Stressed out? An investigation of whether allostatic load mediates associations between neighbourhood deprivation and health

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ABSTRACT

Deprived neighbourhoods have long been associated with poorer health outcomes. However, many quantitative studies have not evidenced the mechanisms through which place 'gets under the skin' to influence health. The increasing prevalence of biosocial data provides new opportunities to explore these mechanisms and incorporate them into models of contextual effects. The stress pathway is a key biosocial mechanism; however, few studies have explicitly tested it in neighbourhood associations. This paper addresses this gap by investigating whether allostatic load, a biological response to chronic stress, mediates relationships of neighbourhood deprivation to physical and mental health. Data from UK Understanding Society is used to undertaken a multilevel mediation analysis. Allostatic load is found to mediate the association between neighbourhood deprivation and health, substantiating the biological mechanism of the stress pathway. More deprived areas are associated with higher allostatic load, and in turn worse allostatic load relates to poorer physical and mental health. Allostatic load is a stronger mediator of physical health than mental health, suggesting the stress pathway is more pertinent to explaining physical health gradients. Heterogeneity in the results between physical and mental health suggests more research is needed to disentangle the biosocial processes that could be important to health and place relationships.

1. Introduction

There is a long history of research seeking to better understand how where you live interacts with your health and wellbeing (Brown et al., 2010; Jones and Moon, 1992). Persistent health inequalities between areas mean local context (commonly referred to as 'the neighbourhood') remains a focal point of interest in health relationships (Office for National Statistics, 2014; World Health Organisation, 2008). It is widely acknowledged that living in disadvantaged areas negatively impacts your life chances. This idea underlies much of the neighbourhood effects research paradigm and has generally found support in the literature (Kawachi and Berkman, 2003; Van Ham et al., 2012). Given this consistency of findings, interest has turned towards investigating the mechanisms that may explain relationships between deprivation and health.

Within the literature which has unpacked the 'black-box' of neighbourhood effects (Macintyre et al., 2002), a developing area is concerned with biological plausibility. There is an extensive literature detailing how features of the social and physical environment may play a role in contextual relationships with health and wellbeing (see Diez Roux and Mair, 2010; Rosenberg, 2017). Now researchers are turning their attention to the question of how environments 'get under the skin'. The complexity of environment-health interactions, and their potential to accumulate over the lifecourse, makes research at the dynamic interface of the biological and social a fruitful avenue of inquiry. Considering biological plausibility in the embodiment of context can provide insight into pathways that are credible for a range of processes. Tracing the imprint of disadvantage also offers a powerful tool to comprehend histories of vulnerability, and thus to inform policy on health inequalities.

As yet, this literature has not been fully developed and further research is needed to understand processes of health and place relationships and to explore biosocial links in an explicit manner (see Prior et al., 2018). This paper contributes a test of the stress pathway model, which posits that living in disadvantaged areas increases the stress burden residents are exposed to, raising the likelihood of poor health. To address some of the key gaps in the emergent biosocial literature, we adopt a multilevel perspective concerned with neighbourhood in combination with biodata and examine the role of a stress burden *within* relationships of place and health, using mediation analysis. We assess

whether allostatic load, marking a cumulative biological weathering in response to chronic stress, mediates the association between neighbourhood deprivation and individual health.

2. Background

Previous studies have indicated the presence of associations between deprived neighbourhoods and health outcomes across a range of national contexts (Adams et al., 2009; Arcaya et al., 2016; Sundquist et al., 2004). Such studies have been instrumental in demonstrating the impact of neighbourhood on individual health and the inequalities of health status between areas (Wilson et al., 2010). However, many of these studies do not directly address the question of how the neighbourhood would impact the individual. Quasi-experimental studies, such as the Moving to Opportunity (MTO) and Gautreaux residential mobility programs in the US provide insight into neighbourhood and health relationships (Ludwig et al., 2012; Rosenbaum and Zuberi, 2010). For example, improvements in the mental health of those who moved to lower poverty neighbourhoods under MTO have been attributed to reductions in stress exposure (Katz et al., 2001). The role of perceptions and experiences of stress in deprivation-health relationships is a recurring theme in the neighbourhood literature and offers a pathway for exposing the mechanisms of neighbourhood effects.

The increased incorporation of biomarkers within large social surveys is facilitating analysis which appreciates the entanglement of biological and social phenomena. The stress pathway is one theorised biosocial model drawn upon to link places and health. It postulates that the fewer and poorer quality social and physical resources that characterise deprived areas shape exposure to stressful experiences, as well as restricting opportunities for well-being. The resulting stress burden is proposed to negatively impact health (Daniel et al., 2008). The biological response to chronic stress can be captured using the concept of allostatic load, which represents a weathering on physiological functioning resulting from repeated and prolonged exposure to stressors (McEwen and Seeman, 1999; McEwen and Stellar, 1993). Whilst the acute stress response is adaptive in the short-term, chronic activation stimulates a cascade of dysregulations across multiple physiological systems. These dysregulations ultimately increase the chances of morbidity and mortality, contributing to allostatic load and the common language feeling of being 'stressed out' (Juster et al., 2010; McEwen, 2008).

