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## Community severance and health – A novel approach to measuring community severance and examining its impact on the health of adults in Great Britain

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## ABSTRACT

**Background:** Aspects of community severance (the separation of people from goods, services, and each other by busy roads or other transport infrastructure) have been linked to poor health and wellbeing, but few studies have examined this relationship. We created a novel index for community severance and estimated its association with the self-rated health of adults in Great Britain.

**Methods:** Data were collected from a nationally representative online panel survey of 4,111 participants, February–July 2016. To construct an index, polychoric factor analysis (suitable for ordinal variables), was conducted on four survey items related to the perceived impact of roads on ability to walk locally. Community severance index (CSI) scores were negatively skewed, so were categorised into four groups (lowest 40%, second, third, highest). We examined the association of community severance with self-rated health ‘poor’ (fair/bad/very bad) versus ‘good’ (very good/good) using logistic regression, adjusting for potential confounders (age, income, employment status).

**Main results:** Polychoric factor analysis confirmed that it was appropriate to combine the four survey items into a single index (Cronbach’s Alpha = 0.86; Keiser-Meyer-Olkin measure of sampling adequacy = 0.76, factor loadings >0.74). After controlling for confounding factors, being in the highest CSI group was associated with higher odds of reporting poor self-rated health (Odds Ratio: 1.79, 95% Confidence Interval: 1.48–2.17) compared with the lowest CSI group. There was a dose-response gradient, with those in the second and third highest CSI groups also having increased odds of reporting poor self-rated health, though of lower magnitude ((1.21, 95% CI 1.01–1.45) and (1.41, 95% CI 1.16–1.71) respectively).

**Conclusions:** We found an inverse association between CSI and self-rated health. This suggests that to improve health, local governments and road authorities should take steps to reduce community severance through traffic reduction and calming, pedestrian prioritisation, and the installation of well-designed crossing points.

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## 1. Introduction

### 1.1. Community severance

Despite the benefits of connectivity, reliance on motorised travel can have detrimental impacts on the health of populations, due to increased obesity through sedentary behaviour (McCormack and Virk, 2014). Motorised travel also generates harmful air and noise pollution (Beelen et al., 2008; Tzivian et al., 2017; Sørensen et al., 2015), and injuries through collisions (Wang et al., 2013; Retallack and Ostendorf, 2020). To add to this, there is a small but growing body of research into the concept of the “barrier effect” or “community severance”, referring to the separation of people from goods, services, and each other by busy roads or other transport infrastructure, either completely, or because crossing the infrastructure (as a pedestrian) is risky and/or unpleasant. This barrier effect can be static (a physical barrier such as a road or railway line, without pedestrian crossings); dynamic (a barrier created by the volume or speed of traffic); or psychological (an unpleasant road environment or perceptions of risk).

Despite appearing in transport planning documents since the 1960s, (UK MOT, 1963) there has been little in terms of standardisation of measurement of community severance or application of tools. Attempts to measure community severance are varied and have included stated preference models measuring willingness to pay to reduce severance (Grisolía et al., 2015), impacts on walkability in the local area (Clark et al., 1991), pedestrian delays (Guo et al., 2001). Some studies have used a combination of tools, including participatory mapping, spatial analysis, surveys on participant perceptions about traffic and walking, and qualitative methods (Mindell et al., 2017).

Most studies of community severance have focussed on the barrier effect of busy roads on the residents on either side (Grisolía et al., 2015; Appleyard and Lintell 1972). However, busy arterials have also been linked to poor perceptions of liveability even on nearby streets that contain many features of “liveable streets”, such as low traffic volumes and high-quality urban design (Marshall and McAndrews 2017). This suggests the importance of considering the impact of major roads on the people living in the surrounding area.

The provision of crossing points does not necessarily reduce severance and so it is not an “easy fix” for the problem. Grade-separated crossing facilities such as footbridges or underpasses are often inaccessible to pedestrians with restricted mobility and can have an unpleasant or intimidating environment. Crossing points that are far away may also contribute to the suppression of walking trips, especially for older people (Anciaes and Jones 2018). The clearance time for traditional signalised crossing points in the United Kingdom (‘Pelican crossings’) has required that people walk at least 1.2 m/s to cross the road, which excludes the majority of older people, who walk more slowly (Asher et al., 2012, Webb et al., 2017). Since December 2019, local authorities have had the power to reduce the assumed walking speed to 1.0 m/s where they consider it necessary (DfT 2019), though it is not clear how many have made changes. In sum, poor-quality crossing facilities may contribute to “secondary severance” (Anciaes et al., 2016).

