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Early-Life Conditions And Mechanisms Of Population Health

Vulnerabilities:

Actions taken at the neighborhood level seem to be the most effective in improving health status throughout the life course

Alice Furumoto-Dawson, Sarah Gehlert, Dana Sohmer, Olufunmilayo Olopade, and Tina Sacks

Alice Furumoto-Dawson is a senior research associate at the Center for Interdisciplinary Health Disparities Research (CIHDR), University of Chicago. Sarah Gehlert (sgehlert@uchicago.edu) is a professor and the deputy dean for research at the School of Social Services Administration, University of Chicago, and director of the CIHDR. Dana Sohmer is data manager at the CIHDR. Olufunmilayo Olopade is the Walter L. Palmer Distinguished Service Professor in the Department of Medicine (hematology/oncology), University of Chicago. Tina Sacks is a research assistant at the CIHDR.

Abstract

The social status of groups is key to determining health vulnerability at the population level. The impact of material and psychological stresses imposed by social inequities and marginalization is felt most intensely during perinatal/early childhood and puberty/adolescent periods, when developmental genes are expressed and interact with social-physical environments. The influence of chronic psychosocial stresses on gene expression via neuroendocrine regulatory dysfunction is crucial to understanding the biological bases of adult health vulnerability. Studying childhood biology vulnerabilities to neighborhood environments will aid the crafting of multifaceted, multilevel public policy interventions providing immediate benefits and compounded long-term population health yields.

ACORE DETERMINANT OF HEALTH VULNERABILITY at the population level is the social status of groups. Social hierarchies promote intergenerational inheritance of social status and assets in a highly systematic and deterministic fashion (arguably far more than the mostly random factors affecting inheritance of population-linked genetic variants—so-called race). Not only does poverty persist in families through generations, but its distribution and concentration are so durable that neighborhoods develop hierarchies of reputation that resist all but the most massive of social movements and economic upheavals.¹ The close association of U.S. social groups by race, region, and urbanization has been mapped with the geography of health disparities for major chronic disease mortality and longevity. The result has been described as the “eight Americas,” in which, for example, urban African American men face mortality risks equivalent to those of men in developing countries.²

The material and psychological stresses imposed by social inequities and marginalization affect health over the entire life course via multiple pathways.³ The influence of chronic psychosocial stress on gene expression via neurological and hormonal dysfunction is important to understanding the biological bases of adult health vulnerability (for example, metabolic and cardiovascular diseases and cancer). However, during intense periods of development—that is, the perinatal and peripubertal periods—whole suites of genes are expressed and interact with the social and physical environments experienced by the growing child. This phenomenon is not limited to humans. Observational studies and experimental models across a wide

spectrum of social mammals from rats to our closest genetic relatives, the nonhuman primates, underscore the necessary and critical role that social environments play in human physiological as well as psychological development.⁴

This review first considers the existing literature on how early-life conditions set the stage for future vulnerability, first through the lens of social determinants of health across the life course and then in terms of multiple pathways, multilevel causes, and interactions. We take a life-course perspective because it best combines prevailing etiological models of individual disease risk with the long-term effects of physical and social exposures during multiple periods of life.⁵ We outline and consider programs and policies aimed at improving the health and well-being of low-income children in terms of the programs' ability to affect children's future vulnerability.

Social Determinants Of Health Through The Life Course

Studies at the intersection of the social, behavioral, and biological sciences add to an emerging field of physiological evidence supporting the idea that children's development is greatly affected by the social environments in which they are raised.⁶ Although genetic components contribute to inheritance of traits that may predispose individuals to certain health and disease outcomes, the social environment is key to setting those genetic mechanisms in motion. The goal of transdisciplinary research is to identify those factors in the social and physical environment that may trigger physiological responses, thus identifying how society “gets under the skin.”

That the social environment can affect the health of children is well established. Yet scholars have only begun to identify the mechanisms through which factors such as socioeconomic status (SES) and neighborhood environments, including features such as environmental toxins, crime, and experiences of traumatic events, affect health over the life course.

Crucial perinatal and peripubertal periods

Among the periods during which children are most vulnerable to social environmental influences, the perinatal and peripubertal periods represent sensitive times in human development, and disruptive events that occur during these times can leave severe lasting impressions.⁷ Proponents of a biological programming perspective suggest that factors that occur during these critical periods have direct, lasting effects on health, despite circumstances thereafter.⁸ Evidence from studies directly linking premature birth and low birthweight to, for instance, cardiovascular disease in adulthood provide support for this perspective. For example, Catherine Law and colleagues found that the association between birthweight and hypertension begins in utero and persists into adulthood, independent of infant nutrition and adult weight.⁹

