Multilevel Models in Social Epidemiology

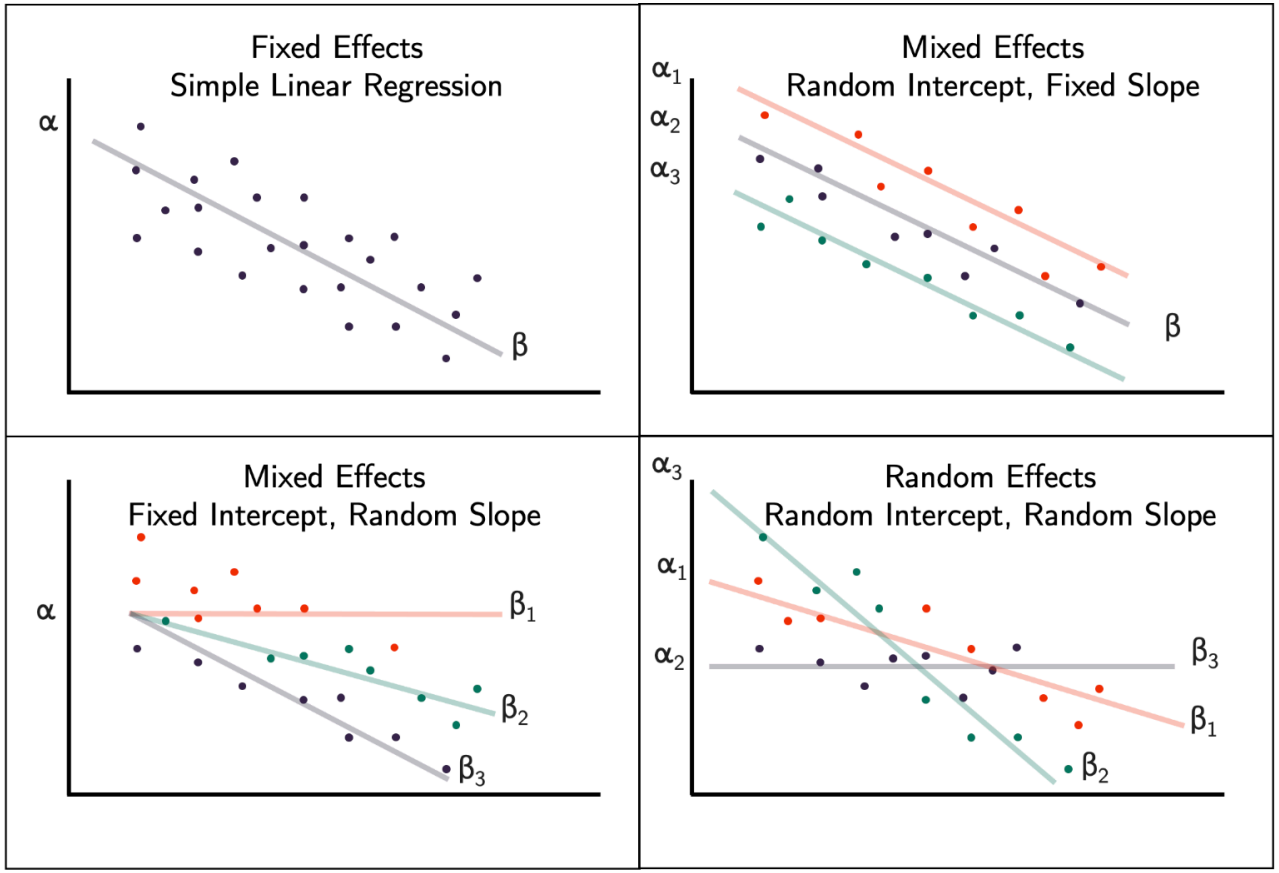
Past, Present and Future

Sam Harper

2024-11-07

“Multilevel” structure:

“Multilevel” models:



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Prelude


THE 90's -

- Multilevel models developed in 1980s in demography (Entwistle), statistics (Wong/Mason), education (Bryk/Raudenbush).
- Use depends critically on theory.

> The development of multi-level approaches in epidemiologic research may facilitate research which elucidates the independent and joint effects of individual and environmental factors on health behaviors and health outcomes.

Von Korff et al. (1992)

American Journal of EPIDEMIOLOGY

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REVIEWS AND COMMENTARY

Multi-level Analysis in Epidemiologic Research on Health Behaviors and Outcomes

Michael Von Korff,[1,2] Thomas Koepsell,[2,3] Susan Curry,[1,2] and Paula Diehr[4]

Individual-level health behaviors and outcomes have multi-level determinants (individual and environmental). Multi-level analysis seeks to explain individual outcomes in terms of both individual and environmental or aggregate variables. Ecologic fallacy (improper inference about individual-level associations based on associations measured only at the aggregate level) can result from confusion about the level of inference that is of ultimate interest. The perspective of multi-level analysis acknowledges the importance of both individual and environmental variables in determining health behaviors and outcomes at the level of the indivisible unit—the individual. The authors review concepts and methods of multi-level analysis and their application to epidemiologic research on health behavior and health outcomes. *Am J Epidemiol* 1992;135:1077–82.

community medicine; epidemiologic methods; health behavior; health promotion; statistics

A major emphasis in epidemiology is the study of how environmental factors influence risks of disease in populations. Because of the importance of human behavior in determining disease risks, the interests of epidemiologists have expanded to encompass the distribution and determinants of behavioral risk factors for both infectious and chronic diseases. Infectious disease epidemiologists have had a long-standing interest in how environmental variables modify individual susceptibility to disease (e.g., herd immunity (1)). Chronic disease epidemiologists sometimes seem to treat behavioral risk factors as attributes only of individuals, paying less attention to the environments in which behaviors develop and risks are realized. Difficulties in inference from ecologic data impede epidemiologic research concerning the effects of environmental factors on individual-level health behaviors and disease risks. In 1950, Robinson (2) demonstrated how ecologic bias may occur when an aggregate-level association is erroneously

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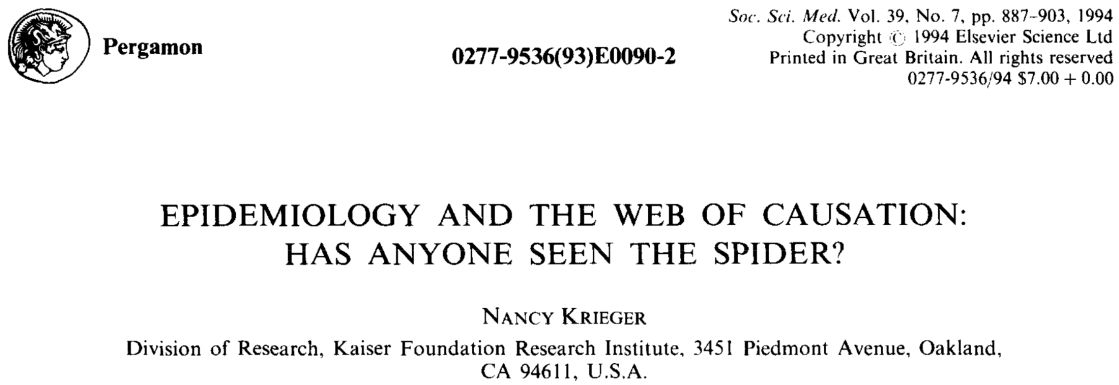
Epidemiology has lost its way

Social context and ‘population perspective’ has been forgotten.



Pergamon

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EPIDEMIOLOGY AND THE WEB OF CAUSATION:
HAS ANYONE SEEN THE SPIDER?

NANCY KRIEGER

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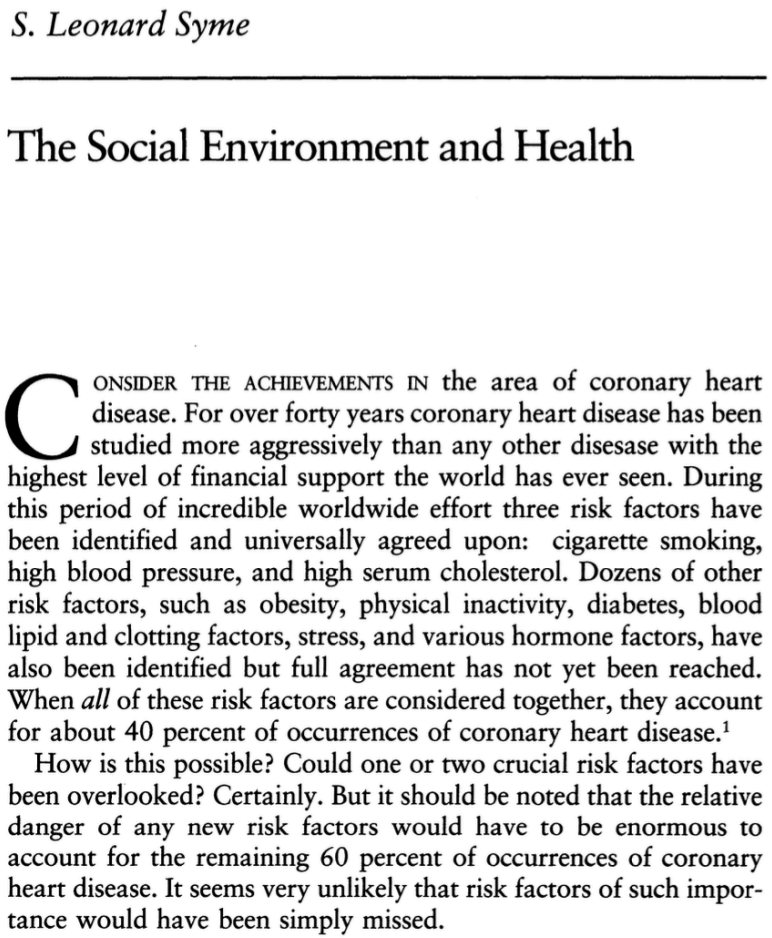
The Fallacy of the Ecological Fallacy: The Potential Misuse of a Concept and the Consequences

Traditional Epidemiology, Modern Epidemiology, and Public Health

Choosing a Future for Epidemiology: II. From Black Box to Chinese Boxes and Eco-Epidemiology

Krieger (1994); Schwartz (1994); Pearce (1996); Susser and Susser (1996)

And needs to refocus on “environments”



S. Leonard Syme

The Social Environment and Health

CONSIDER THE ACHIEVEMENTS IN the area of coronary heart disease. For over forty years coronary heart disease has been studied more aggressively than any other disesase with the highest level of financial support the world has ever seen. During this period of incredible worldwide effort three risk factors have been identified and universally agreed upon: cigarette smoking, high blood pressure, and high serum cholesterol. Dozens of other risk factors, such as obesity, physical inactivity, diabetes, blood lipid and clotting factors, stress, and various hormone factors, have also been identified but full agreement has not yet been reached. When *all* of these risk factors are considered together, they account for about 40 percent of occurrences of coronary heart disease.[1]

How is this possible? Could one or two crucial risk factors have been overlooked? Certainly. But it should be noted that the relative danger of any new risk factors would have to be enormous to account for the remaining 60 percent of occurrences of coronary heart disease. It seems very unlikely that risk factors of such importance would have been simply missed.

> Our work with individuals has been useful and productive, but this approach alone clearly will not lead to an effective program of health promotion and disease prevention. A new inititive focusing on the environments in which we live much now become a priority for us all.