The divisive effect of road traffic is experienced at a greater level by those who are less able to cross busy roads, e.g., older people, those with restricted mobility, and children, who lose independent mobility if crossing is, or is perceived by parents to be, dangerous (Smith and Gurney, 1992; Hillman et al., 1990). For example, in a stated preference study, participants who reported a poor health condition or who had mobility restrictions had the lowest probability of choosing to cross roads with high traffic speeds (Anciaes, 2015).

### 1.2. Community severance and health

The mechanism through which community severance is theorised to affect health is through the large or busy road acting as a barrier by suppressing walking trips, increasing sedentary behaviours, and reducing local social contacts. This barrier effect can also impede access to amenities important to health, such as food shops, services, parks, recreation facilities, employment, and education (Mindell and Karlsen 2012). There is a significant body of research that links low social contact to poor health. The review by Holt-Lunstad et al. (2010) found that having many social contacts has the same (large) effect on reducing mortality as quitting smoking. Walkable neighbourhoods, characterised by low levels of motorised traffic, roads that are safe and convenient to cross, and high-quality urban design, are associated with better health-related quality of life (Zhao and Chung 2017) and with increased walking for transport (Ribeiro and Hoffmann 2018). The seminal study by Appleyard and Lintell (1972) in San Francisco found an inverse relationship between traffic volume and number of neighbours known to the research participants. This has been replicated in other cities. For example, a study of three streets in Bristol (UK) confirmed that community severance by traffic affected the number of social contacts reported; the perception of the size of an individual’s “home territory”; and levels of independence granted to children (Hart and Parkhurst 2011). A study by Sauter and Hüttenmoser in Basel (Switzerland) focused on traffic speed, rather than volume, and found that despite good urban design, streets with fast moving traffic negatively affected the frequency and intensity of neighbourhood social contact (Sauter and Hüttenmoser 2008).

Perceptions of traffic may have an impact on health behaviours and encourage sedentary behaviour. The review by Jacobsen et al. (2009) found that negative perceptions of motorised traffic were associated with lower propensity to walk and/or cycle. Fear of collisions, delays, and the unpleasantness of being near traffic were all reasons suggested by the author.

Since Mindell and Karlsen’s 2012 systematic review into community severance and health, which found that there were no studies exploring the association between community severance and health, there has been one paper published examining this effect on health or wellbeing measures. A 2019 study by Anciaes et al. linked perceptions of road traffic conditions and their impact on walking to measures of subjective wellbeing. Participants with the worst perceptions of road traffic and associated impact on walking reported, on average, much lower subjective wellbeing than those who did not.

The UCL Street Mobility Project (2014–2017) collected data from the communities around four busy roads in England and produced a suite of tools including a stated preference survey, participatory mapping, spatial analysis, a video survey, street audits, and a neighbourhood mobility survey (Mindell, 2014). Analysis of data collected in areas surrounding four busy roads in England suggested an effect of community severance on wellbeing (Anciaes et al., 2019). The present study uses nationally representative data collected among adults in England, Wales, and Scotland to 1) create an index of community severance, and 2) examine its association with self-rated health.

This paper makes two contributions to the community severance literature and the wider transport and health literature. The first contribution is to develop an index of community severance based on perceptions about various aspects of travel, directly reported by survey participants. A previous index of severance inferred perceived severance through participant choices over scenarios for crossing the road (Anciaes and Jones 2020). These scenarios have an implicit destination that pedestrians need to access across the road. Our index captures general perceptions of severance, including psychological aspects, independently of the type of destinations on the other side of the road. The second contribution of the paper is to estimate associations between levels of community severance and

