

Investigating ‘place effects’ on mental health: implications for population-based studies in psychiatry

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Background. Interest in features of our local environments that *may* promote better mental health and wellbeing continues to rise among decision makers. Our purpose was to highlight a selection of these challenges and some promising avenues for enhancing the quality of evidence.

Method. An analysis of approximately 267,000 people was used to test the local relative deprivation hypothesis, wherein the shortfall of a person’s socioeconomic circumstances from their neighbours is said to impact negatively upon mental health. This case was used to anchor further discussion of challenges to identifying and interpreting genuine ‘place effects’ from spurious correlations.

Results. A Median Odds Ratio of 1.29 computed via multilevel logistic regression showed that the odds of experiencing psychological distress (as measured by the Kessler score) varied by geographical area. Approximately 67% of this was attributed to a cross-classified measure of household income and neighbourhood deprivation. Compared to people on high incomes living in affluent neighbourhoods, the odds ratio of psychological distress for people on low incomes in affluent areas was 4.73 (95% confidence interval (95% CI) 4.39, 5.09), whereas that for people on low incomes in deprived areas was significantly higher at 5.83 (95% CI 5.41, 6.28).

Conclusions. While no evidence was found to support local relative deprivation hypothesis, the pattern suggests that more affluent areas may contain features that are conducive to better mental health. Selection of bespoke geographical boundaries, use of directed acyclic graphs and more evaluations of natural experiments are likely to be important in taking the field of enquiry onwards.

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Introduction

Mental health is fundamental to society and economy (Commission on Social Determinants of Health, 2008). There are, however, important variations in mental health which manifest geographically and these can be demonstrated statistically (e.g., Chaix *et al.* 2005). Quantifying the spatial distributions of mental health is (or ought to be) of substantive interest to the health sector in so that appropriate levels of services can be allocated efficiently and equitably to address variation in local need (McLafferty, 2003). But it is not just about satisfying local need for treatment; there is also interest in public health and urban planning on the extent that

neighbourhoods can be designed to promote greater mental health among their residents as a result (Jackson *et al.* 2013; Kent & Thompson, 2014). Liveable neighbourhoods as part of the arsenal of preventive health (Wilson, 2014). Therein, however, lies a fundamental question that continues to fuel debate among geographers, epidemiologists, sociologists, economists, etc., to what extent do these geographies of mental health actually reflect the impact of ‘place’, or are they simply a manifestation of preferential choices and segregating forces dictated largely by the housing and labour markets?

The proposition that who and what a person lives near can influence their life-chances is not new (Faris & Dunham, 1939; Wilson, 1987; Massey *et al.* 1991; Corburn, 2007). This hypothesis is reflected within several publications within this very journal (e.g., Losert *et al.* 2012). Likewise, readers and contributors to the enormous ‘place effects’ genre of research

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more widely have already witnessed much lively and valuable debate (Dorling *et al.* 2001; Macintyre *et al.* 2002; Diez Roux, 2004; Durlauf, 2004; Oakes, 2004; Kling *et al.* 2008; VanderWeele, 2010; Galster & Hedman, 2013; Slater, 2013; Astell-Burt *et al.* 2014). Recent research on 'place effects' and mental health has covered a range of potentially modifiable exposures operating at the local level, such as socioeconomic deprivation (Henderson *et al.* 2005), safety (Stafford *et al.* 2007), social capital (Murayama *et al.* 2012), education (Wight *et al.* 2006) and 'green spaces' such as public parks (Astell-Burt *et al.* 2013); the latter being increasingly popular among urban planners interested in designing 'healthy' built environments (Australian Government, 2011; Nilsson *et al.* 2011). If geographical clusters of mental health reflect not just selective processes attributable to household relocation, but in fact something more profound about the local environments in which people live, identifying which of those features have pathogenic and/or so-called 'salutogenic' properties (Antonovsky, 1996) is a public health imperative to put mental health promotion at the core of all urban planning (Rydin *et al.* 2012).

