Accepted Manuscript

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PII: S0277-9536(15)00287-7

DOI: 10.1016/j.socscimed.2015.05.014

Reference: SSM 10079

To appear in: *Social Science & Medicine*

Please cite this article as: Astell-Burt, T., Feng, X., Kolt, G.S, Jalaludin, B., Does rising crime lead to increasing distress? Longitudinal analysis of a natural experiment with dynamic objective neighbourhood measures, *Social Science & Medicine* (2015), doi: 10.1016/j.socscimed.2015.05.014.

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Social Science and Medicine

Short Report (2000 to 4000 words)

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ABSTRACT

Identifying 'neighbourhood effects' to support widespread beliefs that where we live matters for our health remains a major challenge due to the reliance upon observational data. In this study we reassess the issue of local crime rates and psychological distress by applying unobserved bias models to a sample of participants who remain in the same neighbourhoods throughout the study. Baseline data was extracted from the 45 and Up Study between 2006 and 2008 and followed up as part of the Social Economic and Environmental Factors (SEEF) Study between 2009 and 2010. Kessler 10 scores were recorded for 25 545 men and 29 299 women reported valid outcomes. Annual crime rates per 1,000 (including non-domestic violence, malicious damage, break and enter, and stealing, theft and robbery) from 2006 to 2010 inclusive were linked to the person-level data. Change in exposure to crime among participants in this study, therefore, occurs as a result of a change in the local crime rate, rather than a process of neighbourhood selection. Gender stratified unobserved bias logistic regression adjusting for sources of time-varying confounding (age, income, employment, couple status and physical functioning) indicated that an increase in the risk of experiencing psychological distress was generally associated with an increase in the level of neighbourhood crime. Effect sizes were particularly high for women, especially for an increase in malicious damage (Odds Ratio $_{\text{Tertile 3 vs Tertile 1}}$ 2.40, 95% Confidence Interval 1.88, 3.05), which may indicate that damage to local built environment is an important pathway linking neighbourhood crime with psychological distress. No statistically significant association was detected for an increase in non-domestic violence, although the effect was in the hypothesised direction. In summary, the application of unobserved bias models to analyse data that takes

into account the temporally dynamic characteristics of where people live warrants further investigation.

Keywords: Crime; mental health; unobserved bias models; longitudinal study; neighbourhood; health selective migration; reverse causation; confounding

Highlights:

- First longitudinal study of crime and mental health with dynamic area measures
- Rising crime was associated with an increasing risk of psychological distress
- Effect sizes were stronger for crime related to damage to the built environment

Strengths and limitations of the study:

- Longitudinal data on person-level outcomes and confounders;
- Time-varying objective data on area-level crime rates;
- Fixed effects analysis of a residentially stable sample, to control for confounding;
- Data were restricted to persons aged 45 years and older
- The study is limited by potentially unobserved sources of time-varying confounding

1. Introduction

There is a widespread belief that the characteristics of the neighbourhoods in which we live, such as the provision of food outlets (Caspi et al., 2012), green spaces (Astell-Burt et al., 2013) and other factors subsumed within the concept of 'liveability' (Giles-Corti et al., 2014) can play an important role in determining our health (Kawachi & Berkman, 2003). Identifying causal 'neighbourhood effects' to support those beliefs remains, however, a major challenge (Oakes, 2004). Short of the ability to randomly assign large groups of people to new surroundings and to monitor their health trajectories over time (Kling et al., 2008; Leventhal & Brooks-Gunn, 2003; Ludwig et al., 2012; Ludwig et al., 2011), the pool of evidence is likely to remain with observational studies that have been the source of so much debate from within epidemiology (Oakes, 2004; Sobel, 2006; VanderWeele, 2008) and in other disciplines (Dietz, 2002; Durlauf, 2004; Slater, 2013). A key challenge is that the identification of a so-called 'neighbourhood effect' is tainted by unmeasured confounding that randomisation would otherwise serve to eradicate (Hernan et al., 2004). This confounding is bound up with the related issue of health-selective migration (Boyle & Norman, 2009), wherein an individual with a particular set of health-related circumstances may select into (or out of) a certain type of neighbourhood, inducing correlation between exposure and outcome variables where there is, in fact, potentially no causation whatsoever. Thus, as the pressure to conduct scientific research with existing data to generate 'real world' impact continues to increase, re-assessing our most valued hypotheses and trusted theories with better data and more sophisticated analytical techniques becomes ever more important.

