The effect of neighbourhood cohesion on mental health across sexual orientations:
a longitudinal study

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Abstract

Given the persistent mental health disparities between sexual minorities and the general population, social epidemiological research should address this disparity by investigating the differential impact of neighbourhood social environments across sexual orientations. There is growing evidence that neighbourhood cohesion, conceptualized as a sense of belonging and social connection, is an important social determinant of mental health in the general population, but little is known about its impact across sexual orientations.

Using data from the *UK household longitudinal study* (2009-2018) including waves 1, 3, 6, and 9 ($n= 52,903$), this paper examined the longitudinal relationship between neighbourhood cohesion and mental health (using GHQ-12) across sexual orientations. A fixed-effect regression approach was taken to model the within-person change over time in GHQ predicted by neighbourhood cohesion with disaggregated analyses by gender and sexual orientation.

Across all sexual orientations and genders, individuals who experienced an increase in neighbourhood cohesion also saw an improvement in their mental health over time. Moreover, the effect of neighbourhood cohesion on mental health over time differed by sexual orientation. Each 1-point increase in neighbourhood cohesion (on a 5-point scale) lead to mental health improvements of -0.8 GHQ score (95%CI -0.89 to -0.71) for heterosexual males at the lowest end, and up to -1.71 GHQ score (95%CI -2.31 to -1.11) for homosexual men at the highest end.

Given that the study demonstrates notable differences in the effects of neighbourhood social environment across gender and sexual orientations, this points to the need to consider sexual orientation (along with gender) as a key modifier in research involving neighbourhood effects. Future studies should evaluate the effectiveness of specific policies aimed at improving the neighbourhood social environment for sexual minorities to help close mental health disparities.

Keywords: *LGB health, mental health, neighbourhood effects, social cohesion*

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Introduction

There is growing evidence that neighbourhood social environment can shape mental health¹⁻⁴. Given that the average person spends a third of their day in their residential neighbourhood⁵, the formation of social cohesion (i.e. a sense of belonging and social connections) in the neighbourhood setting may be an important social determinant of mental health. Studies have found that neighbourhood cohesion can improve mental health in the general population^{2,3,6-36}. However, studies of neighbourhood cohesion on the mental health across ethnic groups have inconsistent findings³⁷⁻⁴¹, and the impact of neighbourhood cohesion on lesbian, gay, and bisexual (LGB) individuals is virtually unknown due to the lack of prior research.

LGB individuals have consistently reported worse mental health⁴²⁻⁴⁸ (e.g. depression⁴⁵, anxiety⁴⁶, and suicide-related behaviours^{47,48}) as compared to the general population. A meta-analysis based on studies conducted in the UK ($n=94,818$) found that homosexual and bisexual individuals had poorer mental health compared to heterosexuals. Another study presented evidence that heterosexuals had lower rates of psychological distress when compared to homosexuals and bisexuals (16.8%, 26.2%, and 34.0% respectively, differences all at $p<0.001$)⁴⁴. Understanding the relationship between neighbourhood cohesion and LGB mental health may help inform the development of LGB social inclusionary policies to help close the mental health disparity.

What is neighbourhood social cohesion:

Neighbourhood social cohesion, often used interchangeably with *neighbourhood cohesion* or *social cohesion*, generally refers to a sense of belonging in one's neighbourhood and social connections shared with one's neighbours^{6,49}. There has been increasing efforts to define neighbourhood cohesion with greater consistency and conceptual rigour, demonstrated by continuous refinement of validated instruments across multiple studies^{4,9,10,50–53}; with one of the most popular instruments created by Buckner⁴⁹, featured in large scale surveys such as the *UK household longitudinal study* (UKHLS)⁵⁴ and the *Caerphilly Health and Social Needs Study* in Wales⁵⁵.

Buckner's measure of neighbourhood cohesion includes 3 constructs: 1) the degree of neighbouring within the neighbourhood, 2) the psychological sense of community, and 3) the level of attraction to the neighbourhood⁴⁹. The measure of neighbouring in the community is developed through simple actions such as daily casual greetings to helping one another (e.g. borrowing items, shovelling the driveway, house sitting, etc.) which builds on the level of trust felt within the neighbourhood^{7,56}. This element of trust amongst neighbours is an important part of developing a strong sense of community⁵⁰. The psychological sense of community is also cultivated through shared norms and values held by residents in the neighbourhood⁵⁷. Residents who are able to identify with their fellow neighbours are more inclined to bond and build trusting relationships. Individuals who report feeling a strong community belonging show more inclination to

remain residing in the area and are incentivized to dedicate time and energy to improve and maintain the neighbourhood^{58,59}.