Impact of mother's health during pregnancy—Factors that influence a mother's health during pregnancy, such as poor nutrition and exposure to environmental pollutants, are all associated with preterm delivery and low birthweight.¹⁰ Complications experienced in childhood, such as remaining slim and small for gestational age—most often the outcome of low birthweight—or being obese, or having early puberty, suggest that adverse experiences in utero and childhood may lead to impaired growth and development and can result in deficiencies in adulthood.¹¹

Responses to the social environment—Exposure to childhood poverty and abuse, trauma, and neglect also have been linked to various conditions in adulthood.¹² The Pitt County Study, a community-based longitudinal study of hypertension risk factors, compared groups of working- and middle-class African American men. The authors concluded that low childhood SES is associated with an increased risk for hypertension in adulthood. Although

risk declined with increases in adult SES, men who were disadvantaged in both childhood and adulthood were almost seven times more likely than others to have hypertension, which suggests a cumulative burden of social circumstances throughout the life course.¹³

Bruce McEwen holds that the body's physiological response to demands from the social environment is cumulative rather than simply a series of independent episodes of stress.¹⁴ Repeated activation of coping mechanisms in response to stressors eventually takes its toll on the body. McEwen's concept of allostatic load characterizes repetitive wear and tear on the body as physiological responses to social circumstances. Evidence from animal and human studies demonstrates that chronic stressors can alter stress hormone levels.¹⁵ These elevated stress hormone levels interact with inflammatory processes through constant regulation of stress hormone receptors and the hypothalamic-pituitary-adrenal axis, the system that regulates stress hormone levels.¹⁶ Both elevated stress hormone levels and increased inflammation over the life course contribute to greater risk for cardiovascular diseases, diabetes, cancer, and other disorders that disproportionately affect vulnerable populations.¹⁷

Although everyone experiences stress, vulnerable populations such as low-SES groups and racial minorities are almost certainly differentially exposed to multiple stressors, such as living in deteriorated, high-crime neighborhoods; being exposed to societal discrimination; and having limited access to goods and services. Arline Geronimus's "weathering hypothesis" posits that as a result of societal marginalization and economic hardships, people of low SES are far more likely than those of higher SES are to experience health deterioration relatively earlier in life.¹⁸ Similarly, in recent work using data from the National Health and Nutrition Examination Survey (NHANES IV), Geronimus and colleagues found that across all age groups, African Americans have higher allostatic load than whites. These findings are not entirely explained by poverty, which suggests that "weathering" as a result of societal marginalization contributes to disparate health outcomes across populations.¹⁹

Social environment and disease outcomes—Studies at the Center for Interdisciplinary Health Disparities Research (CIHDR) use the concepts of allostatic load and weathering to understand how stressors in the social environment influence disease outcomes. Animal models in the McClintock Laboratory have implicated altered stress hormone levels to explain how changes in the social environment get "under the skin" to induce aggressive mammary cancer.²⁰ Rats that are isolated, especially during puberty, quit exploring their environments, develop tumors at higher rates, and die much earlier than other rats.²¹ Social isolation activates stress hormone receptors, changes gene expression, and results in the survival of cancer cells. CIHDR investigators are testing this model in humans to examine how social environmental conditions, such as decayed infrastructures and violent crime, may get "under the skin" to influence the expression of breast cancer.

Research to date suggests intervening physiological mechanisms by which social and environmental experiences early in life affect adult health outcomes. Certain structural- or societal-level factors influence exposures to risk and vulnerability to disease regardless of individual experiences or behavior.²² Childhood social conditions and environments certainly affect health by influencing lifestyles, behavior, choices, and preferences; however, a fundamental-causes approach assumes that it is those structural and societal factors, such as social standing or experiences of racism and discrimination, that ultimately lead to disparate health outcomes.

Social And Physical Environments: Multiple Pathways, Multilevel Causes, And Interactions

In addition to the physiological pathways to health and disease, scholars are increasingly looking at the social and physical environments as contributing factors to health outcomes among vulnerable populations. Much of the early-life environment is influenced by the features of neighborhoods in which children are raised. Neighborhood conditions, such as environmental toxins, public services and stores, and investments in recreational spaces, influence child health and well-being.²³ Increasingly, racial disparities in early exposure to environmental toxins such as lead, particulate matter, and proximity to pollution emission sources have been implicated as likely contributors to poor health, particularly sickness and death from asthma.²⁴

Work from across the social sciences emphasizes that daily life in neighborhoods gives rise to a sense of identity and inclusion that is interconnected with place, community, and civil society.²⁵ Growing up in communities with disrupted connections and marked by economic neglect, societal stigmatization, and exclusion has been linked repeatedly to numerous negative effects on well-being and health, from birth to death, in multiple domains.²⁶ In fact, Chiquita Collins and David Williams's analysis of residential racial segregation found striking associations between segregation and all-cause mortality for African American men and women.²⁷

The observation that “place,” both in the physical sense of locale and in the sense of social position, greatly influences health and disease is ancient.²⁸ Yet that observation fails to address why and how “place” matters so much to health that it places some population groups at extraordinary risk. More recently, epidemiologists have argued about whether it is context (higher-order characteristics such as neighborhood density) or composition (the biological or social characteristics of individuals) that matters. It is a debate with parallels at the human population level: the debate of environment versus genes in individual development.²⁹ Sally MacIntyre and Anne Ellaway argue that “the distinction between people and places, composition and context, is somewhat artificial. People create places, and places create people.”³⁰ In the biomedical research community there are those who make a similar argument about biology being necessarily the dynamic interaction of genetics and environment.

