

Do changes in residents' fear of crime impact their walking? Longitudinal results from RESIDE.

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Abstract

Objective: To examine the influence of fear of crime on walking for participants in a longitudinal study of residents in new suburbs.

Methods: Participants (n=485) in Perth, Australia, completed a questionnaire about three years after moving to their neighbourhood (2007-2008), and again four years later (2011-2012).

Measures included fear of crime, neighbourhood perceptions and walking (mins/week). Objective environmental measures were generated for each participant's neighbourhood, defined as the 1600m road network distance from home, at each time-point. Linear regression models examined the impact of changes in fear of crime on changes in walking, with progressive adjustment for other changes in the built environment, neighbourhood perceptions and demographics.

Results: An increase in fear of crime was associated with a decrease in residents' walking inside the local neighbourhood. For each increase in fear of crime (i.e., one level on a five-point Likert scale) total walking decreased by 22 minutes per week ($p=0.002$), recreational walking by 13 minutes per week ($p=0.031$) and transport walking by 7 minutes per week ($p=0.064$).

Conclusion: This study provides longitudinal evidence that changes in residents' fear of crime influences their walking behaviours. Interventions that reduce fear of crime are likely to increase walking and produce public health gains.

N=200 words

Introduction

Intuitively, we expect the perception of an unsafe environment will induce people to constrain their walking or physical activity. However, while studies investigating the neighbourhood influences on physical activity routinely include some measure of perceived crime or safety, the findings in adult samples remain largely inconclusive (Foster and Giles-Corti, 2008). One critique of studies examining the relationship between perceptions of safety from crime and physical activity is a reliance on judgements or cognitive assessments of crime and safety, rather than emotional or affective responses to crime. For instance, it is plausible that people may judge an area to be unsafe due to crime, but unless the crime they perceive causes an emotional response, such as fear or anxiety, it may not impact their behaviour (Foster and Giles-Corti, 2008).

Relatively few studies investigating the impact of perceived safety on physical activity have incorporated measures best conceptualised as 'fear of crime' (Dawson et al., 2007; Foster et al., 2013a; Kramer et al., 2013; McGinn et al., 2008; Roman et al., 2009; Ross, 2000; Stafford, 2007). For example, in a sample of African Americans living in urban public housing developments, fear of crime was not associated with moderate intensity physical activity (Roman et al., 2009). In contrast, among older British civil servants, participation in vigorous intensity physical activities was lower among those reporting greater fear of crime, although there was no association with walking (Stafford, 2007). Similarly in the Netherlands, lower fear of crime was associated with increased odds of cycling (Kramer et al., 2013), and elsewhere, both Ross (2000) and Foster et al. (2013) identified that people who feared victimisation were less likely to walk (Foster et al., 2013a; Ross, 2000). While there is some mixed evidence, on balance, these studies suggest that fear of crime may indeed be a deterrent to walking or physical activity.

Another limitation of studies examining crime-related safety and physical activity has been a reliance on cross-sectional study designs, with few studies using prospective or longitudinal designs (Dawson et al., 2007; Handy et al., 2008; Sallis et al., 2007). Moreover, just one longitudinal study appears to include an emotional measure of crime safety (Dawson et al., 2007). Dawson et al. (2007) examined perceived barriers to walking for older adults participating in a walking program in the UK. While they identified that worry about personal safety (e.g., being attacked) reduced at follow-up, this was not examined as a separate influence on changes in physical activity between baseline and follow-up. Indeed, to date, no studies appear to have

examined the impact of changes in emotional responses to crime, such as fear of crime, on walking or physical activity.

This study addresses an important evidence gap by examining the influence of fear of crime on walking using a longitudinal study design. We examined: (1) whether changes in fear of crime influence changes in walking undertaken within the neighbourhood; and (2) whether the relationship between fear of crime and walking could be explained by other variables. Numerous individual, social and built environment factors have been associated with walking, including: neighbourhood perceptions (e.g., attractive aesthetics, physical disorder, traffic) (Cerin et al., 2009; Mendes de Leon et al., 2009; Nagel et al., 2008; Sugiyama and Ward-Thompson, 2008), aspects of social capital (e.g., social cohesion, collective efficacy) (Foster et al., 2013a; Mendes de Leon et al., 2009; Wen et al., 2007) and neighbourhood 'walkability' (Owen et al., 2007). Thus, we controlled for a range of factors to better illuminate any independent relationship between fear of crime and walking (see Figure 1).

