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Review Article

# Crime, perceived safety, and physical activity: A meta-analysis

Erika Rees-Punia[a,*], Elizabeth D. Hathaway[b], Jennifer L. Gay[a,c]

[a] Department of Kinesiology, University of Georgia, Athens, GA, USA
[b] Department of Health and Human Performance, University of Tennessee-Chattanooga, Chattanooga, TN, USA
[c] Department of Health Promotion and Behavior, University of Georgia, Athens, GA, USA

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ABSTRACT

Perceived safety from crime and objectively-measured crime rates may be associated with physical inactivity. The purpose of this meta-analysis is to estimate the odds of accumulating high levels of physical activity (PA) when the perception of safety from crime is high and when objectively-measured crime is high. Peer-reviewed studies were identified through PubMed, Web of Science, ProQuest Criminal Justice, and ScienceDirect from earliest record through 2016. Included studies measured total PA, leisure-time PA, or walking in addition to perceived safety from crime or objective measures of crime. Mean odds ratios were aggregated with random effects models, and meta-regression was used to examine effects of potential moderators: country, age, and crime/PA measure. Sixteen cross-sectional studies yielded sixteen effects for perceived safety from crime and four effects for objective crime. Those reporting feeling safe from crime had a 27% greater odds of achieving higher levels of physical activity (OR = 1.27 [1.08, 1.49]), and those living in areas with higher objectively-measured crime had a 28% reduced odds of achieving higher levels of physical activity (OR = 0.72 [0.61, 0.83]). Effects of perceived safety were highly heterogeneous ($I^2$ = 94.09%), but explored moderators were not statistically significant, likely because of the small sample size. Despite the limited number of effects suitable for aggregation, the mean association between perceived safety and PA was significant. As it seems likely that perceived lack of safety from crime constrains PA behaviors, future research exploring moderators of this association may help guide public health recommendations and interventions.

## 1. Introduction

Physical inactivity is a global public health problem associated with billions of dollars in healthcare costs and millions of premature deaths each year.(Ding et al., 2016; Lee et al., 2012) Inactive populations perceive various barriers to physical activity (PA), many of which involve aspects of the physical or social environment.(Brownson et al., 2001; Seefeldt et al., 2002) Features of the neighborhood environment consistently associated with lower levels of PA include sidewalk inaccessibility and perceived traffic risks.(Duncan et al., 2005) Although perceived lack of safety from crime is often cited as a barrier to PA in qualitative studies, quantitative studies assessing this association are inconsistent.(Gallagher et al., 2010; Foster and Giles-Corti, 2008; Carver et al., 2008; Loukaitou-Sideris, 2006; Ries et al., 2008; Van Cauwenberg et al., 2012; Marquez et al., 2016)

Neighborhood crime frequently is assessed as perceived safety from crime. Objective measures of crime (e.g., police-reported crime rates), are less common in PA studies. While related, it is possible that the two measures assess different constructs, and therefore should be considered independently.(McGinn et al., 2007; Orstad et al., 2016) The effects of both measures on PA have been explored with varied results, not only between perceived safety from crime and objective crime data, but across study samples. It is likely that sample characteristics impact the direction and magnitude of the association. For example, specific demographic groups, such as women, older adults, racial/ethnic minorities, and lower socio-economic populations may feel more vulnerable to crime, and may therefore perceive themselves as less safe while being active in crime-prone areas.(Foster and Giles-Corti, 2008; Hale, 1996)

Although there are reviews exploring the effect of crime on PA, a formal meta-analysis has not been conducted to date.(Foster and Giles-Corti, 2008; Carver et al., 2008) As prior reviews and studies present conflicting results, the purpose of this meta-analysis is to estimate the odds of accumulating high levels of PA when the perception of safety from crime is high and when objectively-measured crime rate is high, and to explore the role of potential moderators in peer-reviewed cross-sectional studies. We hypothesized that low perceptions of safety and high reported crime would be associated with lower levels of physical

* Corresponding author at: Dept. of Kinesiology, University of Georgia, 330 River Rd., Athens, GA 30602, USA.
*E-mail address:* Erika.rees25@uga.edu (E. Rees-Punia).

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activity, especially among youth and those living in low- or middle-income countries.

## 2. Methods

### 2.1. Study search

This review was conducted in accordance with MOOSE (Meta-analysis Of Observational Studies in Epidemiology) guidelines.(Stroup et al., 2000) Peer-reviewed articles published prior to December 31st, 2016 were located by investigators through searches of PubMed, Web of Science, ProQuest Criminal Justice, and ScienceDirect databases using the search terms *exercise, walking,* or *physical activity* plus one or more of the following: *crime, safe*(*ty*), *violence*, and/or *Neighbourhood Environment Walkability Scale* (*NEWS*).(Saelens et al., 2003) Authors removed duplicate publications and manually searched reference lists for publications not discovered in database searches.