In this study we propose an analytical strategy to reassess the issue of local crime rates and mental health. It is generally hypothesised that a rising level of crime will make the local area a less safe place to live, leading to an increased risk of psychological distress (Jackson & Stafford, 2009; Stafford et al., 2007). Evidence for an effect of local crime on health, other than the deplorable effects of domestic violence (Coker et al., 2002), remains equivocal and tends to be derived from cross-sectional data with self-reported exposure and outcome measures (Foster & Giles-Corti, 2008; Lorenc et al., 2012; Lovasi et al., 2014). This is highly problematic, since if a participant recognises an increase in the local crime rate that serves to worry them to the extent that, for example, they no longer feel safe where they live, they may leave the neighbourhood entirely if they have the socioeconomic resources to do so. Meanwhile, self-reporting both exposure and outcome variables can induce 'same source bias'. Without taking into account either of these issues, studies may end up reporting exaggerated or spurious parameter estimates. Accordingly, this longitudinal study examines the risk of psychological distress for people who remain within the same neighbourhood over time in relation to time-varying neighbourhood crime rates provided by a different source. Mimicking a randomised community trial (Macintyre, 2011; Oakes, 2004) that could not be ethically implemented as it would involve deliberate exposure to potentially harmful levels of neighbourhood crime, the analysis presented amounts to an evaluation of a 'natural experiment' (Craig et al., 2012) to answer the question**,** does rising crime lead to increasing distress?

2. Method

2.1 Study design

Unobserved bias (i.e. 'fixed effects') models were proposed to analyse repeated measures of person and place characteristics. Fitting a fixed intercept for each person adjusts for variation

within individuals, giving rise to a situation wherein each participant becomes their own control (Allison, 2005) and thereby accounting all sources of *time-invariant* confounding, both measured and unmeasured. While this approach remains somewhat unusual in epidemiology (Gunasekara et al., 2013), in which random effects models tend to predominate (Duncan et al., 1998; Subramanian et al., 2009), our focus was squarely upon eliminating sources of confounding in an effort to identify the effect of an increase in local crime on the risk of psychological distress. It is recognised at the outset that unobserved bias models do not account for *time-varying* sources of confounding, but since they do help avoid time-invariant confounding whereas random effects do neither, this was the basis for their implementation.

2.2 Person-level data

Data was extracted from the 45 and Up Study (45 and Up Study Collaborators, 2008). Originally, participants in the 45 and Up Study were randomly sampled from the Medicare Australia database (the national provider of universal health care in Australia). Approximately 10% of the population aged 45 years and older living in New South Wales (NSW), the most populous state in Australia, took part between 2006 and 2008. A range of health and sociodemographic measures were assessed through a self-complete postal survey, of which the first 100 000 respondents were then invited to complete a follow-up questionnaire as part of the Social Economic and Environmental Factors (SEEF) Study between 2009 and 2010. The follow-up questionnaire replicated many of the questions asked at baseline, affording longitudinal analyses. A total of 28 057 men and 32 347 women completed the SEEF follow-up (overall response rate of 60.4%, 3.4 ± 0.95 years follow-up time). Ethical approval for the 45 and Up Study was granted by the University of New South Wales Human Research Ethics Committee (HREC 05035/HREC 10186) and the SEEF Study by the University of Sydney Human Research Ethics Committee (ref no. 10-2009/12187).