[Insert Figure 1 about here]

Methods

Study context

The RESIDential Environments (RESIDE) Project is a longitudinal natural experiment of people building houses and relocating to 73 new housing developments across Perth, Western Australia. All people building new homes in the study areas were invited to participate by the state water authority following the land transfer transaction (response rate 33.4%). Participants completed a self-report questionnaire before they moved into their home (n=1813), and on three occasions after relocation at approximately 12 (n=1467), 36 (n=1230) and 84 months (n=531). At each time-point, objective environmental measures were generated in Geographic Information Systems (GIS) for each participant's individual 'neighbourhood'. RESIDE was approved by The University of Western Australia's Human Research Ethics Committee (#RA/4/1/479) and is described elsewhere (Giles-Corti et al., 2008). The current study draws on participants (n=485) who completed the fear of crime items in the 36 and 84 month questionnaires (comparable items were only available for these time-points). For this study, we refer to the 36 month time-point as 'baseline' and the 84 month time-point as 'follow-up'.

Measures

Outcomes: Walking was measured using the Neighbourhood Physical Activity Questionnaire (NPAQ), which has acceptable reliability ($ICC \geq 0.82$), and distinguishes the location and purpose of walking (Giles-Corti et al., 2006). Walking outcomes included changes in minutes/week of walking in the neighbourhood for: (1) transport; (2) recreation; and (3) total walking. Continuous change variables were calculated for each outcome (i.e., baseline values minus follow-up values).

Independent variable: Fear of crime was derived from the question: In your everyday life, how fearful, or not, are you about the following situations: (1) having someone break into your house while you're at home; (2) being attacked by someone with a weapon; (3) being robbed or mugged on the street; (4) having your property damaged by vandals; (5) having someone loiter near your home at night (Cronbach's $\alpha=0.92$) (Ferraro, 1995; Warr and Stafford, 1983). Participants rated each item on a Likert scale (1=not at all fearful, 5=extremely fearful) which were averaged and a continuous change variable calculated.

Adjustment variables

Individual variables included gender, age, marital status, education, household income, and changes in marital status and household income between baseline and follow-up.

Social environment measures included perceptions of collective efficacy (i.e., the belief that residents will act for the common good) (Sampson et al., 1997) and neighbourhood problems, focusing on: (1) neighbourhood maintenance; (2) social incivilities; (3) graffiti and vandalism; (4) traffic noise; and (5) dangerous or drink driving. Items are documented elsewhere (Foster et al., 2010, 2013a). All measures were continuous, and change variables were calculated.

Objective built environment measures were generated using GIS for the 1600m road network service area around each participant's home at baseline and follow-up. These included: (1) land-use mix (i.e., the evenness of development across shop/retail, other retail, office/business, health/welfare/community services, and entertainment/recreational/cultural land uses); (2) street connectivity (i.e., count of \geq three-way intersections); (3) residential density (i.e., ratio of the land area in residential use to the number of residential dwellings); (4) the number of bus stops; and (5) the proportion of land allocated to parks and reserves. Continuous change variables were calculated.

Statistical analyses

Analyses were conducted in SPSS version 21. Chi square and independent sample t-tests were used to examine differences between participants who completed the baseline questionnaire only, and those who completed both baseline and follow-up (Table 1). Mixed linear regression models were used to examine associations between the objective and perceived change variables and changes in walking, with adjustment for baseline demographics and clustering within residential development (Table 2). Finally, a series of multivariable models examined the association between changes in fear of crime and changes in walking after progressive adjustment for: (1) baseline individual, neighbourhood perceptions and built environment factors; (2) changes in built environment factors between baseline and follow-up; (3) changes in neighbourhood perceptions between baseline and follow-up; and (4) changes in demographics between baseline and follow-up (Table 3).

Results

Participants who completed both the baseline and follow-up surveys were on average 1.6 years older than those who completed baseline only. There were no significant differences in the other socio-demographic or walking variables, indicating that participant attrition did not influence the associations observed.