Implications For Health Policy And Interventions

A fairly extensive research literature exists to tie child and adolescent health and well-being—from prenatal influences through sexual maturation and the formation of social networks and their own households—to neighborhood contexts. We know that many of the worst influences on human development are synergistic in causing morbidity and mortality (for example, premature birth, asthma, hypertension, obesity, and impaired glucose tolerance) and that the joint probability of being exposed to several such factors escalates with both household and neighborhood poverty. For example, the Harlem Asthma Project, a New York City Environmental Justice Movement group using techniques of community-based participatory research, found that 25 percent of children in a household survey of Harlem's predominately African American and Latino inner-city residents met diagnostic criteria for asthma—far higher than national prevalence rates, suburban rates, or rates among white children.³¹ Other studies have found higher levels of local air pollutants, environmental toxins, infections, and inflammation in low-income African American and Latino neighborhoods, along with synergistic effects of these environmental exposures with exposure to household smoking on risk for developing childhood asthma.³² Lastly, maternal asthma has been found to have multiplicative effects on premature birth over baseline risks, such that African American women, who are already twice as likely as white women to have premature first childbirths, are at four times the risk if asthmatic.³³ This implies that racial disparities in birth outcomes

and neonatal mortality will become more difficult to eliminate as these children develop into young adults and begin to have children of their own.

We are only beginning to grapple with the implications of the synergistic and complex relationship between health and environment in terms of designing and fielding programmatic approaches to address population health vulnerability. Problematically, the persistence of African American household poverty based in economically disadvantaged, socially isolating, and distressed neighborhoods reinforces threats to child and youth development and carries with it the intergenerational transfer of health vulnerabilities.³⁴ Yet as Dolores Acevedo-Garcia and colleagues point out, most environmental interventions remain unidimensional and often address a single factor, such as lead exposure or renovation of public parks.³⁵ Not surprisingly, such interventions have had very modest or no effects.

Moving to Opportunity programs

Analyses of the Moving to Opportunity (MTO) programs, federally financed interventions that moved families out of public housing, have produced some of the most convincing evidence of the positive effects of improved neighborhood conditions on health (notably self-reported stress, mental health, diet, and obesity among girls).³⁶ The methodological strength of the MTO randomized-control design lends credence to the importance of the neighborhood context in shaping youth development, promoting well-being, and potentially improving health outcomes. The MTO programs initially targeted adult employment and youth delinquency and were developed in response to housing discrimination claims. Although the experiment was aimed at individual households, its empirical foundation suggests that neighborhoods may be the more appropriate level.

Examples of other neighborhood planning programs

Three examples illustrate a range of contrasts in the planning of urban neighborhoods, including to what extent neighborhood residents are included in the process. This is important, because of the degree to which the design of public spaces and infrastructure may ultimately affect the health of children and youth.

Chicago's Bronzeville neighborhood—The first example is Chicago's historic Bronzeville neighborhood, a study in contrasts in terms of urban renewal and neighborhood transformation. The low-rise Ida B. Wells public housing clusters were designed by African Americans in the 1920s. Their initial construction was vehemently opposed by real estate interests and local politicians, yet in retrospect, they have features, such as walkability, common green spaces, and integration with existing mixed-use neighborhood structures, that are now touted by urban planners. Even after decades of neglect, they stand in contrast to the now demolished blocks of the high-rise, federally designed Robert Taylor Homes and Cabrini Green projects.³⁷ These high-rise housing projects were built in the wake of highways that promoted white flight and devastated the black metropolis.

