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Short Report

Identification of the impact of crime on physical activity depends upon neighbourhood scale: Multilevel evidence from 203,883 Australians

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ABSTRACT

Equivocal findings on crime as a deterrent for physical activity may be due to effects of geographic scale on exposure measurement. To investigate this hypothesis, physical activity was measured in 203,883 Australians and linked to standardised crime counts within small ('Census Collection Districts'; approx. 330 residents) and larger areas ('Statistical Local Areas'; approx. 32,000 residents). A median rate ratio of 2.26 indicated substantive geographic variation in moderate-to-vigorous physical activity (MVPA). Adjusting for confounders, multilevel negative binomial regression reported lower MVPA with more crime consistently in small, but not in larger areas. Reducing small pockets of local crime may encourage more physically active lifestyles.

1. Introduction

Interest in crime as a determinant of health has increased appreciably (Ball et al., 2010; Doyle et al., 2006; Foster and Giles-Corti, 2008; Gomez et al., 2004; Jackson and Stafford, 2009; Kawachi et al., 1999; Lorenc et al., 2012; Piro et al., 2006; Stafford et al., 2007; Sundquist et al., 2006; Wilkinson et al., 1998). Local crime is hypothesised to discourage participation in physical activity because of threats (whether perceived or real) to personal safety, yet the evidence accumulated to date is equivocal (Foster and Giles-Corti, 2008). Higher rates of crime have been associated with lower levels of walking and moderate-to-vigorous physical activity (MVPA) in some studies (Gomez et al., 2004; McDonald, 2008; Piro et al., 2006), but not all (Ball et al., 2010; Doyle et al., 2006).

Ball et al. (2010) considered one possible explanation for these inconsistent findings to be the issue of geographic scale, wherein larger aggregations of ecological data may hide smaller pockets of proximal crime that could have more powerful impacts on behaviour. This issue is well recognised in the geographical literature and highly related to the 'modifiable areal unit problem' (MAUP), wherein different sets of spatial boundaries used to measure the phenomena of interest (in this case, crime rates) can potentially yield different magnitudes of association (Flowerdew et al., 2008; Openshaw and Taylor, 1981). These issues continue to interest scientists engaged in a range of geographically manifesting exposures, including socioeconomic circumstances and air pollution (Halonen et al., 2013; Parenteau and Sawada, 2011; Tarkiainen et al., 2010; Thomas et al., 2006).

No study, however, has explored whether the measurement of crime at different geographic scales leads to different magnitudes of association with MVPA. Of further note, is that not all types of crime are likely deterrents of participation in physical activity, but those which occur outdoors in the neighbourhood (e.g. non-domestic violence) would likely have a stronger impact than crime which tends to occur within the household (e.g. domestic violence). In line with 'Broken Windows' theory of urban decline (Wilson and Kelling, 1982), it is also plausible that some types of crime which leave visual stimuli (e.g. malicious damage to property, such as graffiti and destruction of public facilities) provide repeatedly observable cues that serve to promote anxiety or stressful responses (Stafford et al., 2007) and reinforce discouragement of MVPA participation.

The purpose of this brief report was (i) to examine the extent to which neighbourhood crime is associated with MVPA, and (ii) to determine whether crime measured locally has a stronger impact on MVPA participation in comparison to a measure of crime which takes into account a wider geographical scope.

2. Method

2.1. Data

The 45 and Up Study (45 and Up Study Collaborators, 2008) contains health, behavioural, socioeconomic and geographical

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information on 267,072 people aged 45 years and older living in New South Wales (NSW), the most populous state in Australia. Recruitment into the 45 and Up Study was via the Medicare Australia database (the provider of universal health insurance in Australia), which was used to randomly identify potential participants. Approximately 18% self-completed a survey between 2006 and 2009. This survey contained questions on a range of health and socio-demographic information, including participation in physical activity, address, and a range of possible confounders (see below). Further detail on the 45 and Up Study is published elsewhere (45 and Up Study Collaborators, 2008). The University of New South Wales Human Research Ethics Committee approved the 45 and Up Study.

2.2. MVPA

MVPA was assessed in the questionnaire using variables derived from the Active Australia Survey (Australian Institute of Health and Welfare, 2003). The Active Australian Survey assess both frequency and duration of walking for transport and recreation and MVPA (W. Brown et al., 2004). The questions were as follows:

> How many TIMES did you do each of these activities LAST WEEK? (put "0" if you did not do this activity)
> *Vigorous physical activity* (*that made you breathe harder or puff and pant, like jogging, cycling, aerobics, competitive tennis, but not household chores or gardening*)
> *Moderate physical activity* (*like gentle swimming, social tennis, vigorous gardening or work around the house*)

This instrument has established acceptable test–retest reliability and validity in the adult Australian population, and is a useful evaluative tool for detecting physical activity behaviour change (W.J. Brown et al., 2004; Reeves et al., 2010). The separate questions on the number of times an individual participated in moderate and vigorous activities each week were summed into a single variable. Approximately 63,189 individuals had missing data and these were omitted, leaving a total of 203,883 participants for analysis.