Buckner's measure of neighbourhood cohesion has been validated and used in North America^{50,51}, the UK^{53,60}, Europe⁹, and Asia^{10,52}. A validation analysis of Buckner's neighbourhood cohesion index showed adequate levels for homogeneity, with an internal consistency of $\alpha = 0.813$; for test-retest reliability, the intra-class correlation coefficient was 0.701 (95% CI 0.497 to 0.832)¹⁰. This instrument was also validated for use at a small-area-level and individual level perception of neighbourhood cohesion⁶¹. A shortened instrument was adapted to be used for the *UK household longitudinal study*⁵⁴ and *Caerphilly Health and Social Needs Study*⁵⁵ to fit the context of a community survey.

Neighbourhood cohesion and mental health:

There were three systematic reviews that examined the effects of neighbourhood cohesion on mental health published in 2002, 2012 and 2019^{4,32,36}. In general, they found that while cross-sectional studies were able to find a positive relationship between neighbourhood cohesion and mental health, longitudinal studies had inconsistent results. Cross-sectional studies have consistently reported that high neighbourhood cohesion is associated with reduced mental distress^{2,3,6-29}. In a random sample of residents in the Netherlands ($n = 18,173$), an increase of neighbourhood cohesion was associated with lowered psychological distress with a standardized effect of -0.16 (95% CI -0.27 to -0.06) on the Kessler Psychological Distress Scale¹². However, the study sample was recruited only from 4 cities in the Netherlands with the highest population density,

which limits the generalizability of the results to non-urban areas. A pooled analysis of elderly adults in the UK from multiple surveys (combined $n = 10,312$) found a moderate association between neighbourhood cohesion and mental wellbeing⁸. For each standard deviation increase in neighbourhood cohesion, effect sizes between different surveys ranged from +0.80 (95% CI 0.65 to 0.94) up to +1.86 (95% CI 1.57 to 2.25) on the Warwick-Edinburgh scale. However, the use of cross-sectional design in all of the above studies have limited ability to establish the direction of effect between neighbourhood cohesion and mental health.

On the contrary, longitudinal studies have not consistently found an association between neighbourhood cohesion and mental health^{30,31,33–35,51,56}. A study found that while residents in low cohesion neighbourhoods experienced a decline of -1.94 Mental Health Inventory score (95% CI -3.09 to -0.79) over 7 years, residents in neighbourhoods with medium and high levels of cohesion did not experience an improvement in mental health³⁰. In a 5-year follow-up study, researchers did not find an association between neighbourhood cohesion and the odds of incident depression for either men or women³¹. The study mentions that the null findings could be the result of its relatively small sample size ($n = 2609$) and short follow-up time, and potentially underpowered to detect a change in depression status. A cohort study ($n = 15,438$) in Central and Eastern Europe found that a decrease in social cohesion score was associated with increased odds of depressive symptoms in men (OR 1.13, 95% CI 1.05 to 1.23) but not in women³⁴. A limitation of this study is that neighbourhood cohesion was only

measured at baseline but it could have changed over the study period of 3 years. The practice of measuring neighbourhood cohesion at a single point in time may also be a limitation in other longitudinal studies^{33,51,56}. While previous studies have found that the impact of neighbourhood cohesion on mental health differs between subgroups, including gender^{16,19,31,33,34} and ethnic minorities³⁷⁻⁴¹, further investigation is necessary to understand the impact of neighbourhood cohesion for other population subgroups.

Neighbourhood cohesion by sexual orientation:

Investigations into mental health disparities between the general population and sexual minorities have primarily drawn on minority stress theory to explain these mental health differences^{62,63}. These LGB minorities stressors include family rejection⁶⁴, social isolation from the LGB community⁶⁵, social ostracization by members of certain religious and political groups^{62,64}, and exposure to LGB hate-crimes⁶⁶. While minority stress theory has helped to identify and quantify the effects of a number of unique LGB stressors⁶²⁻⁶⁶, this body of literature has typically not considered how social determinants of mental health affecting the general population (e.g. social and neighbourhood cohesion) may have a differential impact for sexual minorities⁶⁷. However, it is still unclear how neighbourhood cohesion plays a part in influencing mental health disparities across sexual orientations. To fill the existing knowledge gap, *my study addresses the potential longitudinal effect of neighbourhood cohesion on mental health across sexual orientations.*