**Table 1**  
Descriptive statistics stratified by gender, weighted.

Variables	Variable category	Men N (%)	Women N (%)	Total N (%)
<i>N Unweighted</i>		1,991	2,120	4,111
N (valid %)		1,959 (100)	2,057 (100)	4,016 (100)
Self-rated health	Poor	776 (40)	748 (36)	1,524 (38)
	Good	1,183 (60)	1,310 (64)	2,493 (62)
Community Severance	Lowest (<1.1)	783 (40)	779 (38)	1,562 (39)
	Second (1.10–1.72)	465 (24)	481 (23)	946 (24)
	Third (1.73–2.22)	330 (17)	421 (20)	751 (19)
	Highest (>=2.23)	381 (19)	376 (18)	757 (19)
Age group	18–34	451 (23)	698 (34)	1,149 (29)
	35–44	313 (16)	348 (17)	661 (16)
	45–54	381 (19)	342 (17)	724 (18)
	55–64	308 (16)	270 (13)	578 (14)
	65–74	415 (21)	345 (17)	760 (19)
	75 +	90 (5)	54 (3)	144 (4)
Ethnicity	White	1,828 (93)	1,897 (92)	3,725 (93)
	Other	131 (7)	161 (8)	291 (7)
Education	None, primary or secondary	1,283 (65)	1,365 (66)	2,648 (66)
	University or higher	676 (35)	693 (34)	1,369 (34)
Income	>£41,000	481 (25)	387 (19)	869 (22)
	£28,001–£41,000	475 (24)	439 (21)	914 (23)
	£21,000–£28,000	306 (16)	292 (14)	599 (15)
	£14,001–£21,000	300 (15)	334 (16)	634 (16)
	≤£14,000	273 (14)	435 (21)	708 (18)
	Prefer not to say	123 (6)	170 (8)	293 (7)
Employment status	Employed full/part time	1,165 (59)	1,110 (54)	2,275 (57)
	Unemployed or other economically inactive <sup>a</sup>	233 (12)	269 (13)	502 (12)
	Retired	527 (27)	413 (20)	941 (23)
	Homemaker	34 (2)	265 (13)	299 (7)
Relationship status	In a relationship	1,226 (63)	1,172 (57)	2,399 (60)
	Single	548 (28)	548 (28)	1,132 (28)
	Widowed/separated/divorced	184 (9)	301 (15)	485 (12)
Disability	Yes	401 (20)	395 (19)	796 (20)
	No	1,558 (80)	1,663 (81)	3,221 (80)
How often do you meet or see any of your neighbours?	Less than once or twice a month	276 (14)	336 (16)	612 (15)
	Once or twice a month	282 (14)	331 (16)	614 (15)
	Once or twice a week	739 (38)	790 (38)	1,529 (38)
	More than once or twice per week	662 (34)	600 (29)	1,261 (31)
What proportion of people who live on your side of the road do you know?	None	112 (5)	141 (7)	253 (6)
	Not many	590 (30)	646 (31)	1,236 (31)
	Some	731 (37)	728 (35)	1,459 (36)
	Most	526 (27)	543 (26)	1,069 (27)
Presence of a car in the household	No	334 (17)	526 (26)	860 (21)
	Yes	1,625 (83)	1,531 (74)	3,156 (79)
Location type <sup>b</sup>	Urban (population >10,000)	849 (43)	788 (38)	1,637 (41)
	Town and fringe	700 (36)	858 (42)	1,559 (39)
	Village, hamlet and isolated dwelling	409 (21)	412 (20)	821 (20)

<sup>a</sup> 'Other economically inactive' encompasses those who are not employed, retired, nor a homemaker but do not meet the definition of 'unemployed' (which includes 'actively seeking work').

<sup>b</sup> As defined by the Office for National Statistics for England and Wales.

self-rated health, testing whether community severance is linked to poorer health. As noted above, to our knowledge, no other studies have quantified these associations, although there are various plausible pathways from severance to health, as shown by Mindell and Karlsen (2012).

## 2. Material and methods

### 2.1. Data source and study design

Data used in this analysis are cross-sectional and come from an Omnibus survey conducted in 2015 by the polling company Populus, who manage a panel of 115,000 participants across Great Britain (i.e. England, Scotland, and Wales). Omnibus surveys collect data from participants on a variety of subjects during the same interview. Demographic data is collected in a standardized format in each survey. Clients can then pay to add questions to the survey. Surveys are completed online. In order to gather a representative sample of the Great Britain population, the company uses quota sampling and weighting techniques. Targets for quotas and rates stem from the National Readership Survey, a randomly selected annual study of 34,000 adults in the UK (JICNARS, 1991). Researchers from UCL purchased questionnaire space, adding questions relating to community severance measures and social contact (Supplementary material Appendix 1). These were answered by 4,111 individuals aged 18+, in February and July of 2016.

### 2.2. Characteristics of the participants

Table 1 shows sample characteristics stratified by gender. The final sample size after deletion of participants with missing data was 4,021. 62% of the weighted sample reported their health as being “good” or “very good”. This value is lower than the national averages reported by the 2015 Health Survey for England (76%) (UK Data Service, 2015c) and the 2015 Scottish Health Survey (74%) (UK Data Service, 2015a), but higher than the average reported by the 2015 Welsh Health Survey (UK Data Service, 2015b) (51%). 7% of participants described their ethnicity as non-white, in line with national averages (ONS 2019). 20% of participants had a disability or long-term health condition, similar to averages reported in the 2011 census for England (18%) (ONS 2013), Wales (23%) (ONS 2013), and Scotland (20%) (NRS 2011). The presence of a car in the household (79%) was similar to car ownership in the population of Great Britain (78%) (Office of National Statistics, 2019).