[Insert Table 1 about here]

The mean changes in objective built environment variables and neighbourhood perceptions between baseline and follow-up are shown in Table 2. Change in fear of crime was the only variable associated with change in mean minutes/week of walking, and this was consistent for total walking ($\beta=-19.91, p=0.004$), transport walking ($\beta=-7.86, p=0.027$) and recreational walking ($\beta=-10.96, p=0.051$). There were too few residents with a change in the proportion of parks and reserves for a reliable estimate to be obtained; and this measure was excluded from the results and further analyses.

[Insert Table 2 about here]

The association between change in fear of crime and change in minutes/week of walking was examined with progressive adjustment for other neighbourhood attributes (Table 3). The relationship between changes in fear of crime and total walking remained constant, despite controlling for baseline individual factors, neighbourhood perceptions, and built environment factors, and changes in these variables over time. For every increase in fear of crime (i.e., one level on the five-point Likert scale), walking within the neighbourhood reduced by about 22 mean minutes/week (Model 4: $p=0.002$). When total walking was examined in its component parts (i.e., recreation or transport walking), we found slightly different results. The association between changes in fear of crime and recreational walking strengthened slightly after controlling for other changes, where for every one level increase in fear of crime, recreational walking reduced by over 13 mean minutes/week (Model 4: $p=0.031$). In contrast, the relationship between changes in fear of crime and mean minutes/week transport walking attenuated slightly after full adjustment (i.e., from 7.77 to 6.90 minutes).

[Insert Table 3 about here]

Discussion

For this sample of suburban residents, we found longitudinal evidence that increases in fear of crime were associated with decreases in the time spent walking in the neighbourhood. The relationship was most pronounced for total walking, however these associations also held true for recreational and transport walking. While previous cross-sectional studies suggest a negative relationship between fear of crime and walking (Foster et al., 2013a; Ross, 2000) or physical activity (Dawson et al., 2007; Kramer et al., 2013; McGinn et al., 2008; Stafford, 2007), our longitudinal results suggest a causal relationship which warrants replication elsewhere.

It is also worth highlighting our focus on fear of crime, which is an emotional response to crime, rather than a judgement or assessment about crime (Ferraro, 1995). To date, there has been little consistency in the findings of studies exploring the association between crime-related safety and physical activity outcomes (Foster and Giles-Corti, 2008). Our results suggest the distinction between the 'affective' and 'cognitive' dimensions of fear (Lorenc et al., 2012) may be important, and that researchers in this field should be mindful of this.

Previous cross-sectional RESIDE analyses also identified a negative association between fear and transport walking, which remained constant, despite progressive adjustment for individual, social and built environment factors (Foster et al., 2013a). However, car ownership is widespread in Perth, and since all participants had access to a vehicle, fearful participants had a viable alternative to transport walking. In contrast, our previous cross-sectional analyses found the association between fear and recreational walking attenuated completely after controlling for social and built environment factors (Foster et al., 2013a). The presence of an inviting, convivial public realm, has been associated with both greater perceived safety (Austin et al., 2002; Foster et al., 2010; Wood et al., 2008) and recreational walking (Sugiyama et al., 2013; Sugiyama et al., 2009), thus an aesthetically appealing environment may mitigate the impact of fear on recreational walking (Foster et al., 2013a). However, in this longitudinal study, we found no such pattern of attenuation for recreational walking. Indeed, there was minimal attenuation for any of the walking outcomes. It may be that, in our longitudinal sample, other changes between time-points were too small to impact the relationship between fear of crime and walking. Alternatively, this lack of attenuation in the fear-walking relationship might reveal something about the nature of fear of crime. Scholars suggest fear of crime may reflect other, more nebulous anxieties, which are unconsciously 'projected onto a knowable and name-able fear' (Farrall et al., 2009, p.261). This notion resonates for our sample of homeowners, who Farrall et al. (2009) might characterise as 'anxious' (i.e., minimal experience of crime, and living in relatively low crime, well maintained and socially cohesive areas), and yet their 'fear' still impacts their walking.

