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Neighborhoods and health: where are we and were do we go from here?

Environnement résidentiel et santé : état de la question et perspectives pour le futur

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Abstract

In recent years there has been an explosion of interest in neighborhood health effects. Most existing work has relied on secondary data analyses and has used administrative areas and aggregate census data to characterize neighborhoods. Important questions remain regarding whether the associations reported by these studies reflect causal processes. This paper reviews the major limitations of existing work and discusses areas for future development including: (1) definition and measurement of area or ecologic attributes; (2) consideration of spatial scale; (3) cumulative exposures and lagged effects; (4) the complementary nature of observational, quasi-experimental, and experimental evidence. As is usually the case with complex research questions, consensus regarding the presence and magnitude of neighborhood health effects will emerge from the work of multiple disciplines, often with diverse methodological approaches, each with its strengths and its limitations. Partnership across disciplines, as well as among health researchers, communities, urban planners, and policy experts will be key.

Résumé

On assiste depuis quelques années à un intérêt de plus en plus marqué pour les effets de l'environnement résidentiel sur la santé. La plupart des travaux existants reposent sur des analyses secondes et ont recours à des données administratives et à des données agrégées de recensements concernant des zones résidentielles pour caractériser les environnements. Ils soulèvent des questions importantes concernant, notamment la causalité des relations observées. L'article passe en revue les principales limites de ces études et propose des pistes pour la recherche relatives à : 1) la définition et la mesure des caractéristiques écologiques des zones résidentielles ; 2) la prise en compte de l'échelle spatiale ; 3) le cumul d'expositions et leurs effets à long terme ; 4) la complémentarité des approches observationnelle, expérimentale et quasi expérimentale. Comme toujours quand il s'agit d'une question de recherche complexe, progresser dans la connaissance des effets de l'environnement résidentiel sur la santé et de leur importance suppose la mise en œuvre d'approches multidisciplinaires et le recours à des méthodes différentes ayant chacune leurs forces et leurs faiblesses. Le partenariat entre disciplines, mais aussi entre chercheurs du champ de la santé, acteurs des collectivités locales, de l'urbanisme, du logement et plus généralement des politiques publiques est crucial.

Keywords: Neighborhood environment; Health; Measurement; Causality; Ecological attributes; Spatial scale

Mots clés : Environnement résidentiel ; Santé ; Mesure ; Causalité ; Caractéristiques écologiques ; Échelle spatiale

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tant methodological limitations as repeatedly noted by researchers working in the field [18,19]. The chief limitation is that these measures are imperfect and obviously very crude proxies for the physical and social features of neighborhoods hypothesized to affect health. This generates two problems. First, their use necessarily results in misestimates of the overall causal effects of neighborhoods on health simply because of the measurement error inherent in using neighborhood socioeconomic characteristics as a proxy for the direct measure of the relevant construct. A second problem is that their use does not allow identification of the specific neighborhood features that are relevant, or of the processes by which neighborhoods affect health. Identifying these features and these processes is key to developing health-promoting interventions targeted at neighborhood conditions. Nevertheless it is important to emphasize that the causal effect of interest even in studies that use aggregate neighborhood socioeconomic characteristics is not the literal effect of neighborhood socioeconomic composition per se, but rather the causal effect of the social and physical neighborhood attributes which neighborhood SEP is proxying. The counterfactual contrast can therefore be clearly articulated, although the treatment or "exposure" is measured with error and its effective components cannot be identified. These social and physical features of neighborhood are external to the individual and are also modifiable and therefore perfectly valid as potential causal factors. The "treatment" being investigated is changing these social and physical attributes, and not moving rich people into poor neighborhoods or vice versa, as is sometimes implied [22]. Even though neighborhood SEP may appear endogenous to individual SEP (because it is constructed by aggregating personal SEP) the dependence of the aggregate measures on a single individual is trivial; moreover the aggregate SEP measures is used to proxy a variety of clearly exogenous characteristics. Of course they may be poor proxies; hence the need to move beyond this initial approach to direct measurement of the neighborhood constructs of interest.