2.3 Outcome variable

All 10 items for constructing the Kessler Psychological Distress Scale ('K10') (Kessler et al., 2002) were asked at baseline and follow-up. The K10 measures symptoms of psychological distress experienced across 4 weeks prior to a participant's completion of the questionnaire. These questions included whether a participant had felt tired for no reason, nervous, hopeless, restless, depressed, sad or worthless. Participants had 5 choices for each of the 10 questions (none of the time =1, a little of the time =2, some of the time =3, most of the time =4, all of the time=5) and these were summed to give the overall score. The K10 ranges from scores of 10 to 50, with higher scores denoting poorer mental health. In line with previous work (Byles et al., 2012; Feng & Astell-Burt, 2013; Feng et al., 2013), a binary variable was constructed with scores of 22 and over identifying participants at high risk of psychological distress. This cut-point has been widely validated (Furukawa et al., 2003; Kessler et al., 2002) and is officially recommended by the Australian Bureau of Statistics (Australian Bureau of Statistics, 2003).

2.4 Data on the incidence of local crime

An application to use geocoded crime counts from 2006 to 2010 inclusive was approved in 2013 by the NSW Bureau of Crime Statistics and Research. Crime counts were aggregated to the level of the 'Statistical Local Area' (SLA) as this was the smallest geographical scale that was available for analysis in the SEEF data. SLAs had approximately 32 000 residents on average in 2006, with 193 out of 199 SLAs in NSW included in the sample. Since the focus of the study was on local crime occurring outdoors, four different classifications of crime were examined. (i) Non-domestic violence refers to offences against the person that take place outside of the household, including (but not limited to) assault, murder, attempted murder, manslaughter,

sexual offences and harassment. (ii) Malicious damage to property refers to the wilful destruction, damage or defacement of public or private property, including graffiti. (iii) Break and enter is the unlawful entry of a structure (e.g. a household or shop premises) with the intent to commit an offence where the entry is either forced or unforced. (iv) Stealing, theft and robbery includes a range of offences, including (but not limited to) stealing from dwellings, motor vehicles, people, retail stores, money or goods, with or without a weapon. Additionally, a 'total crime' variable was created based upon an aggregation of the aforementioned measures. Reports of crime that do not typically occur outdoors, such as domestic violence, were not analysed. Assignment of crime measures for each participant was year-specific, meaning that each participant was assigned the local crime rate reported in the same year as they completed the survey. Each SLA crime count was standardised per 1000 people using data from the 2006 census in line with previous research (Ball et al., 2010). For reporting purposes, this variable was expressed in tertiles (low, moderate, high).

2.5 Time-varying confounders

Through implementing unobserved bias models, multivariate adjustment was required only for a selected set of measures to account for time-varying confounding. Changes in demographics, socioeconomic circumstances and physical health are likely to play important roles in determining the well-known variation in mental health across the adult lifecourse (Jokela et al., 2013; Kuh & Ben-Schlomo, 2004) and, simultaneously, the likelihood of moving from one neighbourhood to another (Clark & Withers, 2002; de Groot et al., 2011). Demographic measures used in this study included a participant's age (grouped into 45y-54y, 55y-64y, 65y-74y, and $\geq$75y) and couple status (in a couple, or not in a couple). Measures of socioeconomic circumstances included economic status (retired, employed, disabled or long-term sick, or unemployed) and annual household income (in Australian dollars, grouped into <$19k, $20k-

$39**k**, $40k-$69k, >$70k). Although a range of other health indicators were available, including self-reported doctor-diagnosed health conditions, overall physical health was measured using the Medical Outcomes Study Physical Functioning Scale (Stewart & Kamberg, 1992; Syddall et al., 2009). The MOS-PF is a 10-item scale covering vigorous activities (e.g. climbing stairs) to more basic actions related to day to day living (e.g. bathing). Other relevant measures such as highest educational qualification and country of birth were also available, but did not vary through time and as such, there was no requirement to adjust for these characteristics. Given previous studies indicate potential gender differences in the impact of neighbourhood crime on psychological distress (Lorenc et al., 2012), analyses were conducted separately for men and women.

2.6 Sample

A total of 26 998 (96.2%) men and 31 024 (95.9%) women reported valid outcome data. Participants missing the K10 at either baseline and/or follow-up were omitted from the analysis (3.9% of the overall sample). Additionally, the focus was upon those participants who did not change their neighbourhood of residence during the study period to reduce bias due to health-selective migration, resulting in the further omission of 1453 (5.4%) men and 1725 (5.6%) women that had valid outcome data. The final sample included 25 545 men and 29 299 women, with missing data on all other variables retained and accounted for using additional categories.

