heller, R.F., 2007. The population effect of crime and neighbourhood on physical activity: An analysis of 15 461 adults. Journal of Epidemiology and Community Health 61:34-39.
Hayes, A.F., 2008. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. Guilford Press, New York.
Hill, C.A., Donelan, K., Frankel, M.R., 1999. Within-household respondent selection in an RDD telephone survey: A comparison of two methods . North Carolina: Research Triangle Insitute.
Hoehner, C.M., Brennan Ramirez, L.K., Elliott, M.B., Handy, S.L., Brownson, R.C., 2005. Perceived and objective environmental measures and physical activity among urban adults. American Journal of Preventive Medicine 28:105-16.
Hooker, S.P., Wilson, D.K., Griffin, S.F., Ainsworth, B.E., 2005. Perceptions of environmental supports for physical activity in African American and white adults in a rural county in South Carolina. Preventing chronic disease [electronic resource]. 2.
Huston, S.L., Evenson, K.R., Bors, P., Gizlice, Z., 2003. Neighborhood environment, access to places for activity, and leisure-time physical activity in a diverse North Carolina population. American Journal of Health Promotion 18:58-69.
King, A.C., Castro, C., Wilcox, S., Eyler, A.A., Sallis, J.F., Brownson, R.C., 2000. Personal and environmental factors associated with physical inactivity among different racial - Ethnic groups of U.S. middle-aged and older-aged women. Health Psychology 19:354-64.
Li, F., Fisher, K.J., Brownson, R.C., Bosworth, M., 2005. Multilevel modelling of built environment characteristics related to neighbourhood walking activity in older adults. Journal of Epidemiology and Community Health 59:558-64.
Lim, K., Taylor, L., 2005. Factors associated with physical activity among older people - A population-based study. Preventive Medicine 40:33-40.
Lorenc, T., Clayton, S., Neary, D., Whitehead, M., Petticrew, M., Thomson, H., Cummins, S., Sowden, A., Renton, A., 2012. Crime, fear of crime, environment, and mental health and wellbeing: Mapping review of theories and causal pathways. Health and Place 18:757-65.
Lorenc, T., Petticrew, M., Whitehead, M., Neary, D., Clayton, S., Wright, K., Thomson, H., Cummins, S., Sowden, A., et al., 2013. Environmental interventions to reduce fear of crime: systematic review of effectiveness. Systematic reviews 2:30.
Loukaitou-Sideris, A., 2006. Is it safe to walk? Neighborhood safety and security considerations and their effects on walking. Journal of Planning Literature 20:219-32.
MacKinnon, D.P., Lockwood, C.M., Hoffman, J.M., West, S.G., Sheets, V., 2002. A comparison of methods to test mediation and other intervening variable effects. Psychol. Methods 7:83-104.
Mathews, A.E., Colabianchi, N., Hutto, B., Pluto, D.M., Hooker, S.P., 2009. Pedestrian activity among California adults. J. Phys. Act. Health 6:15-23.
Mota, J., Lacerda, A., Santos, M.P., Ribeiro, J.C., Carvalho, J., 2007. Perceived neighborhood environments and physical activity in an elderly sample. Perceptual and Motor Skills 104:438-44.
Oakes, J.M., Forsyth, A., Hearst, M.O., Schmitz, K.H., 2008. Recruiting participants for neighborhood effects research: Strategies and outcomes of the Twin Cities Walking Study. Environ. Beha. 41:787-805.
Oyeyemi, A.L., Adegoke, B.O., Sallis, J.F., Oyeyemi, A.Y., De Bourdeaudhuij, I., 2012. Perceived crime and traffic safety is related to physical activity among adults in Nigeria. BMC Public Health 12.