There have already been several reviews of the literature focused specifically on the question of whether places determine mental health (Truong & Ma, 2006; Clark *et al.* 2007; Kim, 2008; Mair *et al.* 2008). Our purpose is not to retrace old ground, but to reflect on the ongoing challenge of identifying 'place effects' on mental health and some developments in the field with the aid of a case-study example. We emphasise the need for: (i) greater consideration of geographical units used to define exposure; (ii) more widespread use of directed acyclic graphs (DAGs) for developing stronger tests of *a priori* hypotheses; and (iii) greater ambition, but also more transparency about the potential added value of exploiting natural experiments to raise the quality of evidence available for decision makers.

People and places

Various theories on place effects have been summarised elsewhere (Jencks & Mayer, 1990; Galster, 2008). Looking beyond the 'socioeconomic gradient' in health (Marmot, 2006), some scientists have argued that how much income a person earns relative to others is an important determinant of mental health (Wilkinson & Pickett, 2009). This theory of 'relative deprivation' has prompted considerable debate (Muntaner & Lynch, 1999; Wilkinson, 1999; Marmot & Wilkinson, 2001; Lynch & Davey Smith, 2002) and continues to attract scientific enquiry (Kondo *et al.* 2009; Fone *et al.* 2013; Pabayo *et al.* 2013; de Vries *et al.* 2014). It is not only that having more income typically endows one with greater command over material resources, but the extent of the

income difference between the desired situation and the person desiring it is also said to matter (Runciman, 1966). Social comparisons render those on relatively higher incomes with greater prestige in society, whereas those on lower incomes are said to experience more stress and dissatisfaction through invidious social comparisons (Wilkinson, 1999). Although the majority of the epidemiological evidence thus far has examined this 'relative deprivation' hypothesis with respect to inequality at the national level (Subramanian & Kawachi, 2004), these social comparisons are also likely to be made within the neighbourhoods in which people live (Galster, 2008). Recognising the patterning of mental health by income, the research question being asked is whether said patterning is modified by the socio-economic circumstances of the neighbourhoods in which people reside? Through considering this question, we highlight several challenges in the analysis of causality that geographers, epidemiologists, sociologists, economists, etc. must continue to contend with in the future.

Method

To test this question, we took responses to the Kessler 10 Psychological Distress Scale (Furukawa *et al.* 2003) in the Sax Institute's 45 and Up Study (The University of New South Wales Human Research Ethics Committee (HREC 05035/HREC 10186) approved the 45 and Up Study.). (45 and Up Study Collaborators, 2008). Between 2006 and 2008, approximately 267,000 Australians aged 45 years and older living in New South Wales (NSW) participated, having been randomly sampled from the Medicare Australia database. Approximately 12% were identified as being at a high risk of experiencing psychological distress (scores of ≥ 22). The University of New South Wales Human Research Ethics Committee (HREC 05035/HREC 10186) approved the 45 and Up Study.

We fitted this binary variable as the outcome within a multilevel logistic regression in MLWIN (Rasbash *et al.* 2000), with adjustment for an interaction between gender and age (fitted as linear and square terms, to account for curvilinear associations in mental health as people age). Intercepts were allowed to vary, which afforded an estimate of the variance in psychological distress manifesting across areas of residence (proxied by 'Statistical Local Areas'). The 'area-level' variance was estimated at 0.07 (standard error = 0.009), which can be re-expressed in the form of a Median Odds Ratio (MOR) (Merlo *et al.* 2006) of about 1.29. This suggests that the median difference in the odds of experiencing psychological distress from one area to another is 29%; there is geographical variation of psychological distress in our sample. This variation is illustrated by a residual plot in Fig. 1 and a