To operationalise allostatic load, a set of biomarkers is typically used to construct a composite index, for instance, summarising the number of biomarkers falling into high risk quartiles (Seeman et al., 1997). Factor analysis has shown that biomarkers used to construct allostatic load measures tend to load onto a single common factor, suggesting this summary approach to be sufficient (Howard and Sparks, 2016; Wiley et al., 2016). Results by Wiley et al. (2016), comparing factor loadings of their full model with a series of models where different sub-systems and their associated biomarkers were dropped, were consistent with item parameter invariance. This implies the same latent factor representing allostatic load may be identified even if the underlying set of biomarkers varies (Wiley et al., 2016). Higher allostatic load has consistently been found to relate to mortality and worse health outcomes (Hwang et al., 2014; Juster et al., 2010). For example, allostatic load has been shown to be predictive of cognitive and physical functioning decline (Seeman et al., 1997), chronic diseases (Mattei et al., 2010) and depressive symptoms (Seplaki et al., 2006). Allostatic load, therefore, provides a valid tool to trace the biological memory of disadvantage over time and link neighbourhood circumstances to individual health.

Studies which have implicated stress exposure using allostatic load have focused on individual-level factors, such as socioeconomic status, poverty and adverse experiences (Barboza Solís et al., 2015; Gruenewald et al., 2012; Kakinami et al., 2013). Others have invoked neighbourhood by examining how individual perceptions of

neighbourhood features relate to allostatic load (Van Deurzen et al., 2016). By focusing on individual-level perspectives, researchers are missing the context of health relationships and are not recognising the inherently social construction of life (Krieger, 1994). Where place or neighbourhood characteristics have been explored, allostatic load has been positioned as an outcome rather than as an intervening variable in environment-health pathways. These studies have generally corroborated the negative health consequences of adverse neighbourhood circumstances on allostatic load (Bird et al., 2010; Brody et al., 2014; Theall et al., 2012). However, there remains a need for more studies examining the neighbourhood space, allostatic load and health in other national contexts; research using data from US studies has dominated the literature so far. This paper considers how allostatic load acts in pathways from neighbourhood circumstance to general states of health and functioning, for a nationally representative sample of Great Britain.

The potential of mediation analysis in helping to disentangle the mechanisms linking gradients in circumstance to health inequalities has been recognised. For example, Schulz et al. (2012) used the causal steps criteria (Baron and Kenny, 1986) to show the relationship of neighbourhood poverty to allostatic load was mediated by psychosocial stress for residents of Detroit. However, there have been very few studies to date which assess allostatic load as a mediator of health relationships. For instance, Hu et al. (2007) were not able to support allostatic load as a mediator of the relationship of socioeconomic status to self-rated health and activity limitations. In contrast, Sabbah et al. (2008) provided evidence of a mediating influence of allostatic load on socioeconomic gradients in periodontal and ischaemic heart disease. However, both studies relied on the attenuation of a previous relationship to evaluate the presence of mediation, an approach which is problematic as it does not allow researchers to distinguish a mediator from a confounder. This technique also does not follow recommendations for conducting mediation analysis which require that the indirect effect - that is the effect that travels through the mediator - must be investigated (Hayes, 2009). Moreover, investigations that explicitly explore the role of allostatic load, and which do so in multilevel frameworks are currently lacking.

This paper aims to address these limitations by employing large-scale data from Great Britain to investigate the stress pathway, placing allostatic load as a mediator in the proposed causal pathway from neighbourhood deprivation to health. Fig. 1 demonstrates the model of the stress pathway conceptualised in this study. As part of this assessment we hypothesise: (1) higher deprivation predicts worse allostatic load; (2) higher allostatic load is associated with worse physical and mental health; (3) higher deprivation relates to worse physical and mental health. To the author's knowledge this will offer a novel test of whether and how allostatic load acts as a mediator in a multilevel, neighbourhood framework.

3. Methods

This study uses data from Understanding Society (Knies, 2016; University of Essex, 2016a). At Waves 2 and 3 (collected between 2010 and 2012) separate nurse health assessments were carried out and
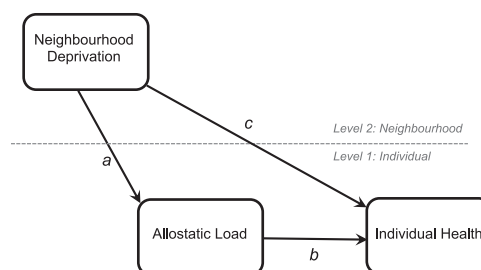

Fig. 1. Diagram of the stress pathway.