Syme (1994)

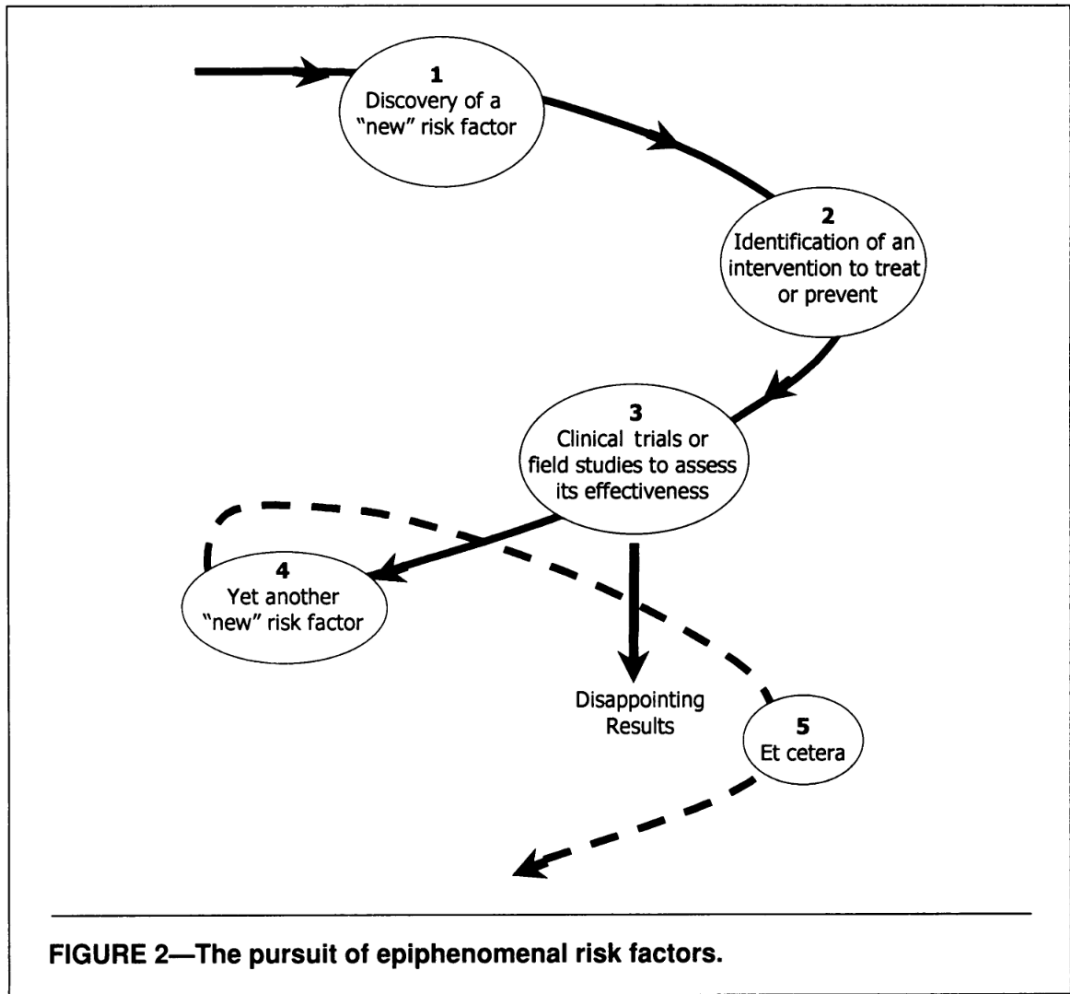


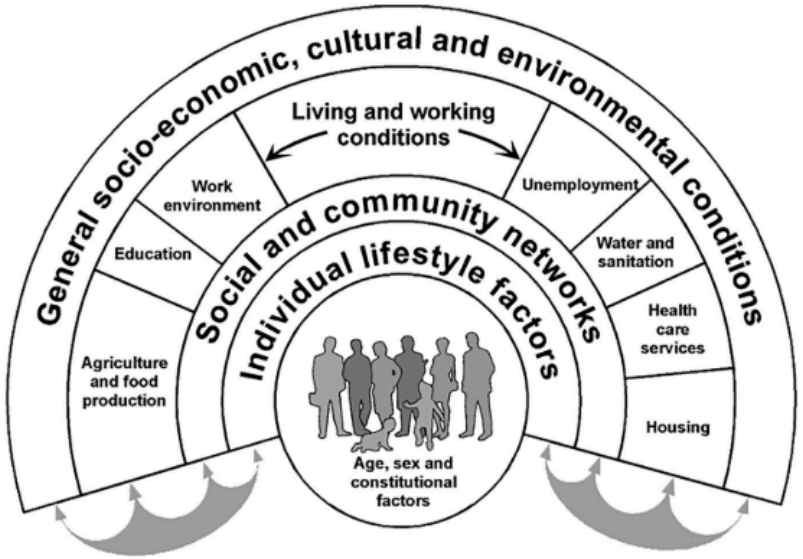
FIGURE 2—The pursuit of epiphenomenal risk factors.

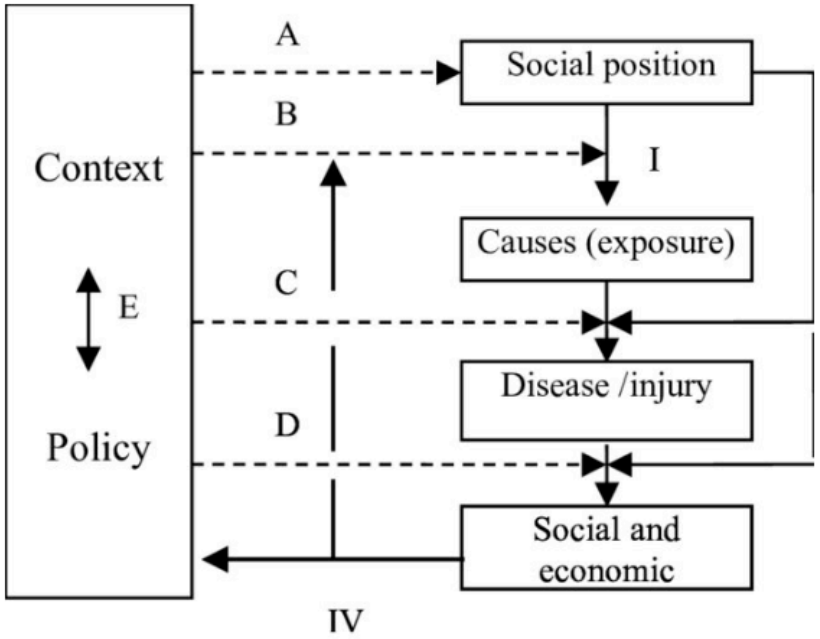
Risk factors and risky behaviors are obviously manifested in individuals, but they are generated and reinforced within an ecosocial context and they are strongly related to social position. There are signs of a shift in focus from people to place to social position, which mirrors the different levels of causality behind complex human behavior. Again, appropriate methods and outcome measures for the evaluation of higher-level healthy public policy have yet to be developed, although some promising work is under way (e.g., the design and analysis of community-level trials, hierarchical or multilevel modeling, geographic

McKinlay and Marceau (1999)

Multilevel health determinants

Social context a crucial element of conceptual models for ‘social determinants of health’

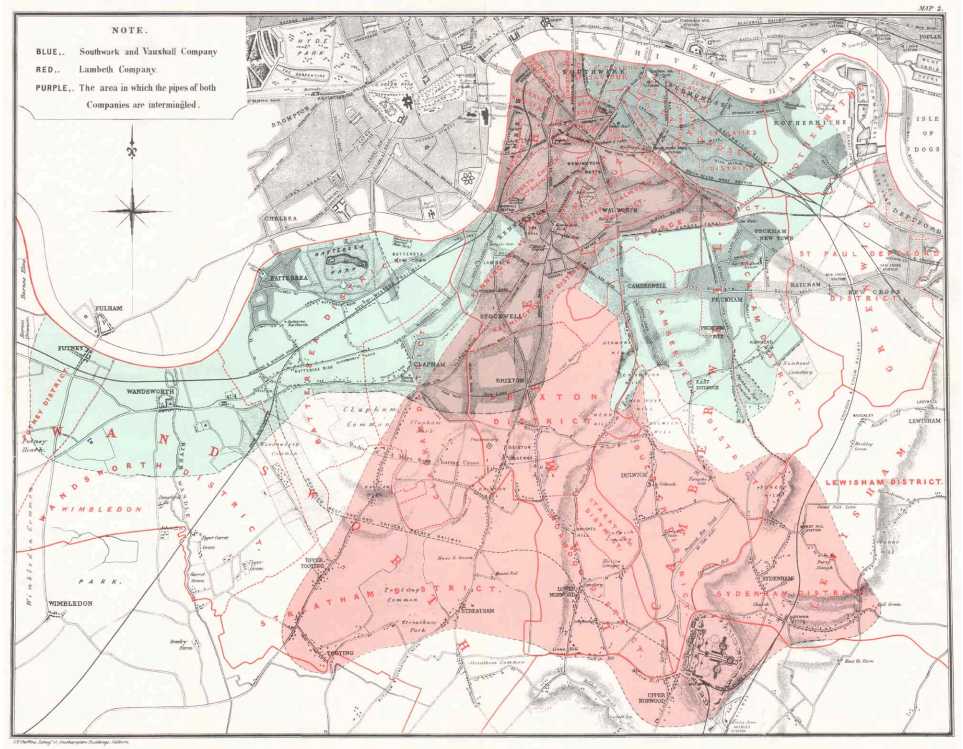




Dahlgren and Whitehead (1991); Diderichsen and Hallqvist (1998)

Why multilevel social epidemiology?

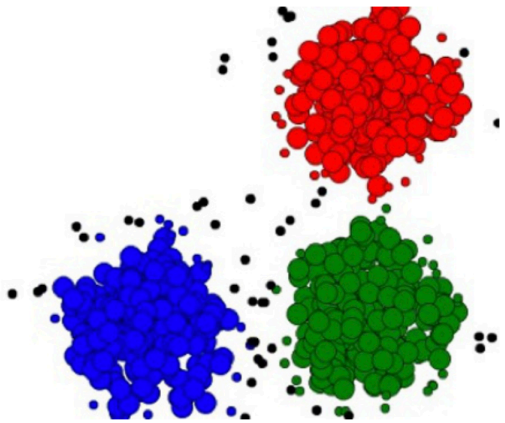
- Place-based comparisons of health are revealing (Villermé, Farr, Graunt, Snow, DuBois, many others)
- Communities inherently reflect social dynamics.
- Host-Agent-Environment (physical and social).
- “Population perspective”, contra biomedical individualism.



John Snow’s ‘Grand Experiment’. See Snow (1855) reprinted (1936)

Act 1: The Big Idea

Early influential studies in social epidemiology



Neighborhood ‘effects’ on violence, mortality

- Focus on mutual adjustment
- Clustering addressed as nuisance

Extended to CVD, low birthweight, other outcomes

- Random effects implementation
- Exploration of multi-level EMM

US: O’Campo et al. (1995); Anderson et al. (1997); Diez-Roux et al. (1997); O’Campo et al. (1997). EUR: Ecob (1996); Congdon (1997)

- Strong theory, field measurements, sophisticated models, potential mechanisms linked to violent crime.

> Multilevel analyses showed that a measure of collective efficacy yields a high between-neighborhood reliability and is negatively associated with variations in violence, when individual-level characteristics, measurement error, and prior violence are controlled. Associations of concentrated disadvantage and residential instability with violence are largely mediated by collective efficacy.

the north central Pacific, the estimated residence time of ^{210}Pb at mid-depths is 200 to 400 years, decreasing to 80 to 100 years toward the Pacific margins [Y. Nozaki , K. K. Turekian, K. von Damm, *Earth Planet. Sci. Lett.* **49**, 393 (1980); H. Craig, S. Krishnaswami, B. L. K. Somayajulu, *ibid.* **17**, 295 (1973)]. Given the observed differences in the Pb isotopic composition of Mn crusts and nodules from different ocean basins (*18*), the residence time must be less than the ~10^3-year mixing time of the oceans [W. S. Broecker and T.-H. Peng, *Tracers in the Sea* (Eldigio Press, Columbia Univ., Palisades, NY, 1982)] but in the central Pacific may be sufficiently long to mix and integrate differing inputs from incoming water masses and the basin margins. Studies of ^{210}Pb indicate residence times in the upper ocean of ~10 years [R. M. Sherrell, E. A. Boyle, B. Hamelin, *J. Geophys. Res.* **97**, 11257 (1992)], which are much shorter than the residence time in deep water. The most important mechanism for Pb transport to the deep sea is scavenging by particulates, particularly organic particulates [A. R. Flegal and C. C. Patterson, *Earth Planet. Sci. Lett.* **64**, 19 (1983)], which may have varied considerably in the geologic past because of changes in biologic productivity.

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16 December 1996; accepted 19 June 1997

Neighborhoods and Violent Crime: A Multilevel Study of Collective Efficacy

Robert J. Sampson, Stephen W. Raudenbush, Felton Earls

It is hypothesized that collective efficacy, defined as social cohesion among neighbors combined with their willingness to intervene on behalf of the common good, is linked to reduced violence. This hypothesis was tested on a 1995 survey of 8782 residents of 343 neighborhoods in Chicago, Illinois. Multilevel analyses showed that a measure of collective efficacy yields a high between-neighborhood reliability and is negatively associated with variations in violence, when individual-level characteristics, measurement error, and prior violence are controlled. Associations of concentrated disadvantage and residential instability with violence are largely mediated by collective efficacy.

For most of this century, social scientists have observed marked variations in rates of criminal violence across neighborhoods of U.S. cities. Violence has been associated with the low socioeconomic status (SES) and residential instability of neighborhoods. Although the geographical concentration of violence and its connection with neighborhood composition are well established, the question remains: why? What is it, for example, about the concentration of poverty that accounts for its association with rates of violence? What are the social processes that might explain or mediate this relation (*1*–*3*)? In this article, we report results from a study designed to address these questions about crime and communities.