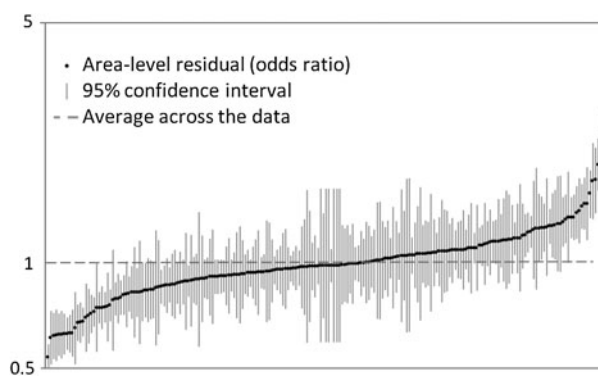


Fig. 1. Geographical variation in psychological distress, expressed in the form of odds ratios on a residual plot, adjusted for age.

close-up of the Sydney metropolitan area (home to over 4.5 million people) in Fig. 2.

To measure relative deprivation at the neighbourhood level, we categorised responses to a question on annual household income for each participant (\$0–19, 999, \$20 000–69, 999, \geq \$70, 000) and cross-classified this variable with tertiles of the Socio Economic Index For Areas (SEIFA) scale of advantage/disadvantage (Pink, 2011). The SEIFA scale takes into account a range of socio-economic indicators, including income. According to

this cross-classification, a participant may be described as 'relatively deprived' if their level of income was low but they were living in an area scoring highly on the SEIFA scale (i.e., an affluent neighbourhood). Conversely, a person may be considered to be a source of disamenity to their neighbours if they had a high income but lived in a deprived area. Fitting this cross-classification as a set of fixed effect dummy variables allowed a relatively straightforward interpretation (as opposed to fitting two-way interactions).

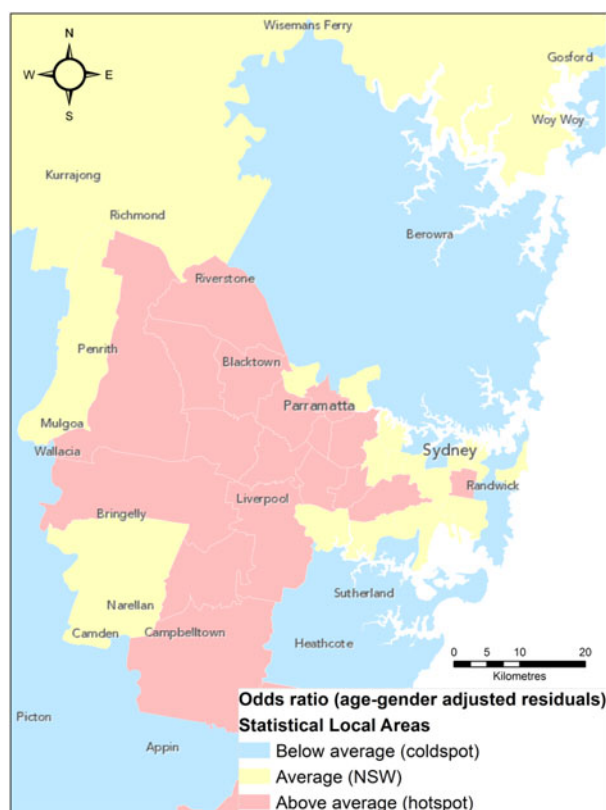


Fig. 2. Geographical variation in psychological distress in Sydney Metropolitan area, expressed as a map of area-level residuals classified above, below or not significantly different to the average across NSW, adjusted for age and gender.

