Article:
Li, D., Ramos, M.R., Bennett, M.R. orcid.org/0000-0002-9523-6053 et al. (2 more authors) (2021) Does ethnic diversity affect well-being and allostatic load among people across neighbourhoods in England? Health & Place, 68. 102518. ISSN 1353-8292

https://doi.org/10.1016/j.healthplace.2021.102518

Title: Does ethnic diversity affect well-being and allostatic load among people across neighbourhoods in England?

Keywords: Health, well-being, allostatic load, neighbourhood, ethnic diversity

Authors: Danying Li [a,b,*], Miguel R Ramos [a,c], Matthew R Bennett [a], Douglas S Massey [d], Miles Hewstone [e]

Affiliations:

[a] Department of Social Policy, Sociology and Criminology, School of Social Policy, University of Birmingham, Birmingham, B15 2TT, United Kingdom

[b] Centre for Health Economics & Policy Innovation, Department of Economics & Public Policy, Imperial College Business School, Imperial College London, SW7 2AZ, United Kingdom

[c] Centro de Investigação e Intervenção Social, Instituto Universitário de Lisboa, 1649-026 Lisboa, Portugal

[d] Office of Population Research, Princeton University, Princeton, NJ, 08544, United States

[e] University of Oxford, Oxford, OX2 6AE, United Kingdom

*Corresponding author, email: danying.li@imperial.ac.uk

Abstract

Modern societies are facing unprecedented changes in their ethnic composition. Increasing ethnic diversity poses critical new challenges as people interact with new cultures, norms, and values, or avoid such encounters. Heated academic and political debates focus on whether and how changes in ethnic composition affect societies and local communities. Yet, there is insufficient scientific evidence of how living in a more diverse society affects individuals' well-being and health. The aim of this study is to test the extent to which increasing neighbourhood ethnic diversity affects individuals' subjective health and well-being and objective stress levels as measured by allostatic load.

We analyse a large panel data set containing over 47,000 English respondents living in 15,545 neighbourhoods in England from the British Household Panel Survey and the UK Household Longitudinal Study, from 2004 to 2011. We match respondents to neighbourhoods and merge contextual information about levels of neighbourhood ethnic diversity and deprivation from UK Censuses, whilst controlling for background characteristics. We distinguish between short- and long-term effects of ethnic diversity on individual subjective well-being and health as well as allostatic load using a set of multilevel mixed-effects models. We make cautious causal interpretations by estimating fixed-effects models and cross-lagged panel models. We assess the robustness of our findings by replicating our analysis using alternative composite measures of diversity and allostatic load.

In the short-term, increasing ethnic diversity of local areas is associated with a dip in subjective well-being, but short-term changes are not prolonged or profound enough to affect chronic stress (allostatic load). The initial negative impact of ethnic diversity on subjective well-being and health dissipates with time. In the long-term, no effects of ethnic diversity on well-being and health or chronic stress (allostatic load) are detected.

Understanding the dynamic nature of the effects of ethnic diversity on individuals has critical implications for social and public health policies – issues prominent in, for example, the UK (Brexit) and the US (election of President Donald Trump). Our analysis identifies and enables the promotion of beneficial effects, while targeting the pernicious components to turn diversity into a valuable asset in a globalising world.

Introduction

It is well established that some societal characteristics, such as social inequality, have profound consequences for well-being and health (Marmot, 2005). In a new era of globalisation and rapid social change, however, other challenging societal characteristics have also come to be seen as threats to well-being. One of the most prominent is ethnic diversity. In fact, many societies are now facing increases in ethnic diversity, and in several countries (e.g., UK, France) religious and ethnic hostility have come to be seen as the greatest threats to social stability (Pew Research Center, 2014). Today changes in demographic composition and speculation about the consequences of diversity have been at the forefront of both academic and political discussions, sparking heated debates about the effects of rising diversity on social cohesion, individual well-being, and public health. Pessimistic attitudes towards increasing ethnic diversity are emerging, as evidenced by the rise in populism in Europe and North America. Despite the significance of ethnic diversity and its rapid increase, we have limited knowledge about how living in a diverse society affects individual health.

This study aims to assess the influence of ethnic diversity on individual well-being and health. Here we defined ethnic diversity as the heterogeneity found in terms of ethnicity within a specific geographical area. Previous studies have largely focused on testing the relationship between neighbourhood ethnic diversity and trust or social cohesion, leading to a mixed pattern of negative, positive and mixed findings (Putnam, 2007, Laurence and Bentley, 2015, Schmid et al., 2014, Alesina and La Ferrara, 2002, Dinesen and Sønderskov, 2018). A few studies have investigated the effect of neighbourhood diversity on individual well-being (Tropp, 2019, Ramos et al., 2019), also yielding mixed results; and it remains unclear how objective measures of health are related to ethnic diversity. Our study addresses this confusion by assessing the impact of increasing ethnic diversity in local areas on individuals' subjective health and well-being, as well as their chronic stress levels, measured objectively by allostatic load. We adopt an emerging perspective of growing significance that considers the effects of social diversity on individual outcomes to stem from dynamic processes that unfold across time (Ramos et al., 2019, Page-Gould et al., 2008). To test this proposition, we merge contextual

neighbourhood data with two large nationally representative panel data sets – the British Household Panel Survey (BHPS) and the UK Household Longitudinal Study (UKHLS) (University of Essex Institute for Social Economic Research, 2017).

Several theories seek to explain how ethnic diversity negatively affects individuals' well-being and health. The *Threat Proposition* argues that increasing ethnic diversity cultivates hostility as superordinate groups perceive newcomers as threats (Blalock, 1967). Interacting with out-group members may also introduce uncertainty into social relations and lead to conflicts with in-group members, followed by increased prejudice and hostility toward out-groups, with important effects on individual well-being. *Constrict Theory* extends the possible effects of ethnic diversity from prejudice to trust and argues that, in ethnically diverse neighbourhoods, residents tend to "hunker down", hindering out-group and even in-group trust (Putnam, 2007). Similarly, the *Ethnic Density Hypothesis* proposes that individuals have better mental health when they live in areas with higher proportions of people of the same ethnicity (Shaw et al., 2012, Bécares et al., 2018). Better social support and networks within higher in-group density areas help explain why living in these areas is associated with a decreased risk of mental-health disorders (Das-Munshi et al., 2010, Stafford et al., 2010). It thus seems plausible to assume that negative well-being and adverse health outcomes result from ethnic diversity.

In contrast, *Contact Theory* argues that increased diversity leads to increased intergroup contact, which improves intergroup trust to reduce threat and lower levels of prejudice (Brown and Hewstone, 2005). Furthermore, recent research suggests that contextual effects of diversity ought to be considered as a dynamic process with both short-term and long-term effects on health and well-being (Ramos et al., 2019, Page-Gould et al., 2008). While an analysis of short-term effects of diversity may be suitable for observing perceived threats and negative responses to a new social context, analyses of longer-term effects are necessary to capture the net effect of ethnic diversity, after its initial challenges have been overcome (Ramos et al., 2019).