The current body of evidence examining the effect of neighbourhood cohesion on mental health is limited by small sample size^{7,14,19,31}, convenience sampling^{6,8,9,12,21,27}, the overuse of cross-sectional design^{2,3,6-29}, and neglects to address the potential differential impact on sexual minorities. Using a large, nationally representative *UK household longitudinal survey* (UKHLS)⁶⁸, this study uses data collected from 2009 - 2018 to answer the following research question: Are changes in neighbourhood cohesion associated with mental health change over time? Does it differ by sexual orientations?

Methods

The study sample, drawn from *the UK household longitudinal study*⁶⁸, is a stratified, clustered, random sample of households recruited in the first wave (2009-2011) in addition to a small number of pre-existing households from the British Household Panel Survey (BPHS) for a total of approximately 40,000 households at baseline. Respondents in the household over the age of 16 were interviewed every 1-2 years. At the time of our study, a total of 9 waves were available for analysis (2009-2018)⁶⁹. Further information about this survey can be found at <https://www.understandingsociety.ac.uk/>. This paper used data from waves 1, 3, 6, and 9 based on the variables of interest in this study.

Predictor Variables

Sexual Orientation

Respondents were asked “Which of the following options best describes how you think about yourself?”, and provided with the following options: 1) heterosexual/straight; 2) gay/lesbian; 3) bisexual; 4) other; 5) prefer not to say. Sexual orientation was captured through a self-completed survey without an interviewer to ensure they were comfortable to disclose⁷⁰. Similar single question methods for identifying sexual orientation have been validated against a multi-question instrument (developed to broadly capture life-time sexual identity, behaviours, and attraction)⁷¹. Kappa statistics for agreement between the single item question and the multi-question instrument was 0.89. Sexual orientation was treated as time-invariant in this study. The reason being that LGB individuals often take time to come to terms with their sexuality (i.e. the coming-out process); therefore, the sexual orientation indicated in participants’ latest response was used to identify their sexual orientation.

Buckner’s Neighbourhood Cohesion

Neighbourhood cohesion was measured using the Buckner’s neighbourhood cohesion index collected in Waves 1, 3, 6, and 9⁵⁴. Adapted from the original questionnaire, the survey used a shortened form which included 1 of 4 items measuring attraction to neighbourhood, 3 of 6 items measuring social interactions within the neighbourhood, and 4 out of 9 items measuring psychological sense of community. The questions were rated on a scale of 1

(strongly agree) to 5 (strongly disagree). These responses were totaled and derived to reflect a final cohesion score of 1 for lowest cohesion to 5 for highest cohesion. Cronbach's alpha for all 4 waves were between 0.86 to 0.88, which demonstrates a high level of internal consistency for the measure. The shortened version of Buckner's neighbourhood cohesion index is found in *Appendix 1*.

Outcome Variable

General Health Questionnaire (GHQ-12)

Mental health status was measured using a validated, short-form version of the General Health Questionnaire⁷². The GHQ-12 has proven to be a quick, reliable, and sensitive tool best suited for surveys and frequently incorporated into research studies^{73,74}. It is a 12-item, self-administered screening measure used to measure psychological distress in the general population. The GHQ-12 has been shown to be an excellent proxy tool for detecting psychological distress when used in community and public health surveys⁷⁵. UKHLS summed and converted valid answers to all 12 questions from the original questionnaire, administered in every wave, into a single scale⁷⁶. The GHQ was scored on a scale of 0 to 36 with higher scores representing a greater degree of psychological distress.

Control Variables

The study included within-person estimator (i.e. individual-level fixed-effect) to control for observed and unobserved time-invariant factors (e.g. race, ethnicity, family history of mental illness), year fixed-effect to control for macroeconomic fluctuations, household fixed-effect to account for unobserved

household characteristics, and region fixed-effect to account for persistent regional differences (e.g. geographically differential access to healthcare). For the region fixed-effect, individuals were categorized as a resident of one of the following 12 regions: North-east of England, North-west, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South-East, South-West, Wales, Scotland, and Northern Ireland. The study also controlled for time-variant individual-level confounders (with data collected at each wave) including age, marital status, household income, physical health (measured with the SF-12 physical component score), and whether they have relocated since the last wave. Natural log of age was used in models to ensure it was not collinear with year. The study also accounted for regional time-variant confounders, which included region-level deprivation (measured by the mean regional income from 2009-2018 National Survey for Living Costs and Food⁷⁷) and LGB density. Studies show that LGB-specific stressors such as social isolation from the LGB community can influence LGB mental health^{62,63,65}. As a measure of LGB social isolation, regional LGB density was derived through the Annual Population Survey from 2012-2018⁷⁸.