### 2.3. Data

#### 2.3.1. Exposure - community severance

The Omnibus survey included six questions developed as part of the “My Neighbourhood, My Streets” questionnaire created by the Street Mobility and Network Accessibility Project (Appendix 1) (Scholes et al., 2016). The survey asked: “Thinking about everywhere within a 20-min walk or about a mile of your home, how often, if ever, do the following factors affect your ability to walk to places?” Participants selected any number of the following options:

- Speed of traffic
- Amount of traffic
- Lack of crossing points (for example, for nearby roads, railways, or waterways)
- Crossings do not allow adequate time to cross
- Poor lighting, poor pavements or paths
- Noise pollution or air pollution

Participants ranked their experience of these factors in terms of affecting their ability to walk to places using four categories: never, occasionally, often, always. Based on our review of the literature, we selected the questions relating to speed of traffic, amount of traffic, lack of crossing points, and adequate crossing time as the questions most suited to measuring community severance. The other two aspects (lighting/pavements/paths and noise/air pollution) are not directly related to the ease of crossing roads (e.g., they are also experienced when walking along roads and, in the case of noise/air pollution, also inside buildings).

#### 2.3.2. Outcome measure - self rated health

Self-rated health was measured using a Likert scale of five responses: very good, good, fair, bad, and very bad. These responses were condensed for the main analyses to binary responses of ‘good’ (very good and good) and ‘poor’ (fair, bad and very bad). Dichotomising responses to the self-rated health question has been shown to produce similar results to retaining their ordinal state (Manor et al., 2000).

#### 2.3.3. Confounders and effect modifiers

The following variables were identified as potential confounders to adjust for in the multivariate regression model due to possible associations with both self-rated health and community severance: age group (18–34, 35–44, 45–54, 55–64, 65–74, 75+); gender (male, female); ethnicity (white, non-white); employment status (employed full or part time, unemployed, retired, homemaker); relationship status (single, in a relationship, widowed/separated/divorced); and income groups (up to £14,000, £14,001–£21,000, £21,001 to £28,000, £28,001 to £41,000, >£41,000, and prefer not to answer). Associations with both self-rated health (Table 3) and

community severance (Supplementary material Table A2) were found for age, income, and employment status.

Other variables were classed as potential mediators and so were not adjusted for in the regression modelling (i.e., lying on the theorised causal pathway between community severance and health). This includes: 1) the two measures for local social contact (seeing neighbours once per week or less vs. more than once per week, and the proportion of people known who live on the participant's side of the road); 2) disability or long-term health condition status (yes, no); 3) the presence of a car in the household (yes, no) and 4) the type of home location (urban (population >10,000); town and fringe; village, hamlet and isolated dwelling).

## 2.4. Analysis

### 2.4.1. Factor analysis

We used factor analysis to condense the results of the four selected survey questions into one latent variable that could be used as a scoring system to measure participants' perception of community severance. Standard factor analysis based on a Pearson correlation matrix assumes that the variables are continuous and follow a multivariate normal distribution. As our data was based on Likert scales and is categorical and ordinal, factor analysis using a polychoric correlation matrix produces a more accurate representation of the data (Holgado-Tello et al., 2010).

Factors were selected for inclusion based on Kaiser's criterion (i.e., eigenvalue > 1) and examination of a scree plot. The Kaiser-Meyer-Olkin test was used to assess sampling adequacy with scores assessed as: in the 0.90s 'marvellous'; in the 0.80s 'meritorious'; in the 0.70s 'middling'; in the 0.60s 'mediocre'; in the 0.50s 'miserable'; and below 0.50 'unacceptable' (Kaiser et al., 1974). To examine whether the variables were not inter-correlated, we used Bartlett's Test of Sphericity (Bartlett 1950) and accepted a significant result at  $p < 0.05$  to reject the null hypothesis, as factor analysis is valid only where the factors are inter-related. To test the internal reliability of the scale items, we used Cronbach's alpha, which requires a minimum acceptable result of 0.7 (Cronbach 1951). To assess the factors most important to the underlying latent variable and suitability for inclusion, we used varimax rotation (Kaiser 1958). Recommended rules for acceptable factor loadings for consideration vary from 0.32 (Tabachnick and Fidell 2013) to up to 0.70 dependent on sample size and number of factors. As a rule of thumb, Hair suggests a sample size of 350 to consider factor loading scores of 0.35 statistically significant (Hair, 2010). Given that the sample size was over 4000, we selected a cut-off point of 0.35 for considering factor loadings for inclusion.

### 2.4.2. Multivariable modelling

We used binary logistic regression to model the dichotomised outcome variable of "good" vs. "poor" self-rated health adjusting for demographic and socio-economic factors. We also modelled the community severance outcome to identify potential confounders (Supplementary table A2). Variables that were associated with both outcomes (good/poor health and community severance) in age-adjusted analyses ( $p < 0.10$ ) were adjusted for in the multivariate regression. A likelihood ratio test was performed on the model after the inclusion of each variable to examine improvement to model fit (inclusion supported if  $p < 0.10$ ). Likewise, the likelihood ratio test was used to examine whether environment type or the presence of a car in the household modified the severance and self-rated health association. To examine possible multicollinearity between the independent variables, we examined variance inflation factors scores, with scores of 10 or more indicating multicollinearity (Chatterjee and Hadi 2006). The analysis was conducted using Stata 16.0. Factor analysis and multicollinearity tests used the *polychoric* and *collin* extensions to Stata, respectively.