A second limitation of using neighborhood socioeconomic indicators as proxies for relevant neighborhood attributes pertains to difficulties in estimating associations of neighborhood socioeconomic context with health outcomes independently of person-level SEP. Person-level SEP is often perceived as a key confounder of any neighborhood health effects because of the known relationship between SEP and health, and because of the strong residential segregation by SEP that exists in most of today's societies. It has been argued for example that the limited overlap in personal SEP between wealthy and poor neighborhoods makes personal SEP adjusted estimates of neighborhood effects questionable because they are based on extrapolations well beyond the range observed in the data [22]. The extent to which this is true is an empirical question that can be examined in each specific dataset. Careful analyses of neighborhood effects have investigated the overlap in the distributions before making any adjustments as one would with any adjustment variable [21]. The amount of overlap that is sufficient is ultimately a matter of judgement. The whole purpose of adjustment is to compare groups with different distributions, how different these distributions have to be for the adjusted results to be questionable is a matter of debate. Of course, as in any analysis, showing the data and making assumptions explicit is key.

Because of the limitations noted above, considerable debate still exists on whether the associations observed reflect causal processes, and if they do, what the specific relevant aspects of neighborhoods—aspects that we could potentially intervene on to improve health—might be. Identifying these specific features is crucial not only for strengthening evidence regarding the presence of causal neighborhood effects but also because it would indicate aspects that could be intervened on to improve health. A large body of recent work has begun to focus on investigating area or neighborhood effects in much more detail. The fundamental questions that these studies are trying to address are:

- What is it about areas that matter or what are the specific area characteristics relevant to health?
- How does it matter or what are the specific processes through which these characteristics affect health?
- What are the spatial scales at which these processes operate and are different scales relevant for different health outcomes?
- Can we change area characteristics and show an effect on health?

Fundamental to answering these questions is the development of conceptual models of the specific processes through which neighborhoods or areas may affect a given health outcome. These models are crucial to developing operational hypotheses, which can be tested with empirical data. Much greater specificity in the hypotheses and empirical tests carried out to date is necessary to strengthen inferences regarding causal effects of neighborhoods on health. The development of these conceptual models as well as the empirical testing of hypotheses derived from them will require addressing a set of key issues that include definition and measurement of area or ecologic attributes, consideration of spatial scale, cumulative exposures and lagged effects, and complementary study designs. Each of these is discussed in detail below.

3. Defining and measuring area attributes

Conceptualizing and measuring the area or neighborhood-level factors hypothesized to be relevant to a particular health outcome continues to be a major challenge. Beginning with an explicit conceptual model of what the most relevant factors might be, as well as clearly hypothesized pathways through which they may affect health outcomes is key. An example of such a model for cardiovascular disease is shown in Fig. 1. In contrast to the sophistication of the measurement of individual characteristics in epidemiology, the measurement of the attributes of areas or neighborhoods remains in its infancy. Thus developing measures of neighborhood or area-level constructs and documenting their validity and reliability continues to be an important need in the field. Two basic approaches

when the outcome is directly measured by the investigator as opposed to reported by the participant. But even in the case of directly measured outcomes a limitation of the use of participant reports is that each measure is based on the report of a single participant, and individual reports of neighborhood conditions may have substantial error. This error may arise from simple lack of knowledge of the resident on certain conditions in the neighborhood and from the necessarily subjective nature of perceptions. Of course, if it is hypothesized that an individual's perception of neighborhood conditions is the construct relevant to health (as opposed to the objective condition) then participant self-reports are the measure of choice, although the interpretation of results may be rendered complex by the same-source bias issue alluded to above.

