Appendix A: Exposure Assumptions

1. Area-based exposure measures

(a) Proximity to the intervention is central to classifying exposure

Researchers must justify the theoretical grounds upon which it is reasonable to assume that the impact of an intervention is dependent on proximity to any given environment. This may differ depending on what the outcome of interest is and what the *induction* or *latency* period might be. This requires careful consideration of the programme theory.

(b) A 'zone of influence' exists and can be defined at an appropriate areal scale (with reasonable margin for error)

Evaluators must also justify the size and shape of the geographic spatial units. Such considerations encounter the "modifiable areal unit problem" (MAUP);[1] where the selection of the size and shape of an observational unit may have implications for the findings of the evaluation. Where spatial units are deemed necessary it is important that their definition reflects theoretical considerations about the process and relationship between the intervention and outcomes.[2,3] In some epidemiological studies it is common to define spatial boundaries using a measure of 'walkable distance' between a residential location and a relevant place (e.g. fast food outlets, alcohol outlets, bus stop, green space).[4] However sensitivity analysis may be required to investigate whether findings differ on the basis of the size and shape of the spatial units selected.

(c) Exposure can be treated as a binary scale

It is common practice to characterise exposure to environment interventions as a binary variable ('exposed' or 'unexposed').[5] This approach is attractive in terms of convenience and consistency with conventional approaches for allocating treatments to binary conditions in randomised controlled trials. However, justification is required where an arbitrary distance (e.g. a 'walkable distance') is used to suggest that exposure is zero beyond a given distance. Where the definitions of exposure categories are modifiable and/or made by members of the research team, the reasons for doing so should be reported and discussed in the presentation of the design.

2. Individually computed distances

a) Proximity of home location to the intervention is central to classifying exposure

As was the case for area-based exposures, characterising exposure to an intervention through individually computed distances assumes that proximity to the intervention (usually from a residential address) is central to the classification of exposure.

(b) A distance-decay effect predicts uptake and impact

Unlike area-based measures, exposures that use individually computed distances assume greater variation in exposure across space. An individually computed distance measure moves away from crude, and often binary classifications of exposure, suggesting that those living closer to the intervention are progressively exposed to a greater extent than those living further away. Evidence that increased uptake or use of new environmental facilities is mediated by proximity to the intervention has been reported in several studies of the effects of interventions in the built environment on physical activity. Likewise, research simulating the effects of improvements to food environments predicted effects on body mass index (BMI) that exhibited a distance-decay pattern, whereby those residing closest to improved facilities had the largest decrease in BMI. [6]

(c) Computed distances reflect actual distances

Calculating distances between a participant's residential address and the location of an intervention may be subject to error where automated GIS techniques are used to calculate the shortest distance to the intervention. Research has shown that the shortest route computed in GIS software may not accurately reflect actual travel preferences of study participants. [7] However, other research has suggested that comparisons of predicted (GIS) and actual (GPS) travel distances are comparable when preferences about travel mode(s) are taken into consideration. [8]

3. Individually calibrated exposure

(a) Exposure to an intervention is not dependent on the residential location

Exposure to a place-based intervention is possible even when populations reside in locations remote from the intervention. This method of calculating exposure assumes that individual mobility patterns and routine behaviours will contribute to differential levels of exposure.

This method relaxes the assumption of residential proximity in previous approaches in an attempt to avoid falling into the 'local trap'. [9]

(b) Total exposure is the sum of exposure at key 'anchor points'

Combining exposure for residential and workplace locations may help to produce a more intricate calculation of exposure to an intervention. Though most people divide their time between home and work environments, this approach would fail to consider exposure that may occur outside of these two environments — environments that occupy the 'third place'.[10,11] For example, it is possible for individuals to become exposed to place-based health interventions during the time they spend outside work or home, or on the journey between the two. [4]

(c) The intervention's 'zone of influence' can be defined and justified at an appropriate spatial scale (with reasonable margin for error)

The same principles apply here as for area-based exposure measures. Defining 'interaction' with an intervention, whether a geographic area or a particular point of interest (e.g. bar, supermarket, fast food outlet) requires some conceptual or theoretical justifications for how close one might need to be to, or how long one might need to spend in the close vicinity of, a given geographic point. Alone, quantitative data about spatial and temporal interactions between individuals and environments may not be sufficient to understand whether exposure equates to perceived exposure, or whether exposure (or perceived exposure) accurately predicts uptake or behaviour change.

Appendix References

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