Harvard's Play across Boston project—A second example comes from Play across Boston, a Harvard School of Public Health project whose initial inventory of recreational and physical activity resources found that inadequate, less accessible, and poorly maintained public recreational spaces were both detrimental to child and youth populations and racially discriminatory. Additionally, during the final phases of the massive Massachusetts Big Dig project, inner-city youth designs for public parks and recreational spaces elicited in planning sessions were shelved with little comment.³⁸

Sustainable South Bronx and South Bronx Active Living—One more urban planning example demonstrates the potential of reconstructing inner-city neighborhoods to support

human development by engaging community residents of all ages and by directly addressing issues of health inequalities, environmental justice, and the public commons while being fiscally efficient and locally sustainable. Sustainable South Bronx and the South Bronx Active Living Campaign partnership, funded by the Robert Wood Johnson Foundation, consciously promote a “Greening the Ghetto” approach.³⁹

Importance of community-based participatory research

The lesson to be learned from the above examples is that although the new urbanists and the “green” cities movement bring important concepts and resources to the problem of health disparities, they are insufficient.⁴⁰ Rather, to be effective, efforts must be integrated with the best practices of community-based participatory research.⁴¹ Examples of projects that have incorporated these practices to decrease rates of childhood asthma include the Environmental Justice Movement, exemplified by the Harlem Asthma Project and Boston’s ACE–Dorchester Square clean-up of illegal dumps, bus depots, and trash transfer facilities.⁴²

National programs

Before outlining policy recommendations to address the neighborhood context of human development, it is important to acknowledge existing national programs that address child health and well-being. Federal and state programs such as Women, Infants, and Children (WIC) and Head Start are aimed at mitigating the effects of poverty on infant and child development. Evaluations of WIC find that it is highly effective in reducing preterm low and very low birthweights; both maternal and child anemia; and obesity. Eliana Garces and colleagues concluded that WIC is cost-effective, citing a return of nine dollars for every dollar spent in terms of reducing costs for medical and supportive services.⁴³ In the case of Head Start, immediate increases were seen in measures of child health (for example, immunizations and dental care) and school readiness, as well as parents’ skills and mental health.⁴⁴ Although the initial positive academic effects of Head Start programs fade, James Heckman and Lance Lochner suggest that early-intervention programs may improve the lifetime economic and social prospects of participants.⁴⁵ As such, investments in early childhood programs may mitigate childhood social and economic conditions that often lead to poor health.

“When it comes to population-based health vulnerabilities, there is no such thing as ‘benign’ neglect.”

Policy recommendations

A range of prescriptions under the overarching themes of civil inclusion and programmatic interventions to improve child health are key to successfully addressing the basis of human development and population health vulnerabilities. These include the following. (1) Integrating issues of health and psychological and social development into urban planning and design: This should be coupled with recreational planning for children and youth. (2) Including education and school system renovation and planning as an essential part of community reconstruction, along with school-based clinics and curricula.

(3) Addressing the abundance of vacant buildings and lots, illegal dumps, and the paucity of well-maintained public recreational and social spaces, which may reduce the settings in which youth violence and gender-based violence may occur.⁴⁶ (4) Including community policing and criminal justice reforms within an integrated perspective of public safety and well-being. Innovative programs to familiarize police officers with mental health issues and link them to community mental health resources should be extended as broadly as possible.⁴⁷ (5) Rebuilding black civil society and broadening public discourses, especially including black youth, to address discrimination and poverty in local political and economic spheres, especially housing and financial markets, employment, and commercial development.⁴⁸

As the United States enters the twenty-first century, a vision of neighborhood reconstruction guided by community-based partnerships for health and social justice is necessary, not optional. The Katrina disaster exposed the extreme vulnerabilities of a population group defined by poverty, racial discrimination, and geography and focused a global spotlight on the consequences of policies that fail to acknowledge and address those vulnerabilities. When it comes to population-based health vulnerabilities, there is no such thing as “benign” neglect.

Concluding Observations

Although only modest data on the long-term effects of existing policies and programs for future vulnerability are available, two major conclusions can be made. First, policies and programs are more effective if they target neighborhoods and address various domains, such as children's cognitive development and parenting skills, rather than focusing exclusively on child health. Conversely, interventions targeted solely at the health system without considering other spheres of influence on children's health will not be as successful as those that take more holistic approaches. Second, all programs and policies, whether designed to address health outcomes specifically or neighborhoods generally, are likely to have greater success and longevity with the input of community stakeholders.

As the vision of Healthy People 2010 is extended to Healthy Communities 2020, the vulnerability of childhood biology to the social environment of neighborhoods can provide a window of opportunity to craft multifaceted, multilevel public policy interventions.⁴⁹ Public and private supports that bring the resources of academic and professional expertise to bear are needed to initiate such comprehensive programs; however, long-term success depends on the active participation of communities and local agencies.⁵⁰ Efforts such as the National Institutes of Health's (NIH's) Population Health and Health Disparities initiative that require such collaborations are a step in the right direction. In addition, such initiatives offer a new paradigm for funding basic research in a transdisciplinary mode that allows for a more inclusive vision of health. Universities must be prepared to develop and facilitate co-equal partnerships with communities that undergird successful collaborations in community-based participatory research.⁵¹ It is at this level that research is translated into policy changes, and “best practices” become institutionalized as standard practice. Implementation at the level of neighborhoods and local governance will have both immediate, tangibly supportable benefits and compounded long-term population health yields as today's children become tomorrow's parents.

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