The effect sizes documented in this study were quite large, with a one-level increase in fear of crime associated with a 22 minute decrease in mean minutes/week of total walking. Given that public health guidelines recommend 150 minutes/week of moderate intensity physical activity to achieve health benefits (World Health Organization, 2010), interventions that successfully address fear of crime may prove an effective means to increase walking and improve health. This begs the question: is the negative relationship between fear of crime and walking actually amenable to intervention? Numerous factors are associated with fear of crime, including a sense of vulnerability (Hale, 1996), previous victimisation (Ferraro, 1995; Hale, 1996), social capital (Gibson et al., 2002; Riger et al., 1981; Scarborough et al., 2010) and neighbourhood presentation and design (e.g., physical incivilities, neighbourhood upkeep, retail destinations) (Foster et al., 2010; Foster et al., 2013c; Hale, 1996; Lorenc et al., 2012; Lorenc et al., 2013b). Moreover, many of these neighbourhood attributes are also associated with walking (Foster and Giles-Corti, 2008;

Giles-Corti et al., 2013; Mendes de Leon et al., 2009; Saelens and Handy, 2008), and therefore may provide potential points for intervention. For example, initiatives that enhance social connectedness or improve the upkeep of public spaces might have a dual role in minimising fear of crime (Foster et al., 2010; Wood et al., 2008) or perceived crime (Foster et al., 2013b), and improving the conviviality of the neighbourhood to promote walking (Mendes de Leon et al., 2009; Sugiyama et al., 2009).

However, while there are well documented cross-sectional associations between these social and built environment factors and fear of crime (Foster et al., 2013c; Hale, 1996; Lorenc et al., 2012), the evidence base for potentially causal associations is more limited. Indeed, few interventions appear effective in reducing fear (Hale, 1996; Lorenc et al., 2013a). The most promising environmental interventions involve improvements to home security and the public realm, but most evaluations are hampered by poor study designs (Lorenc et al., 2013a). Further, the success (or otherwise) of interventions remain contingent on the social environment and setting, and the pathways are complex. For example, community based programs (e.g., Neighbourhood Watch) appear more effective in middle class areas, where the victimisation risk is low (Hale, 1996), and although there is uncertainty about whether such schemes reduce fear (Fleming, 2005), volunteering can improve social interactions and trust in neighbours (Cohen et al., 2003; Ferguson, 2007), which in turn might reduce fear. Longitudinal studies and well-designed natural experiments are needed inform future interventions.

Our study was set in the relative safety of the Australian suburbs, amongst participants who purchased new homes (Giles-Corti et al., 2008). Thus, it is plausible that our relationship between fear of crime and walking is a middle class phenomenon. Similar cross-sectional associations between fear of crime and constrained physical activity have been identified among relatively affluent populations (e.g., British civil servants)(Stafford, 2007), and in relatively wealthy countries (e.g., UK, USA, The Netherlands) (Dawson et al., 2007; Kramer et al., 2013; McGinn et al., 2008; Ross, 2000; Stafford, 2007). Yet notably, no such associations were observed for public housing tenants (Roman et al., 2009). Furthermore, Ross (2000) highlighted that although residents in poorer neighbourhoods were more fearful, they were also more likely to walk. These studies highlight that lower SES residents often have no alternative but to walk or exercise, regardless of their fears (Roman et al., 2009; Ross, 2000). Indeed, Ross (2000) noted that, if residents in poor neighbourhoods were not fearful, their walking levels might be higher still. Further research in

mixed socio-economic environments and developing countries might investigate this apparent discrepancy in the associations between fear and physical activity.