2.7 Statistical analysis

The characteristics of the study sample and patterns of psychological distress were described using cross-tabulations and percentages. The odds of experiencing psychological distress were modelled using binary logit regression fitted with the K10 variable equal/above (‘1’) or below a

score of 22 (‘0’’) for each participant. A fixed effects strategy was implemented immediately to avoid making any inferences based upon gender-specific models subject to time-invariant confounding. Each measure of crime was fitted separately, followed by adjustment for the time-varying confounders (age, income, employment, couple status and physical functioning). Fixed effect parameters were exponentiated to odds ratios (OR) and 95% confidence intervals (95% CIs). All analyses were conducted in Stata v.12 (StataCorp, College Station, TX).

3. Results

Approximately 7.8% of the sample was found to be experiencing psychological distress. 53.5% of the sample was female and 83.8% was aged between 45 and 74 years. Table 1 reports the prevalence of psychological distress across person characteristics, the level of crime and by whether a person moved. A higher prevalence of psychological distress was observed among women, people on lower annual household incomes, disabled or long-term sick, not living in a couple, with low functional status. The prevalence of psychological distress was higher in neighbourhoods with more crime, regardless of the definition. Approximately 7.78% (95% CI 7.45%, 8.11%) of men and 10.03% (95% CI 9.68%, 10.37%) of women were identified as experiencing psychological distress at baseline. Prevalence of psychological distress decreased to 6.26% (95% CI 5.96%, 6.55%) for men and 6.95% (95% CI 6.65%, 7.24%) for women at follow-up.

Bivariate (i.e. unadjusted) unobserved bias models indicated that an increase in the risk of experiencing psychological distress was generally associated with an increase in the level of neighbourhood crime (Table 2). Effect sizes were particularly high for women, especially for an increase in malicious damage (OR_{T3vsT1} 3.06, 95%CI) 2.44, 3.83). Although the direction of association was in the hypothesised direction for non-domestic violence, wide confidence

intervals spanned unity. Tables 3 and 4 report the findings from models adjusted for time-varying confounders. Effect sizes were attenuated to some extent, though remaining reasonably strong for men and especially for women. An increase in malicious damage was associated with a significant increase in the risk of psychological distress among women (OR_{T3vsT1} 2.40, 95%CI 1.88, 3.05). Similar associations were found for the 'break and enter' and 'stealing, theft and robbery' types of crime. As with the bivariate models, no statistically significant association was detected between an increase in non-domestic violence and risk of psychological distress for men or women.

4. Discussion

Previous research has found inconsistent associations between local crime and health (Foster & Giles-Corti, 2008; Lorenc et al., 2012). Among a sample of people who did not move home during the study period, our findings indicate that a rise in the local crime rate is associated with an increased risk of experiencing psychological distress. The influence of local crime was particularly strong in the case for women generally, and especially for those living in areas experiencing a change in the rate of malicious damage. This may indicate that damage to the local built environment may be an important pathway linking neighbourhood crime with psychological distress. Overall, we tentatively conclude that the local crime rate is a determinant of mental health, at least in the short-term, and that attempts to prevent and reduce levels of neighbourhood crime should also be regarded as investments in public health.

Despite considerable appetite for the role of place as a determinant for health and other outcomes (World Health Organization, 2008), we have noted that the methodological challenges for identifying such effects are far from trivial (Dietz, 2002; Durlauf, 2004; Oakes, 2004; Slater, 2013; Sobel, 2006; VanderWeele, 2008). Randomised trials solve some problems,

such as unobserved confounding, but the ability to implement experimental designs relevant to the research question addressed in this study is severely constrained by ethical, pragmatic and institutional concerns. This study represents an attempt to use longitudinal data in a way that constrains the potential for confounded parameter estimates. By geo-linking objective measures of crime to a validated measure of psychological distress (Kessler et al., 2002), this study is also distinct from those which assessed correlations between self-reported fear of crime and self-reported health outcomes (Jackson & Stafford, 2009; Stafford et al., 2007). While effect sizes in this study were larger for women, importantly, an increase in the local crime rate was also associated with incidence of psychological distress for men. Investments in crime prevention, therefore, ought to have benefits for mental health across the board.

