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PERSPECTIVE

Community assets as protective factors buffering health effects of environmental hazards: framework and considerations for environmental epidemiologists

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Abstract

Disparities in the adverse health effects due to ambient environmental exposures have long been documented in the environmental epidemiology literature. A growing body of environmental epidemiology literature has focused on how detrimental aspects of the physical environment (e.g. poor housing quality) and social environment (e.g. chronic social stressors) can exacerbate the adverse health effects of environmental exposures (e.g. air pollution, heat). However, the literature on protective factors which might mitigate adverse health effects of environmental exposure is more limited. We borrow from the climate resilience and disaster preparedness literature to discuss how protective community assets may be identified, operationalized, and understood in environmental epidemiologic research. We outline two major pathways through which community assets may protect environmental health: by reducing overall exposure (mediation) and by reducing susceptibility (effect modification). This framework can help environmental epidemiologists and other public health researchers select and understand appropriate community assets to test as effect modifiers or mediators of associations between environmental exposures and adverse health outcomes. We present examples of community assets organized into five domains and highlight pragmatic challenges that may arise when considering assets in large-scale epidemiologic research—for example, limitations on availability of publicly available data at meaningful spatial scales, and challenges interpreting available community asset data. Finally, we posit that research focused on community assets can inform scalable, impactful health-promoting interventions.

1. Introduction

In recent decades, the field of environmental epidemiology has documented how detrimental aspects of the physical and social environment can increase health risks associated with environmental exposures such as air pollution and heat (Clougherty and Kubzansky 2009, Clougherty *et al* 2014). However, there are fewer discussions about how community-level protective factors might reduce adverse health impacts of environmental exposure (Shankardass 2012)—such a focus could provide opportunities for effective intervention (Garcia *et al* 2024). A focus on community assets has environmental justice implications, given that in communities with multiple stressors, community assets are also present, affording opportunities to strengthen their protective effects. Here, we borrow from the disaster preparedness and climate resilience literature, and from our previous work on psychosocial stress and environmental susceptibility, to present a framework for understanding how protective factors at the community level ('community assets') may benefit health during exposure to environmental hazards. We define community assets broadly as items or services in a community that can be used to improve the condition of community members—specifically, here we focus on community assets that can be identified and operationalized using administrative data. In the context of environmental epidemiology, we argue that assets can buffer the adverse health effects of ambient environmental exposures through two primary pathways: by reducing total exposure (i.e. mediation), and/or by reducing susceptibility (i.e. effect modification). In this perspective, we present a framework to guide research more clearly on how to integrate a community assets perspective in environmental epidemiologic research. Additionally, we discuss complexities in operationalizing and understanding assets and the protective mechanisms through which they may operate.

2. Existing frameworks

Our focus on community assets is informed by several existing frameworks of community resilience. Norris *et al* (2008) focuses on how community 'adaptive capacities' increase community health resilience in the face of disaster. The four adaptive capacity domains identified are: community competence (e.g. collective efficacy, political partnerships), social capital (e.g. perceived social support, sense of community), economic development (e.g. resource distribution), and information and communication (e.g. trusted sources of information, responsible media). Additionally, we consider Abramson *et al*'s Resilience Activation Framework (RAF) (2015) , which suggests individual mental health-related resilience is influenced by access to, and engagement with, community-level resilience attributes. We are further informed by Cutter *et al*'s (2008) disaster resilience of place model, which classifies six domains of community resilience indicators: (ecological, social, economic, institutional, infrastructure, and community competence). Cutter suggests that a disaster's total impact is determined by a community's inherent vulnerability and resilience across the six domains, the disaster characteristics, and the community's coping responses. In another framework, Kais and Islam (2016) emphasize how antecedent conditions affect community resilience—they call these conditions 'community capitals,' encompassing the natural, cultural, human, economic, social, built, and political domains. This framework focuses on slower-onset and ongoing climatic changes (e.g. temperature increase), as opposed to acute climate disasters addressed in other resilience frameworks.