Limitations

First, this study had a relatively small sample size. RESIDE participants were originally recruited to complete three surveys over five years, however subsequent funding allowed for a fourth survey. The low initial response rate arose partly from the need to recruit participants through an intermediary and may limit the generalisability of our findings. Whilst there was also considerable attrition over time, analyses of participant drop-out (including comparisons of subjects with and without follow-up data in Table 1) showed that drop-out was not related to walking behaviour and hence should not impact the results. Second, most participants (>70%) remained in the same house between baseline and follow-up, meaning there was minimal change in the built environment. Nonetheless, for participants that moved neighbourhoods, it was important to control for the environmental features associated with fear of crime (Foster et al., 2010; Foster et al., 2013c; Hale, 1996) and walking (Christian et al., 2013; Giles-Corti et al., 2013; Sugiyama et al., 2009). Third, our findings may not be widely generalisable, as the sample comprised homeowners living in relatively new suburbs. Nonetheless, our results are certainly applicable to many suburban areas throughout Australia and the United States. Finally, there are limitations associated with self-report measures. Our fear of crime measure adheres to recommendations in the literature (Ferraro, 1995); however quantitative measures can overestimate fear, and struggle to capture the nuances of 'fear' relating to time, location and social context, (Farrall et al., 1997). Future studies might assess the frequency or intensity of fear (Farrall et al., 2009; Jackson and Stafford, 2009). Self-report walking measures are also predisposed to over-reporting and recall biases, however this allowed us to focus on walking conducted within the neighbourhood, which was paramount (Giles-Corti et al., 2005). Further, if the self-reporting bias is in the same direction on both occasions, it would be less of a concern in our longitudinal analysis examining the change in self-report walking. In general, measurement error dilutes effect estimates so the true effect sizes could be larger than our estimates.

This study also had several strengths, including its longitudinal design which facilitated exploring potential causal relationships between fear of crime and walking. However, longitudinal observational studies still do not prove causality, and intervention studies are required. Furthermore, we adjusted for a range of established and potential influences on walking, including

objective built environment measures at baseline, and changes in these measures over time, and our associations remained relatively constant.

Conclusion

This study provides longitudinal evidence that changes in residents' fear of crime influence their walking behaviours. We found that for every one level increase in fear of crime, participants walking inside their neighbourhood reduced by over 22 minutes, even after full adjustment. Thus, interventions that target resident's fear of crime may be a means to increase walking and improve public health outcomes. However, in order to design better interventions, there is an need to understand what factors contribute to an increase in residents' fear of crime, particularly in these suburban developments which – by most local, national and international standards – are relatively safe. Future research might also explore changes in fear of crime and physical activity behaviours in more socio-economically diverse populations and settings.

Conflict of interest

The authors declare that there are no conflicts of interest.

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Table 1 Socio demographic and behavioral characteristics of RESIDE study participants in Perth, Western Australia, at baseline (2007-2008) by whether they completed questionnaires at follow-up (2011-2012).

Characteristic	Completed baseline only (n=697) %	Completed baseline and follow-up (n=531) %	<i>p</i>
Gender (Male)	39.7	37.7	0.506
Mean age (SD)	43.8 (11.7)	45.4 (11.8)	0.021
Marital status			
Partner	85.1	87.2	0.282
No partner	14.9	12.6	
Education			
Secondary or less	37.5	34.0	0.150
Trade/apprenticeship	39.1	37.8	
Bachelor or higher	23.4	28.2	
Income			
<\$50,000	15.6	16.5	
\$50,000-\$69,999	15.8	18.2	
\$70,000-\$89,999	18.1	17.3	0.581
\$90,000+	43.5	42.8	
No response	7.0	5.3	
Children <18 years at home	2.0 (0.8)	1.9 (0.8)	0.284
Mean fear of crime(SD)	2.6 (1.0)	2.6 (0.9)	0.151
Mean total walking (SD)	112.5 (159.1)	114.3 (143.6)	0.775
Mean walking for recreation (SD)	88.5 (131.2)	92.0 (122.6)	0.635
Mean walking for transport (SD)	25.1 (68.2)	26.3 (69.0)	0.841

Bold denotes $p < 0.05$; SD=Standard Deviation

Table 2: Associations between changes in the built environment and neighborhood perceptions variables and changes in walking between baseline and follow-up (2007-2008 and 2011-2012) for RESIDE participants in Perth, Western Australia.