Whatever its effects on subjective well-being and health, diversity may also affect objective health outcomes, such as allostatic load (AL), defined as "wear-and-tear" on one's body when exposed to

stressful situations (McEwen, 1998a). If residents living in ethnically diverse areas perceive diversity as a threat or have prejudiced views towards out-group members, ethnic diversity may act as a stressor and lead to the secretion of stress-related hormones, at least in a short term. In particular, exposure to rising ethnic diversity may trigger the release of cortisol as part of the stress response of the HPA axis, as well as pro-inflammatory cytokines (e.g. IL-6) and inflammatory markers (e.g. C-reactive protein and fibrinogen). Based on small-scale experiments, Page-Gould and colleagues find that after a first interaction with a cross-ethnic partner, participants with higher prejudice scores display a peak in cortisol reactivity, but these responses diminish during subsequent interactions. However, it remains unclear how ethnic diversity in neighbourhoods, may affect stress indicators.

This paper contributes to the current debate concerning the effects of local ethnic diversity on individual-level well-being and health, measured both subjectively and objectively. Using data from the BHPS and the UKHLS linked to UK Censuses, we construct a large panel data set that consists of eight observational waves and 47,247 adults living in 15,545 English geographic units known as Lower Layer Super Output Areas (LSOAs).The use of panel data in diversity research is still rare and tracking individuals over time provides a more detailed and robust perspective than the typical cross-sectional or repeated cross-sectional analyses. Panel data methods also increase the strength of statistical inferences as the time ordering of events can be specified.

We empirically test the impact of ethnic diversity on individuals' subjective well-being and health using a multilevel and longitudinal approach (people nested in areas over time). Due to data limitations, the impact of ethnic diversity on AL is only tested in a cross-sectional setting, but we use a dynamic analysis allowing us to examine how short- and long-term changes in ethnic diversity relate to AL. Previous studies have not analysed subjective well-being and health and indicators of objective health. Here we compare findings on how diversity is associated with both subjective and objective outcomes, and further investigate the timeframe during which any adverse effects of ethnic diversity might dissipate. To our knowledge, we are the first to use a large nationally representative panel data set to assess the impact of ethnic diversity on both subjective well-being and AL.

Methods

Data and Design

This study merges individual-level and contextual-level data. Individuals are matched to their corresponding LSOAs using unique LSOA identifiers (See Supplementary Information SI for detailed description of the UK geographic units). Subjective well-being and health, as well as other individual characteristics, are drawn from the English sample of waves 14-18 of the BHPS and waves 1-3 of the UKHLS, covering 2004-2011 (see SI for detailed information of BHPS/UKHLS). Contextual information is only available between 2004 and 2011, resulting in the exclusion of BHPS/UKHLS waves outside of this timeframe.

Subjective health and well-being are measured with life satisfaction, and self-perceived physical health and mental health. Objective stress level is derived from the UKHLS Nurse Health Assessment (McFall et al., 2014, University of Essex Institute for Social Economic Research, 2014) and is measured by AL (SI Appendix 2). The AL analysis is cross-sectional and comprises fewer observations because the biomarkers are only available at one timepoint for each eligible BHPS (2011-2012) / UKHLS (2010-2011) participant.

We adopt LSOA as the contextual level of our analysis. LSOAs in England have a minimum population of 1000 and maximum of 3000. The levels above LSOA are Middle Layer Super Output Area (MSOA) and Local Authority District (LAD). MSOAs have a minimum of 5000 and maximum of 15,000 individuals, and LADs typically have populations of 25,000 to 200,000. Although LSOA, MSOA and LAD have all been used in the literature to define a neighbourhood, studies have illustrated that estimates are most robust and the effects are stronger when neighbourhood is defined at a smaller geographical level (Dinesen and Sønderskov, 2015). In addition, if ethnic diversity does affect individuals' well-being and health, this process is more likely to happen within their local areas because individuals perceive threats around them more strongly.

Contextual information, namely ethnic diversity and Index of Multiple Deprivation (IMD), of LSOAs are derived from the NewETHPOP Project (Rees et al., 2017) and the 2004, 2007 and 2010

English Indices of Multiple Deprivation. IMD is a composite measure of seven domains of deprivation, including income, employment, education, health, crime, barriers to housing and services, and living environment deprivation. It is the official measure of deprivation for LSOAs in England. NewETHPOP provides annual ethnic population estimates for English local authority districts (LADs) between the 2001 and 2011 UK Censuses. These estimates are used to calculate LSOA-level yearly ethnic diversity (see SI for the calculation). Linear interpolation is applied to obtain yearly LSOA-level IMD scores.

English participants with non-missing LSOA-level ethnic diversity and IMD information and a complete set of dependent/independent variables are included in the main analysis. LSOAs that changed boundaries between 2001 and 2011 are excluded from our analysis to ensure comparability (these LSOAs comprise less than 1% of our final sample). Our final sample thus consists of 121,736 individual-wave observations from 2004 to 2011 in 15,545 English LSOAs for subjective health and well-being analyses; and 7441 individuals in 4716 English LSOAs for the AL analysis.

Measures

Ethnic Diversity: We use the Herfindahl Index (Hirschman, 1964), a widely used measure of diversity in the literature, to measure ethnic diversity of English LSOAs. The index is calculated using Census categories based on 10 ethnic groups (white, black Caribbean, black African, other black, Indian, Pakistani, Bangladeshi, Chinese, other Asian, and others). Diversity is calculated using the formula:

$$HI_{k,t} = 1 - \sum_{j} S_{k,t,j}^{2}$$

where $S_{k,t,j}$ is the proportion of people who belong to ethnic group j in LSOA k at time t. This index ranges between 0 and 1, indicating the probability that two randomly selected individuals in an LSOA belong to different ethnic groups. A higher index value therefore indicates a greater level of ethnic diversity.

The 2001 and 2011 UK Censuses provide population statistics by ethnicity at the LSOA-level, leaving the demographic changes in ethnic population between intercensal years unknown. To

overcome this issue, we calculate the annual growth rates of population in each English LAD by ethnicity based on the NewETHPOP estimates (Rees et al., 2017) and calculate the population by ethnicity for LSOAs, assuming that population of each ethnic group in all LSOAs within the same LAD change at the same rate each year. We then calculate Herfindahl Index using the formula given above for all LSOAs and all intercensal years using our ethnic population estimates. There are concerns with the validity of our assumption. Assuming that the population of each ethnic group in all LSOAs within the same LAD changes at the same rate each year may not seem plausible. However, a Pearson's correlation test shows that LSOA-level ethnic diversity (measured by Herfindahl Index), calculated using our estimates for year 2011 is very close to that using 2011 UK Census ($r^2 = 0.975$). In addition, we calculated the LSOA-level change in ethnic diversity between 2001 and 2011 using UK Censuses data (*change_real*) and using our estimates (*change_estm*). The correlation between these two variables is strong ($r^2 = 0.71$). The mean difference between the two is 0.003. We therefore argue that our assumption is valid. Nonetheless, we also estimate our main model at the LAD level (See SI Table S5).