Unlike some previous cross-sectional research (Clark et al., 2008), however, our study did not find an increase in the level of non-domestic violence to be associated with the risk of psychological distress. This finding warrants further attention as the relationship with non-domestic violence may be contingent upon other contextual factors that were not available to consider in this study, such as the time of day at which offences were committed and whether they involved use of weapons or excessive alcohol consumption (Lovasi et al., 2014).

Using longitudinal data on all measures, including exposure to crime, afforded the relatively rare opportunity to examine whether a change in exposure was associated with a change in the outcome free of time-invariant confounding. This strategy alone did not omit the possibility of time-varying confounding, wherein participants who were in better physical health or able to mobilise resources could potentially leave their neighbourhood for subjectively safer pastures if they sensed an increase in crime. Accordingly, changes in income, economic status, couple status, age and physical functioning were taken into account. Furthermore, restriction of the sample into those who remained in the same neighbourhood for the duration of the study additionally helped to minimise this source of confounding. If the association between local

crime and psychological distress was predominantly the artefact of health-selective migration, little evidence would have been expected among a sample of residentially stable participants. This was not the case. Importantly, this strategy for restriction to non-movers also helps to minimise the issue of bi-directionality, since it is reasonable to believe that a change in the local crime rate could influence a resident's mental health, but it seems less plausible that a change in mental health has an influence on the local crime rate among those who remained in-situ.

The prevalence of psychological distress decreased for both men and women between baseline and follow-up in line with previous findings (Byles et al., 2012). The changes in mental health associated with a change in exposure to local crime among those who did not move within the study period can be considered *less* biased. They cannot, however, be entirely free from confounding as there is the possibility that people may not only select where they live based on their immediate expectations, but also how they envisage what it will be like to live in their neighbourhood further on in time (e.g. anticipated infrastructural developments and potential accrual of wealth via rising house prices). Further to this point, the 'fixed effects' modelling approach combined estimates from people experiencing a rise in the crime rate with those experiencing a drop. It is **not** entirely clear as to whether the effect of an increase in crime is proportional to the effect of a decrease in crime on the risk of psychological distress; however, this is the subject of further research. Geographical scale is another moot point. Our study was limited to aggregations of crime data at the SLA boundaries, which can be relatively large and may mask more proximal change in exposure to crime (Astell-Burt et al., 2015; Flowerdew et al., 2008). Finally, it cannot be said that all participants who remained within their neighbourhood did so because they had no choice. Given that objectively measured crime is not necessarily strongly correlated with a fear of crime, it is possible that effect sizes among this sample are biased *downward* because it contains those who felt less affected by the putative change in

exposure. Future work comparing objective with subjective measures of local crime in relation to psychological distress would be useful in this regard.

In summary, the local crime rate is a potentially important determinant of mental health. The application of unobserved bias models to analyse data which not only takes into account change over time among residentially stable participants, but also the temporally dynamic characteristics of where they live through objective measurement, warrants further investigation in studies concerned with potential neighbourhood effects on health.

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Table 1: Descriptive statistics of the study sample, stratified by gender