Inspired by these frameworks, we present a general framework for how community assets may protect individual health from adverse effects due to environmental exposure in figure 1. Our framework categorizes community assets into five domains: *human capital* (education, information, medical care, knowledge), *economic capital* (household income, tax revenue, employment), *social capital* (social networks, cohesion, status), *political capital* (effective governance, fair distribution of resources), and *environmental capital* (the built environment [e.g. greenspace, safe walking paths]). We also include upstream structural determinants of health to explain why assets may or may not be available (or accessible) in a community (Heller *et al* 2024)—for example, historical redlining has been linked to disparities in air pollution and heat exposure (Salazar-Miranda *et al* 2024), and access to high-quality housing (*environmental capital*) (Milletich *et al* 2025) and healthcare (*human capital*) (Yang *et al* 2025). Accounting for structural determinants of health helps clarify why certain community assets are available, or accessible, in a given community.

By focusing on community assets, we hope this framework can offer opportunities for interventions towards broad public health benefit. Pragmatically, community assets can often be identified and quantified using administrative data with broad geographic coverage, bolstering the applicability of community assets to epidemiologic research with large study populations. This is in contrast to individual-level attributes that may help protect environmental health, but are often difficult to measure at the population scale (e.g. self-efficacy (Tamura *et al* 2021) or perceived social support (Ozbay *et al* 2008)). In table 1, we present examples of community asset data indicators with publicly available data sources in the US that have broad geographic coverage. The table also highlights pragmatic challenges in identifying and operationalizing assets using administrative data. Some assets have few administrative data indicators, (e.g. inclusive governance). Other asset indicators are complex to interpret—for example, linguistic isolation can indicate presence of an ethnic enclave (i.e. high social cohesion, protective to health) or it can indicate social isolation (i.e. low social cohesion, harmful to health) (Au *et al* 2024). Future research should consider which assets are most salient for the environmental exposure and population of interest

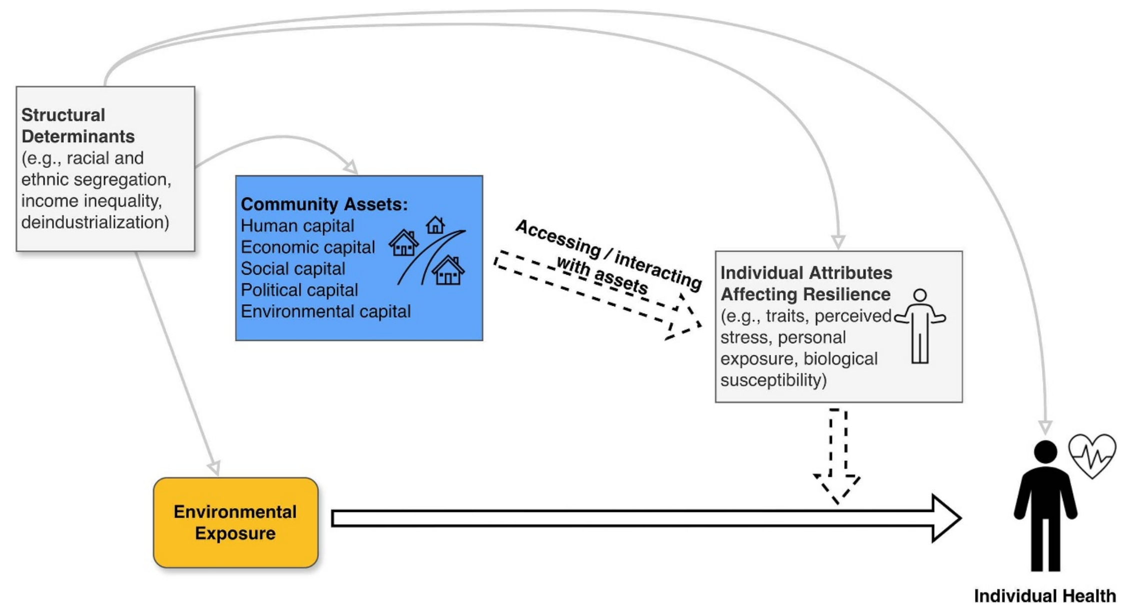

Figure 1. A framework outlining how community assets may protect health during exposure to environmental hazards. Note that community stressors are not present in this framework for simplicity, though these are addressed in figure 2.

based on existing evidence and theory and develop methods to assess and evaluate the community assets in epidemiologic studies.