We also measure ethnic diversity with two alternative diversity indices as robustness checks (SI p.3-4): the Shannon's H Index (Shannon, 1948), and the Evenness Index (Mulder et al., 2004, Pielou, 1966). The Shannon's H Index is similar to the Herfindahl Index, but more weight is attributed to individuals belonging to smaller groups. This is a valuable alternative measure of diversity because if reflects people's common tendency to overestimate the proportion of minority group members in society (Ramos et al., 2019). The Evenness Index refers to how equal in size the different groups are in a given geographical space. When the Evenness Index is high, conflict between groups is more likely to occur. Both indices complement the Herfindahl Index and add valuable additional information regarding diversity in society. In additional analyses using these indices, our main results remain the same (see SI Table S1).

Well-being and Health: Individuals' subjective well-being and health are measured by a composite score with three dimensions: life satisfaction, self-perceived physical health and mental health, derived from the BHPS/UKHLS questionnaire (for detailed questions and answers, see SI p.5). We combine three dimensions into one subjective well-being and health score using factor analysis to depict the

overall profile of one's well-being and health[1]. Note that this factor analysis yielded one single factor, supporting the use of our composite indicator (see SI Appendix 2 for the details and quality of factor analysis and Ramos et al. (2019) for a similar approach). As a robustness check, we further break down the subjective well-being and health indicator into a well-being component (life satisfaction and self-perceived mental health) and a health component (self-perceived physical health). Our main results still hold (see SI Table S3).

We adopt the AL model proposed by McEwen (McEwen, 1998b) to measure individuals' objective stress level, and include cardiovascular, metabolic, neuroendocrine and immune biomarkers available in UKHLS to calculate AL. AL has been widely used in studies investigating human physiological responses to stressors (Juster et al., 2010, Chandola and Zhang, 2017, Prior et al., 2018), but there are considerable variations in calculating AL in the literature, subject to the availability of biomarkers in each study. Juster et al. (2010) reviewed 58 studies adopting AL models, and found that studies used 4-17 biomarkers and various cut-off points and algorithmic formulations to calculate AL. It is not feasible for us to account for all different measures of AL used in the literature. Therefore, we adopted the same 12 biomarkers used in Chandola and Zhang (2017) where the same data was analysed. We then follow Prior et al. (2018) who also analysed the same data source to calculate an alternative AL to assess the sensitivity of our results (See SI p.5-7 and p.8 for a detailed description of how we measure AL). Our main results still hold when the alternative AL measure is used (see SI Table S2).

Demographics: We control for a wide range of individual characteristics that are associated with well-being and health, including age, age^2, gender (male/female), employment status (yes/no), marital status (married, divorced/separated/widowed, others), UK born (yes/no), ethnicity (White/Indian/Pakistani/Bangladeshi/Black/Others), education level (degree/other degree/A-level/GCSE/other qualification), logarithm of household income, household size, and number of children in household (see SI p.7 for the description of all control variables). In addition, residents' mobility and length of living in their neighbourhood are likely to impact our findings. To distinguish

[1] When predicting the factor score, we have adopted both the regression as well as the Bartlett scoring methods (Bartlett, 1938).

the effect of living in neighbourhoods with increasing ethnic diversity from the effect of moving into/out of neighbourhoods with different levels of ethnic diversity, we conduct a set of sensitivity analyses by separating stayers (defined as those who had never moved home across their observational waves) and non-stayers. We include length of residence (in years) and re-estimate the main model as a robustness check of our findings (see SI Table S6). The BHPS/UKHLS does not measure the length of residence directly, and therefore this variable derived from an inconsistent measure of year moved to current address, leading to an additional 20,000 individual-year observations of missing data. Due to potential unreliability, we thus do not include length of residence in our main analysis.

Statistical Analysis

We adopt a three-level multilevel modelling framework to analyse the effects of ethnic diversity on well-being and health. Three levels are present as individual *i* are observed over time *t,* and clustered in LSOA *j*. The outcome variable is, in turn, the well-being and health score and AL. We decompose our regressor of interest – ethnic diversity, measured by the Herfindahl Index (HI) $HI_{j,t}$, into two parts: (1) the average ethnic diversity within a LSOA between 2001 and 2011 ($\overline{HI_j}$); (2) the deviation of yearly ethnic diversity from its ten-year average level of diversity ($Dev\_HI_{t,j}$). $\overline{HI_j}$ is time-invariant and LSOA-specific, and its coefficient reflects the between-LSOA effects of ethnic diversity. $Dev\_HI_{t,j}$ is time-varying and its coefficient captures the within-LSOA effects of ethnic diversity. $\overline{HI_j}$ represents the long term effect of ethnic diversity, and $Dev\_HI_{t,j}$ denotes the short term effect of change in ethnic diversity (Ramos et al., 2019, Curran and Bauer, 2011). We calculate the 10-year-average between 2001 and 2011 instead of the 7-year average between 2004 and 2011 for the following reason: ethnic diversity for year 2001 and 2011 were calculated based only on UK censuses data, without estimated data. Thus, the 10-year average is likely to be more accurate in comparison to the 7-year average where estimates would have been used to calculate the difference in ethnic diversity between 2004 and 2011. We separate the short and long-term effects of IMD in the same way. We estimate the following linear model:

$$y_{i,t,j} = \beta_1 + \boldsymbol{\beta_2 X_{i,t,j}} + \beta_3 \overline{HI_j} + \beta_4 Dev\_HI_{t,j} + \beta_5 \overline{IMD_j} + \beta_6 Dev\_IMD_{t,j} + \beta_7 wave_t + \mu_j + \mu_{t,j} + \varepsilon_{i,t,j} \quad [1]$$

where $\boldsymbol{X_{i,t,j}}$ represents individual demographics and characteristics, and μ_{tj} and μ_j denote LSOA-year specific and LSOA-specific random intercepts, respectively. $\varepsilon_{i,t,j}$ is an idiosyncratic error term which is assumed to have zero-mean. We assume $\mu_j, \mu_{t,j}$ and $\varepsilon_{i,t,j}$ are independent. *Wave* is added to the model in order to control for any unobserved and exogenous time effects. When AL is used as the outcome variable, the time dimension of equation [1] is eliminated because the biomarkers used to calculate AL are only observed at one timepoint.

Another objective of this study is to investigate how many years are needed for a negative association between increases in ethnic diversity and health outcomes to dissipate, assuming such an association is detected in our main analysis. We thus fit a multilevel model to examine the effect of differences in ethnic diversity between 2011 and 2010, controlling for the ethnic diversity level in 2010. Next, we replace the difference in ethnic diversity between 2010 and 2011 by the difference between 2009 and 2011, controlling for the ethnic diversity level in 2009. We repeat this process by increasing the gap by one year each time so that the widest gap we have is between 2001 and 2011. We estimate the following linear model for respondents in the UKHLS Wave 3 sample who stayed in the same LSOA during their entire observational period (the last wave in our panel data and mainly collected in year 2011):

$$y_{i,j,2011} = \beta_1 + \boldsymbol{\beta_2 X_{i,j,2011}} + \beta_3 \Delta HI_{t,j} + \beta_4 HI_{t,j} + \beta_5 IMD_{2011,j} + \mu_j + \mu_{t,j} + \varepsilon_{i,j}, \ for\ t = 2001, 2002, \ldots, 2011 \quad [2]$$

where all dependent and independent variables are at their 2011 levels except for $\Delta HI_{t,j}$ and $HI_{t,j}$. We estimate the effects of changes in ethnic diversity on individuals' well-being and health outcomes between various time periods.