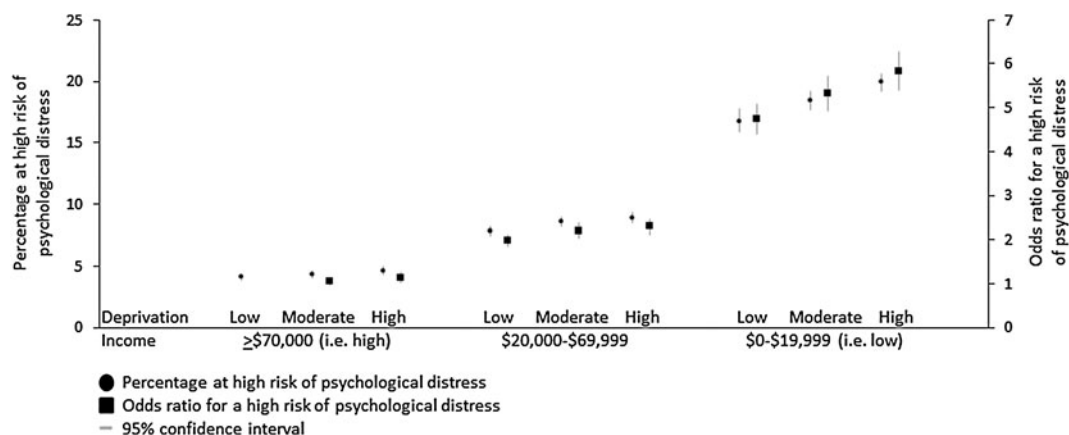


Fig. 3. Psychological distress and local relative deprivation, adjusted for age and gender.

Results

The 'area-level' variance was estimated at 0.07 (standard error = 0.009), which can be re-expressed in the form of a Median Odds Ratio (MOR) (Merlo *et al.* 2006) of around 1.29. This suggests that the median difference in the odds of experiencing psychological distress from one area to another is 29%; there is geographical variation of psychological distress in our sample.

Adding the measure of relative deprivation to the model explained about 67% of the geographical variation, bringing the MOR down to 1.16. Figure 3 shows the familiar pattern of greater odds of psychological distress among people on lower incomes and living in deprived neighbourhoods. It is also clear, however, that these analyses presented no evidence of a 'relative deprivation' effect, since people on lower incomes tended to do *better* if they were resident in more affluent surroundings than their peers living in deprived neighbourhoods. Compared with people on high incomes living in affluent neighbourhoods, the odds ratio of psychological distress for people on low incomes in affluent areas was 4.73 (95% confidence interval (95% CI) 4.39, 5.09), whereas the odds ratio for those on low incomes in deprived areas was significantly higher at 5.83 (95% CI 5.41, 6.28).

Discussion

Key findings and appraisal of the initial hypothesis

Discordance between the amount of income earned and that to which a person desires is said to create relative deprivation. Since people routinely compare themselves to others they see regularly, such as their neighbours, then this potentially psychosocial risk factor may be hypothesised to operate at a local as well as national scale. In this study, people on lower incomes had greater odds of psychological distress, especially if they lived in deprived neighbourhoods. Conversely, people on

higher incomes tended to have better mental health regardless of their neighbourhood socioeconomic circumstances. These results are at odds with the relative deprivation hypothesis. If relative deprivation were a local 'place effect', the inverse to the results found should have been observed. The results clearly do not refute relative deprivation measured at the national scale as a potential pathway, but they do imply that local relative deprivation may not be a negative determinant of mental health as might have previously been thought.

Perhaps what these results do lend support to, however, is a lesser-known and more materialist alternative called the 'pull-up/pull-down hypothesis' (Gatrell, 1997; Boyle *et al.* 2004a, b; Cox *et al.* 2007). Proponents of this hypothesis suggested that a person on lower income who happens to live in an affluent area benefits from the range of local resources and conditions that would not necessarily have been available were they living in a poorer community. These could range from healthy food outlets, health services, more public parks, less crime and pollution, etc. This may be combined with potential benefits of exposure to residents from more favourable socioeconomic backgrounds, supplying 'weak ties' (Granovetter, 1973), different social role models and 'bridging' forms of social capital (Putnam, 2007), perhaps with greater social regard for health-enhancing lifestyles such as physical activity and healthier eating. This idea is not dissimilar to that promoted by work on 'deprivation amplification' (Macintyre, 2007), the concentration of poverty (Wilson, 1987) and advocates of desegregation policies via mixed housing tenure initiatives (Ostendorf *et al.* 2001; Bond *et al.* 2010). Where one lives is argued to matter and the more affluent the surroundings the better, regardless of an individual's income.