2.3. Crime

The NSW Bureau of Crime Statistics and Research supplied crime counts the same period in which the 45 and Up Study was collected (2006–2009 inclusive), aggregated to the level of the 'Census Collection District' (CCD). CCDs were the smallest geographical areas defined by the Australian Standard Geographical Classification (ASGC) in 2006, comprising 330 residents on average (Australian Bureau of Statistics, 2012). As different types of crime could have different impacts on participation in physical activity, five types of crime counts were considered: (i) total crime; (ii) non-domestic violent assaults; (iii) break and enter; (iv) malicious damage to a property (e.g. graffiti); and (v) stealing, theft and robbery. Counts at the CCD scale were aggregated up to the level of a 'Statistical Local Area' (SLA), which had approximately 32,000 residents on average. Crime at the CCD and SLA scales was standardised per 1000 people using data from the 2006 census, sensu previous research (Ball et al., 2010). For crime measured at the CCD scale, non-zero counts were expressed in tertiles (low, moderate, high) and a fourth category was used to identify areas where no crime was reported, as exposure to even a small amount of crime may have an important impact on participation in physical activity. Therefore, this was an ordered nominal variable comprising 'none', 'low', 'moderate', and 'high' levels of local crime. No SLAs had zero crime, so crime counts measured at this scale were formatted as tertiles without the additional zero count category. Year-specific crime counts were assigned to the year in which an individual completed the 45 and Up Study baseline questionnaire.

2.4. Possible confounders

A range of individual-level socio-demographic variables were taken into account that may play an important role in determining whether a person lives in a neighbourhood with a higher crime rate. These included age, gender, marital status, weight status, psychological distress (Kessler et al., 2002), educational qualifications, annual household income, and employment status. In addition, area-level confounders also considered were neighbourhood affluence, measured using the Australian Bureau of Statistics Socio Economic Index for Areas (SEIFA) scores (Pink, 2011) and geographic remoteness (Australian Population and Migration Research Centre, 2012).

2.5. Statistical analysis

An initial logistic regression was fitted to understand correlates of having a missing outcome. Results showed participants with missing outcome data were no more or less likely to be exposed to higher levels of local crime at either the CCD or SLA scales. In contrast, women were slightly more likely to be omitted than men (Odds Ratio (OR) 1.08, 95% CI 1.06, 1.10) and older adults ($\geq$65 years) were more likely to be omitted than their younger counterparts (OR 2.43, 95% CI 2.38, 2.48). The odds of having a missing outcomes were also higher among participants with less than university-level education (OR 1.95, 95% CI 1.90, 2.00), household incomes less than $20,000 per annum (OR 1.89, 95% CI 1.84, 1.93), those not in employment (OR 1.89, 95% CI 1.86, 1.93), nor in a couple (OR 1.26, 95% CI 1.24, 1.29), at high risk of psychological distress (OR 1.42, 95% CI 1.38, 1.45), underweight versus 'normal' weight (OR 1.25, 95% CI 1.16, 1.35), not resident in the most affluent neighbourhoods (OR 1.17, 95% CI 1.14, 1.20), and living in remote communities (OR 1.12, 95% CI 1.10, 1.14).

Cross-tabulations, means and percentages were used to explore patterns between MVPA, crime and each confounder in the complete-outcome sample. Multilevel negative binomial regression models (Leyland and Goldstein, 2001) were then used to investigate and account for geographic variation in MVPA. Random intercepts were fitted for CCDs. The 203,883 participants were nested within 11,672 CCDs. To assess the extent to which MVPA participation varied between CCDs, geographic variation in an 'empty model' was expressed as the median rate ratio (MRR; calculated in the same way as the median rate ratio (Merlo et al., 2006)). An MRR larger than one indicates that the area of residence is potentially important for understanding variation in MVPA participation. Crime variables were added into separate models and adjusted sequentially for confounders. Parameters were exponentiated to rate ratios (RRs) and statistical significance was assessed using 95% confidence intervals (95% CI). Analyses were conducted in 2014 using MLwIN v2.29 (Rasbash et al., 2000).

3. Results

Table 1 shows differences in the distribution of participants according to how crime exposure was measured. Reasonably large numbers of participants lived in CCDs that did not experience crime of a particular type. Lower mean MVPA session counts were observed in areas with more crime at the CCD scale, except for non-domestic violence. By contrast, little difference in MVPA was evident when crime was measured at the SLA scale.

Logistic regression was used to assess the odds of living in a CCD with high crime for each confounder. Higher odds were found among women (OR 1.03, 95% CI 1.01, 1.05), participants aged $\geq$65 years (OR 1.06, 95% CI 1.04, 1.09), those experiencing a limiting or