Conditional on finding a significant negative relationship between ethnic diversity and subjective well-being and health, we conduct two analyses that increase confidence in causal interpretations. One is to test a set of fixed-effects models which account for individual time-invariant unobserved

heterogeneity and restrict the sample to stayers who never moved between their observational waves (Laurence and Bentley, 2015, Shen and Kogan, 2019). The other is to estimate a cross-lagged panel model (Kenny and Harackiewicz, 1979, Ramos et al., 2012) that focuses on a group of individuals who participated in all survey waves between year 2004-2011 (i.e., BHPS wave 14-18 and UKHLS wave 2-3) and did not move home at any time during this period. These analyses are not conducted for AL due to the cross-sectional nature of the UKHLS Nurse Health Assessment. All analyses are preformed using Stata MP 15.1, apart from the cross-lagged analysis in which we use Mplus 8.

Results

In total, 121,736 observations from wave 14-18 of BHPS and wave 1-3 of UKHLS (2004-2011) are included in the subjective well-being and health analysis, and 7,441 from wave 2 (2010) or 3 (2011) of UKHLS in the AL analysis. Coefficients and 95% confidence intervals (CI) obtained from estimating equation [1] are reported in Table 1 and Figure 1. The short-term change in ethnic diversity of LSOAs is negatively associated with subjective well-being and health (β=-0.32, p=0.015, 95% CI -0.57 to -0.06). In contrast, the effect of long-term ethnic diversity, measured by the ten-year ethnic diversity average, on subjective well-being and health is not significantly different from zero (β=0.01, p=0.615, 95% CI -0.03 to 0.05). Furthermore, neither short- nor long-term ethnic diversity of LSOAs is significantly associated with AL (β=0.59, p=0.600, 95% CI -1.62 to 2.81, and β=-0.28, p=0.212, 95% CI -0.63 to 0.07, respectively). The effect of short-term ethnic diversity is comparable to that of short-term deprivation and belonging to an ethnic minority group. Our results therefore suggest that in the short-term, individuals' subjective well-being and health may be adversely affected by increasing ethnic diversity of local areas, but in the long-term the effect dissipates over time. Additionally, individuals' stress levels seem unrelated to both short and long-term ethnic diversity. To ensure robustness of our results, we conducted the same analysis using two different ethnic diversity measures (see SI page 4-5 for details) and an alternative allostatic load measure (see SI page 8). Corresponding results are provided in SI Table S1 and S2. Furthermore, we break down our overall subjective well-being and health composite indicator into a well-being part and a health part, accordingly. Clearly, both physical health and mental health correlate with subjective well-being (Dolan et al., 2008), and combining them

facilitates policy implications at the macro-level, but well-being and health are two different concepts. We thus use subjective well-being and health variables as separate outcomes and repeat our main analysis. The additional results support our findings (see SI Tables S3)[2].

As we have detected a negative association between change in diversity and well-being and health, we then investigate how such an association responds if we gradually increase the time gap between the two time points from which we calculate change in diversity. To this end, we estimate the equation [2] using 24,748 UKHLS Wave 3 English respondents who stayed in the same LSOA during their entire observational period. Figure 2 displays the coefficients and 95% CI of the effects of changes in ethnic diversity between 2011 and various base years (see also Table 2), as well as a linear fitted line. The magnitude of the effect of change in diversity and the width of the confidence interval both decrease when the time gap is widened. Our results thus suggest that the negative impact of ethnic diversity on individuals' well-being and health steadily declines over time. After a ten-year period, the effect is close to nil according to the linear prediction shown in Figure 2.

We conduct a set of robustness tests that allow us to provide cautious causal interpretations and mitigate selection bias. We test the potential causal relationship between ethnic diversity and subjective well-being and health in two ways. First, we test a set of fixed-effects models which account for individual time-invariant unobserved heterogeneity and restrict the sample to stayers who had never moved home between their observational waves. Focusing on stayers helps to account for omitted stable neighbourhood-level heterogeneity that may have an impact on the effect of ethnic diversity, such as neighbourhood amenities and housing characteristics (Laurence and Bentley, 2015, Laurence et al., 2019, Shen and Kogan, 2019). In addition, it reduces potential concerns that our findings are driven by self-selection. We include a full set of individual- and neighbourhood-level time invariant controls in

[2] We also estimate equation [1] at the LAD-level as an additional robustness check, considering that assuming ethnic population of all LSOAs change at the same rate may not be a valid assumption (results presented in SI Table S5). Again, we find a significant negative relationship between the short-term ethnic diversity and well-being and health, but a non-significant one for the long-term ethnic diversity. However, results at the LAD-level show a significant negative coefficient of long-term ethnic diversity (β=-0.646, p=0.005, 95% CI -1.07 to -0.22) in the AL model, indicating that ethnic diversity at a larger geographical scale may play a role in reducing individual's stress in the long-term.

all models. Results are presented in Table 3. Columns (1) – (3) present the results for the full sample, stayers, and non-stayers, respectively. We observe that, by controlling for individual-level unobservable heterogeneity, short-term changes in ethnic diversity do not have a significant impact on subjective well-being and health using the full sample [β=-0.31, p=0.123] and the non-stayer subsample [β=0.240, p=0.468]. However, among stayers, the longitudinal associations between short-term increases in ethnic diversity and lower subjective well-being and health scores are consistent with a causal interpretation from diversity change to health outcomes [β=-0.75, p=0.004].

To further strengthen the proposed causal interpretation between ethnic diversity and subjective well-being and health among stayers, and to rule out potential reverse causality, we conduct a cross-lagged analysis that focuses on a group of individuals who participated in all survey waves between 2004 and 2011 (i.e., BHPS waves 14 – 18 and UKHLS waves 2 – 3) and did not move home at any time during this period. It controls for both correlations between ethnic diversity and subjective well-being and health and their autoregressive effects over time. It provides insights on a plausible causal effect if, ethnic diversity at one time point is significantly associated with well-being and health at the subsequent time point, but well-being and health at one time point is not significantly associated with ethnic diversity at the subsequent time point. Figure 3 illustrates the pathways between subjective well-being and health scores observed, and corresponding ethnic diversity of local areas, at each observational point. Standardised coefficients are provided in Figure 3 to ensure comparability. We allow error terms of ethnic diversity and subjective well-being and health to be correlated at each time point. Indicated by large and significant β coefficients within each time-series, we observe that both ethnic diversity and well-being and health are highly stable over time. More importantly, the directional, and possibly causal, relationship between ethnic diversity and well-being and health among stayers is evident. Pathways from ethnic diversity to subjective well-being and health are negative and significant at a 5% significance level (exceptions: at a 10% significance level between waves 14 and 15, and between waves 15 and 16). Pathways from subjective well-being and health to ethnic diversity are non-significant, and are indicated by grey dashed lines. These findings mirror results obtained from fixed-effects models.