Statistical Analysis

A fixed-effects (“within-person”) model was applied to this study as it controls for the impact of all observed and unobserved time-invariant characteristics⁷⁹. Model 1 is a fixed-effect regression to model the GHQ change across person-years predicted by individual fixed-effect, year fixed-effect, household fixed-effect, region fixed-effect, neighbourhood cohesion, and time-

variant control variables (i.e. LGB density, region-level income, physical health, age, residential relocation, marital status, and household income). An interaction term was used to test whether the effects of change in neighbourhood cohesion vary by sexual orientation (i.e. homosexual, bisexual, heterosexual, other, and prefer not to say). Model 2 and 3 were specified in the same way as Model 1, but were gender stratified (i.e. Model 2: male-only analysis, Model 3: female-only analysis). All models were estimated using the PLM package 2.2-3 in R Studio (version 1.2.5001).

Sensitivity Analysis

Neighbourhood effects on health research may be vulnerable to residential self-selection bias resulting from neighbourhood preferences and residential choice⁸⁰. While this study used a longitudinal design and within-person estimators (i.e. individual fixed-effects) to control for unmeasured characteristics that remain constant throughout the study period (e.g. family history of mental illness), a sensitivity analysis was conducted to ensure that the observed longitudinal relationship between neighbourhood cohesion and mental health remained even in the absence of residential relocations. By combining within-person estimators and a sensitivity analysis that excluded all movers, the sensitivity analysis could eliminate the possibility that the reported results were an artifact of residential self-selection bias.

Results

The baseline descriptive statistics of the study participants ($n = 52,903$) is detailed in *Table 1*. The distribution of our study sample across sexual orientations was consistent with other population-based surveys (i.e. sexual minorities typically account for 2-3% of the sample)⁸¹. When cross-tabulated with GHQ scores, it showed that baseline mental health was lower for bisexuals, followed by homosexuals, with heterosexuals reporting the lowest level of psychological distress. GHQ scores were also cross-tabulated with exposure variables, neighbourhood cohesion, and other demographic variables such as gender, age, marital status, and household income. The change in neighbourhood cohesion over the period of Wave 1 to Wave 9 ranged from -4.00 to 4.00 and has a standard deviation of 1.09 (see *Figure 1*).

Regression Results

Across all sexual orientations and genders, individuals who experienced an increase in neighbourhood cohesion also saw an improvement in their mental health (i.e. decrease in psychological distress) over time (Models 1-3). Moreover, the effect of neighbourhood cohesion on mental health over time differed by sexual orientation. Even among sexual minorities, there were significant gender differences in the effect of neighbourhood cohesion on mental health (e.g. gay men vs. lesbians). All models below adjusted for the following variables: 1) individual fixed-effect, 2) year fixed-effect, 3) household fixed-effect, 4) region fixed-effect, 5) neighbourhood cohesion, and 6) time-variant control variables including regional LGB density, residential relocation since the previous

interview, SF-12 physical health component, region-level deprivation, natural log of age, marital status, and household income.

In Model 1, a fixed-effect model that included both male and female participants, there were significant differences in the effect of neighbourhood cohesion on psychological distress between heterosexuals (reference group) and sexual minorities (all at $p < 0.01$ or lower). Heterosexuals who experienced a 1-point increase in neighbourhood cohesion over time (i.e. on a 5-point scale), saw a decrease in psychological distress of -0.87 (95% CI -0.93 to -0.81, $p < 0.001$) change in GHQ score, where a lower score indicated better mental health (see *Table 2*). A similar increase in neighbourhood cohesion for homosexuals was associated with a further decrease in GHQ score of -0.62 compared to heterosexuals (95% CI -1.04 to -0.21), which meant that 1-point increase in neighbourhood cohesion was associated with -1.49 GHQ score for homosexuals (95% CI -1.97 to -1.02). With each point increase in neighbourhood cohesion, bisexual individuals saw an additional decrease -0.73 in GHQ score compared to heterosexuals (95% CI -1.14 to -0.32). In other words, each point increase in neighbourhood cohesion was associated with a GHQ score change of -1.60 for bisexuals (95% CI -2.07 to -1.13). While others and prefer not to say had differing effects of neighbourhood cohesion point increase on GHQ, (-0.99, 95% CI -1.52 to -0.47) and (-1.68, 95% CI -2.1 to -1.26) respectively, the ambiguous nature of these categories impedes any further interpretation of these effects. As such, the following gender-stratified analyses will include these results in the table but omit any additional interpretations.