	N (% High risk of psychological distress)	
	Men	Women
Total crime (tertiles)		
1 (0-41.5)	17241 (5.7%)	19338 (6.9%)
2 (41.6-60.6)	17176 (7.3%)	19910 (9.1%)
3 (60.7-445.1)	16673 (8.0%)	19350 (9.5%)
Non-domestic violence (tertiles)		
1 (0-4.6)	17394 (5.8%)	19302 (7.1%)
2 (4.7-7.0)	16885 (7.4%)	19559 (9.1%)
3 (7.1-69.2)	16811 (7.9%)	19737 (9.2%)
Malicious damage (tertiles)		
1 (0-12.7)	17313 (6.0%)	19279 (7.0%)
2 (12.8-18.3)	17402 (7.2%)	19624 (8.7%)
3 (18.3-111.3)	16375 (7.9%)	19695 (9.8%)
Break and enter (tertiles)		
1 (0-7.7)	17518 (5.7%)	19084 (7.0%)
2 (7.8-11.5)	16472 (7.4%)	20052 (9.0%)
3 (11.6-57.9)	17100 (8.0%)	19462 (9.5%)
Stealing, theft and robbery (tertiles)		
1 (0-12.5)	17375 (5.8%)	19333 (7.2%)
2 (12.6-17.6)	16446 (7.4%)	20030 (9.0%)
3 (17.7-247.5)	17269 (7.9%)	19235 (9.3%)
Age group		
45y-54y	10256 (7.6%)	16852 (8.8%)
55y-64y	16163 (7.0%)	20753 (8.3%)
65y-74y	14108 (6.1%)	13492 (7.3%)
$\geq$ 75y	10563 (7.8%)	7501 (10.5%)
Annual household income		
< $19k	7031 (15.4%)	9578 (14.9%)
$20k - $39k	11143 (7.5%)	11137 (9.0%)
$40k - $69k	10492 (5.5%)	10582 (6.5%)
$\geq$ $70k	16211 (3.5%)	15066 (4.8%)
Missing	6213 (8.5%)	12235 (9.4%)
Economic status		
Retired	26846 (7.1%)	25849 (8.5%)
Employed	21334 (4.9%)	25761 (6.5%)
Disabled or long-term sick	1063 (38.8%)	1101 (39.3%)
Unemployed	589 (16.1%)	855 (19.0%)
Missing	1258 (11.4%)	5032 (10.4%)
Couple status		
In a couple	42406 (6.1%)	42418 (7.4%)
Not in a couple	8412 (11.4%)	15936 (11.4%)
Missing	272 (9.9%)	244 (10.3%)
Physical functioning		
Low (0-85)	15613 (11.8%)	19771 (12.2%)
Moderate (86-99)	16324 (3.7%)	15678 (4.8%)
High (100)	13439 (3.1%)	15395 (4.2%)
Missing	5714 (12.7%)	7754 (15.0%)

Crime counts = n per 1,000 people

Table 2: The association between a change in the local crime rate and a change in the odds of experiencing psychological distress among men and women who remain in the same neighbourhood throughout the study period. Bivariate fixed effects logistic regression.

	Crime tertile (ref: tertile 1 / low)	
	tertile 2 / moderate	tertile 3 / high
	Odds Ratio (95% Confidence Interval)	
MEN		
Total crime	1.11 (0.90, 1.37)	1.59 (1.19, 2.14) ***
Non-domestic violence	1.19 (0.92, 1.53)	1.37 (0.98, 1.91)
Malicious damage	1.11 (0.90, 1.36)	1.54 (1.17, 2.01) **
Break and enter	1.13 (0.93, 1.38)	1.70 (1.30, 2.22) ***
Steal, theft and robbery	1.23 (0.99, 1.53)	1.56 (1.20, 2.02) ***
WOMEN		
Total crime	1.90 (1.57, 2.30) ***	2.59 (1.98, 3.39) ***
Non-domestic violence	1.33 (1.07, 1.66) *	1.32 (0.99, 1.77)
Malicious damage	1.79 (1.50, 2.14) ***	3.06 (2.44, 3.83) ***
Break and enter	1.62 (1.36, 1.92) ***	2.22 (1.75, 2.80) ***
Steal, theft and robbery	1.58 (1.32, 1.88) ***	2.06 (1.64, 2.58) ***

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$ | Fixed effects logistic regression

Table 3: The association between a change in the local crime rate and a change in the odds of experiencing psychological distress among men who remain in the same neighbourhood throughout the study period. Fixed effects logistic regression adjusted for time-varying confounders