White respondents are the majority group in England and may hold more adverse attitudes towards ethnic diversity as increasing diversity may be perceived to bring competition and uncertainty which can be perceived as threats to their majority status (Blalock, 1967). We replicate our analysis for the white and non-white subsample separately. All results still hold when analysing the white subsample, but the significant negative relationship between ethnic diversity and well-being and health is not found among non-white respondents in both analyses (see SI Table S4 and Figures S1, S2).

Discussion

The debate regarding the negative impacts of ethnic diversity on individual outcomes such as cohesion, well-being and health is heated; yet, these claims are based on mixed scientific evidence, which is especially sparse in the case of health. More generally, the negative effects of diversity on social outcomes are inconsistent and lack coherence due to methodological deficiencies, including cross-sectional designs, weak operationalisation of key measures, and endogeneity/self-selection effects. This study addresses these concerns and moves the field forward significantly by using unique nationally representative panel data merged with contextual neighbourhood information using an analytical framework that considers the relationship between contextual changes and individual outcomes as a dynamic process (Ramos et al., 2019, Page-Gould et al., 2008).

Our analysis extensively explores the diversity-health nexus in England by using a large panel data set with eight survey waves and over 120,000 individual-wave observations. We are the first to answer this important question using this robust methodological approach, which makes use of high-quality data, advanced statistical techniques. We show that, in the short-term, an increase in LSOA-level ethnic diversity is associated with worse individual-level well-being and health, but that this association dissipates over time. Additional analyses conducted at LAD-level confirm the same finding (see footnote 2). Our results provide evidence of individuals gradually adapting to ethnic diversity of local neighbourhoods as well as authority districts, despite initial reluctance.

We do not find a statistically significant association between both short- and long-term LSOA-level ethnic diversity and AL. There are several possible explanations for the differences between measures.

First, potential effects of ethnic diversity on AL are already fully absorbed by the adaptation process in the human brain by the time respondents' blood samples were collected. When stress is present, the physiological response initially increases, but eventually recovers to baseline levels (McEwen, 2016). This process is consistent with our findings suggesting that individuals adapt to diversity over time. If a neighbourhood's increasing diversity is a stressor, people's physiological response to diversity will gradually recover to baseline levels despite some potential increases resulting from changes in diversity. Second, in this context, subjective outcomes, such as life satisfaction and mental health status, should be more sensitive to changes in contextual-level factors, compared to objective health outcomes. This is because effects on AL should emerge only after a more prolonged exposure to stress caused by the contextual-level factors. Hence, it may take time until ethnic diversity has detectable significant impacts on AL, if any. However, as biomarkers are only available once for each participant in our data set, we cannot test this hypothesis formally.

There are limitations in this study. First, the analysis for AL is cross-sectional, ruling out the possibility of drawing any longitudinal inferences from our results on AL. Second, due to data limitations, we could not directly test the *contact theory* by modelling the potential effect of intergroup contact might have on moderating the impact of ethnic diversity on well-being and health. In a relevant study analysing the effect of religious diversity on individual's quality of life (Ramos et al., 2019), and in other studies analysing the effect of diversity on trust or social cohesion, such as Laurence (2011) and Stolle et al. (2008), it was studied how intergroup contact influences the effect of diversity exposure. It was found that intergroup contact reduced the adverse effects of diversity. We therefore argue that intergroup contact might explain the non-significant association between long-term ethnic diversity and well-being. Third, we used the Herfindahl Index, which is offers a single index to measure ethnic diversity and there are some changes in diversity that cannot be captured by a single index. For example, an increase in this index could be due to a large increase in one minority group or small increases across all minority groups, and these two scenarios may have different impacts on local residents' well-being and health. To address this concern, a possibility is to include in surveys a measure of perceived diversity, but these measures have the limitation of being subjective and prone to be affected by attitudes

toward diversity. Lastly, the issue of factor indeterminacy may arise when factor scores are used as dependent variables and our results may be subject to bias, despite the fact that this approach (i.e. a two-step procedure where a factor score is computed before being used as the dependent variable) is largely adopted in the literature (Acito and Anderson, 1986). As a robustness check, we carried out the main analysis in a structural equation modelling framework where a one-step procedure was used and our main results still held. In addition, as an avenue for future research, it could be interesting to examine how our results differ across groups with different levels of education, income, and social class. These analyses would help to understand which groups are more vulnerable to the negative health effects associated with ethnic diversity and this could also inform intervention and social policy.

The negative impacts of increasing diversity and immigration, often founded on normative views and a lack of empirical evidence, are the foundation of intense geopolitical debates that underlie recent populist shifts and events such as Brexit and the election of President Trump. The findings of this study show that initial negative health outcomes associated with changing diversity ameliorate over a 10 year follow up. These results illustrate how imperative it is that political debates and policy approaches aimed at fostering peaceful coexistence in an ever more fractured world focus on the long-term benefits of diversity rather than the short-term costs. Words such as “diversity” and “immigration” are politically charged terms but, as our research shows, their adverse implications appear to have been overestimated and distorted. By using narratives focusing on threats and instigating fears of diversity, political leaders are not acting on behalf of their citizens and are, instead, creating social divisions that may go beyond the realm of interethnic relations (e.g., Brexit). The world is changing rapidly and these fast changes require new responses. How we respond to globalisation and diversity will determine the future of our societies.

References

Acito, F. & Anderson, R. D. 1986. A simulation study of factor score indeterminacy. *Journal of Marketing Research,* 23**,** 111-118.

Alesina, A. & La Ferrara, E. 2002. Who trusts others? *Journal of Public Economics,* 85**,** 207-234.

Bartlett, M. S. 1938. Methods of estimating mental factors. *Nature,* 141**,** 609-610.

Bécares, L., Dewey, M. E. & Das-Munshi, J. 2018. Ethnic density effects for adult mental health: systematic review and meta-analysis of international studies. *Psychological Medicine,* 48**,** 2054-2072.

Blalock, H. M. 1967. *Toward a theory of minority-group relations*, New York: Wiley.

Brown, R. & Hewstone, M. 2005. An integrative theory of intergroup contact. *Advances in Experimental Social Psychology,* 37**,** 255-343.

Chandola, T. & Zhang, N. 2017. Re-employment, job quality, health and allostatic load biomarkers: prospective evidence from the UK Household Longitudinal Study. *International Journal of Epidemiology,* 47**,** 47-57.

Curran, P. J. & Bauer, D. J. 2011. The disaggregation of within-person and between-person effects in longitudinal models of change. *Annual Review of Psychology,* 62**,** 583-619.

Das-Munshi, J., Becares, L., Dewey, M. E., Stansfeld, S. A. & Prince, M. J. 2010. Understanding the effect of ethnic density on mental health: multi-level investigation of survey data from England. *BMJ,* 341**,** c5367.