### 2.2. Study selection

Included articles were peer-reviewed and available in English. Articles reporting associations for the most comparable and commonly cited measures of total PA, leisure-time PA, or walking, as well as perceived safety from crime or objective measures of crime were considered for inclusion. Studies with restrictive PA outcomes, such as biking for transportation, occupational physical activity, or park usage, were excluded from analyses as they were not comparable with total PA, leisure-time PA, or walking. Studies evaluating associations between crime/safety from crime and PA self-efficacy or independent mobility were similarly excluded. As crime, particularly crime against persons or violent crime, was the focus of this analysis, studies explicitly exploring other types of perceived safety (i.e., traffic safety) were excluded. Studies reporting associations of crime safety/objectively-measured crime and PA alongside other aspects of the social or physical environment were considered for inclusion, so long as the effect of crime/crime safety could be isolated.

Of the 677 articles initially identified, 252 duplicate articles and 323 articles failing to meet inclusion criteria based on the abstract were removed, leaving 102 publications that were further considered for inclusion in the analysis. Included studies reported sufficient details for the calculation of odds ratios, as effect sizes are only suitable for aggregation if in similar statistical form.(Lipsey and Wilson, 2001) Adjustments for confounders differed considerably across included studies, therefore only crude (i.e., unadjusted) odds ratios (OR) and 95% confidence intervals (CI) were analyzed as an attempt to preserve the homogeneity of results. If other summary statistics were reported, or if a study had insufficient information to calculate the effect size, the corresponding author was contacted and asked to provide the crude OR for the association of interest. A flowchart of publication selection is provided in Fig. 1.

### 2.3. Effect size calculation

Two authors (E.R-P. and E.D.H.) independently extracted all data and adjudicated discrepancies prior to aggregation. Included effects represent the unadjusted odds of higher PA accumulation (vs. lower) when higher perceived safety from crime (vs. lower) is reported, and the unadjusted odds of higher PA (vs. lower) with higher levels of police-reported crime against persons or police-reported violent crime (vs. lower). When studies reported safety from crime in tertiles ($N = 2$), results including the middle tertile were not included in the analysis, so the dichotomous structure was preserved. In two instances, the reference category was opposite of that seen in other studies ($N = 2$ reported 'safe from crime' as referent where all other studies reported 'unsafe from crime' as referent), so the OR were re-calculated using the appropriate referent. To normalize the distribution of the OR and center values around one rather than zero, OR were transformed into their natural logarithms prior to aggregation.

In addition to OR and 95% CI, variables were coded as potential moderators for the perceived safety from crime analysis. Moderation analyses were limited by the relatively small number of effects ($N = 16$) and were restricted to: country of the sample, age group, safety from crime measure, and PA measure. Moderator variable codes for each study included: 1) low/middle-income country vs. high income country,(Sallis et al., 2016) 2) youth vs. adult, 3) self-reported leisure-time or total PA vs. self-reported walking vs. objectively-measured total PA, and 4) Neighbourhood Environment Walkability Scale (NEWS) crime safety subset questions vs. other questions on perceived crime safety. For the study of objectively-measured crime, the number of effects was too small, precluding a moderator analysis.

### 2.4. Statistical analysis

Variance was calculated for studies where an original 2 × 2 table was not available:

$$Variance\ OR_i = [\ln(OR_u/OR_i)/1.96]^2$$

where $OR_u$ is the upper confidence interval and $OR_i$ is the odds ratio. (Petitti, 1994) The inverse of this value was used as the weight for the mean effect size calculations.

Random effects models were used to aggregate a mean log OR and 95% CI for perceived safety from crime and objective measures of crime. Mean log OR and 95% CI were back-transformed for reporting purposes.

Heterogeneity of effects were tested with the $Q$ and $I^2$ statistics. (Higgins et al., 2003) A significant $Q$ statistic indicates heterogeneity between effects, and $I^2$ describes the percent of variability in effects due to true heterogeneity rather than sampling error.

Moderator analyses were conducted to explore the source of variability among effect sizes. Potential moderators of the association between PA and perceived safety from crime were chosen a priori. To assure systematic differences in effect size by methodological artifacts (such as exposure or outcome measure quality) were not present, moderation analyses were conducted on the various measures of PA (self-reported leisure and total PA vs. self-reported walking vs. objectively-measured total PA) as well as the various measures of perceived crime safety (Neighbourhood Environment Walkability Scale [NEWS] crime safety subset questions vs. other questions on perceived crime safety). As differences in effect sizes were expected across sub-groups, moderation was also explored by participant age group (youth vs. adults)(Hale, 1996) and country (low- and middle-income countries [India, Brazil] vs. high income countries [Belgium, Canada, England, Scotland, USA]).(Sallis et al., 2016) Mean OR and 95% CI were estimated for each level of the moderators using a random effects model, and meta-regression was used to test moderator effects.

To assess the potential influence of publication bias, the fail-safe N was estimated. The fail-safe N describes the number of unpublished null effects of average sample size necessary to diminish the significance of the mean effect.(Rosenberg, 2005) Egger's test and funnel plots (standard error plotted against effect size) were assessed to detect sample size bias.(Egger et al., 1997) A sensitivity analysis calculating the mean effect excluding all outlying effects was conducted.

All analyses were conducted using the *metafor* package for R version 3.3.2.(Viechtbauer, 2010)

## 3. Results

### 3.1. Study characteristics

Effect sizes were gathered from 16 total studies evaluating the association between PA and perceived safety from crime (16 effect sizes from 15 studies) and objectively-measured crime (4 effect sizes from 4