Our basic premise is that social and organizational characteristics of neighborhoods explain variations in crime rates that are not solely attributable to the aggregated demographic characteristics of individuals. We propose that the differential ability of neighborhoods to realize the common values of residents and maintain effective social controls is a major source of neighborhood variation in violence (*4*, *5*). Although social control is often a response to deviant behavior, it should not be equated with formal regulation or forced conformity by institutions such as the police and courts. Rather, social control refers generally to the capacity of a group to regulate its members according to desired principles—to realize collective, as opposed to forced, goals (*6*). One central goal is the desire of community residents to live in safe and orderly environments that are free of predatory crime, especially interpersonal violence.

In contrast to formally or externally induced actions (for example, a police crackdown), we focus on the effectiveness of informal mechanisms by which residents themselves achieve public order. Examples of informal social control include the monitoring of spontaneous play groups among children, a willingness to intervene to prevent acts such as truancy and street-corner "hanging" by teenage peer groups, and the confrontation of persons who are exploiting or disturbing public space (*5*, *7*). Even among adults, violence regularly arises in public disputes, in the context of illegal markets (for example, prostitution and drugs), and in the company of peers (*8*). The capacity of residents to control group-level processes and visible signs of social disorder is thus a key mechanism influencing opportunities for interpersonal crime in a neighborhood.

Informal social control also generalizes to broader issues of import to the well-being of neighborhoods. In particular, the differential ability of communities to extract resources and respond to cuts in public services (such as police patrols, fire stations, garbage collection, and housing code enforcement) looms large when we consider

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Sampson et al. (1997) *Science*, cited >15,000 times.

Focus on ‘simultaneous’ effects:

> By incorporating multiple levels of determination in the study of individual outcomes, multilevel analysis allows for the effects of macro- and micro-level variables as well as their interactions

Potential:

> Multilevel analysis is one way to begin to *restore a population or societal dimension to epidemiologic research*

Diez-Roux (1998)

Research Forum

Bringing Context Back into Epidemiology: Variables and Fallacies in Multilevel Analysis

Ana V. Diez-Roux, MD, PhD

ABSTRACT

A large portion of current epidemiologic research is based on methodologic individualism: the notion that the distribution of health and disease in populations can be explained exclusively in terms of the characteristics of individuals. The present paper discusses the need to include group- or macro-level variables in epidemiologic studies, thus incorporating multiple levels of determination in the study of health outcomes.

These types of analyses, which have been called contextual or multilevel analyses, challenge epidemiologists to develop theoretical models of disease causation that extend across levels and explain how group-level and individual-level variables interact in shaping health and disease. They also raise a series of methodological issues, including the need to select the appropriate contextual unit and contextual variables, to correctly specify the individual-level model, and, in some cases, to account for residual correlation between individuals within contexts. Despite its complexities, multilevel analysis holds potential for reemphasizing the role of macro-level variables in shaping health and disease in populations. (*Am J Public Health.* 1998;88:216–222)

Introduction

Throughout the history of public health, and depending on the theory of disease causation prevalent at the time, different aspects of individuals and their environments have been considered important as potential “causes” of disease.[1–3] In its origins, public health was essentially ecological, relating environmental and community characteristics to health and disease.[4–8] With the advent of the germ theory and the associated unicausal theory of disease causation, infectious organisms became the relevant “environmental” factors.[9] Other aspects of the environment were important insofar as they were conducive to reproduction or transmission of the biological “causes” of disease.[10] In this century, the growing importance of chronic diseases led to the search for new causal factors. Emphasis shifted from environmental factors to individual-level factors, and research focused on behavioral and biological characteristics as risk factors for chronic diseases.

The study of the causes of disease thus shifted from the environment as a whole to specific factors within the environment (biological organisms) and to the behaviors of individuals. The model of disease causation shifted from a rather vague, holistic determination to the unicausal model of the germ theory and to the multicausal model (the “web of causation”) prevalent today, in which a variety of biological and behavioral risk factors are presumed to interact in the causation of disease.[11] This process has been accompanied by progressive “individualization” of risk (i.e., attributing risks to characteristics of individuals rather than to environmental or social influences affecting populations).

This individualization of risk has perpetuated the idea that risk is individually determined rather than socially determined, discouraging research into the effects of macro-level or group-level variables on individual-level outcomes. “Lifestyle” and “behaviors” are regarded as matters of free individual choice and dissociated from the social contexts that shape and constrain them.[12] This tendency by which disease patterns are explained solely in terms of the characteristics of individuals is analogous to the doctrine of methodological individualism in social science.[13] According to this doctrine, “facts about society and social phenomena are to be explained solely in terms of facts about individuals.”[13(p77)] Its logical correlate is that all variables are best measured at the individual level, rather than at the group or macro level, because it is the individual who is presumed to be truly important in the causation of disease. Group-level variables are included in the analyses only as rough approximations for individual-level data when the latter are unavailable. As discussed further in the sections to follow, ignoring the role of group- or macro-level variables may lead to an incomplete understanding of the determinants of disease in individuals as well as in populations. Group- or macro-level variables affect individuals directly and also constrain the choices that individuals make.

The methodological individualism prevalent in epidemiologic research today can be countered in several ways. On one hand, interpretation of individual-level effects should bear in mind their relationship to macro-level processes. Many variables measured at the individual level are strongly conditioned by social processes

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The ‘Big Idea’:

> The big idea is that what matters in determining mortality and health in a society is less the overall wealth of that society and more how evenly wealth is distributed.

- Inequality = contextual, but how?

BMJ

Editor's Choice

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The big idea

Big ideas are exciting. Politicians are constantly searching for them and usually failing to find any. Every scientist would like to discover one, and scientific journals love them as well. Big ideas don't often arise, but the *BMJ* has been associated with several—and one of them is explored further this week. The big idea is that what matters in determining mortality and health in a society is less the overall wealth of that society and more how evenly wealth is distributed. The more equally wealth is distributed the better the health of that society. One political implication, appealing to those on the left, is that the best way to improve health in a society might be to take measures to distribute wealth as equally as possible. Such measures would be more likely to be effective than measures that increased overall wealth but also increased inequalities—exactly the measures advocated over the past 10-20 years in Britain, the United States, and many other countries.

The studies that support the big idea have so far compared data from different countries. But two studies we publish today both test the idea within the United States. George Kaplan and others have found a significant correlation between the percentage of total household income received by the poorer 50% and all cause mortality across the 50 American states (p 999). The association is unaffected by adjusting for median state incomes. The researchers also found significant associations with low birth weight, homicide, violent crime, work disability, poor educational outcomes, and various measures of social harm. A second study from Harvard uses two different measures of income inequality and again finds strong associations with all cause mortality and mortality from heart disease, cancer, and homicide (p 1004). The authors conclude that "policies that deal with the growing inequities in income distribution may have an important impact on the health of the population." We must hope that Bill Clinton reads the *BMJ*—and just in case he doesn't we are sending him a copy.

This issue contains several other studies related to inequalities in health and an essay from Graham Watt on why we don't do better in responding to the problem (p 1026). Tolstoy, as so often, has an answer. "I sit on a man's back, choking him and making him carry me, and yet reassure myself and others that I am very sorry for him and wish to ease his lot by all means—except by getting off his back." Watt thinks that self interest might eventually prompt the wealthy to respond because they are worried by begging and personal safety. "To see the future we need only look to the United States, where inequalities are wider and one half of the society is frightened by the other." Watt wants doctors and scientists to take the lead.

A society, Britain, that manages little excitement over the longstanding and huge problem of health inequalities is currently recovering from a bout of hysteria over bovine spongiform encephalopathy spreading to humans, and we publish six letters on the subject (p 1037). One from John Harrison points out that the United States Environmental Protection Agency has published guidelines on communicating risk to the public: "accept the public as a legitimate partner; listen to your audience; be honest, frank, and open; meet the needs of the media; speak clearly and with compassion; coordinate and collaborate with other credible sources; and plan carefully and evaluate performance." Maybe the British government will do better next time.

“Editor’s choice” (1996), Papers by Kaplan et al. (1996) and Kennedy et al. (1996) used ecological designs

State of the Evidence: 2001

- 25 studies but only 10 used multilevel models, however…

> In 23 of the 25 studies we identified, researchers reported a *statistically significant association* between at least one neighbourhood measure of socioeconomic status and health, controlling for individual socioeconomic status.

- Potential for intervention:

> …serve the purpose of identifying types of geographical areas where traditional public health interventions, aimed at individual risk reduction, may best be targeted.

Pickett (2001), cited >1500 times

A brief conceptual tutorial of multilevel analysis in social epidemiology: linking the statistical concept of clustering to the idea of contextual phenomenon

Juan Merlo, Basile Chaix, Min Yang, John Lynch, Lennart Råstam

J Epidemiol Community Health 2005;**59**:443–449. doi: 10.1136/jech.2004.023473

A brief conceptual tutorial on multilevel analysis in social epidemiology: interpreting neighbourhood differences and the effect of neighbourhood characteristics on individual health

Juan Merlo, Basile Chaix, Min Yang, John Lynch, Lennart Råstam

J Epidemiol Community Health 2005;**59**:1022–1029. doi: 10.1136/jech.2004.028035

A brief conceptual tutorial on multilevel analysis in social epidemiology: investigating contextual phenomena in different groups of people

Juan Merlo, Min Yang, Basile Chaix, John Lynch, Lennart Råstam

J Epidemiol Community Health 2005;**59**:729–736. doi: 10.1136/jech.2004.023929

A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena

Juan Merlo, Basile Chaix, Henrik Ohlsson, Anders Beckman, Kristina Johnell, Per Hjerpe, L Råstam, K Larsen

J Epidemiol Community Health 2006;**60**:290–297. doi: 10.1136/jech.2004.029454

> Traditional measures of association such as odds ratios thus provide an incomplete epidemiological basis for decision making in public health interventions.

Merlo (2003); Merlo (2005a); Merlo (2005b); Merlo (2006)

Inequalities in neighbourhoods and communities

Communities are important for physical and mental health and well-being. The physical and social characteristics of communities, and the degree to which they enable and promote healthy behaviours, all make a contribution to social inequalities in health.

Is Child Health at Risk While Families Wait for Housing Vouchers?

tions, or both.[7] Policymakers cannot ignore the growing evidence that housing policies have important health consequences.[11–13] This study suggests that expanding access to vouchers may immediately improve the health of America's children. ■

August 2001, Vol 91, No. 8 | American Journal of Public Health

Where We Live Matters for Our Health: Neighborhoods and Health

1. Introduction

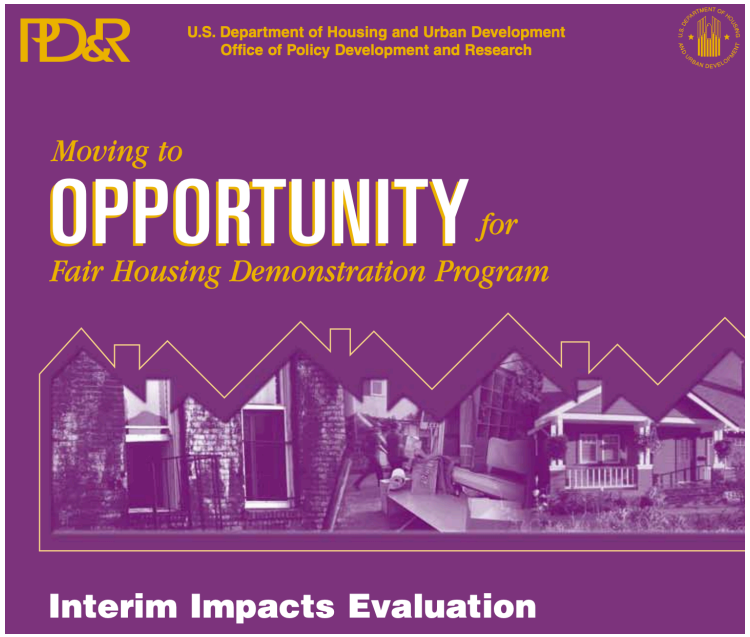
Just as conditions within our homes have important implications for our health, conditions in the neighborhoods surrounding our homes also can have major health effects. Social and economic features of neighborhoods have been linked with mortality, general health status, disability, birth outcomes, chronic conditions, health behaviors and other risk factors for chronic disease, as well as with mental health, injuries, violence and other important health indicators.[1, 2-4]

ROBERT WOOD JOHNSON FOUNDATION

Act 2: A Crisis of Confidence?

Large-scale ‘multilevel’ RCT

- ~4600 families in high poverty *randomized* to housing vouchers.
- Generated large differences in exposure to high-poverty neighborhoods.
- 5-year follow-up (2003):
  - No impacts on economic self-sufficiency of mothers.
  - Other outcomes mixed, some positive, some negative.
- Many limitations.