Dinesen, P. T. & Sønderskov, K. M. 2015. Ethnic diversity and social trust: Evidence from the micro-context. *American Sociological Review,* 80**,** 550-573.

Dinesen, P. T. & Sønderskov, K. M. 2018. Ethnic diversity and social trust: a critical review of the literature and suggestions for a research agenda. *In:* USLANER, E. M. (ed.) *The Oxford Handbook on Social and Political Trust.* Oxford University Press.

Dolan, P., Peasgood, T. & White, M. 2008. Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being. *Journal of Economic Psychology,* 29**,** 94-122.

Hirschman, A. O. 1964. The paternity of an index. *The American Economic Review,* 54**,** 761-762.

Juster, R.-P., Mcewen, B. S. & Lupien, S. J. 2010. Allostatic load biomarkers of chronic stress and impact on health and cognition. *Neuroscience & Biobehavioral Reviews,* 35**,** 2-16.

Kenny, D. A. & Harackiewicz, J. M. 1979. Cross-lagged panel correlation: practice and promise. *Journal of Applied Psychology,* 64**,** 372.

Laurence, J. 2011. The effect of ethnic diversity and community disadvantage on social cohesion: A multi-level analysis of social capital and interethnic relations in UK communities. *European Sociological Review,* 27**,** 70-89.

Laurence, J. & Bentley, L. 2015. Does ethnic diversity have a negative effect on attitudes towards the community? A longitudinal analysis of the causal claims within the ethnic diversity and social cohesion debate. *European Sociological Review,* 32**,** 54-67.

Laurence, J., Schmid, K. & Hewstone, M. 2019. Ethnic diversity, ethnic threat, and social cohesion:(re)-evaluating the role of perceived out-group threat and prejudice in the relationship between community ethnic diversity and intra-community cohesion. *Journal of Ethnic and Migration Studies,* 45**,** 395-418.

Marmot, M. 2005. Social determinants of health inequalities. *The Lancet,* 365**,** 1099-1104.

Mcewen, B. S. 1998a. Protective and damaging effects of stress mediators. *New England Journal of Medicine,* 338**,** 171-179.

Mcewen, B. S. 1998b. Stress, adaptation, and disease: Allostasis and allostatic load. *Annals of the New York Academy of Sciences,* 840**,** 33-44.
Mcewen, B. S. 2016. Central role of the brain in stress and adaptation: allostasis, biological embedding, and cumulative change. *Stress: Concepts, Cognition, Emotion, and Behavior.* Academic Press.
Mcfall, S., Petersen, J., Kaminska, O. & Lynn, P. 2014. Understanding Society Waves 2 and 3 nurse health assessment, 2010-2012: guide to nurse health assessment. University of Essex, ISER.
Mulder, C., Bazeley-White, E., Dimitrakopoulos, P., Hector, A., Scherer-Lorenzen, M. & Schmid, B. 2004. Species evenness and productivity in experimental plant communities. *Oikos,* 107**,** 50-63.
Page-Gould, E., Mendoza-Denton, R. & Tropp, L. R. 2008. With a little help from my cross-group friend: reducing anxiety in intergroup contexts through cross-group friendship. *Journal of Personality and Social Psychology,* 95**,** 1080.
Pew Research Center 2014. Middle Easterners see religious and ethnic hatred as top global threat. *Pew Research Center's Global Attitudes Project.* Pew Research Center's Global Attitudes Project.
Pielou, E. C. 1966. The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology,* 13**,** 131-144.
Prior, L., Manley, D. & Jones, K. 2018. Stressed out? An investigation of whether allostatic load mediates associations between neighbourhood deprivation and health. *Health & Place,* 52**,** 25-33.
Putnam, R. D. 2007. *E pluribus unum*: diversity and community in the twenty-first century the 2006 Johan Skytte Prize Lecture. *Scandinavian Political Studies,* 30**,** 137-174.
Ramos, M. R., Bennett, M. R., Massey, D. S. & Hewstone, M. 2019. Humans adapt to social diversity over time. *Proceedings of the National Academy of Sciences,* 116**,** 12244-12249.
Ramos, M. R., Cassidy, C., Reicher, S. & Haslam, S. A. 2012. A longitudinal investigation of the rejection–identification hypothesis. *British Journal of Social Psychology,* 51**,** 642-660.
Rees, P., Clark, S., Wohland, P., Lomax, N. & Norman, P. 2017. Using 2001 and 2011 censuses to reconcile ethnic group estimates and components for the intervening decade for English local authority districts. *In:* STILLWELL, J. & DUKE-WILLIAMS, O. (eds.) *The Routledge Handbook of Census Resources, Methods and Applications: Unlocking the UK 2011 Census* Routledge.
Schmid, K., Ramiah, A. A. & Hewstone, M. 2014. Neighborhood ethnic diversity and trust: The role of intergroup contact and perceived threat. *Psychological Science* 25**,** 665-674.
Shannon, C. E. 1948. A mathematical theory of communication. *Bell System Technical Journal,* 27**,** 379-423.
Shaw, R. J., Atkin, K., Bécares, L., Albor, C. B., Stafford, M., Kiernan, K. E., Nazroo, J. Y., Wilkinson, R. G. & Pickett, K. E. 2012. Impact of ethnic density on adult mental disorders: narrative review. *The British Journal of Psychiatry,* 201**,** 11-19.
Shen, J. & Kogan, I. 2019. Does the religious context matter? The causal effect of religious diversity on individual life satisfaction in the UK. *Journal of Ethnic and Migration Studies***,** 1-22.
Stafford, M., Bécares, L. & Nazroo, J. 2010. Racial discrimination and health: exploring the possible protective effects of ethnic density. *Ethnicity and Integration.* Springer.

Stolle, D., Soroka, S. & Johnston, R. 2008. When does diversity erode trust? Neighborhood diversity, interpersonal trust and the mediating effect of social interactions. *Political Studies,* 56**,** 57-75.

Tropp, L. R. 2019. Adaptation to diversity: individual and societal processes. *Proceedings of the National Academy of Sciences,* 116**,** 12131-12133.

University of Essex Institute for Social Economic Research 2014. Understanding Society: Waves 2 and 3 Nurse Health Assessment, 2010 - 2012 [data collection]. UK Data Service.

University of Essex Institute for Social Economic Research 2017. Understanding Society: waves 1-7, 2009-2016 and harmonised BHPS: waves 1-18, 1991-2009 [data collection]. UK Data Service.