Figure 2 (interaction plot for Model 1) shows that bisexuals had the steepest slope followed by homosexual and finally heterosexual individuals. In a follow-up analysis, a three-way interaction was tested to examine the effect of change in neighbourhood cohesion on mental health across sexual orientations and gender. The results (not shown) indicated a significant 3-way interaction (i.e. effect of neighbourhood cohesion varied by sexual orientation and gender) at $p < 0.05$; therefore, gender stratified analyses were conducted.

In the male stratified analysis (Model 2 -- *Table 3*), changes in neighbourhood cohesion had the greatest effect on the mental health of homosexual men, followed by bisexual, and finally heterosexual men ($p < 0.05$ for all interactions). The results showed that a 1-point increase in neighbourhood cohesion was associated with an improvement in GHQ of -0.80 (95% CI -0.89 to -0.71, $p < 0.001$) for heterosexual men, -1.71 (95% CI -2.31 to -1.11) for homosexual men, and -1.48 (95% CI -2.18 to -0.78) for bisexual men. An interaction plot for the male stratified analysis, seen in *Figure 3*, shows how homosexual men had the steepest slope followed by bisexual men and finally heterosexual men.

For the female stratified analysis (Model 3 -- *Table 4*), while a change in neighbourhood cohesion had the strongest effect on psychological distress for bisexual women ($p < 0.01$ for the difference between bisexual and heterosexual), a relatively smaller effect was found for homosexual and heterosexual women ($p = 0.415$ for the difference between homosexual and heterosexual women). Given a 1-point increase in neighbourhood cohesion, there was a predicted change

of -0.92 (95% CI -1.00 to -0.83, $p<0.01$) in GHQ score for heterosexual women, -1.20 (95% CI -1.95 to -0.44) for homosexual women, and -1.68 (95% CI -2.32 to -1.03) for bisexual women. *Figure 4* shows an interaction plot for the female stratified analysis where the predicted values of bisexual females had the steepest slope followed by homosexual females and finally heterosexual females.

Sensitivity Analysis

When individuals who moved within the study time frame were removed from the sample, the effect of neighbourhood cohesion (change over time) continued to have a differential influence on the psychological distress of heterosexuals versus sexual minorities (with interaction of cohesion*sexual orientation significant at $p<0.01$). Results show that with a 1-point change in neighbourhood cohesion, there was a predicted change in GHQ score of -0.87 (95% CI -0.94 to -0.81, $p<0.001$) in GHQ score for heterosexuals, -1.44 (95% CI -1.93 to -0.95) for homosexuals, and -1.53 (95% CI -2.03 to -1.04) for bisexuals, with $p<0.01$ for all interaction terms. *Figure 5* shows an interaction plot for the sensitivity analysis where the predicted values of bisexuals had the steepest slope followed by homosexual and finally, heterosexual individuals.

Discussion

This study provides evidence that neighbourhood cohesion has a dose-response relationship with mental health over time (i.e. increases in neighbourhood cohesion led to decrease in mental distress over time), which supports the results of prior studies^{30,31,33–35,51,56}. This study uniquely contributes to the literature by providing evidence that this relationship differs by sexual orientation: gay and bisexual men and bisexual women benefit more than their heterosexual counterparts from an improvement in neighbourhood cohesion, while lesbians were similarly affected as heterosexual women. To help contextualize the effect of a step-change in neighbourhood cohesion (i.e. 1 point on a 5 point scale) on GHQ in this study (i.e. ranging from 0.8 GHQ for heterosexual men, 1.2 for lesbians, 1.6 for bisexual women, and up to 1.7 for gay men), it is important to note that the general population in Western Europe has mean GHQ of 10.8 and SD of 4.7⁷⁵. At the lowest end, GHQ score of heterosexual males is expected to improve by 0.17 standard deviations for a 1-step increase in neighbourhood cohesion, while at the highest end, homosexual males' GHQ score improves by 0.36 standard deviations for the same increase in neighbourhood cohesion. While the models included *others* and *prefer not to say* as options for sexual orientation, the interpretation of these categories remain difficult as it is unclear who they are (e.g. queer, asexual, pansexual, etc.).