Interim analysis published at https://www.huduser.gov/Publications/pdf/MTOExec.pdf

PERGAMON

Social Science & Medicine 58 (2004) 1929–1952

SOCIAL SCIENCE & MEDICINE

www.elsevier.com/locate/socscimed

The (mis)estimation of neighborhood effects: causal inference for a practicable social epidemiology

J. Michael Oakes*

PERGAMON

Social Science & Medicine 58 (2004) 1953–1960

SOCIAL SCIENCE & MEDICINE

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Commentary

Estimating neighborhood health effects: the challenges of causal inference in a complex world

Ana V. Diez Roux*

PERGAMON

Social Science & Medicine 58 (2004) 1961–1967

SOCIAL SCIENCE & MEDICINE

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Commentary

The relevance of multilevel statistical methods for identifying causal neighborhood effects

S.V. Subramanian*

Harvard School of Public Health, Department of Society, Human Development and Health, 677 Huntington Avenue,

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Social Science & Medicine 58 (2004) 1969–1971

SOCIAL SCIENCE & MEDICINE

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Rejoinder

Causal inference and the relevance of social epidemiology

J. Michael Oakes

Division of Epidemiology and Population Research Center, University of Minnesota, 1300 South 2nd Street, Minneapolis, MN 55454, USA

A skeptical view

> The recent and enthusiastic adoption of the multilevel model for neighborhood effects research appears to be a case of *statisticism*, a term used to describe an almost ritualistic appeal to significance testing and both sampling and measurement error when they are not the problem

Oakes (2004)

A skeptical view

> The recent and enthusiastic adoption of the multilevel model for neighborhood effects research appears to be a case of *statisticism*, a term used to describe an almost ritualistic appeal to significance testing and both sampling and measurement error when they are not the problem

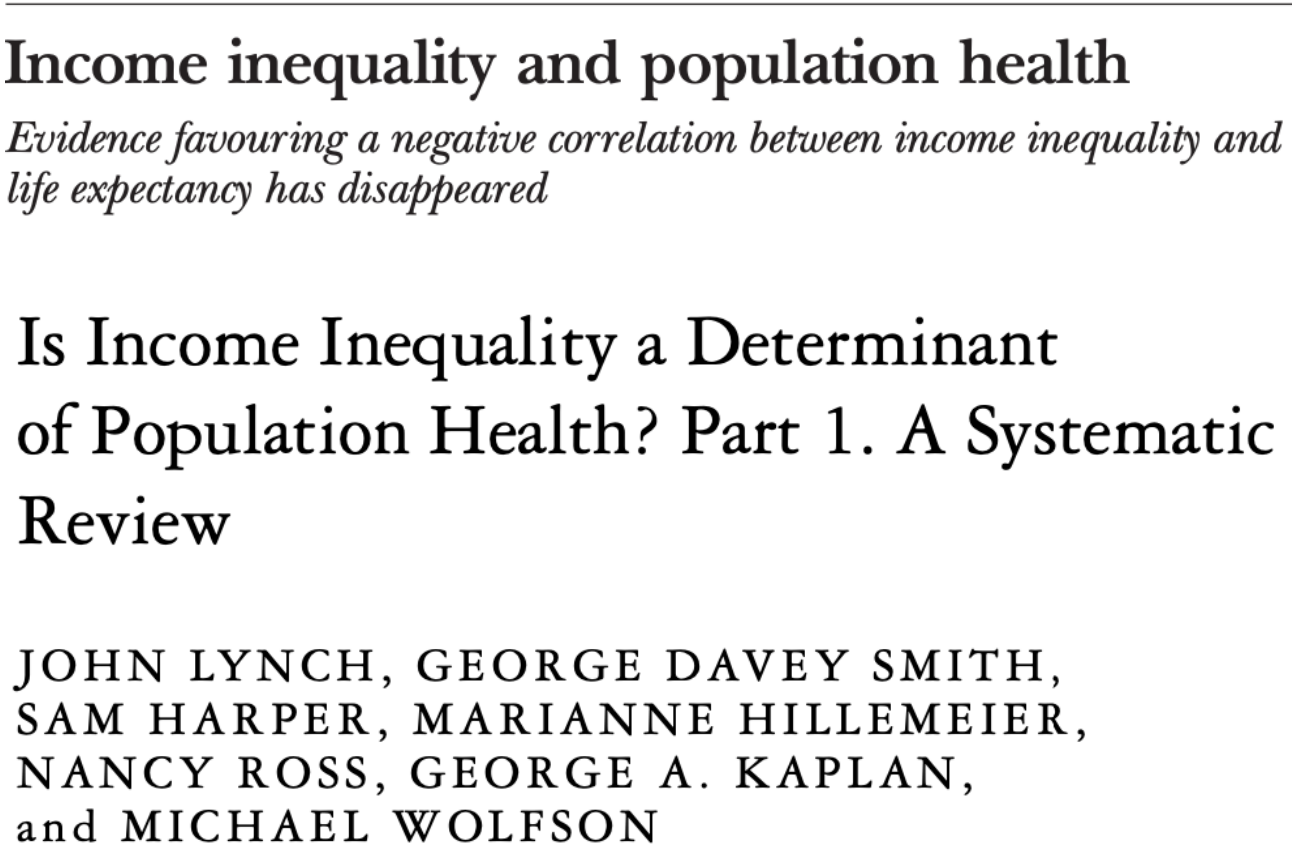
Oakes (2004)

What are the problems?

- Social stratification
- Endogeneity
- Extrapolation
- Spillovers

Income inequality: not so bad for health?

- Evidence for the income inequality/health link was "slowly dissipating"
- Multilevel studies inconsistent in US.
- Weak evidence from Europe and Asia.
- Individual-level controls matter.



Income inequality and population health

Evidence favouring a negative correlation between income inequality and life expectancy has disappeared

Is Income Inequality a Determinant of Population Health? Part 1. A Systematic Review

JOHN LYNCH, GEORGE DAVEY SMITH, SAM HARPER, MARIANNE HILLEMEIER, NANCY ROSS, GEORGE A. KAPLAN, and MICHAEL WOLFSON

Mackenbach (2002); Lynch et al. (2004)

Fixed effects: No.

Is Exposure to Income Inequality a Public Health Concern? Lagged Effects of Income Inequality on Individual and Population Health

Jennifer M. Mellor and Jeffrey Milyo

Objective. To examine the health consequences of exposure to income inequality.
Data Sources. Secondary analysis employing data from several publicly available sources. Measures of individual health status and other individual characteristics are obtained from the March Current Population Survey (CPS). State-level income inequality is measured by the Gini coefficient based on family income, as reported by the U.S. Census Bureau and Al-Samarrie and Miller (1967). State-level mortality rates are from the *Vital Statistics of the United States*; other state-level characteristics are from U.S. census data as reported in the *Statistical Abstract of the United States*.
Study Design. We examine the effects of state-level income inequality lagged from 5 to 29 years on individual health by estimating probit models of poor/fair health status for samples of adults aged 25–74 in the 1995 through 1999 March CPS. We control for several individual characteristics, including educational attainment and household income, as well as regional fixed effects. We use multivariate regression to estimate the effects of income inequality lagged 10 and 20 years on state-level mortality rates for 1990, 1980, 1970, and 1960.
Principal Findings. Lagged income inequality is not significantly associated with individual health status after controlling for regional fixed effects. Lagged income inequality is not associated with all cause mortality, but associated with reduced mortality from cardiovascular disease and malignant neoplasms, after controlling for state fixed-effects.
Conclusions. In contrast to previous studies that fail to control for regional variations in health outcomes, we find little support for the contention that exposure to income inequality is detrimental to either individual or population health.

Key Words. Income inequality, social determinants of health, health status, mortality

Random effects: Yes!

Income Inequality as a Public Health Concern: Where Do We Stand? Commentary on "Is Exposure to Income Inequality a Public Health Concern?"

S. V. Subramanian, Tony Blakely, and Ichiro Kawachi

The Income Inequality/Health Link: A Disappearing Connection?

Research interest on the link between income distribution and population health can be traced back to Richard Wilkinson's seminal paper published in 1992 in the *British Medical Journal*, showing a correlation between income inequality and life expectancy among nine industrialized countries (Wilkinson 1992). Ten years on, despite dozens of papers published on this topic, the issue continues to be debated. Is income inequality a public health concern? A growing number of studies argue that it is not. A series of papers published in the January 2002 issue of the *British Medical Journal* (Muller 2002; Osler et al. 2002; Shibuya, Hashimoto, and Yano 2002; Sturm and Gresenz 2002) prompted an editorial that declared that the evidence for the income inequality/health link was "slowly dissipating" (Mackenbach 2002). In this issue of the Journal, Mellor and Milyo provide two additional tests of the empirical link between income distribution and health, and find little support for a robust association (Mellor and Milyo 2002). Is it time then for researchers to pack their bags and go home, reassured now that there is no threat to public health from the widening gulf between the haves and have-nots in America, and in the rest of the world?

Such a conclusion, we argue, would be both hasty and premature. To date, the debate on the income inequality/health link has been carried out almost entirely on the merits of empirical data analyzed by different investigators. Like any debate that hinges on the analyses of empirical data,

Mellor and Milyo (2003); Subramanian et al. (2003a)

Zombie hypothesis…

Dunn et al. (2024)

Original research

State-level association between income inequality and mortality in the USA, 1989–2019: ecological study

James R Dunn [1], Gum-Ryeong Park [1,2], Robbie Brydon [1], Michael Veall [1], Lyndsey A Rolheiser [3], Michael Wolfson [4], Arjumand Siddiqi [2,5], Nancy A Ross [6]

ABSTRACT

Background Prior studies have shown a positive relationship between income inequality and population-level mortality. This study investigates whether the relationship between US state-level income inequality and all-cause mortality persisted from 1989 to 2019 and whether changes in income inequality were correlated with changes in mortality rates.

Methods We perform repeated cross-sectional regressions of mortality on state-level inequality measures (Gini coefficients) at 10-year intervals. We also estimate the correlation between within-state changes in income inequality and changes in mortality rates using two time-series models, one with state- and year-fixed effects and one with a lagged dependent variable. Our primary regressions control for median income and are weighted by population.

Main outcome measures The two primary outcomes are male and female age-adjusted mortality rates for the working-age (25–64) population in each state. The secondary outcome is all-age mortality.

Results There is a strong positive correlation between Gini and mortality in 1989. A 0.01 increase in Gini is

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Income inequality and mortality had a strong positive correlation across US states in the 1980–1990 period.

WHAT THIS STUDY ADDS

⇒ The correlation between income inequality and mortality that existed in 1989 did not persist over the following 30 years and greater increases in inequality were associated with decreases in mortality. State median income became highly correlated with mortality by the end of the period.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Research should examine the protective factors that allowed high-income (and high-inequality) states to experience reductions in mortality while lower-income states experienced increases. Policymakers should enact proven population health interventions, whether or

Neighborhood evidence to 2007

- 86 multilevel papers on neighborhoods
- 80% cross-sectional designs
- Inconsistencies within and across studies.

Policy implications

- Various health outcomes are influenced by area context although the specific processes through which such influences occur remain unclear. The implementation and evaluation of policy interventions aimed at changing area exposures represents an opportunity to fill this knowledge gap.

853

REVIEW

Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998

Mylène Riva, Lise Gauvin, Tracie A Barnett

J Epidemiol Community Health 2007;61:853–861. doi: 10.1136/jech.2006.050740

To map out area effects on health research, this study had the following aims: (1) to inventory multilevel investigations of area effects on self rated health, cardiovascular diseases and risk factors, and mortality among adults; (2) to describe and critically discuss methodological approaches employed and results observed; and (3) to formulate selected recommendations for advancing the study of area effects on health. Overall, 86 studies were inventoried. Although several innovative methodological approaches and analytical designs were found, small areas are most often operationalised using administrative and statistical spatial units. Most studies used indicators of area socioeconomic status derived from censuses, and few provided information on the validity and reliability of measures of exposures. A consistent finding was that a significant portion of the variation in health is associated with area context independently of individual characteristics. Area effects on health, although significant in most studies, often depend on the health outcome studied, the measure of area exposure used, and the spatial scale at which associations are examined.

See end of article for authors' affiliations

Correspondence to: Mylène Riva, Department of Social and Preventive Medicine, University of Montreal, PO Box 6128, Downtown Station, Montreal, Quebec, Canada, H3C 3J7; mylene.riva@umontreal.ca

Accepted for publication 17 December 2006

A brief search of published reports on area effects on health shows a striking increase over the past decade in the number of studies adopting a multilevel approach to the study of social determinants of health. The impetus for such research probably results from a convergence of conceptual and methodological innovations, including an appreciation of the importance of the social environment to health and greater accessibility of multilevel modelling techniques and software. However, multilevel investigations of area effects on health abound with conceptual and methodological challenges which have given rise to numerous debates. Debated issues are summarised in table 1.