Characteristic	Mean (SD)	Δ Total walking		Δ Recreational walking		Δ Transport walking	
		Estimate (SE)	<i>p</i>	Estimate (SE)	<i>p</i>	Estimate (SE)	<i>p</i>
Built environment							
Δ Land use mix*	0.02 (0.12)	-14.64 (56.13)	0.795	0.01 (42.69)	1.000	-3.65 (30.77)	0.906
Δ Street connectivity*	2.49 (18.51)	0.16 (0.33)	0.629	0.05 (0.27)	0.858	0.09 (0.17)	0.587
Δ Residential density	-0.10 (2.81)	2.25 (2.23)	0.314	2.40 (1.75)	0.171	0.12 (1.20)	0.920
Δ Number of bus stops*	1.34 (11.99)	-0.13 (0.52)	0.798	-0.02 (0.41)	0.967	0.10 (0.29)	0.727
Neighborhood perceptions							
Δ Collective efficacy	0.01 (0.45)	-0.24 (13.40)	0.986	0.36 (11.02)	0.974	1.98 (6.89)	0.773
Δ Traffic noise *	0.10 (0.88)	2.47 (6.79)	0.716	8.92 (5.57)	0.110	-5.60 (3.40)	0.100
Δ Dangerous/drink driving *	0.08 (0.87)	1.62 (6.95)	0.816	2.75 (5.77)	0.634	-3.06 (3.58)	0.393
Δ Social incivilities*	0.05 (0.48)	3.47 (12.99)	0.789	11.32 (11.87)	0.298	-2.97 (6.61)	0.654
Δ Graffiti and vandalism	0.02 (0.82)	-0.54 (7.19)	0.940	0.91 (6.00)	0.879	-1.04 (3.73)	0.781
Δ Neighborhood maintenance *	0.10 (0.60)	7.48 (10.06)	0.458	6.30 (8.33)	0.450	2.23 (5.13)	0.664
Δ Fear of crime*	-0.24 (0.87)	-19.91 (6.79)	0.004	-10.96 (5.62)	0.051	-7.86 (3.54)	0.027

All models adjust for baseline age, gender, marital status, education, household income, clustering within residential development and baseline walking levels.

Bold denotes $p < 0.05$

*Significant differences ($p < 0.05$) between baseline and follow-up values based on paired sample t-tests

Table 3 Multivariable models examining the influence of changes in fear of crime on changes in: (1) total walking; (2) recreational walking; and (3) transport walking, with progressive adjustment for: baseline individual factors, neighbourhood perceptions and built environment characteristics (Model 1); changes in built environment characteristics (Model 2); changes in neighborhood perceptions (Model 3); and changes in individual factors (Model 4), for RESIDE participants in Perth, Western Australia (2007-2008 and 2011-2012).

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Environments at baseline		Δ Built environment		Δ Neighbourhood perceptions		Δ Individual variables	
	Estimate (SE)	P	Estimate (SE)	P	Estimate (SE)	P		
Δ Total walking								
Δ fear of crime	-20.729 (6.847)	0.003	-20.797 (6.860)	0.003	-22.943 (7.206)	0.002	-22.450 (7.316)	0.002
Δ Walking for recreation								
Δ fear of crime	-11.407 (5.635)	0.043	-11.623 (5.647)	0.040	-13.0512 (5.902)	0.028	-13.022 (6.005)	0.031
Δ Walking for transport								
Δ fear of crime	-7.768 (3.606)	0.032	-7.962 (3.626)	0.029	-7.898 (3.797)	0.039	-6.897 (3.718)	0.064

Model 1: Adjusted for baseline age, gender, education, income, marital status, walking, clustering within residential developments, land use mix, street connectivity, residential density, number of bus stops, proportion of service area allocated to public open space, collective efficacy, problems with neighborhood maintenance, problems with social incivilities, problems with graffiti and vandalism, problems with traffic noise, and problems with dangerous or drink driving.

Model 2: Adjusts for Model 1 variables and: changes in objective built environment variables between baseline and follow-up (i.e., land use mix, street connectivity, residential density, number of bus stops).

Model 3: Adjusts for Model 2 variables and: changes in neighborhood perceptions between baseline and follow-up (i.e., collective efficacy, problems with neighborhood maintenance, problems with social incivilities, problems with graffiti and vandalism, problems with traffic noise, and problems with dangerous or drink driving).

Model 4: Adjusts for Model 3 variables and: changes in individual factors between baseline and follow-up (i.e., marital status, income).

Bold denotes $p < 0.05$