MEN ONLY	Total crime	Non-domestic violence	Malicious damage	Break and enter	Steal, theft and robbery
			Odds Ratio (95% Confidence Interval)		
Crime (ref: tertile 1)					
tertile 2	1.09 (0.87, 1.35)	1.13 (0.87, 1.47)	1.06 (0.85, 1.32)	1.09 (0.89, 1.34)	1.23 (0.98, 1.54)
tertile 3	1.49 (1.09, 2.03) *	1.27 (0.90, 1.80)	1.39 (1.04, 1.86) *	1.59 (1.20, 2.11) ***	1.51 (1.15, 1.98) **
Age group (ref: 45y-54y)					
55y-64y	1.02 (0.77, 1.35)	1.00 (0.76, 1.33)	1.03 (0.78, 1.37)	1.03 (0.78, 1.37)	1.04 (0.78, 1.38)
65y-74y	1.04 (0.68, 1.59)	1.00 (0.65, 1.52)	1.08 (0.70, 1.66)	1.07 (0.70, 1.64)	1.07 (0.70, 1.63)
$\geq$ 75y	0.57 (0.33, 1.00) *	0.54 (0.31, 0.94)	0.61 (0.35, 1.07)	0.61 (0.35, 1.06)	0.60 (0.34, 1.05)
Annual household income (ref: $\leq$ $19k)					
$20k - $39k	0.66 (0.53, 0.82) ***	0.66 (0.53, 0.82)	0.66 (0.53, 0.82) ***	0.66 (0.53, 0.82) ***	0.65 (0.53, 0.81) ***
$40k - $69k	0.65 (0.49, 0.86) **	0.65 (0.49, 0.86)	0.66 (0.50, 0.87) **	0.65 (0.49, 0.86) **	0.65 (0.49, 0.86) **
$\geq$ $70k	0.44 (0.32, 0.62) ***	0.44 (0.32, 0.61)	0.45 (0.32, 0.63) ***	0.45 (0.32, 0.62) ***	0.44 (0.32, 0.62) ***
Missing	0.66 (0.51, 0.85) ***	0.66 (0.51, 0.85)	0.66 (0.51, 0.85) ***	0.66 (0.51, 0.84) ***	0.66 (0.51, 0.85) ***
Economic status (ref: Retired)					
Employed	1.06 (0.80, 1.41)	1.08 (0.81, 1.44)	1.06 (0.79, 1.41)	1.06 (0.79, 1.41)	1.05 (0.79, 1.40)
Disabled or long-term sick	2.39 (1.62, 3.51) ***	2.41 (1.64, 3.55)	2.36 (1.61, 3.48) ***	2.35 (1.60, 3.46) ***	2.37 (1.61, 3.49) ***
Unemployed	1.33 (0.76, 2.34)	1.38 (0.79, 2.42)	1.38 (0.79, 2.42)	1.42 (0.80, 2.49)	1.35 (0.77, 2.37)
Missing	1.49 (1.02, 2.17) *	1.47 (1.01, 2.15)	1.47 (1.01, 2.15) *	1.51 (1.03, 2.20) *	1.48 (1.01, 2.17) *
Couple status (ref: In a couple)					
Not in a couple	1.39 (1.02, 1.90) *	1.37 (1.00, 1.86)	1.39 (1.02, 1.90) *	1.40 (1.03, 1.91) *	1.41 (1.03, 1.93) *
Missing	0.91 (0.46, 1.82)	0.89 (0.45, 1.77)	0.93 (0.47, 1.87)	0.89 (0.44, 1.76)	0.90 (0.45, 1.81)
Physical functioning (ref: Low)					
Moderate	0.82 (0.67, 1.00)	0.83 (0.68, 1.01)	0.82 (0.67, 1.00) ***	0.82 (0.67, 1.00) *	0.81 (0.66, 0.99) *
High	0.82 (0.63, 1.08)	0.84 (0.64, 1.09)	0.82 (0.63, 1.07)	0.82 (0.63, 1.08)	0.81 (0.62, 1.06)
Missing	1.17 (0.98, 1.41)	1.20 (1.00, 1.44)	1.18 (0.98, 1.42)	1.18 (0.98, 1.42)	1.17 (0.97, 1.41)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$ | Fixed effects logistic regression | Adjusted for time-varying confounders | Men only

Table 4: The association between a change in the local crime rate and a change in the odds of experiencing psychological distress among women who remain in the same neighbourhood throughout the study period. Fixed effects logistic regression adjusted for time-varying confounders.