In a previous review of social determinant studies examining effects of area socioeconomic status (SES) on health, 23 of 25 studies reported significant associations between at least one measure of area SES and health, while controlling for individual SES.[1] The investigators concluded that data supported the existence of modest small area effects on health but that extant data were replete with methodological problems. More specifically, they stated: "It is clear from our review that investigations of the role of neighbourhood level [small area] social factors on health are characteristics of preliminary, exploratory studies in epidemiology. Certain aspects of study design are in need of improvement before the field can advance […] We hope that this review will show what has already been achieved and point the way to more sophisticated studies of societal determinants of health" (pp 120–121).

In an effort to map out multilevel research on social determinants of health, to identify the types of evidence available, and to gauge whether or not "more sophisticated studies" are being conducted, we undertook a scoping study of research of area effects on health published between July 1998 and December 2005. Unlike the more familiar systematic review, a scoping study addresses broad research topics where many different study designs are applied, with the aim of comprehensively examining the extent, range, and nature of research activity and to identify key concepts and results.[36 37]

Given the broad diversity of studies, we restricted the scoping review to multilevel investigations of area effects on self rated health (SRH), cardiovascular disease and risk factors, and mortality among adults. These health indicators were selected because of their relevance to understanding the broader socio-spatial patterning of health. SRH is a highly predictive measure of morbidity and mortality, independent of other medical, behavioural, or psychosocial factors,[38] and cardiovascular disease is one of the leading causes of mortality in developed countries.

We further restricted study selection to multilevel investigations allowing for estimation of between-area variation (random effects). As pointed out by Merlo and colleagues,[24] "clustering of individual health within neighbourhoods (areas) is not a statistical nuisance that only needs to be considered for obtaining correct statistical estimations, but a key concept in social epidemiology that yields important information by itself" (p 443). As measures of variation provide information on the portion of health differences among people that may be attributable to the areas in which they live, they are central to understand the significance of specific contexts for health.[24]

In keeping with the framework for conducting a scoping study proposed by Arksey and O'Malley,[36]

Abbreviations: MeSH, medical subject heading; SES, socioeconomic status; SRH, self rated health

Riva et al. (2007)

Neighborhood effects at 20 years

> "it is not clear how much we are learning, or whether such lessons are improving population health… experimental evidence of neighborhood effects is mixed, and observational studies too often report mere correlations, side-stepping critical effect identification issues. Since epidemiologists have long known that disadvantaged environments are not healthy, the utility of studies that do not face the difficult methodological challenges is questionable"

Oakes et al. (2015)

Curr Epidemiol Rep (2015) 2:80–87
DOI 10.1007/s40471-015-0035-7

SOCIAL EPIDEMIOLOGY (JM OAKES, SECTION EDITOR)

Twenty Years of Neighborhood Effect Research: An Assessment

J. Michael Oakes · Kate E. Andrade · Ifrah M. Biyoow · Logan T. Cowan

Published online: 16 January 2015

Abstract This paper reviews the magnitude and empirical findings of social epidemiological neighborhood effects research. An electronic keyword literature search identified 1369 empirical and methodological neighborhood effects papers published in 112 relevant journals between 1990 and 2014. Analyses of temporal trends were conducted by focus, journal type (e.g., epidemiology, public health, or social science), and specific epidemiologic journal. Select papers were then critically reviewed. Results show an ever-increasing number of papers published, notably since the year 2000, with the majority published in public health journals. The variety of health outcomes analyzed is extensive, ranging from infectious disease to obesity to criminal behavior. Papers relying on data from experimental designs are thought to yield the most credible results, but such studies are few and findings are inconsistent. Papers relying on data from observational designs and multilevel models typically show small statistically significant effects, but most fail to appreciate fundamental identification problems. Ultimately, of the 1170 empirically focused neighborhood effects papers published in the last 24 years, only a handful have clearly advanced our understanding of the phenomena. The independent impact of neighborhood contexts on health remains unclear. It is time to expand the social epidemiological imagination.

Keywords Multilevel · Meta-analysis · Housing policy · Social environment

This article is part of the Topical Collection on *Social Epidemiology*

J. M. Oakes (✉) · K. E. Andrade · I. M. Biyoow · L. T. Cowan
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Introduction

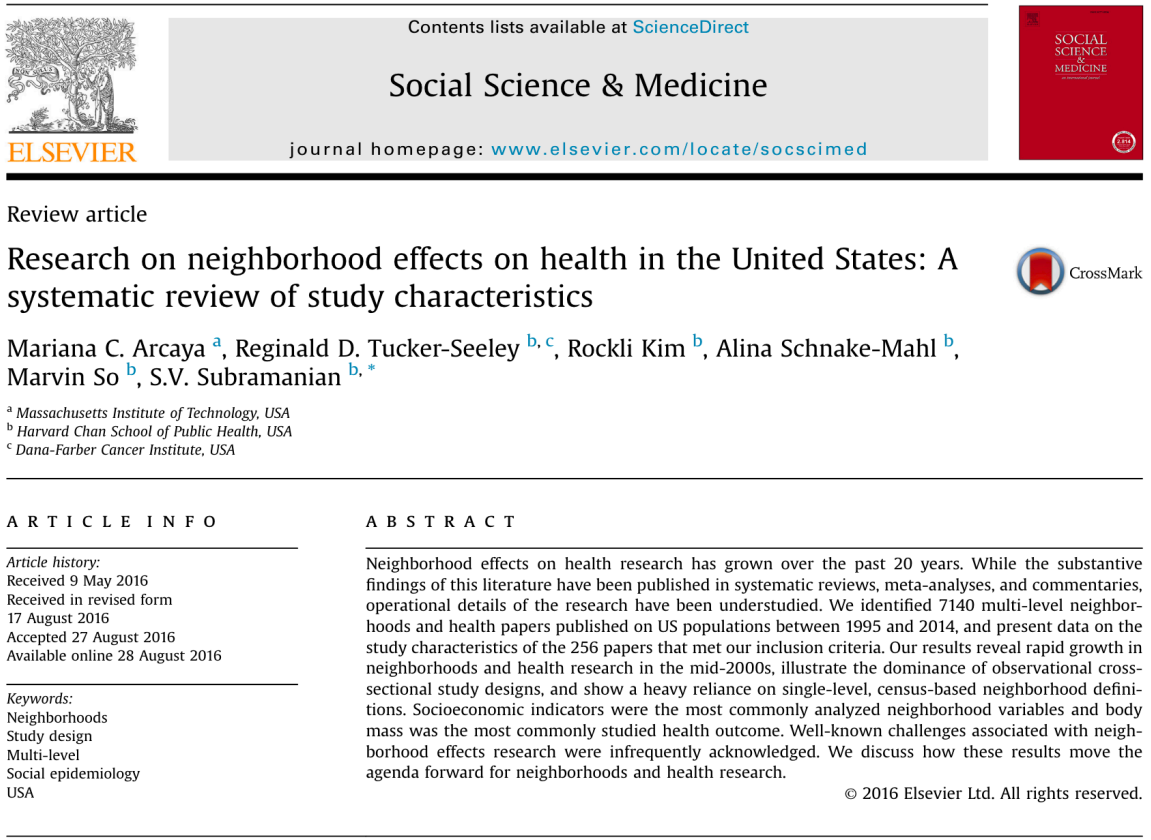
Scholarship addressing the effect of the biologic environment on human health dates back 2500 years to Hippocratic medical corpus [1], but the idea of estimating the independent impact of a community's social characteristics on the health of its members appears to date back to Durkheim's 1897 study of suicide [2]. Since then, epidemiologists and other population scientists have systematically investigated the *independent* effect of social and environmental contexts on human thinking, behavior, and health [3]. The motivating question is: Above and beyond one's background characteristics, how do contexts change outcomes? This question, however phrased, may be the Holy Grail of social science research for it speaks directly to the importance and impact of social and environmental contexts, above and beyond genetic predispositions or perhaps even human motivations and values. Consider the following questions: Does a selfish person become altruistic when she resides in an altruistic community? Do more socioeconomically equal neighborhoods prevent heart disease?

Within epidemiology, the contextual effect question illuminates the impact of the environment, both biological and social, on health outcomes, above and beyond the characteristics of the host. From a methodological perspective, contexts may be viewed as effect modifiers or yield biosocial interactions in their own right. For social epidemiology in particular, researchers have tended to focus more narrowly on the impact of the socioeconomic characteristics of residential neighborhoods on health.

It is not surprising that a vast amount has been written about contextual effects; theoretical, methodological, and empirical scholarship abounds. So as to better appreciate advances, gaps, and shortcomings, it is occasionally helpful to take stock and assess what the collective effort has produced. Although excellent empirical summaries for epidemiologists

More of the same?

- Now > 250 papers
- Most still using cross-sectional designs with Census data.
- Emphasized the importance of *timing* of exposures over the lifecourse.
- Pleas for more diversity in study designs.



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Review article

Research on neighborhood effects on health in the United States: A systematic review of study characteristics

Mariana C. Arcaya [a], Reginald D. Tucker-Seeley [b, c], Rockli Kim [b], Alina Schnake-Mahl [b], Marvin So [b], S.V. Subramanian [b, *]

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ABSTRACT

Neighborhood effects on health research has grown over the past 20 years. While the substantive findings of this literature have been published in systematic reviews, meta-analyses, and commentaries, operational details of the research have been understudied. We identified 7140 multi-level neighborhoods and health papers published on US populations between 1995 and 2014, and present data on the study characteristics of the 256 papers that met our inclusion criteria. Our results reveal rapid growth in neighborhoods and health research in the mid-2000s, illustrate the dominance of observational cross-sectional study designs, and show a heavy reliance on single-level, census-based neighborhood definitions. Socioeconomic indicators were the most commonly analyzed neighborhood variables and body mass was the most commonly studied health outcome. Well-known challenges associated with neighborhood effects research were infrequently acknowledged. We discuss how these results move the agenda forward for neighborhoods and health research.

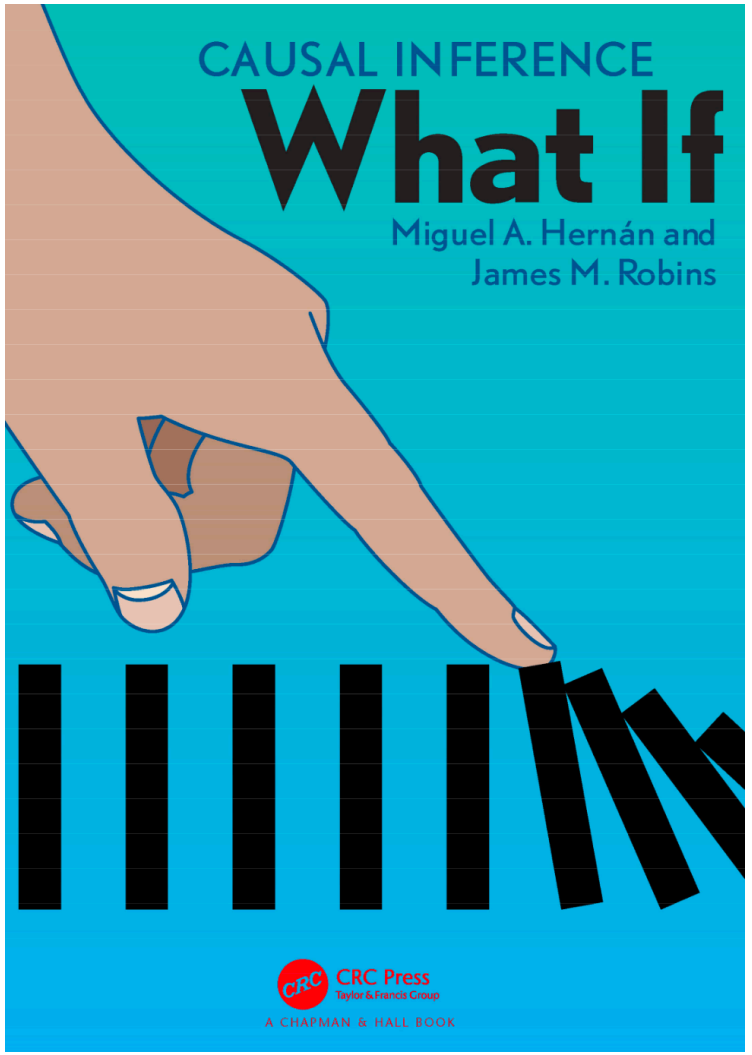
Arcaya et al. (2016)

Act 3: A Way Forward?