This raises a substantively interesting research question: what are the reason(s) why people on lower incomes that live in more affluent surroundings appear

to have better mental health? Can we isolate, empirically, what those features of the local environment might be, in so that we can use that information to optimise urban design to enhance mental health within disadvantaged communities? The remainder of this paper reflects on the challenges to realising this ambition.

Drawing the boundaries

The given analysis was a fairly basic example of a multilevel model, wherein the reality of people sharing local geographies, having access to similar services and exposure to various localised phenomena is not conceptualised merely as a nuisance to be controlled; it is an important avenue for scientific enquiry (Subramanian & O'Malley, 2010). These models are, by and large, standard procedure for quantitative studies of people within places (Jones & Duncan, 1996; Diez Roux, 2004; Subramanian *et al.* 2009). From the results, it is clear that (i) geographic variation in psychological distress exists; and (ii) much of this variation can be attributed to differences in socio-economic circumstances between individuals and, to a lesser extent, the places in which they live. Claims over causality, however, would be highly premature. Previous work has already noted that the partitioning of variance and expression as an MOR in a multilevel logistic regression is a useful tool to describe geographical variation in the outcome of interest; these tools cannot nonetheless assert a causal effect of 'place' on said outcome (Merlo & Chaix, 2006). There are many reasons why, some of which are widely recognised, but others less so.

One of the more routinely appreciated reasons is the set of geographical boundaries used to delineate 'neighbourhood'. The problem is that much of the work, including that presented here, has used sets of geographical boundaries that were created for purposes other than to ascertain the exposure that is of direct interest to the study (Flowerdew *et al.* 2008). The imposition of 'off-the-shelf' geographical boundaries may reflect the places of residence of some people quite well, but for others rather poorly, even for people who live next door to each other since conceptualisations of where people live are highly subjective (Galster, 2001). This means the use of geographical boundaries is often only arbitrarily related to the conceptualisation of the exposure (in this case, neighbourhood disadvantage), leaving open the potential for misclassifying contextual variables. As a result, findings from analyses can potentially vary as a consequence of manipulating where the geographic boundaries are drawn; a problem often referred to as the 'modifiable areal unit problem' (Openshaw & Taylor, 1981). Although concerted efforts have been made to address this issue using increasingly

sophisticated technologies that involve tracking the whereabouts of individuals using global position systems to create bespoke neighbourhoods (Kwan, 2012), the ability to apply these techniques across a range of potential exposures and to upscale them to very large population health data remains a major challenge.

Joining the dots

Among many other standard critiques of this field of research has been the issue of selective (im)mobility, wherein place-based exposures cannot be understood as randomly distributed. Therefore, while a place-level variable may be objectively measured (as opposed to relying upon a participant's self-reported perception of their neighbourhood), estimation of the exposure-outcome pathway is still likely to be biased. Hence, those confounding factors that determine why a person may have ended up in one neighbourhood and not another need to be taken into account. For this purpose, the potential for wider use of 'DAGs' would be highly beneficial. DAGs can help to formalise hypothesised causal mechanisms, possible threats to their identification (both measured and unmeasured), along with other assumptions being made by the investigator (Pearl, 1995; Greenland *et al.* 1999). Some studies have provided useful examples of how DAGs can be applied effectively to refine estimates of the impact of residential environments on health outcomes (Fleischer & Diez-Roux, 2008; Chaix *et al.* 2010; Sharkey & Elwert, 2011). Although there may remain sources of confounding that an investigator is unable to measure that do have an impact on where a person elects to live, the use of DAGs helps to highlight this limitation, to keep the level of inference in check, and to identify potential targets for future research.

So what might the DAG for the analysis in this study have looked like? A basic version is illustrated in Fig. 4. The DAG specifies the effect of income on psychological distress is likely to be confounded by age and gender. The dotted line indicates we have hypothesised that neighbourhood deprivation moderates the impact of income on psychological distress. The DAG also identifies age and gender as confounders of neighbourhood deprivation. It does not take into account the plausibility of mediating pathways since these are less of an overt concern for the relative deprivation hypothesis (Wilkinson, 1999). Overall, this DAG indicates that the income effect on psychological distress is conditional on the level of neighbourhood deprivation to which a person is exposed. It implies that a person of a certain income was moved from a deprived neighbourhood to one considerably more affluent, *ceteris paribus*, the impact of income on psychological distress would change accordingly.