Considering the risk of lost information when categorising variables, we also analysed community severance as a continuous variable within both a logistic regression and a multinomial regression using self-rated health as a four-point category variable (very good, good, fair and poor, combining bad and very bad into one category due to low numbers). This is available in the supplementary information Tables A3-A5).

### 2.4.3. Missing data

The following questions had small numbers of participants selecting "prefer not to answer": ethnicity (36 participants), educational status (38) and marital status (19). A further 11 participants selected "don't know" for educational status. As numbers of missing data were so small, we performed a complete case analysis, deleting the participants with data missing on ethnicity, educational status, and/or marital status from the dataset. After deletion, there were 4,021 participants remaining.

The largest number of missing values were in the income variable (324, reduced to 289 after the previous deletions). While the lowest income groups are usually the most likely to not report multiple information, the highest income group have been shown to give a single non-response to questions on income (Lillard et al., 1986). Participants with missing data on income were coded as "prefer not to say" and analysed as a separate group.

**Table 2**  
Factor loadings (Varimax Rotation).

Variable	Factor 1 (eigenvalue = 2.89) Loadings	Uniqueness	Kaiser Meyer Olkin Test result
Speed of traffic	0.90	0.19	0.73
Amount of traffic	0.90	0.19	0.72
Lack of crossing points	0.85	0.29	0.81
Adequate crossing time	0.74	0.45	0.81

**Table 3**  
Logistic regression of potential explanatory factors with poor self-rated health.

Variable (reference group)	Bivariate associations with poor self-rated health, adjusted for age		Multivariate associations (final model) <sup>a</sup>	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Community severance (lowest)				
<i>Second</i>	1.27 (1.07–1.51)	0.006	1.21 (1.01–1.45)	0.036
<i>Third</i>	1.52 (1.26–1.83)	<0.001	1.41 (1.16–1.71)	<0.001
<i>Highest</i>	1.92 (1.60–2.30)	<0.001	1.79 (1.48–2.17)	<0.001
Age (18–34)				
<i>35–44</i>	1.67 (1.36–2.06)	<0.001	1.90 (1.52–2.39)	<0.001
<i>45–54</i>	2.45 (2.00–2.99)	<0.001	2.65 (2.13–3.29)	<0.001
<i>55–64</i>	3.26 (2.64–4.03)	<0.001	3.10 (2.43–3.94)	<0.001
<i>65–74</i>	2.64 (2.17–3.22)	<0.001	2.44 (1.75–3.39)	<0.001
<i>75+</i>	2.39 (1.68–3.42)	<0.001	1.99 (1.26–3.15)	0.003
Gender(male)				
<i>Female</i>	0.97 (0.85–1.10)	0.606		
Ethnicity (white)				
<i>Non white</i>	1.13 (0.87–1.47)	0.371		
Education (university or higher)				
<i>None, Primary or secondary</i>	1.50 (1.30–1.74)	<0.001		
Income (highest)				
<i>Second highest</i>	1.58 (1.27–1.96)	0.001	1.30 (0.96–1.76)	0.095
<i>Middle</i>	1.70 (1.27–1.96)	<0.001	1.48 (1.19–1.84)	<0.001
<i>Second lowest</i>	2.64 (2.10–3.32)	<0.001	1.54 (1.21–1.96)	0.001
<i>Lowest</i>	3.74 (2.99–4.68)	<0.001	2.26 (1.79–2.89)	<0.001
<i>Prefer not to say</i>	1.64 (1.22–2.21)	<0.001	2.61 (2.06–3.31)	<0.001
Employment (Employed full and part time)				
<i>Unemployed/other economically inactive</i>	3.73 (3.02–4.62)	<0.001	2.91 (2.32–3.65)	<0.001
<i>Retired</i>	1.71 (1.28–2.26)	<0.001	1.52 (1.14–2.03)	0.005
<i>Homemaker</i>	2.20 (1.71–2.82)	<0.001	1.80 (1.40–2.33)	<0.001
Marital Status (in a relationship)				
<i>Single</i>	1.48 (1.25–1.74)	<0.001		
<i>Separated/divorced/widowed</i>	1.23 (1.00–1.50)	0.048		
How often do you meet/see neighbours? (Three or more times a week)				
<i>Once or twice a week</i>	1.04 (0.89–1.22)	0.594		
<i>Once or twice a month</i>	1.16 (0.94–1.42)	0.165		
<i>Less often or never</i>	1.42 (1.15–1.75)	0.001		
What proportion of people who live on your side of the road do you know? (Most)				
<i>Some</i>	0.98 (0.83–1.16)	0.806		
<i>Not many</i>	1.53 (1.29–1.83)	<0.001		
<i>None</i>	1.35 (1.00–1.84)	0.051		
Car in household (car)				
<i>No car</i>	1.74 (1.49–2.04)	<0.001		
Location (urban)				
<i>Town and fringe</i>	1.04 (0.90–1.21)	0.603		
<i>Village, hamlet and isolated dwelling</i>	1.16 (0.97–1.39)	0.094		
<i>Constant</i>			0.12 (0.09–0.15)	<0.001