Merging of multilevel and causal inference

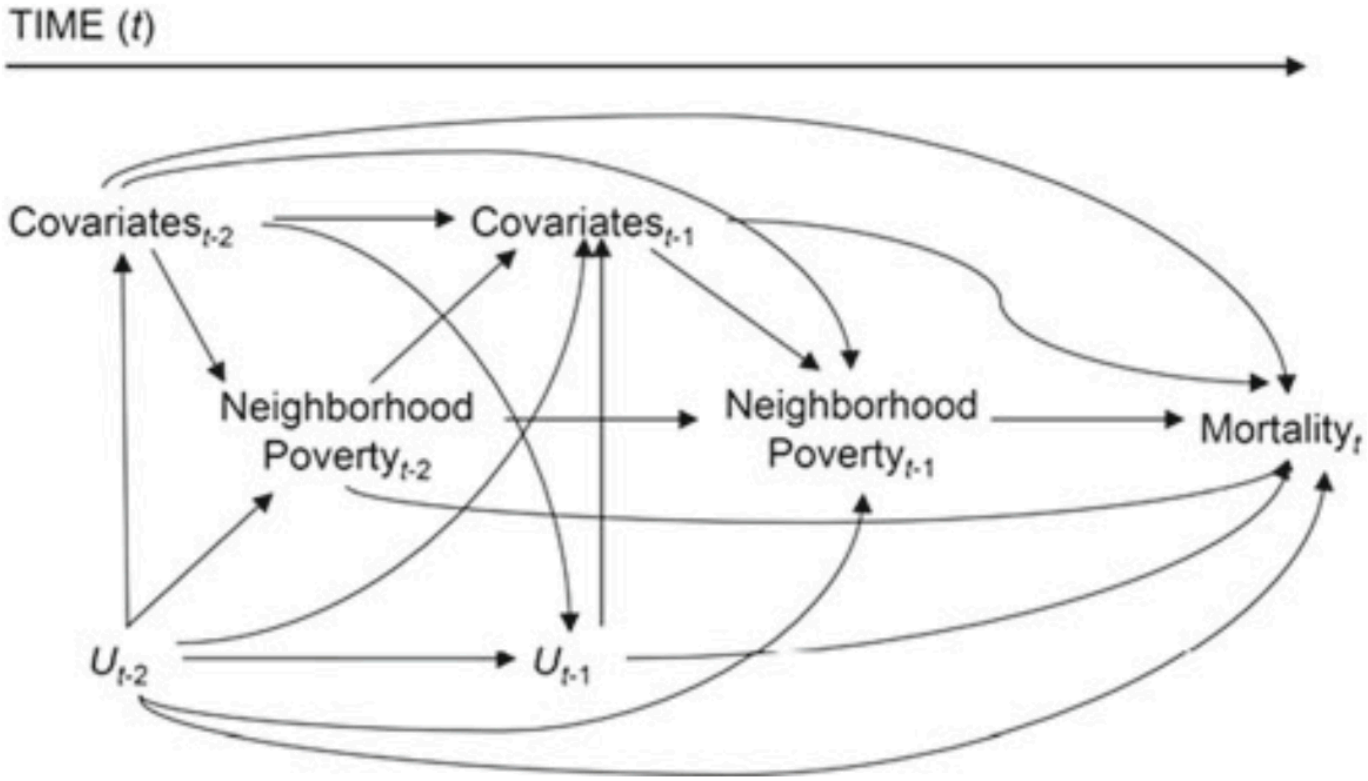
- Greater focus on credible study designs.
  - Cluster RCTs
  - Quasi-experiments
- Utilizing longitudinal data to focus on *changes* in exposure
- Weighting methods to deal with observables and post-exposure covariates
- Extensions to mediation

All fit within the scope of multilevel design and analysis



Methods development and clarification

- Defining assumptions for causal effects of contextual exposures
- Time-varying exposures and confounding
- Conditional vs. marginal effects



Nandi and Kawachi (2011)

See also Hong and Raudenbush (2008); Cerdá et al. (2010); Glymour et al. (2010); Hubbard et al. (2010); Subramanian and O'Malley (2010)

“Fixing” neighborhood research?

American Journal of Epidemiology

Vol. 180, No. 8
DOI: 10.1093/aje/kwu233
Advance Access publication:
September 26, 2014

Practice of Epidemiology

Are Neighborhood Health Associations Causal? A 10-Year Prospective Cohort Study With Repeated Measurements

Markus Jokela*

* Correspondence to Dr. Markus Jokela, Institute of Behavioural Sciences, University of Helsinki, Siltavuorenpenger 1A, P.O. Box 9, 00014 Helsinki, Finland (e-mail markus.jokela@helsinki.fi).

> These findings provide little support for social causation as the explanation for associations between neighborhood characteristics and health outcomes.

Jokela (2014)

Healthy discussion of MTO design / results

MOVING TO OPPORTUNITY: A SYMPOSIUM

Neighborhood Effects on Economic Self-Sufficiency: A Reconsideration of the Moving to Opportunity Experiment[1]

Susan Clampet-Lundquist
Saint Joseph's University

Douglas S. Massey
Princeton University

What Can We Learn about Neighborhood Effects from the Moving to Opportunity Experiment?[1]

Jens Ludwig
University of Chicago

Jeffrey B. Liebman
Harvard University

Jeffrey R. Kling
Brookings Institution

Greg J. Duncan
University of California, Irvine

Lawrence F. Katz
Harvard University

Ronald C. Kessler
Harvard Medical School

Lisa Sanbonmatsu
National Bureau of Economic Research

Clampet-Lundquist and Massey (2008); Ludwig et al. (2008); Also Sampson et al. (2008)

Healthy discussion of MTO design / results

MOVING TO OPPORTUNITY: A SYMPOSIUM

Neighborhood Effects on Economic Self-Sufficiency: A Reconsideration of the Moving to Opportunity Experiment[1]

Susan Clampet-Lundquist
Saint Joseph's University

Douglas S. Massey
Princeton University

> …the ITT estimate…can successfully measure the effects of the policy initiative, but is not well suited to capturing neighborhood effects.

- Assessed *duration* of exposure to neighborhood conditions
- Find benefits of shorter exposure to low-poverty

Clampet-Lundquist and Massey (2008)

Healthy discussion of MTO design / results

> Random assignment of families to different MTO mobility groups··· generates large differences in average neighborhood trajectories

> Nonexperimental analyses of the type conducted by CM reintroduce all of the selection bias problems that MTO was designed to overcome.

What Can We Learn about Neighborhood Effects from the Moving to Opportunity Experiment?[1]

Jens Ludwig
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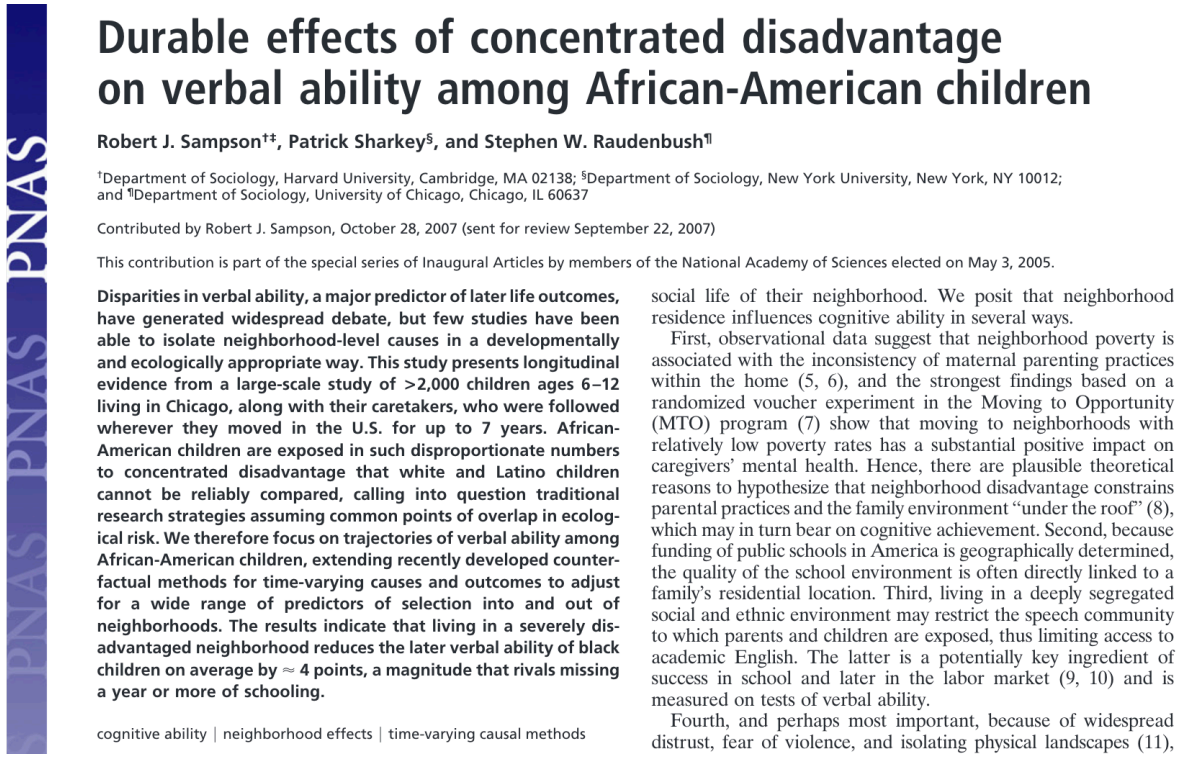
Ronald C. Kessler
Harvard Medical School

Lisa Sanbonmatsu
National Bureau of Economic Research

Ludwig et al. (2008)

Observational data as a neighborhood experiment

- Time-varying covariates controlled using IPTW, exposure effects estimated using MSMs.
- Can replicate MTO findings.
- Found significant lagged effect of living in concentrated disadvantage compared with advantage at wave 1



PNAS PNAS PNAS

Durable effects of concentrated disadvantage on verbal ability among African-American children

Robert J. Sampson[†‡], Patrick Sharkey[§], and Stephen W. Raudenbush[¶]

[†]Department of Sociology, Harvard University, Cambridge, MA 02138; [§]Department of Sociology, New York University, New York, NY 10012; and [¶]Department of Sociology, University of Chicago, Chicago, IL 60637

Contributed by Robert J. Sampson, October 28, 2007 (sent for review September 22, 2007)

This contribution is part of the special series of Inaugural Articles by members of the National Academy of Sciences elected on May 3, 2005.

Disparities in verbal ability, a major predictor of later life outcomes, have generated widespread debate, but few studies have been able to isolate neighborhood-level causes in a developmentally and ecologically appropriate way. This study presents longitudinal evidence from a large-scale study of >2,000 children ages 6–12 living in Chicago, along with their caretakers, who were followed wherever they moved in the U.S. for up to 7 years. African-American children are exposed in such disproportionate numbers to concentrated disadvantage that white and Latino children cannot be reliably compared, calling into question traditional research strategies assuming common points of overlap in ecological risk. We therefore focus on trajectories of verbal ability among African-American children, extending recently developed counterfactual methods for time-varying causes and outcomes to adjust for a wide range of predictors of selection into and out of neighborhoods. The results indicate that living in a severely disadvantaged neighborhood reduces the later verbal ability of black children on average by ≈ 4 points, a magnitude that rivals missing a year or more of schooling.

cognitive ability | neighborhood effects | time-varying causal methods

social life of their neighborhood. We posit that neighborhood residence influences cognitive ability in several ways.

First, observational data suggest that neighborhood poverty is associated with the inconsistency of maternal parenting practices within the home (5, 6), and the strongest findings based on a randomized voucher experiment in the Moving to Opportunity (MTO) program (7) show that moving to neighborhoods with relatively low poverty rates has a substantial positive impact on caregivers' mental health. Hence, there are plausible theoretical reasons to hypothesize that neighborhood disadvantage constrains parental practices and the family environment "under the roof" (8), which may in turn bear on cognitive achievement. Second, because funding of public schools in America is geographically determined, the quality of the school environment is often directly linked to a family's residential location. Third, living in a deeply segregated social and ethnic environment may restrict the speech community to which parents and children are exposed, thus limiting access to academic English. The latter is a potentially key ingredient of success in school and later in the labor market (9, 10) and is measured on tests of verbal ability.

Fourth, and perhaps most important, because of widespread distrust, fear of violence, and isolating physical landscapes (11),

Sampson (2008)

Lifecourse ‘lens’ on MTO

- Moving when young increases college attendance and earnings
- Moving as an adolescent has slightly negative impacts.