An alternative to the use of each participant's owns self-report of neighborhood characteristics is to combine the responses of several residents of the same neighborhood [28]. Theoretically, by averaging over measurement error in individual responses, this aggregation process may yield a more valid measure of the "objective" neighborhood construct of interest. This approach can be implemented by aggregating the responses of participants in a health study in order to characterize a given neighborhood represented in the study, or by conducting a separate survey co-located with health study participants in order to derive measures for areas which can then be linked to health study participants based on their place of residence. The rationale for conducting a separate survey is twofold: (1) the focus of the survey is assessment of area or neighborhood characteristics and hence a more detailed assessment can be included than is possible in the health study itself (where neighborhoods are only one of several domains being assessed), (2) the separate survey allows for denser sampling in space which is likely to improve estimation of the area-level construct of interest. In some cases it may be advantageous to combine the separate survey approach with a similar data collection approach targeted at the health study participants themselves. This would allow simultaneous investigation of the self-reported, individual-level perceived measure and the aggregate (potentially more "objective") neighborhood-level measure. An alternative to conducting a separate survey is to employ trained raters to evaluate neighborhoods in systematic fashion on pre-specified dimensions. This approach, originally used in sociology has been termed systematic social observation [29]. It has the advantage that raters can be trained and assessments conducted in a systematic and quality controlled manner. A disadvantage is that some constructs (e.g. social cohesion) may not be measurable using this approach because their assessment necessitates the knowledge and perceptions of residents. The logistics and cost of systematic social observation also make it a difficult approach to implement across very broad geographic areas. The advantages of systematic social observation over survey and census measures in characterizing specific neighborhood conditions relevant to health are only beginning to be systematically evaluated [30,31].

A growing body of work has begun to focus on assessing the measurement properties of area measures constructed by aggregating the responses of survey participants or the observations of raters. This field has been referred to as ecometrics [28,32]. Traditionally psychometrics has evaluated the measurement properties of scales administered to individuals (for example the extent to which an individual's responses to different items of a scale are consistent with each other). Ecometrics moves beyond the individual-level to an assessment of the measurement properties at the area-level. If the construct of interest differs in a systematic fashion across areas (and if the scale used appropriately captures this variation), respondents or raters within a given area should be more likely to agree in their assessment than respondents or raters from different areas. Thus a key indicator of the measurement properties of the area-level measure is the within-neighborhood ICC for the scale of interest, which quantifies the extent to which respondents or rates agree in their assessment of a given neighborhood. The assessment of the measurement properties of neighborhood-level measures can be assessed using three-level multilevel models (sale items nested within person nested within neighborhoods). Another issue is the construction of the aggregate measure itself especially when the number of observations differs substantially by neighborhoods and some neighborhoods have few observations. In the case of neighborhoods with small numbers of observations, measures based simply on aggregating the observed data may have important measurement error. The use of shrinkage estimates such as empirical Bayes estimates (which address this problem) as well as the potential use of other area-level covariates to improve the estimate for a given area (as in conditional empirical Bayes estimates) is beginning to be evaluated in health research [28,33].

Area-level measures constructed using surveys or raters are usually estimated for pre-defined (and often somewhat arbitrary) geographic areas such as census tracts. However, it may be unreasonable to think that these attributes change dramatically across these arbitrary geographic borders. More novel approaches have begun to use geostatistical methods and point data (e.g. from surveys or rater observations) to model and estimate smooth surfaces of the distribution of these attributes over space [34]. This modeling takes advantage of the spatial patterning in the data and may also make use of co-located covariate information to improve predictions. For example, data on the location of supermarkets can be used to improve survey-derived estimates of the availability of healthy foods. These surfaces can be used to obtain estimates for unobserved locations and also to obtain summary measures for areas of varying size (e.g. for a given radius around each participant's home), which can then be examined in relation to health outcomes.