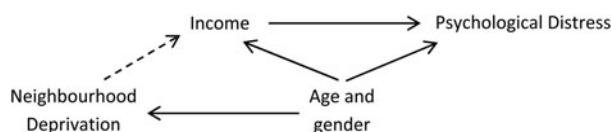


Fig. 4. A DAG specifying the impact of income on psychological distress, conditional upon neighbourhood deprivation and adjusted for age and gender.

Reality is undeniably more complex than this simple DAG suggests. Although we are hypothesising neighbourhood deprivation conditions the impact of income on psychological distress, a person is likely to select their neighbourhood to match their needs and resources, within the constraints of a budget (Cheshire, 2007). Thus, people on low incomes usually live in deprived areas because the housing stock is more affordable. Conversely, houses in more attractive neighbourhoods tend to cost more because they supply the kudos and tangible resources that people might be looking for, such as good schools, safe streets, green spaces etc. So while the relative deprivation hypothesis implies that the socioeconomic circumstances of the neighbourhood in which a person lives modifies the impact of income on psychological distress, we must also face up to the truth that both neighbourhood choice and the ability to leave or remain within a particular neighbourhood are all strongly determined by a person's level of income, as well as a host of unmeasured factors; some of which are known, while others remain unknown.

In the case of this DAG, what this means is that exposure to neighbourhood deprivation is not random and that we should expect some level of correlation between income and local affluence. Those on low incomes who live in affluent areas are, therefore, rather unusual and some have expressed doubt over whether these groups can be treated with the same level of statistical credence as the rest of the sample (Oakes, 2004). Part of this problem is that although income is measured, it will not account fully for why people live where they do. Many people on low incomes may live in affluent areas because their home is fully paid (perhaps through inheritance) and what money they earn is for sustaining small pleasures (e.g., for the sociable side of work), rather than the need to pay bills and rent. That we have not been able to separate out those on low incomes who just about make ends meet *v.* those on low incomes who do so although choice is important, as it could then influence how long a person works, spends driving and the time left to allocate to activities which promote mental health (e.g., interactions with family and friends). While these variables appear to be mediating pathways, they are also confounders in the sense that people on low incomes in affluent areas who dislike having to work multiple

jobs to pay high rents may move to more affordable neighbourhoods. Those persons on low incomes who remain in residents of affluent areas are either supported by other circumstances that go unmeasured, or are themselves rather exceptional, rendering the results for some commentators potentially moot. Nevertheless, the use of DAGs has helped to raise these issues for further debate and that is a positive outcome, for it helps to avoid making premature conclusions and policy prescriptions that may have unintended consequences on society.

More ambitious study designs

It is often suggested that observational (i.e., non-experimental) studies will remain the 'bread and butter' of scientists interested in understanding the role of place on health and life-chances, since the ability to implement experimental designs relevant to the research question at hand is often severely constrained by ethical, pragmatic and institutional concerns (e.g., Sampson, 2008). In contrast, it has been remarked by at least one commentator that there be a moratorium on applications to a major research council for studies of place and health using multivariate analytical methods (Oakes, 2013). Whether this statement was made with perhaps with a little tongue in cheek or not, it is important to consider the extent to which experimental and quasi-experimental study designs are feasible for ascertaining a higher degree of understanding on what neighbourhood features affect mental health; for better *and* for worse (Oakes, 2004; Macintyre, 2011).