<sup>a</sup> Mutually adjusted for community severance, age, income and employment status.

#### 2.4.4. Using factor analysis to create a scoring system for community severance

The initial polychoric factor analysis conducted on the four categorical variables relating to community severance produced two factors, one with an eigenvalue of 2.89 and another of 0.21 (below Kaiser's criteria for inclusion). The scree plot also showed a steep slope after the first factor. We thus conducted another analysis retaining only one factor (Table 2). The Keiser-Meyer-Olkin test for sampling adequacy resulted in an acceptable overall result of 0.76. The lowest individual KMO was 0.72 for the "amount of traffic" and the highest at 0.81 for the "lack of crossing points" and adequate crossing times items.

Bartlett's test of sphericity resulted in a p value of <0.001, rejecting the null hypothesis that the variables are not inter-correlated. Cronbach's alpha, testing the internal reliability of the scale items, was 0.86, above the minimum acceptable figure of 0.70 suggesting acceptable levels of reliability.

The mean community severance score generated from the extracted factor was 1.7 (standard deviation 0.73, range 0.07 to 4.27), with higher scores indicating greater severance. The kurtosis score was 4.35 and the skewness was 1.28. A histogram indicated non-normality (Fig. 1). The variable was then split into four groups. Due to the considerable skew, 40% of the sample were categorised into the "lowest" group, and three further groups split into approximately 20% of the remaining sample each.



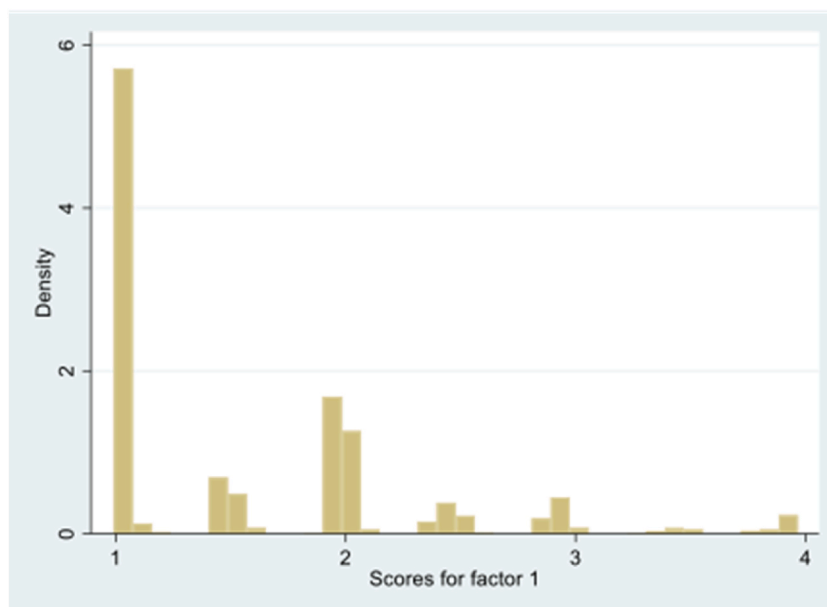


Fig. 1. Histogram of community severance scores.

### 3. Results

#### 3.1. Bivariate associations with poor self-rated health and community severance

Age-adjusted bivariate logistic regression analyses were performed to model the impact of possible confounding factors on the severance and self-reported health association. Results are shown in Table 3. Bivariate analysis indicated a significant positive association between high levels of severance and poor self-rated health (Odds ratio (OR) 1.92 for the highest versus lowest group (95% confidence interval 1.60–2.30). This relationship appeared to follow a dose-response pattern, with all levels of severance showing a positive association with poor self-rated health but with a declining magnitude.

How often participants met or saw their neighbours was statistically significantly associated with poor self-rated health only where participants met or saw their neighbours less often than once or twice a month or never. There was also a marginally significant association between those who reported knowing “none” and “not many” people on their side of the road and greater odds of poor health. As measures of social contact are theorised to be on the causal pathway between community severance and self-rated health, they were not included as potential confounders in the multivariate analysis.