4. Spatial scale

Early work on areas or neighborhoods and health used administrative areas as proxies for neighborhoods or, more generally, for the areas potentially relevant to health. Data availability and feasibility issues largely drove the use of these area definitions: it was relatively easy to link health study participants to routinely available data (such as census data) that could be used to characterize their place of residence. These administrative areas are obviously poor proxies for

damental critique of these types of analyses has been that persons exposed and unexposed to the neighborhood characteristic of interest differ in other factors related to the health outcome, which will confound any associations of neighborhood characteristics with health outcomes. This issue (which is traditional confounding in epidemiologic terms) has also been referred to as "the selection problem" (because persons are selected or select themselves into neighborhoods based on individual characteristics related to the outcome) and non-exchangeability of exposed and unexposed. This non-exchangeability implies that the observational comparison does a poor job of approximating the counterfactual contrast necessary for drawing causal inferences. The traditional approach to this problem in epidemiology is to estimate associations after adjusting for individual-level confounders using stratification or regression approaches such as multilevel models. Critics have argued that this approach often relies on extrapolations beyond the range observed in the data due to limited overlap in individual-level characteristics for persons living in different types of neighborhoods, and hence that associations estimated using this approach are necessarily always biased [22].

The extent to which persons living in "exposed" and "unexposed" neighborhoods are comparable in individual-level characteristics, as well as the extent to which distributions overlap, can be (and should be) empirically examined in the data before any adjustment is performed. The amount of overlap in the distributions necessary for the adjusted estimate to be "valid" ultimately depends on the assumptions one is willing to make. Even when distributions do not exactly overlap, the potential for bias (because of limited overlap and consequent off-support inference) does not imply that bias is always present. Reporting the actual distributions, and therefore making the assumptions explicit, is important and likely to be more productive and informative than blanket critiques of all analyses because of the "non-exchangeability" problem. The extent to which non-exchangeability and non-overlapping distributions are a problem may also differ substantially depending on the sample and on the specific neighborhood characteristic being examined. For example, non-overlapping distributions in individual-level socioeconomic indicators may be a problem when extreme categories of neighborhoods categorized based on aggregate SEP measures are compared. But it may be less of a problem when specific neighborhood features are examined. Propensity score approaches [42] have increasingly been used as an alternative to regression adjustment in studies of neighborhood effects with most studies to date confirming the results obtained using regression adjustment [43–45]. An advantage of propensity score matching is that it allows estimates to be derived from subgroups of the sample, which are directly comparable. A limitation is that propensity score matching estimates the association of interest using a selected subgroup; hence it may not be generalizable to the full sample of interest [45]. In addition, propensity score approaches obviously do not solve the problem of mismeasured or unmeasured confounders. Another challenge in estimating neighborhood effects pertains to identifying which variables are true confounders (and hence should be adjusted for) and which are mediators (and hence should not). Some variables could conceivably be both confounders and mediators. Although statistical methods to deal with these situations have been developed [46], their data requirements have precluded their application in neighborhood health effects research to date.

The limitations necessarily inherent in traditional observational studies have highlighted the need for alternative and complementary approaches. One potentially useful approach is the use of instrumental variables [47]. In the context of neighborhood effects research a useful instrument would be a variable that is (a) causally related to the neighborhood characteristic of interest; (b) affects the health outcome only through the neighborhood characteristic; and (c) does not share common causes with the outcome. Unfortunately finding instrumental variables of use in neighborhood health effects research is a major challenge, and results may be highly sensitive to violations of often-unverifiable assumptions [48]. A related approach is to capitalize on naturally occurring changes in neighborhoods and quasi-experiments (whenever available) in order to evaluate their health effects. This approach will often require researchers to work closely with policy makers, urban planners, and communities in order to conduct health assessments in a manner, which will allow estimation of these effects. A third, and to some "ideal", approach is to conduct randomized trials. Randomized trial approaches to the study of neighborhood health effects are virtually non-existent. The one often cited example (Moving to Opportunity in the United States) [49,50] randomized poor individuals to moving or not moving to non-poor areas, and hence did not directly examine a neighborhood-level intervention. Randomized trials of neighborhood interventions have two important challenges: (a) the need to randomize large numbers of distinct and spatially unrelated "neighborhoods" (in order to minimize spatial spillover effects) which may be infeasible in many settings; and (a) the need to have a clear understanding of what the treatment or intervention should be.