Parks, S.E., Housemann, R.A., Brownson, R.C., 2003. Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. Journal of Epidemiology and Community Health 57:29-35.
Piro, F.N., Nœss, Ø., Claussen, B., 2006. Physical activity among elderly people in a city population: The influence of neighbourhood level violence and self perceived safety. Journal of Epidemiology and Community Health 60:626-32.
Poortinga, W., 2006. Perceptions of the environment, physical activity, and obesity. Social Science and Medicine 63:2835-46.
Roman, C.G., Chalfin, A., 2008. Fear of Walking Outdoors. A Multilevel Ecologic Analysis of Crime and Disorder. American Journal of Preventive Medicine 34:306-12.
Roman, C.G., Knight, C.R., Chalfin, A., Popkin, S.J., 2009. The relation of the perceived environment to fear, physical activity, and health in public housing developments: evidence from Chicago. Journal of public health policy 30 Suppl 1:S286-308.
Ross, C.E., 2000. Walking, exercising, and smoking: Does neighborhood matter? Social Science and Medicine 51:265-74.
Saelens, B.E., Handy, S.L., 2008. Built environment correlates of walking: A review. Medicine and Science in Sports and Exercise 40:S550-S66.
Saelens, B.E., Sallis, J.F., Black, J.B., Chen, D., 2003. Neighborhood-based differences in physical activity: an environment scale evaluation. American Journal of Public Health 93:1552-58.
Sallis, J.F., Johnson, M.F., Calfas, K.J., Caparosa, S., Nichols, J.F., 1997. Assessing Perceived Physical Environmental Variables That May Influence Physical Activity. Research Quarterly for Exercise and Sport 68:345-51.
Scarborough, B.K., Like-Haislip, T.Z., Novak, K.J., Lucas, W.L., Alarid, L.F., 2010. Assessing the relationship between individual characteristics, neighborhood context, and fear of crime. Journal of Criminal Justice 38:819-26.
Shenassa, E.D., Liebhaber, A., Ezeamama, A., 2006. Perceived safety of area of residence and exercise: A pan-European study. American Journal of Epidemiology 163:1012-17.
Skogan, W.G., Maxfield, M.G., 1981. Coping with crime: Individual and neighborhood reactions. Sage Publications Beverly Hills, CA.
Stafford, M., Cummins, S., Ellaway, A., Sacker, A., Wiggins, R.D., Macintyre, S., 2007. Pathways to obesity: Identifying local, modifiable determinants of physical activity and diet. Soc. Sci. Med. 65:1882-97.
Strath, S.J., Greenwald, M.J., Isaacs, R., Hart, T.L., Lenz, E.K., Dondzila, C.J., Swartz, A.M., 2012. Measured and perceived environmental characteristics are related to accelerometer defined physical activity in older adults. International Journal of Behavioral Nutrition and Physical Activity 9.
Troiano, R.P., Berrigan, D., Dodd, K.W., Mâsse, L.C., Tilert, T., McDowell, M., 2008. Physical activity in the United States measured by accelerometer. Med. Sci. Sports Exerc. 40:181-88.
Troped, P.J., Saunders, R.P., Pate, R.R., Reininger, B., Addy, C.L., 2003. Correlates of recreational and transportation physical activity among adults in a New England community. Preventive Medicine 37:304-10.
Trost, S.G., McIver, K.L., Pate, R.R., 2005. Conducting accelerometer-based activity assessments in field-based research. Med. Sci. Sports Exerc. 37:S531-S43.
Van Dyck, D., Cerin, E., Conway, T.L., De Bourdeaudhuij, I., Owen, N., Kerr, J., Cardon, G., Frank, L.D., Saelens, B.E., et al., 2012. Perceived neighborhood environmental attributes associated with adults' transport-related walking and cycling: Findings from the USA, Australia and Belgium. International Journal of Behavioral Nutrition and Physical Activity 9.
Vest, J., AM, V., 2005. Perceptions of neighborhood characteristics and leisure-time physical inactivity - Austin/Travis County, Texas, 2004. Morbidity and Mortality Weekly Report 54:926-28.