WOMEN ONLY	Total crime	Non-domestic violence	Malicious damage	Break and enter	Steal, theft and robbery
			Odds Ratio (95% Confidence Interval)		
Crime (ref: tertile 1)					
tertile 2	1.68 (1.38, 2.04) ***	1.18 (0.93, 1.48)	1.62 (1.35, 1.95) ***	1.44 (1.21, 1.72) ***	1.36 (1.13, 1.63) ***
tertile 3	2.01 (1.52, 2.66) ***	1.09 (0.80, 1.47)	2.40 (1.88, 3.05) ***	1.77 (1.39, 2.26) ***	1.65 (1.30, 2.09) ***
Age group (ref: 45y-54y)					
55y-64y	0.78 (0.62, 0.96) *	0.74 (0.59, 0.92) **	0.84 (0.67, 1.05)	0.77 (0.62, 0.96) *	0.78 (0.62, 0.96) *
65y-74y	0.38 (0.27, 0.53) ***	0.34 (0.24, 0.48) ***	0.44 (0.32, 0.63) ***	0.38 (0.27, 0.54) ***	0.38 (0.27, 0.53) ***
$\geq$ 75y	0.12 (0.07, 0.21) ***	0.11 (0.06, 0.18) ***	0.16 (0.09, 0.26) ***	0.12 (0.07, 0.20) ***	0.12 (0.07, 0.21) ***
Annual household income (ref: $\leq$ $19k)					
$20k - $39k	0.82 (0.67, 0.99) *	0.80 (0.66, 0.97) *	0.83 (0.69, 1.01)	0.82 (0.68, 0.99) *	0.81 (0.67, 0.98) *
$40k - $69k	0.76 (0.59, 0.96) *	0.74 (0.58, 0.94) *	0.77 (0.60, 0.98) *	0.75 (0.59, 0.95) *	0.75 (0.59, 0.96) *
$\geq$ $70k	0.77 (0.59, 1.01)	0.73 (0.56, 0.96) *	0.80 (0.61, 1.05)	0.76 (0.58, 1.00) *	0.76 (0.58, 1.00) *
Missing	1.00 (0.82, 1.21)	0.99 (0.82, 1.20)	1.01 (0.84, 1.23)	1.00 (0.82, 1.20)	1.00 (0.82, 1.21)
Economic status (ref: Retired)					
Employed	0.77 (0.61, 0.99) *	0.79 (0.62, 1.01)	0.76 (0.59, 0.97) *	0.77 (0.60, 0.98) *	0.77 (0.60, 0.98) *
Disabled or long-term sick	1.41 (1.01, 1.97) *	1.42 (1.02, 1.98) *	1.43 (1.02, 1.99) *	1.40 (1.01, 1.96) *	1.43 (1.03, 2.00) *
Unemployed	1.47 (1.00, 2.17)	1.50 (1.02, 2.21) *	1.50 (1.01, 2.21) *	1.46 (0.99, 2.15)	1.48 (1.00, 2.17) *
Missing	1.13 (0.90, 1.41)	1.15 (0.92, 1.44)	1.13 (0.91, 1.42)	1.14 (0.92, 1.43)	1.13 (0.91, 1.41)
Couple status (ref: In a couple)					
Not in a couple	1.05 (0.79, 1.39)	1.01 (0.77, 1.34)	1.05 (0.80, 1.39)	1.05 (0.79, 1.38)	1.03 (0.78, 1.36)
Missing	0.71 (0.38, 1.33)	0.65 (0.35, 1.22)	0.73 (0.39, 1.36)	0.70 (0.38, 1.31)	0.68 (0.37, 1.27)
Physical functioning (ref: Low)					
Moderate	0.79 (0.66, 0.95) *	0.79 (0.66, 0.95) *	0.77 (0.64, 0.93) **	0.79 (0.65, 0.95) *	0.79 (0.65, 0.95) *
High	0.80 (0.65, 1.00) *	0.83 (0.67, 1.03)	0.77 (0.62, 0.96) *	0.81 (0.66, 1.01)	0.81 (0.66, 1.01)
Missing	1.23 (1.06, 1.43) **	1.25 (1.08, 1.45) **	1.17 (1.00, 1.36) *	1.22 (1.05, 1.42) **	1.23 (1.06, 1.43) **

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$ | Fixed effects logistic regression | Adjusted for time-varying confounders | Women only