Table 1 Modelling individual subjective and objective well-being and health

	(1) Well-being and health	(2) AL	(3) Well-being and health	(4) AL
LSOA-level Variables				
Ethnic Diversity (mean)	-0.110***	-0.143	0.011	-0.280
	[-0.14,-0.08]	[-0.46,0.18]	[-0.03,0.05]	[-0.63,0.07]
Ethnic Diversity (change)	-0.294***	-0.569	-0.315*	0.592
	[-0.45,-0.14]	[-2.74,1.61]	[-0.57,-0.06]	[-1.62,2.81]
IMD (mean)			-0.004***	0.009***
			[-0.00,-0.00]	[0.01,0.01]
IMD (change)			-0.005***	-0.008
			[-0.01,-0.00]	[-0.03,0.02]
Individual-level Variables				
Age			-0.033***	0.110***
			[-0.03,-0.03]	[0.09,0.12]
Age^2			0.000***	-0.001***
			[0.00,0.00]	[-0.00,-0.00]
Male			0.064***	0.401***
			[0.05,0.08]	[0.32,0.48]
Employed			0.179***	-0.175**
			[0.17,0.19]	[-0.28,-0.07]
Married			0.104***	-0.041
			[0.09,0.12]	[-0.17,0.09]
Divorce/Separated/Widowed			-0.041***	0.141
			[-0.06,-0.02]	[-0.00,0.28]
Indian			-0.052**	0.238
			[-0.09,-0.02]	[-0.10,0.57]
Pakistani			-0.120***	0.150
			[-0.16,-0.08]	[-0.36,0.66]
Bangladeshi			-0.071*	-0.645
			[-0.13,-0.02]	[-1.53,0.24]
Black			0.070***	-0.252
			[0.04,0.10]	[-0.63,0.12]
Other			-0.056***	0.164
			[-0.09,-0.03]	[-0.13,0.46]
Degree			0.177***	-0.534***
			[0.16,0.20]	[-0.68,-0.39]
Other Degree			0.107***	-0.285***
			[0.08,0.13]	[-0.44,-0.13]
A-level			0.0800***	-0.311***
			[0.06,0.10]	[-0.46,-0.16]
GCSE			0.078***	-0.273***
			[0.06,0.10]	[-0.41,-0.13]
Other Qualification			0.044***	-0.272***
			[0.02,0.07]	[-0.42,-0.12]
Total Income			-0.011***	-0.022
			[-0.01,-0.01]	[-0.05,0.01]
Home Rented			-0.152***	0.302***
			[-0.17,-0.14]	[0.20,0.41]
Household Size			-0.002	0.055*
			[-0.01,0.00]	[0.00,0.10]
N of Children			0.011**	-0.084*
			[0.00,0.02]	[-0.15,-0.02]
UK Born			-0.072***	0.074
			[-0.09,-0.05]	[-0.43,0.58]
Wave			0.004**	0.050

			[0.00,0.01]	[-0.05,0.15]
Venipuncture start time				0.037***
				[0.03,0.05]
Blood collection system				0.012
				[-0.07,0.10]
Days of blood sample taken to lab				0.001
				[-0.00,0.01]
Took inflammatory med during past 7 days				0.652***
				[0.50,0.80]
Took statins during last 7 days				-0.222***
				[-0.33,-0.11]
Constant	0.024***	3.080***	0.672***	-1.768
	[0.02,0.03]	[3.02,3.14]	[0.61,0.74]	[-3.84,0.31]
Akaike Information Criterion (AIC)	324387.4	33013.1	234828.8	28436.2
Bayesian Information Criterion (BIC)	324447.6	33048.3	235120.1	28671.3
N of Observations	166,887	8,363	121,736	7441
N of Respondents	64,357	8,363	52,412	7441
N of LSOAs	17,584	5,218	15,545	4716

Note: Unstandardized coefficients are shown, and 95% confidence intervals are given in parentheses. Well-being and health is an index combining overall life satisfaction, self-perceived physical health status and GHQ36. AL is the indicator of objective well-being and health, standing for allostatic load. A higher well-being and health score and a lower AL score indicate better health. Ethnic diversity is measured by a 10-group Herfindahl Index. The mean of diversity is the mean of ethnic diversity between 2001 and 2011. The change of diversity is the deviation of diversity from its mean. Total income is in logarithm. IMD stands for Index of Multiple Deprivation. Individual- and LSOA-level random intercepts are included in subjective health and well-being estimations, and individual-level random intercepts are included in allostatic load estimations.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2 The effects of changes in ethnic diversity of local areas on well-being and health

	(1) WB & H	(2) WB & H	(3) WB & H	(4) WB & H	(5) WB & H	(6) WB & H	(7) WB & H	(8) WB & H	(9) WB & H	(10) WB & H
1-y gap	-3.125***									
	[-5.00, -1.25]									
2-y gap		-1.753***								
		[-2.72, -0.78]								
3-y gap			-1.231***							
			[-1.88, -0.58]							
4-y gap				-0.947***						
				[-1.44, -0.46]						
5-y gap					-0.768***					
					[-1.16, -0.38]					
6-y gap						-0.646***				
						[-0.97, -0.32]				
7-y gap							-0.553***			
							[-0.83, -0.28]			
8-y gap								-0.483***		
								[-0.72, -0.24]		
9-y gap									-0.425***	
									[-0.64, -0.21]	
10-y gap										-0.377***
										[-0.56, -0.19]

Notes: Unstandardized coefficients are presented, 95% confidence intervals are given in parentheses. WB&H stands for subjective well-being and health. N=24,748. Although not shown in the table, a full set of independent variables are included in estimations. The ethnic diversity level as well as the IMD of the year from which we take the difference are included in all estimations. Please see equation [2] in the main paper for model specifications. A set of simple *t*-test results suggest all coefficients presented above are statistically different between each other.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 Testing the possible causal relationship between short-term ethnic diversity and well-being and health among stayers and non-stayers

Outcome: well-being and health	(1) Full sample	(2) Stayers	(3) Non-stayers
Age	-0.003	-0.014**	0.006
	[-0.01,0.01]	[-0.02,-0.00]	[-0.01,0.02]
Age²	0.000	0.000*	-0.000
	[-0.00,0.00]	[0.00,0.00]	[-0.00,0.00]
Employed	0.079***	0.064***	0.116***
	[0.06,0.10]	[0.04,0.09]	[0.08,0.16]
Married	0.007	-0.059	0.012
	[-0.05,0.06]	[-0.15,0.03]	[-0.05,0.08]
Divorce/Separated/Widowed	0.041	-0.060	0.078
	[-0.04,0.12]	[-0.18,0.06]	[-0.03,0.19]
Degree	-0.171***	-0.166***	-0.130
	[-0.26,-0.08]	[-0.26,-0.07]	[-0.32,0.06]
Other Degree	-0.133**	-0.143**	-0.062
	[-0.22,-0.04]	[-0.25,-0.04]	[-0.25,0.12]
A-level	-0.114**	-0.122**	-0.035
	[-0.18,-0.04]	[-0.20,-0.05]	[-0.20,0.13]
GCSE	-0.056	-0.060	-0.016
	[-0.12,0.01]	[-0.13,0.01]	[-0.17,0.14]
Other Qualification	-0.063	-0.096*	0.040
	[-0.14,0.02]	[-0.18,-0.01]	[-0.14,0.22]
Total Income	-0.002	-0.003	-0.000
	[-0.01,0.00]	[-0.01,0.00]	[-0.01,0.01]
Home Rented	0.030	0.016	0.030
	[-0.00,0.06]	[-0.06,0.10]	[-0.00,0.06]
Household Size	-0.004	-0.004	0.002
	[-0.01,0.01]	[-0.02,0.01]	[-0.01,0.02]
N of Children	0.014	0.009	0.008
	[-0.00,0.03]	[-0.01,0.03]	[-0.02,0.03]
Ethnic Diversity (Change)	-0.314	-0.747**	0.240
	[-0.71,0.08]	[-1.25,-0.24]	[-0.41,0.89]
IMD (Change)	-0.001	-0.003	0.001
	[-0.01,0.00]	[-0.01,0.00]	[-0.01,0.01]
_cons	0.199	0.564***	-0.180
	[-0.02,0.42]	[0.26,0.87]	[-0.52,0.16]
N	122,001	99,147	22,854