This study contributes to research on neighbourhood effects on health since much of this literature has neglected to investigate potential differential impact across sexual orientations, with notable exceptions in recent years^{82,83}.

While there is growing high-quality evidence linking social cohesion and mental health, to date, there are no longitudinal studies documenting the effect of neighbourhood cohesion on mental health across sexual orientations. Given that the study demonstrates notable differences in the effects of neighbourhood across gender and sexual orientations, this points to the need to consider sexual orientation (along with gender) as a key modifier in research involving neighbourhood effects. This study contributes to research on social determinants of LGB health, by showing that social determinants of health for the general population may have a different impact on sexual minorities. The study also demonstrates that neighbourhood effects on mental health may have varying levels of impact even within the larger category of ‘sexual minority’, e.g. the impact of neighbourhood cohesion on mental health for lesbians and bisexual women were different. To ensure that differences by gender and sexual orientations are not neglected, future studies may consider the use of gender stratification and further disaggregated analysis by sexual orientation as demonstrated in this study.

There are several aspects of this study that could limit the generalizability of the findings. 1) UKHLS measure of sexual orientation (based on a single item question on sexual identity) does not include questions on sexual behaviours - which might lead to exclusion of individuals who are uncomfortable with LGB labels but nonetheless engage in same-sex sexual activities (e.g. men who have sex with men that do not identify as gay/bisexual⁸⁴). Individuals with sexual orientations other than heterosexual, bisexual, and homosexual (e.g. asexual,

pansexual, and queer) may feel that they were not well represented on the survey question. These individuals may have chosen the “other” category for their sexual orientation, or they may have chosen what they thought was the next best fit. Due to the ambiguous nature of “other” and how individuals with atypical sexual orientations might have responded, study results may not be generalizable to these groups. 2) UKHLS survey questions also did not include questions on transgender and non-binary gender identities, which limited the analysis only to sexual orientations. 3) The study’s use of participant-assessed neighbourhood exposure (i.e. neighbourhood cohesion) could potentially lead to same-source bias since an individual’s mental health status may influence their judgment of their neighbourhood⁸⁵. Since neighbourhood cohesion is based on an individual’s self-assessment, it may not necessarily reflect the general collective opinion of each neighbourhood’s residents. Information on individual assessments versus neighborhood-wide collective assessment of neighbourhood cohesion is not available through the UKHLS (due to the low number of participants per neighbourhood), but could be used in future studies to further clarify whether the effect of collectively assessed neighbourhood cohesion on mental health differs by sexual orientations. 4) While the study cannot capture every unobserved time-variant confounders (e.g. sudden death of a friend), individual qualities such as their capacity to handle stressful situations (i.e. resilience) are accounted for by the individual fixed-effect. Also, major events such as Brexit and economic recession would have been accounted for through the models’ time fixed-effect.

Despite these limitations, this study also had a number of methodological improvements compared to prior studies. While prior studies on neighbourhood cohesion suffered from limitations including small sample size^{7,14,19,31}, convenience sampling^{6,8,9,12,21,27}, and the overuse of cross-sectional design^{2,3,6–29}, this study utilized a large, randomly-stratified, nationally representative panel sample to provide stronger evidence of the effect of neighbourhood cohesion on mental health. By using a within-person estimator (i.e. individual fixed-effect), along with household, year, and region-level fixed-effects, the study ensures that unobserved time-invariant confounders at the individual level (e.g. genetics or family history of mental illness), household factors (e.g. household composition, the impact of living in a dysfunctional household, etc.), time-variant large scale socioeconomic shocks (e.g. Brexit and economic recessions), and region-specific factors (e.g. geographically differential access to healthcare) are accounted for in this study. The use of sensitivity analysis also ensured that the effects of neighbourhood cohesion on mental health (across sexual orientations) are not an artifact of residential selection effect.