> ⋯ suggests that the duration of exposure to better environments during childhood is an important determinant

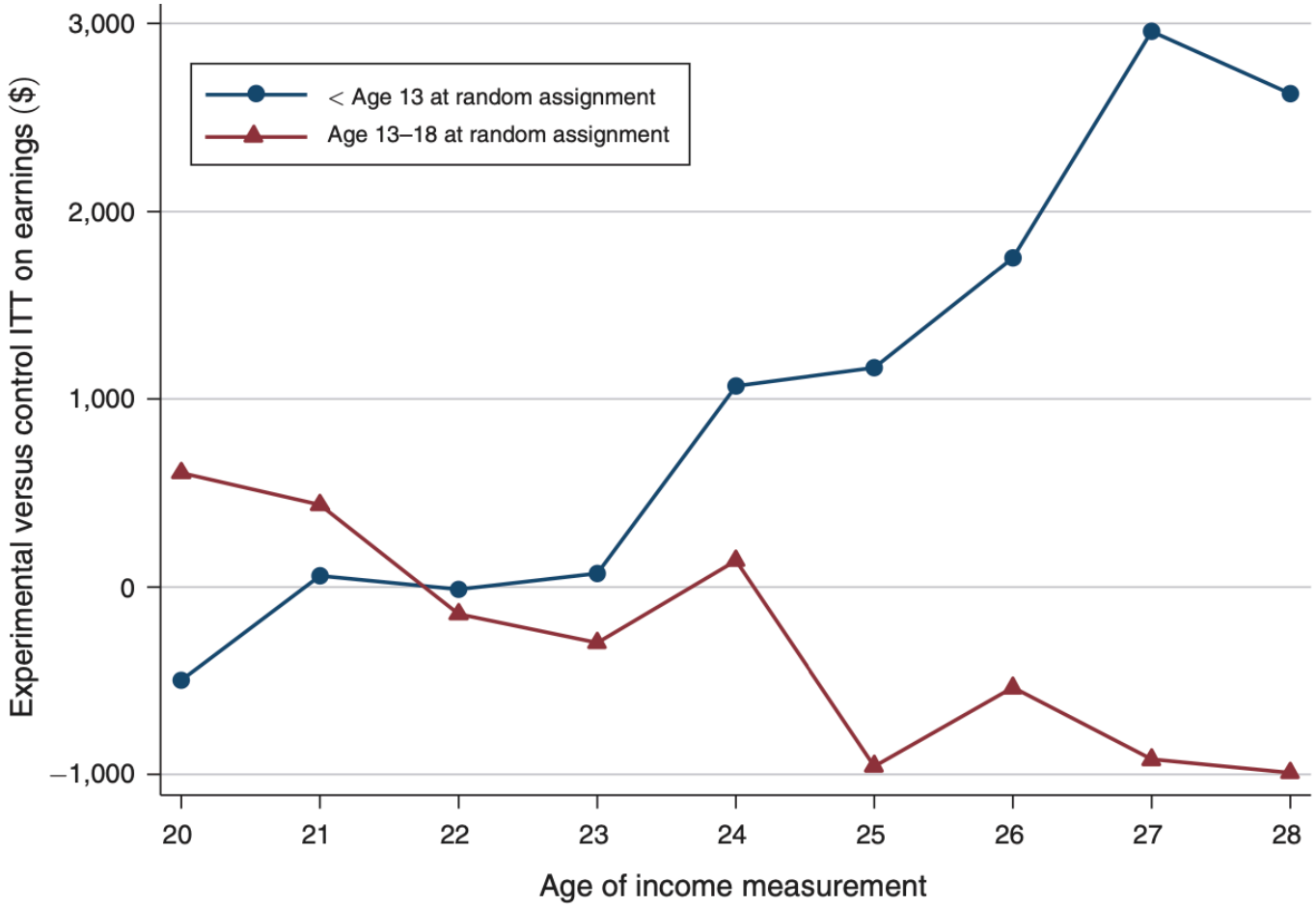


FIGURE 1. IMPACTS OF EXPERIMENTAL VOUCHER BY AGE OF EARNINGS MEASUREMENT

Chetty et al. (2016)

JAMA Network | Open

Original Investigation | Global Health

Association of Neighborhood Disadvantage With Cardiovascular Risk Factors and Events Among Refugees in Denmark

Rita Hamad, MD, PhD; Buket Öztürk, MSc; Else Foverskov, PhD; Lars Pedersen, PhD; Henrik T. Sørensen, MD, PhD; Hans E. Bøtker, MD, PhD; Justin S. White, PhD

Abstract

IMPORTANCE Refugees are among the most disadvantaged individuals in society, and they often have elevated risks of cardiovascular risk factors and events. Evidence is limited regarding factors that may worsen cardiovascular health among this vulnerable group.

OBJECTIVE To test the hypothesis that refugee placement in socioeconomically disadvantaged neighborhoods is associated with increased cardiovascular risk.

DESIGN, SETTING, AND PARTICIPANTS The study population of this quasi-experimental, registry-based cohort study included 49 305 adults 18 years and older who came to Denmark as refugees from other countries during the years of Denmark's refugee dispersal policy from 1986 to 1998. Refugees were dispersed to neighborhoods with varying degrees of socioeconomic disadvantage in an arbitrary manner conditional on observed characteristics. The association of neighborhood disadvantage on arrival with several cardiovascular outcomes in subsequent decades was evaluated using regression models that adjusted for individual, family, and municipal characteristics. Health outcomes were abstracted from the inpatient register, outpatient specialty clinic register, and prescription drug register through 2016. Data analysis was conducted from May 2018 to July 2019.

EXPOSURES A composite index of neighborhood disadvantage was constructed using 8

Key Points

Question Is there an association of neighborhood socioeconomic disadvantage with the development of cardiovascular risk factors, myocardial infarction, and stroke among refugees?

Findings In this quasi-experimental cohort study, 49 305 refugees who were assigned to more disadvantaged neighborhoods across Denmark were at increased risk of developing hypertension, hyperlipidemia, diabetes, and myocardial infarction over subsequent decades. No associations were found for stroke.

Meaning Neighborhood characteristics may be associated with long-term cardiovascular risk among refugees.

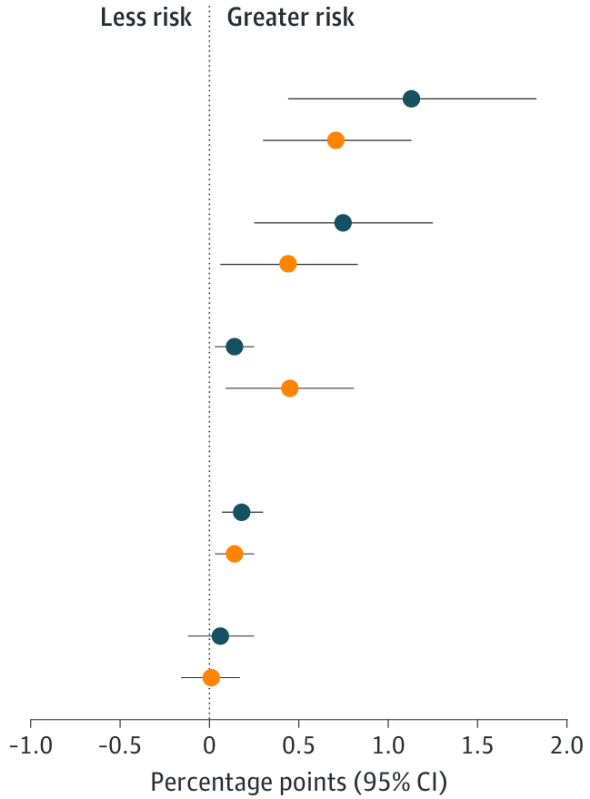
…incoming refugees were assigned to neighborhoods with varying levels of disadvantage throughout the country

…As a result, this study attempts to address the challenges of selective migration present in existing studies on neighborhood outcomes.

Hamad et al. (2020)

Association of Neighborhood Disadvantage With Cardiovascular Outcomes, N = 49 305

Risk factors	Percentage points (95% CI)	*P* Valu
Hypertension		
Unadjusted	1.13 (0.44 to 1.83)	.001
Adjusted	0.71 (0.30 to 1.13)	.001
Hyperlipidemia		
Unadjusted	0.75 (0.25 to 1.25)	.003
Adjusted	0.44 (0.06 to 0.83)	.01
Diabetes		
Unadjusted	0.14 (0.03 to 0.25)	.01
Adjusted	0.45 (0.09 to 0.81)	.01
End points		
MI		
Unadjusted	0.18 (0.07 to 0.30)	.002
Adjusted	0.14 (0.03 to 0.25)	.01
Stroke		
Unadjusted	0.06 (-0.12 to 0.25)	.49
Adjusted	0.01 (-0.16 to 0.17)	.92



…refugees who were assigned to more disadvantaged neighborhoods were more likely to develop hypertension, hyperlipidemia, diabetes, and MI in subsequent decades.

Effect sizes were small, representing a 2% increase from baseline rates for each condition…

Hamad et al. (2020)

- Recent review of 'causal analyses' of neighborhood effects.
- Much more mixed.
- Evidence of selection and confounding.
- Lots of heterogeneity.
- Stronger evidence for children than adults.

Table 1. Conclusions from Causal Analyses of Neighborhood Effects

Significant Effects	No Effects
Cognitive and behavioral development	
Ahern et al. 2008; Cerda et al. 2010; Nandi et al. 2010; Sanbonmatsu et al. 2011; Cerda et al. 2012; Gibbons, Silva, and Weinhardt 2013; Santiago et al. 2014, this volume	Novak et al. 2006; Jokela 2014
Educational performance and attainment	
Rosenbaum 1995; Duncan, Connell, and Klebanov 1997; Vartanian and Gleason 1999; Crowder and South 2003; Clampet-Lundquist 2007; Fauth, Leventhal, and Brooks-Gunn 2007; Galster et al. 2007; DeLuca et al. 2010; Schwartz 2010; Sharkey and Sampson 2010; Jargowsky and El Komi 2011; Sharkey et al. 2012, 2014; Casciano and Massey 2012; Gibbons, Silva, and Weinhardt 2014; Santiago et al. 2014; Carlson and Cowan 2015; Chetty, Hendren, and Katz 2015; Galster et al. 2015, 2016; Galster, Santiago, and Stack 2015; Tach et al. 2016; Galster and Santiago, forthcoming	Plotnick and Hoffman 1999; Ludwig, Ladd, and Duncan 2001; Jacob 2004; Sanbonmatsu et al. 2006, 2011; Kling, Liebman, and Katz, 2007; Gibbons, Silva, and Weinhardt 2013; Weinhardt 2014
Teen fertility	
Harding 2003; Popkin, Leventhal and Weismann 2010; Sanbonmatsu et al. 2011; Santiago et al. 2014; Chetty, Hendren and Katz 2015; Galster and Santiago, forthcoming	Plotnick and Hoffman 1999
Physical and mental health	
Leventhal and Brooks-Gunn 2003; Cohen et al. 2006; Votruba and Kling 2009; Glymour et al. 2010; Ludwig et al. 2011; Sanbonmatsu et al. 2011; Do et al. 2013; Kessler et al. 2014; Moulton, Peck, and Dillman 2014; Santiago et al. 2014	Schootman et al. 2007; Hearst et al. 2008; Johnson et al. 2008; Jokela 2014

Galster and Sharkey (2017); See also Chyn and Katz (2023) for a very recent review

Community RCTs are (often) MLMs!

JAMA Internal Medicine | Original Investigation | FIREARM VIOLENCE

Effect of Abandoned Housing Interventions on Gun Violence, Perceptions of Safety, and Substance Use in Black Neighborhoods

A Citywide Cluster Randomized Trial

Eugenia C. South, MD, MS; John M. MacDonald, PhD; Vicky W. Tam, MA; Greg Ridgeway, PhD; Charles C. Branas, PhD

IMPORTANCE Structural racism has resulted in long-standing disinvestment and dilapidated environmental conditions in Black neighborhoods. Abandoned houses signal neglect and foster stress and fear for residents, weakening social ties and potentially contributing to poor health and safety.

OBJECTIVE To determine whether abandoned house remediation reduces gun violence and substance-related outcomes and increases perceptions of safety and use of outdoor space.

DESIGN, SETTING, AND PARTICIPANTS This cluster randomized trial was conducted from January 2017 to August 2020, with interventions occurring between August 2018 and March 2019. The study included abandoned houses across Philadelphia, Pennsylvania, and surveys completed by participants living nearby preintervention and postintervention. Data analysis was performed from March 2021 to September 2022.

INTERVENTIONS The study consisted of 3 arms: (1) full remediation (installing working windows and doors, cleaning trash, weeding); (2) trash cleanup and weeding only; and (3) a no-intervention control.

MAIN OUTCOMES AND MEASURES Difference-in-differences mixed-effects regression models were used to estimate the effect of the interventions on multiple primary outcomes: gun violence (weapons violations, gun assaults, and shootings), illegal substance trafficking and use, public drunkenness, and perceptions of safety and time outside for nearby residents.