Perhaps the most well-known example in the field comes from what was originally a study of self-sufficiency and social mobility; the 'Moving To Opportunity' (MTO) project. A major strength of MTO's design was to allocate vouchers to a randomly selected group of socioeconomically disadvantaged participants, affording them the opportunity to move to somewhat more affluent neighbourhoods than that which they had previously lived in. This process eliminated much of the confounding related to selective (im)mobility, given that the ability to move to what was theorised to be areas of greater opportunity was randomly allocated. While the MTO investigators found little by ways of social mobility and self-sufficiency as a result of improving the socioeconomic circumstances of where

people lived (Katz *et al.* 2001; Kling *et al.* 2007), what has since been found was improvements in mental health (Leventhal & Brooks-Gunn, 2003; Ludwig *et al.* 2012) as well as other positive health outcomes (Ludwig *et al.* 2011). Qualitative research following up those who moved from poor to more affluent neighbourhoods reported improvements in home aesthetics, more satisfaction and sense of neighbourhood togetherness, lower levels of crime and a belief that the new areas were better for bringing up children (Turney *et al.* 2013); perhaps another score for the 'pull up/pull down' hypothesis and against that of local relative deprivation.

MTO is clearly successful in many ways, not least in making the scientific community think about how research on place and health could be done using a randomised design. It is not done nearly enough and perhaps enthusiasm is diminished by the potentially rather daunting level of financial input that may be required to implement such a study. An MTO-style design would also not be very useful, however, for answering questions such as what happens when a feature of a neighbourhood changes around a community that remains in-situ? Arguably, this is a situation that reflects the likely decision-making process wherein changes in built environment are made in existing communities, rather than moving communities to entirely new areas. Recent examples include capitalising upon changes occurring within parks (Cohen *et al.* 2009, 2012; Branas *et al.* 2011; Veitch *et al.* 2012) and the opening of supermarkets (Wrigley *et al.* 2003; Cummins *et al.* 2005, 2014) and housing regeneration programmes (Egan *et al.* 2013).

Assessing the potential impact of these neighbourhood-level changes around people who remain in the same place are essential, as the ability to modify the exposure of interest is not usually within the investigators control. Herein lie many key challenges, however. These changes in built environment are not randomly assigned; they are viewed as 'natural experiments' (Craig *et al.* 2012). Supermarket companies, for example, will not open their stores in random locations but in fact target them geographically, based at least in part upon the consumer profiles of the communities which they will likely serve.

A lack of blinding in these types of studies presents another problem. For example, as one park receives an upgrade, the qualities of another park located nearby that may be used as a control could diminish in relative (or absolute) terms, violating the stable unit treatment valuation assumption (or 'SUTVA') (Oakes, 2004). Meanwhile, one cannot force study participants to remain within the neighbourhood following the change in built environment. Some people may wish

to capitalise on change in house prices or may not be able to afford a change in rent, whereas others may simply not like the change in their neighbourhood environment (among a myriad of possible reasons). The ability to leave the neighbourhood may be associated with mental and physical health and this may yet result in clustering of certain health outcomes where there is no causation (Boyle *et al.* 2009). Thus, the selective (im)mobility problem remains a major challenge not only for observational cross-sectional studies, but also those using experimental and quasi-experimental techniques. In these situations, rather than a nuisance, it is arguable that understanding the determinants of this health-selective (im)mobility is as central to the research enterprise as is the identification of 'place effects'.

To conclude, while more ambitious study designs are encouraged, it is up to the scientists conducting those studies to be fully transparent in where the implementation of such a design minimises confounding and where it does not. Evaluations of natural experiments and quasi-experiments are crucial for enhancing the quality of evidence available for decision makers and they need research support from funding councils (although, maybe not entirely at the expense of observational studies). These types of study designs have clear guidelines available for their assessment (Craig *et al.* 2012) and have been used effectively to evaluate major place-based initiatives designed, at least in part, to promote better mental health (Melhuish *et al.* 2008; Edwards *et al.* 2011), as well as to understand the impact of structural change such as new supermarkets and park upgrades. Combining these designs with a careful selection of suitable (bespoke) geographical units to define exposure and the use of DAGs to identify potential threats to causal inference would be very helpful to enhance the quality of evidence available for decision makers who ultimately shape the built environments in which we live and the services we interact with.

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Conflict of Interest

None

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