Policy relevance of study

A sense of neighbourhood cohesion involves developing a sense of belonging and building substantial relationships with other members in the neighbourhood. Evidence from this study indicates that the need for a sense of belonging in one's neighbourhood may be heightened for gay men, and bisexual men and women compared to the general population. Our findings point to the need for a range of programs that foster social cohesion and inclusion for sexual

minorities. One example of these programs includes the development of ‘positive space’ campaigns across various institutional⁸⁶ and municipal⁸⁷ settings aimed at using visual cues in public spaces (such as rainbow stickers and flags) to denote a welcoming atmosphere for sexual minorities. In the 2017 *HouseProud* study, LGBTQ+ social housing residents indicated that the following policies would improve inclusiveness: 1) having a dedicated LGBTQ+ liaison (to represent their concerns and address harassment incidents), 2) having visible symbols of LGBTQ+ inclusivity throughout their community, and 3) implementing certification for housing providers to show they have a culture of social acceptance towards LGBTQ+ people⁸⁸. The development of such policies to increase a sense of belonging for LGBTQ+ individuals may improve their mental health. Future studies could evaluate whether the implementation of these policies may improve sense of belonging, and in turn, the mental health of sexual minorities.

Conclusions

Neighbourhood cohesion is an important social determinant of mental health for both sexual minorities and the general population. This study points to the importance of considering sexual orientation in studies of neighbourhood effects on mental health. Additional research to investigate what specific interventions may improve social cohesion for sexual minorities are necessary.

Table 1: Baseline characteristics of study population

Sample characteristics		Proportions (<i>n</i>)	Mean GHQ score (<i>SD</i>), higher is worse
<i>n</i> = 52,903			
Sexual Orientation	Heterosexual	92.5% (48,944)	10.9 (5.32)
	Homosexual	1.4% (761)	11.7 (6.01)
	Bisexual	1.7% (919)	13.0 (6.63)
	Other	1.2% (655)	11.9 (6.50)
	Prefer not to say	3.1% (1,624)	11.1 (5.91)
	p-value	--	
Gender	Male	45.1% (23,844)	10.3 (5.09)
	Female	54.9% (29,059)	11.5 (5.57)
Age	< 25 years	24.1% (12,725)	10.5 (5.58)
	26 - 45 years	33.6% (17,756)	11.2 (5.43)
	46 - 64 years	29.4% (15,539)	11.4 (5.53)
	65+ years	12.9% (6,866)	10.1 (4.44)
Marital status	Single + Divorced + Widowed (married & civil partnership)	52.2% (27,606)	11.2 (5.78)
	Married + Civil Partner (legal)	45.5% (24,089)	10.7 (4.90)
Household income	Quartile 1 (lowest) < \$1536.61	25.0% (13,217)	11.8 (6.01)
	Quartile 2 \$1536.61 - \$2457.51	25.0% (13,221)	11.1 (5.48)
	Quartile 3 \$2457.51 - \$3673.17	25.0% (13,218)	10.7 (5.12)
	Quartile 4 (highest) > \$3673.17	25.0% (13,221)	10.4 (4.84)
Neighbourhood Cohesion	Low (<3.4)	17.9% (9,494)	11.8 (5.70)
	Medium (3.4 - 3.9)	15.0% (7,915)	10.8 (5.01)
	High (>3.9)	22.5% (11,916)	10.4 (5.01)

Table 2: Individual fixed effect model predicting the effect of change in neighbourhood cohesion on GHQ-12 score by sexuality

Predictors	Estimates (95% CI)	p-value
Neighbourhood cohesion (NC)	-0.87 (-0.93, -0.81)	<0.001
NC * heterosexual	reference group	---
NC * homosexual	-0.62 (-1.04, -0.21)	<0.01
NC * bisexual	-0.73 (-1.14, -0.32)	<0.001
NC * others	-0.12 (-0.59, 0.34)	0.599
NC * prefer not to say	-0.81 (-1.17, -0.45)	<0.001
SF-12 physical health	-0.004 (-0.008, 0.001)	<0.1
Residential relocation	0.10 (-0.14, 0.35)	0.395
Marital status (0 for not married, 1 for married)	-0.01 (-0.15, 0.12)	0.795
Household income (in £1000)	-0.009 (-0.017, -0.002)	<0.01
LGB density (% of population identifying as LGB)	0.22 (0.10, 0.34)	<0.001
Region-level income (in £1000)	0.04 (0.01, 0.07)	<0.01

Model 1 is predicted by: 1) individual fixed-effect, 2) year fixed-effect, 3) household fixed-effect, 4) region fixed-effect, 5) neighbourhood cohesion, 6) time-variant control variables (i.e. LGB density, physical health, residential relocation, region-level deprivation, age, marital status, and household income)