Voorhees, C.C., Young, D.R., 2003. Personal, social, and physical environmental correlates of physical activity levels in urban Latinas. American Journal of Preventive Medicine 25:61-68.
Weinstein, A., Feigley, P., Pullen, P., Mann, L., Redman, L., 1999. Neighborhood safety and the prevalence of physical inactivity - Selected states, 1996. Journal of the American Medical Association 281:1373.
Wilbur, J., Chandler, P.J., Dancy, B., Lee, H., 2003a. Correlates of physical activity in urban Midwestern African-American women. American Journal of Preventive Medicine 25:45-52.
Wilbur, J., Chandler, P.J., Dancy, B., Lee, H., 2003b. Correlates of physical activity in urban Midwestern Latinas. American Journal of Preventive Medicine 25:69-76.
Wilcox, S., Bopp, M., Oberrecht, L., Kammermann, S.K., McElmurray, C.T., 2003. Psychosocial and perceived environmental correlates of physical activity in rural and older African American and white women. Journals of Gerontology - Series B Psychological Sciences and Social Sciences 58:P329-P37.
Wilcox, S., Castro, C., King, A.C., Housemann, R., Brownson, R.C., 2000. Determinants of leisure time physical activity in rural compared with urban older and ethnically diverse women in the United States. Journal of Epidemiology and Community Health 54:667-72.
Yang, Y., Diez Roux, A.V., Bingham, C.R., 2011. Variability and seasonality of active transportation in USA: Evidence from the 2001 NHTS. Int. J .Behav. Nutr. Phys. Act. 8.
Young, D.R., Voorhees, C.C., 2003. Personal, social, and environmental correlates of physical activity in urban African-American women. American Journal of Preventive Medicine 25:38-44.
Zhou, R., Li, Y., Umezaki, M., Ding, Y., Jiang, H., Comber, A., Fu, H., 2013. Association between physical activity and neighborhood environment among middle-aged adults in Shanghai. Journal of Environmental and Public Health 2013.

Table 1
Descriptive statistics

	M or proportion	SD
Control variables		
Female (proportion)	0.53	0.50
Age (mean, in years)	39.82	14.83
White race (proportion)	0.64	0.48
Children in household (proportion)	0.38	0.49
Crime cues walkability audit (z-score mean)	0.053	0.274
Perceived safety from crime (mean, 1-4 scale, high values = low safety)	2.14	0.751
Moderate-to-vigorous physical activity (mean minutes/10 hours accelerometer wear)	21.08	18.51
Body mass index (mean)	28.98	7.03
Obesity (proportion)	0.37	0.48

Data collected in Salt Lake City, UT, 2012

Table 2
Test of MVPA mediating the association between perceived fear of crime safety and BMI

	Step 1: Direct relationship			Step 2: Mediation	
Variable	*Estimate*	*SE*	*p*	*Estimate*	*SE*
Intercept	23.89	0.94***	***	25.31	1.04***
Control variables					
Female	0.38	0.46		0.05	0.49
Age	0.09	0.02***	***	0.08	0.02***
White race	-0.96	0.49		-1.03	0.49*
Children in household	1.25	0.50**	**	1.13	0.51*
Crime cues walkability audit	-1.27	0.82		-1.25	0.82
Perceived safety from crime (high value = low perceived safety)	0.80	0.30**	**	0.72	0.30*
MVPA (minutes/10 hours)	--	--		-0.03	0.01**
R^2		0.064			0.072

*** $p <$ .001, ** $p <$ .01, *$p <$ .05
Data collected in Salt Lake City, UT, 2012

Table 3
Test of MVPA mediating the association between perceived fear of crime safety and obesity: Odds ratios and 95% CIs

	Step 1: Direct relationship				Step 2: Mediation			
		Confidence Intervals				Confidence Intervals		
Variable	Estimate	Lower	Upper	*p*	Estimate	Lower	Upper	*p*
Control variables								
Female	1.36	1.01	1.82	*	1.17	0.86	1.60	
Age	1.03	1.02	1.04	***	1.02	1.01	1.03	***
White race	0.65	0.48	0.89	**	0.63	0.46	0.86	**
Children in household	1.23	0.90	1.69		1.18	0.86	1.61	
Crime cues walkability audit	0.96	0.57	1.62		0.97	0.57	1.66	
Perceived safety from crime (high value = low perceived safety)	1.27	1.05	1.54	*	1.23	1.01	1.50	*
MVPA (minutes/10 hours)					0.98	0.98	0.99	***
R^2 (max rescaled)			0.074				0.093	

Note. MVPA = moderate-to-vigorous physical activity; CI = confidence interval
*** $p <$ .001, ** $p <$ .01, *$p <$ .05
Data collected in Salt Lake City, UT, 2012

UU IR Author Manuscript