Bivariate analysis adjusted for age indicated that those without a car in the household had greater odds of reporting poor health than those with one car in the household or more. Participants who lived in a rural environment (village or hamlet) or within a town/fringe area were more likely to report poor health than those in an urban environment.

All the variance inflation factors were below the acceptable level of 10, ranging from 1.02 to 1.26, indicating no multicollinearity between the independent variables.

#### 3.2. Multivariate associations

Table 3 shows the logistic regression model of the associations between self-rated health and community severance after adjusting for potential confounding factors. Variables with a likelihood ratio test result of more than  $p = 0.05$  were dropped from the analysis (e.g., relationship status).

Adjusting for age, income and employment status attenuated the odds of reporting poor self-rated health but they remained significantly raised for all three categories of severance. After controlling for confounding factors, being in the highest CSI group was associated with higher odds of reporting poor self-rated health (Odds ratio (OR): 1.79, 95% confidence interval (CI): 1.48–2.17) compared with the lowest CSI group. There was a dose-response gradient, with those in the second and third highest groups having increased odds of reporting poor self-rated health (OR: 1.21;95% CI: 1.01–1.45) and (OR 1.41 95%CI 1.16–1.71) compared to those in the lowest group respectively, though of lower magnitude.

The sensitivity analyses, with community severance as a continuous variable (Table S3) or as a four-category variable using both a binary (Table S4) and a four-point category measure of self-rated health (Table S5) produced similar results to those shown here.

### 3.3. Interactions

The interaction of community severance with the presence of a car in the household and urban and rural location was tested using logistic regression in the final multivariate model. There was no evidence to suggest that the association between community severance and self-rated health was modified by location type, or with the presence of a car in the household (data not shown).

## 4. Discussion

### 4.1. Community severance scoring

Perceptions of speed and volume of road traffic were the most important aspects of community severance in our factor analysis. Less important, but still loading at more stringent levels of inclusion, were factors relating to crossing points and adequate crossing time. This suggests that community severance is a combination of perceptions of traffic levels and of the ease of crossing the potential barrier.

Aspects of the ease of crossing may have lower loadings due to these elements being more keenly experienced by some groups (e.g., older people, women, people with children), whereas other groups (e.g., younger men) may feel more confident crossing a busy road without the safety of a crossing point. In [Anciaes and Jones \(2018\)](#) study of crossing preferences, women and older people had higher aversion towards footbridges and underpasses than men and younger people. As these factors may not impact those able to cross faster, the community severance factor score results may have been affected.

### 4.2. Community severance and potential confounding variables

Contrary to the literature, being in the oldest age groups appeared to decrease the likelihood of a high community severance index score. Although the relationship was not dose-response, the older age groups had increased odds of a lower community severance index scores than the youngest age group (18–34). It may be that the 18–35 group are more likely to notice community severance due to being more exposed to it in their daily lives. The 18–35 age group are more likely to take part in active travel ([Olsen et al., 2017](#)) and have reduced car ownership levels ([Chatterjee et al., 2018](#)) and live in dense urban areas. Being in the lowest income group was significantly associated with a higher community severance index score, as was being in a non-white ethnic group, being unemployed, retired and a homemaker.

### 4.3. Community severance and health

After adjusting for age, employment, education and income category as potential confounders, those with high or very high community severance index scores had higher odds of reporting poor self-rated health compared with the reference group, with a dose-response relationship. The route from community severance to poor health may involve decreased levels of social contact, increased levels of sedentary behaviour, lack of exercise and increased exposure to the physical and mental health impacts of air and noise pollution, and reduced access to goods, services, and opportunities ([Mindell and Karlsen 2012](#)).

While much of the limited literature suggests that one of the main functions through which community severance affects health is through its impact on social networks ([Appleyard and Lintell 1972](#)) and the importance of social networks for health ([Holt-Lunstad et al., 2010](#)), measures of social contact were only significantly associated with self-rated health at the lowest magnitude. The measures used for social contact (seeing neighbours more than once a week, and proportion of neighbours known on your side of the road) may have affected the accuracy of the results as there are many more aspects of social contact, for example, seeing friends and family members, that could be included in such an analysis. Reverse causality may also explain the association between seeing neighbours infrequently and poor self-rated health, as those seeing neighbours infrequently may be primarily those who are housebound or otherwise isolated due to poor health.

There was no evidence to suggest an interaction between environment type (urban/rural) and community severance and health. The use of a community severance scoring approach may have captured rural severance issues, such as instances where roads with high speeds, or a lack of pedestrian pavements, prevent some groups crossing safely. These examples would not be captured within a study that examined severance purely as a traffic volume/speed issue that may be more relevant in urban environments. These results suggest that community severance can occur in a variety of environment types and is not limited to busy city roads.