Table 3: Individual fixed effect model predicting the effect of change in neighbourhood cohesion on GHQ-12 score by sexuality for males

Predictors	Estimates (95% CI)	p-value
Neighbourhood cohesion (NC)	-0.80 (-0.89, -0.71)	<0.001
NC * heterosexual	reference group	---
NC * homosexual	-0.91 (-1.42, -0.40)	<0.001
NC * bisexual	-0.68 (-1.29, -0.07)	<0.05
NC * others	-0.005 (-0.69, 0.68)	0.988
NC * prefer not to say	-1.16 (-1.67, -0.65)	<0.001
SF-12 physical health	-0.01 (-0.02, -0.008)	<0.001
Residential relocation	-0.04 (-0.39, 0.29)	0.777
Marital status (0 for not married, 1 for married)	-0.03 (-0.23, 0.17)	0.751
Household income (in £1000)	-0.008 (-0.01, 0.001)	0.073
LGB density (% of population identifying as LGB)	0.19 (0.03, 0.36)	<0.05
Region-level income (in £1000)	0.06 (0.02, 0.10)	<0.001

Model 2 is predicted by: 1) individual fixed-effect, 2) year fixed-effect, 3) household fixed-effect, 4) region fixed-effect, 5) neighbourhood cohesion, 6) time-variant control variables (i.e. LGB density, physical health, residential relocation, region-level deprivation, age, marital status, and household income)

Table 4: Individual fixed effect model predicting the effect of change in neighbourhood cohesion on GHQ-12 score by sexuality for females

Predictors	Estimates (95% CI)	p-value
Neighbourhood cohesion (NC)	-0.92 (-1.00, -0.83)	<0.001
NC * heterosexual	reference group	---
NC * homosexual	-0.28 (-0.95, 0.39)	0.415
NC * bisexual	-0.76 (-1.32, -0.20)	<0.01
NC * others	-0.16 (-0.81, 0.48)	0.480
NC * prefer not to say	-0.55 (-1.05, 0.05)	<0.05
SF-12 physical health	0.003 (-0.003, 0.009)	0.360
Residential relocation	0.24 (-0.11, 0.60)	0.176
Marital status (0 for not married, 1 for married)	-0.006 (-0.19, 0.18)	0.952
Household income (in £1000)	-0.01 (-0.02, -0.0002)	<0.05
LGB density (% of population identifying as LGB)	0.25 (0.08, 0.41)	<0.01
Region-level income (in £1000)	0.02 (-0.009, 0.06)	0.135

Model 3 is predicted by: 1) individual fixed-effect, 2) year fixed-effect, 3) household fixed-effect, 4) region fixed-effect, 5) neighbourhood cohesion, 6) time-variant control variables (i.e. LGB density, physical health, residential relocation, region-level deprivation, age, marital status, and household income)

Figure 1: Distribution of Neighbourhood cohesion change from wave 1 to 9 of UKHLS

Figure 2: Relationship between predicted GHQ-12 score and neighbourhood cohesion (NC) by sexual orientation (including both males and females)

Figure 3: Relationship between predicted GHQ-12 score and neighbourhood cohesion (NC) by sexual orientation for males-only

Figure 4: Relationship between predicted GHQ-12 score and neighbourhood cohesion (NC) by sexual orientation for females-only

Figure 5: Relationship between predicted GHQ-12 score and neighbourhood cohesion (NC) by sexual orientation, including only non-movers for sensitivity analysis (including males and females)

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Appendix

Appendix 1: Buckner's neighbourhood cohesion index used in UKHLS

#	Buckner's neighbourhood cohesion index Questions	Concept
1	I feel like I belong to this neighbourhood	Psychological sense of community
2	The friendships and associations I have with other people in my neighbourhood mean a lot to me	Psychological sense of community
3	If I needed advice about something I could go to someone in my neighbourhood	Measure neighbouring
4	I borrow things and exchange favours with my neighbours	Measure neighbouring
5	I would be willing to work together with others on something to improve my neighbourhood	Psychological sense of community
6	I plan to remain a resident of this neighbourhood for a number of years	Attraction to neighbourhood
7	I like to think of myself as similar to the people who live in this neighbourhood	Psychological sense of community
8	I regularly stop and talk with people in my neighbourhood	Measure neighbouring