Current state of knowledge regarding the specific features of neighborhoods that are relevant suggests that more work is needed to identify the interventions or treatments, which it would be most useful to test in a randomized trial if it were possible. The difficulties in conducting a randomized trial of neighborhoods (and the necessarily selected sample of neighborhoods likely to participate) could also raise issues related to the generalizability of results obtained in a perfectly controlled but necessarily selected setting to the larger population of neighborhoods. Thus reliance on observational and quasi-experimental evidence is likely to continue.

7. Conclusion

Clearly, documenting causal effects of neighborhood contexts on health would have important policy implications. Differences across areas or neighborhoods are not "natural" but rather result from specific policies (or from the absence of

[36] Chaix B, Merlo J, Subramanian SV, Lynch J, Chauvin P. Comparison of a spatial perspective with the multilevel analytical approach in neighborhood studies: the case of mental and behavioral disorders due to psychoactive substance use in Malmo, Sweden, 2001. Am J Epidemiol 2005;162:171–82.

[37] Chaix B, Merlo J, Chauvin P. Comparison of a spatial approach with the multilevel approach for investigating place effects on health: the example of healthcare utilisation in France. J Epidemiol Community Health 2005;59:517–26.

[38] Auchincloss AH, Diez Roux AV, Brown DG, O'Meara ES, Raghunathan TE. Insulin resistance is positively associated with distance to wealthy areas: the Multi-Ethnic Study of Atherosclerosis. Am J Epidemiol 2006; [Epub ahead of print].

[39] Borrell LN, Roux AVD, Rose K, Catellier D, Clark BL. Neighbourhood characteristics and mortality in the Atherosclerosis Risk in Communities Study. Int J Epidemiol 2004;33:398–407.

[40] Balfour JL, Kaplan GA. Neighborhood environment and loss of physical function in older adults: evidence from the Alameda County Study. Am J Epidemiol 2002;155:507–15.

[41] Curtis S, Southall H, Congdon P, Dodgeon B. Area effects on health variation over the life-course: analysis of the longitudinal study sample in England using new data on area of residence in childhood. Soc Sci Med 2004;58:57–74.

[42] Rubin DB. Estimating causal effects from large data sets using propensity scores. Ann Intern Med 1997;127:757–63.

[43] Diez Roux AV, Borrell LN, Haan M, Jackson SA, Schultz R. Neighbourhood environments and mortality in an elderly cohort: results from the cardiovascular health study. J Epidemiol Community Health 2004; 58:917–23.

[44] Schootman M, Andresen EM, Wolinsky FD, Malmstrom TK, Miller JP, Miller DK. Neighborhood conditions and risk of incident lower-body functional limitations among middle-aged African Americans. Am J Epidemiol 2006;163:450–8.

[45] Harding D. Counterfactual models of neighborhood effects: the effect of neighborhood poverty on high school dropout and teenage pregnancy. Am J Sociol 2003;109:676–719.

[46] Robins JM, Hernan MA, Brumback B. Marginal structural models and causal inference in epidemiology. Epidemiology 2000;11:550–60.

[47] Greenland S. An introduction to instrumental variables for epidemiologists. Int J Epidemiol 2000;29:722–9.

[48] Hernan MA, Robins JM. Instruments for causal inference: an epidemiologist's dream? Epidemiology 2006;17:360–72.

[49] Katz L, Kling J, Liebman J. Moving to Opportunity in Boston: early results of a randomized mobility experiment. Q J Econ 2001;116:607–54.

[50] Leventhal T, Brooks-Gunn J. Moving to opportunity: an experimental study of neighborhood effects on mental health. Am J Public Health 2003;93:1576–82.