We theorised that the presence of a car in the household may positively affect the participant's access to services, employment, or local amenities that impact health despite high community severance index scores. However, no significant interaction between the presence of a car in the household, health and community severance was found in this study. This may have been affected by the survey design, as we do not know if the survey participants were able to use the car present in the household (as it could be used by another household member). In addition, the survey questions used to generate the community severance index ask about the participant's ability to walk to places, rather than their levels of access to amenities.

### 4.4. Strengths and limitations

The main strength of this study is as a starting point for assessment of the impact of community severance on health. Cross-sectional surveys are relatively quick and cheap to undertake, providing insight into issues without the expense of follow up and are also useful



for establishing the prevalence in the population of interest (Mann 2003). Given the scarcity of studies in this area, it provides a useful resource for hypothesis testing. It is also innovative in that it is one of the first attempts to create a community severance score for use in research. The questions asked were not complex and were therefore suitable for a participant to answer without assistance from a researcher. By including multiple aspects of community severance within a single measure, rather than single aspects (such as traffic volume), we may capture a fuller understanding of the negative impact of living near roads that cause severance.

The use of cross-sectional studies prevents assessment of causality compared with longitudinal studies examining changes over time (Olsen 2010a,b). This study only points to an association between community severance and poor self-rated health. Other limitations of the study include the use of panel data, which leads to a more compliant sample of participants who are more likely to take part in surveys. In addition, members of the population without internet access, as well as those residing permanently or temporarily in institutions and those who are homeless, were excluded from the sample, as occurs with most surveys of random samples of the general population (Mindell et al., 2012). However, those in hospital, prison, or residential care or nursing homes are unlikely to be affected by community severance unless they are able to walk around outside those premises.

The dichotomisation of the outcome variable self-rated health from a five-category variable, and the categorisation of the community severance variable may have resulted in some loss of information. Categorisation of community severance was selected for the main analysis to improve interpretation of results for policy makers. We conducted different sets of analysis to check for similarity of results (there are included in the supplementary material).

The dichotomisation of ethnic groups into “white” and “non-white” was necessary for producing large enough groups for analysis but was a limitation in terms of loss of important information. Ethnic groups in the UK have differences in self-rated health (Mindell et al., 2014) and this study suggested a relationship between ethnicity and community severance index score (OR 1.84 (95% CI 1.40–2.40) comparing non-white versus white participants) but not with self-rated health. A study with a larger sample size would provide more reliable information as to potential effect modification by ethnicity.

There may also be unadjusted confounding or missing control variables in this study. We do not have information on specific health behaviours such as smoking or alcohol intake nor levels of physical activity or sedentary behaviour, which could account for some of the levels of self-rated health (Sargent-Cox et al., 2014). Further research would benefit from considering these factors. Similarly, we had incomplete information about the characteristics of the participants’ residence location. Apart from community severance, the local terrain or steepness of the pavements or paths, and the local climatic conditions, may also affect the ease of walking around a neighbourhood (as occurred in one of our detailed case studies (Mindell et al., 2017)).

Our data was collected in 2016. Since the study, the Coronavirus pandemic (from 2020) changed many aspects of life either temporarily or permanently and may have affected how people experience community severance and how people travel (in general and in their local neighbourhood). The emergency measures to stem the effects of the pandemic (e.g., lockdowns, imposition of travel limitations and home-working) may have reduced community severance in some places (due to the reduction in motorised traffic). However, as most of those measures have now been lifted and traffic levels are closer to pre-pandemic levels, severance levels may have returned to previous levels. On the other hand, it is also possible that homeworking, reduced travel, and the temporary experience of living in a lower-traffic neighbourhood, may have increased people’s awareness of community severance, potentially increasing the effect we have identified.

#### 4.5. Conclusions and policy implications

An inverse association between community severance and self-rated health was identified in this study. Due to the cross-sectional design and the limitations surrounding quota sampling, caution should be exercised in interpreting these findings or generalising to the population of Great Britain. However, this study adds to a growing body of research that supports policies to reduce car domination and develop walkable and accessible streets conducive to activity and community cohesion.

While some steps have been taken to enable more liveable streets in Great Britain, such as allowing local authorities the power to increase the time given to cross at signalised crossing points (DfT 2019), it is unclear to what extent these new powers have been utilized or the impact they have yet had. The results of our analysis suggest that reducing the speed and volume of traffic on roads and increasing the availability of appropriately spaced and timed crossing points, are important in encouraging healthy neighbourhoods. Policy makers should therefore consider the impact of community severance prior to new developments and infrastructure, as well as strategies to reduce community severance where it already exists.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jth.2022.101368>.

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