RESULTS A master list of 3265 abandoned houses was randomly sorted. From the top of this randomly sorted list, a total of 63 clusters containing 258 abandoned houses were formed and then randomly allocated to 3 study arms. Of the 301 participants interviewed during the preintervention period, 172 (57.1%) were interviewed during the postintervention period and were included in this analysis; participants were predominantly Black, and most were employed. Study neighborhoods were predominantly Black with high percentages of low-income households. Gun violence outcomes increased in all study arms, but increased the least in the full remediation arm. The full housing remediation arm, compared with the control condition,

Multimedia

Supplement

AJPH OPEN-THEMED RESEARCH

Effect of Remediating Blighted Vacant Land on Shootings: A Citywide Cluster Randomized Trial

Ruth Moyer, JD, John M. MacDonald, PhD, Greg Ridgeway, PhD, and Charles C. Branas, PhD

Objectives. To determine if remediating blighted vacant urban land reduced firearm shooting incidents resulting in injury or death.

Methods. We conducted a cluster randomized controlled trial in which we assigned 541 randomly selected vacant lots in Philadelphia, Pennsylvania, to 110 geographically contiguous clusters and randomly assigned these clusters to a greening intervention, a less-intensive mowing and trash cleanup intervention, or a no-intervention control condition. The random assignment to the trial occurred in April and June 2013 and lasted until March 2015. In a difference-in-differences analysis, we assessed whether the 2 treatment conditions relative to the control condition reduced firearm shootings around vacant lots.

Results. During the trial, both the greening intervention, −6.8% (95% confidence interval [CI] = −10.6%, −2.7%), and the mowing and trash cleanup intervention, −9.2% (95% CI = −13.2%, −4.8%), significantly reduced shootings. There was no evidence that the interventions displaced shootings into adjacent areas.

Conclusions. Remediating vacant land with inexpensive, scalable methods, including greening or minimal mowing and trash cleanup, significantly reduced shootings that result in serious injury or death.

Public Health Implications. Cities should experiment with place-based interventions to develop effective firearm violence–reduction strategies.

Trial Registration. This trial was registered with the International Standard Randomized Controlled Trial Number (study ID ISRCTN92582209; http://www.isrctn.com/ISRCTN92582209). (*Am J Public Health.* 2019;109:140–144. doi:10.2105/AJPH.2018.304752)

See also Blais, p. 25; and also Galea and Vaughan, p. 28.

30% of shootings in Philadelphia occ
in only 6% of city block groups (112
1816).

In a systematic review of quasiexpe
imental research, Kondo et al. found t
remediating vacant land may be an eff
approach to addressing the hyperconc
tion of gun violence in cities.[12] Additic
in a citywide cluster randomized contr
trial of vacant land remediation in Phi
delphia, Branas et al. found that gun a
were reduced after lots were treated.[13] H
ever, most gun assaults do not result in
actual shooting that causes serious injury
death. We extended the cluster random
controlled trial of vacant land restoratior
estimating the effect of remediating vaca
on firearm shootings that resulted in seri
injury or death during the trial.

METHODS

We used data from a vacant lot clu
randomized controlled trial[13] and the

South et al. (2023); Moyer et al. (2019)

New approaches to measurement

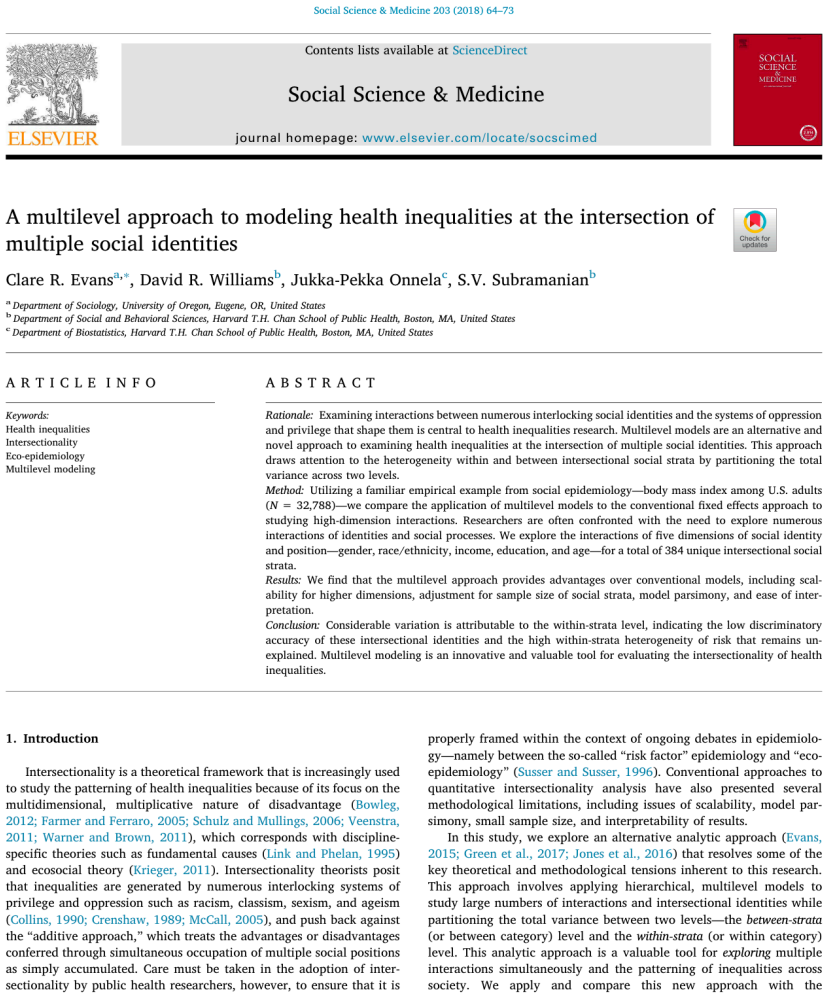
- Multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA)
- Individuals nested within social strata
- Partial pooling of intersectoral identities
- Can reveal heterogeneity beyond simple additive effects.

$$y_{ij} = \beta\gamma_j + \mu_{0j} + e_{0ij}$$

$$[\mu_{0j}] \sim N(0, \sigma^2_{strata})]$$

$$[e_{0ij}] \sim N(0, \sigma^2_{e_0})$$

See Evans et al. (2018), Merlo (2018).



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A multilevel approach to modeling health inequalities at the intersection of multiple social identities

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ABSTRACT

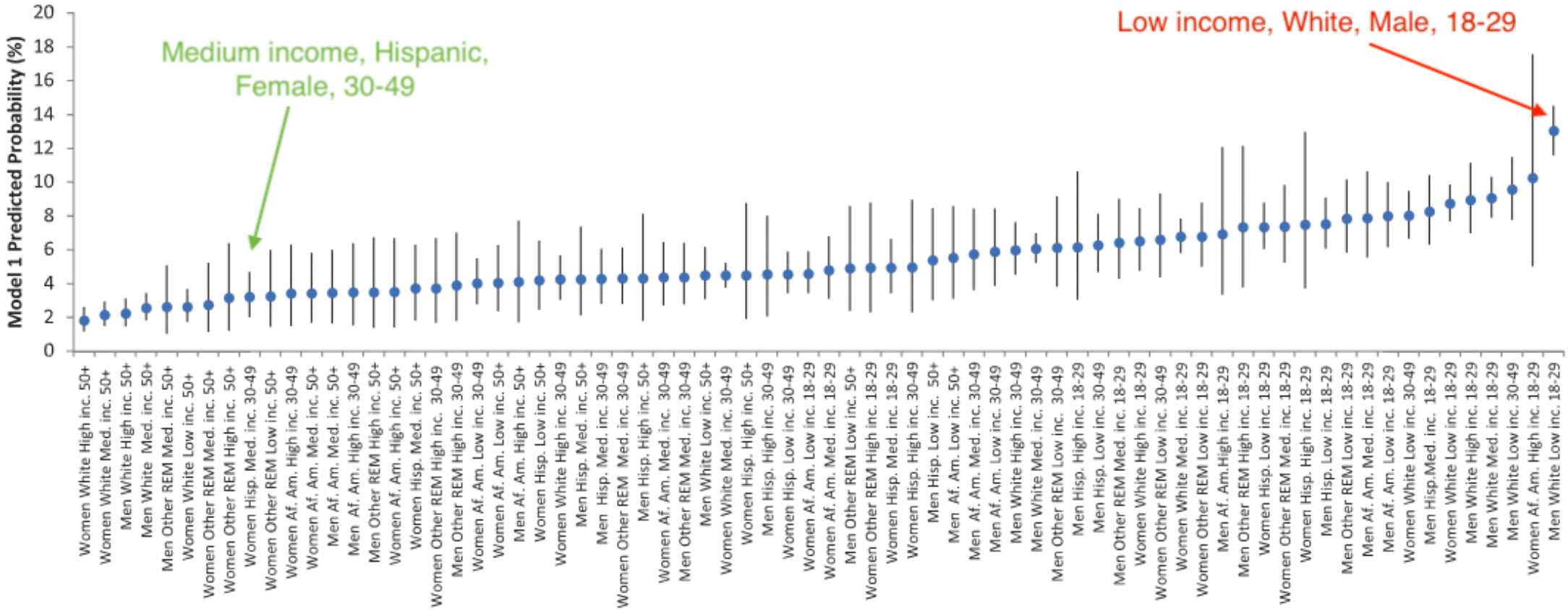
Rationale: Examining interactions between numerous interlocking social identities and the systems of oppression and privilege that shape them is central to health inequalities research. Multilevel models are an alternative and novel approach to examining health inequalities at the intersection of multiple social identities. This approach draws attention to the heterogeneity within and between intersectional social strata by partitioning the total variance across two levels.
Method: Utilizing a familiar empirical example from social epidemiology—body mass index among U.S. adults (N = 32,788)—we compare the application of multilevel models to the conventional fixed effects approach to studying high-dimension interactions. Researchers are often confronted with the need to explore numerous interactions of identities and social processes. We explore the interactions of five dimensions of social identity and position—gender, race/ethnicity, income, education, and age—for a total of 384 unique intersectional social strata.
Results: We find that the multilevel approach provides advantages over conventional models, including scalability for higher dimensions, adjustment for sample size of social strata, model parsimony, and ease of interpretation.
Conclusion: Considerable variation is attributable to the within-strata level, indicating the low discriminatory accuracy of these intersectional identities and the high within-strata heterogeneity of risk that remains unexplained. Multilevel modeling is an innovative and valuable tool for evaluating the intersectionality of health inequalities.

1. Introduction

Intersectionality is a theoretical framework that is increasingly used to study the patterning of health inequalities because of its focus on the multidimensional, multiplicative nature of disadvantage (Bowleg, 2012; Farmer and Ferraro, 2005; Schulz and Mullings, 2006; Veenstra, 2011; Warner and Brown, 2011), which corresponds with discipline-specific theories such as fundamental causes (Link and Phelan, 1995) and ecosocial theory (Krieger, 2011). Intersectionality theorists posit that inequalities are generated by numerous interlocking systems of privilege and oppression such as racism, classism, sexism, and ageism (Collins, 1990; Crenshaw, 1989; McCall, 2005), and push back against the "additive approach," which treats the advantages or disadvantages conferred through simultaneous occupation of multiple social positions as simply accumulated. Care must be taken in the adoption of intersectionality by public health researchers, however, to ensure that it is properly framed within the context of ongoing debates in epidemiology—namely between the so-called "risk factor" epidemiology and "eco-epidemiology" (Susser and Susser, 1996). Conventional approaches to quantitative intersectionality analysis have also presented several methodological limitations, including issues of scalability, model parsimony, small sample size, and interpretability of results.

In this study, we explore an alternative analytic approach (Evans, 2015; Green et al., 2017; Jones et al., 2016) that resolves some of the key theoretical and methodological tensions inherent to this research. This approach involves applying hierarchical, multilevel models to study large numbers of interactions and intersectional identities while partitioning the total variance between two levels—the *between-strata* (or between category) level and the *within-strata* (or within category) level. This analytic approach is a valuable tool for *exploring* multiple interactions simultaneously and the patterning of inequalities across society. We apply and compare this new approach with the

- MAIHDA allows a deeper look at multi-dimensional heterogeneity.



Persmark et al. (2020) on the probability of reporting opioid use disorder.

Summary: What have we learned?

Multilevel models

- Helped to push social epi forward.
- Perhaps short of promises.
- More cross-sectional random effects designs unlikely to help.

Neighborhood effects

- Heterogeneous but reliably negative associations between adverse neighborhood conditions and health.
- Particularly for children with longer exposure.
- Potential underutilization of cluster-randomized interventions.

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