Notes: Fixed-effects models with robust standard errors are estimated. Unstandardized coefficients are shown and 95% confidence intervals are given in parentheses. The well-being and health variable is based on factor analysis of 3 subjective well-being and health indicators: overall life satisfaction, self-perceived physical health status and GHQ36. A full set of time invariant control variables are included in all estimations. Stayers are those who did not move home across all their available observational waves. Non-stayers are the rest of the sample who are not identified as stayers.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 1 Coefficients and 95% CI of short- and long-term ethnic diversity

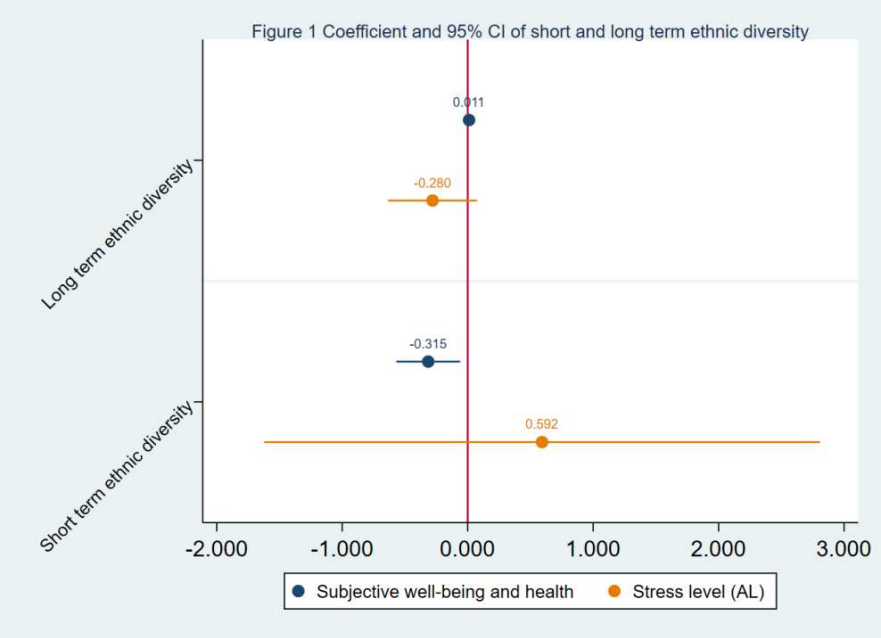


Figure 2 Dynamics of the effect of change in ethnic diversity on subjective well-being and health

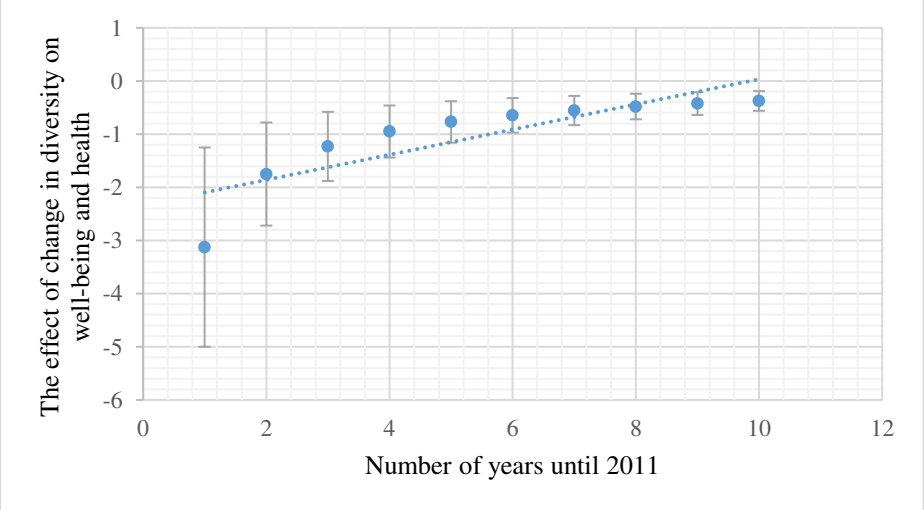
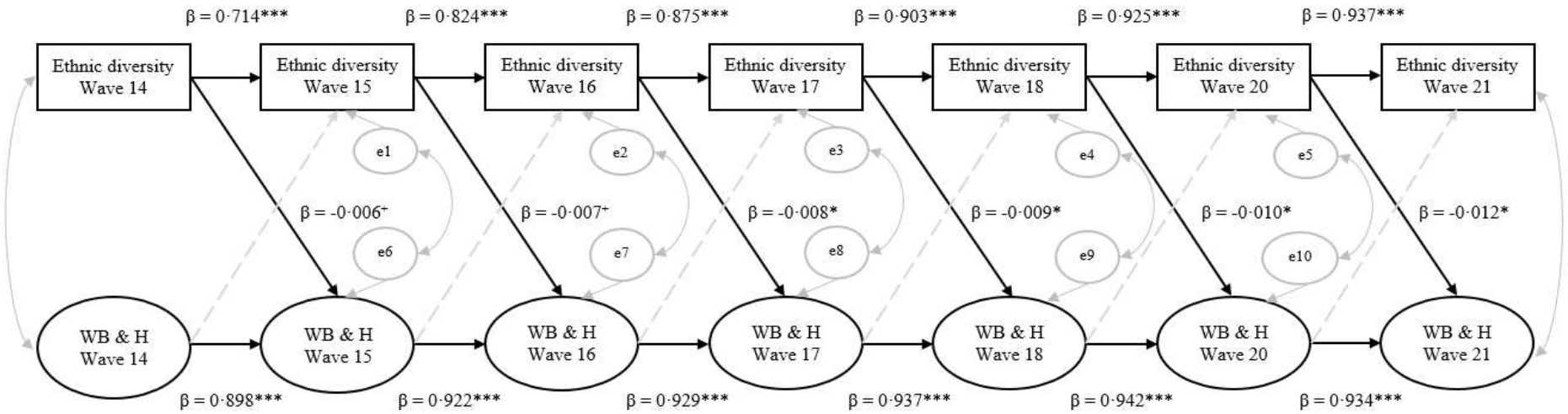


Figure 3 The possible causal relationship between ethnic diversity and well-being and health



Notes: Dashed arrows indicate non-significance $^{+}$ p <0.10 * p < 0.05, ** p < 0.01, *** p < 0.001