Our discussion focuses primarily on administrative data—however, we acknowledge that relying on administrative data alone may miss important information about context, access, and quality that local community knowledge may be able to provide. Though we touch on these challenges in this perspective, a longer discussion of how such community engagement could work for identifying and understanding community assets for environmental epidemiologic research is needed, though it is outside the scope of this paper.

3. Pathways: how community assets protect health

How do community assets protect health in the context of environmental exposures? As illustrated in figure 2, we posit two major pathways—a mediation pathway through which the asset reduces total exposure to environmental hazards, and an effect modification pathway through which the asset reduces susceptibility to environmental hazards. The differentiation between pathways affecting *exposure*, vs *susceptibility*, is informed by previous work on the exacerbating effect of chronic social stressors on environmental health risk (Forastiere *et al* 2007, Schwartz *et al* 2011, Clougherty *et al* 2022). Importantly, we argue that a focus on assets should not replace or ignore knowledge of existing stressors (e.g. violence, poverty) in the community (Clougherty and Kubzansky 2009, Shankardass 2012), as asset access may help reduce total exposure to, or reduce adverse effects of, co-exposure to psychosocial stressors which have been previously shown to exacerbate environmental health risk. Therefore, we hypothesize that community assets protect environmental health by:

(1) **Reducing *total exposure to environmental hazards.*** Community assets which reduce *exposure* to physical stressors (i.e. environmental hazards) are often in the environmental capital domain. Examples include quality housing that reduces personal exposure to heat, air pollution, and indoor allergens (Mannan and Al-Ghamdi 2021, Hu *et al* 2022), tree cover that mitigates urban heat and pollution (Wolf *et al* 2020), and protected bike paths that lower the risk of accidents and vehicle emission exposures. These community assets act as *mediators* between ambient exposure and personal exposure.

(2) **Reducing *susceptibility to environmental hazards.*** Community assets that reduce susceptibility to environmental hazards act as *effect modifiers*, where the effect of environmental exposure on an outcome differs by access to, or engagement with, the community asset. We hypothesize that this can operate through at least three mechanisms: (1) by improving baseline health (reducing biological susceptibility), (2) by reducing total co-exposure to psychosocial stressors, and/or (3) by

Table 1. Examples of community assets for which publicly available data are available across most of the United States. Asset categories are shown in bold, within five domains and across potential pathways. Possible indicators of assets are listed in square brackets [] with associated publicly available data sources for those asset indicators in parentheses (), e.g. **asset** [indicator (data source)]. Data source acronyms are defined in the table footnote.

	Asset Domains				
Asset Pathways	**Human Capital** *(Access to education, information, medical care, knowledge)*	**Economic Capital** *(Household income, tax revenue, employment rate, occupation diversity)*	**Social Capital** *(Social environment: networks, cohesion, status)*	**Political Capital** *(Governance, fair resource distribution)*	**Environmental Capital** *(Neighborhood physical environmental quality)*
Reducing Exposure to Environmental Hazards (Mediation)	**Health literacy** [HS/college graduation rate; % over 25 with HS degree; literacy (ACS); broadband access (FCC, NYS BB)] **Childhood education** [Public school performance data (NCES)]	**Low-risk jobs** [% in white-collar occupations (ACS)]	**Access to libraries** [Library locations (IMLS)] **Access to senior centers** [Senior center locations (BA)]	**Political support for healthy infrastructure** [Capital investments (BA, NETS)]	**Housing quality** [Public housing; mean year house built; rooms/person; heating fuel; Healthy Homes Program (ACS)] **Tree canopy** [Tree canopy; greenness (NLCD)] **School building quality** [School inspections data (Public school district databases)]
Reducing Susceptibility to Environmental Hazards (Effect Modification)	**Healthcare access** [Distance to hospital; health care use & insurance (ACS); health care & pharmacy locations (BA, NETS)] **Health literacy** [HS/college graduation rate; % over 25 with HS degree; literacy (ACS); broadband access (FCC, NYS BB)]	**Food access** [SNAP utilization (ACS); Supermarkets, green markets (BA, NETS)] **Employment** [Employment rate (ACS)] **Economic resources** [Median HH income; % with housing costs >30% of HH income (ACS)]	**Social cohesion** [Residential tenure; owner-occupied units; linguistic isolation; income inequality; racial and ethnic segregation (ACS)]. Social cohesion in schools (School surveys).	**Civic participation** [Voter registration/turnout (CPS)]	**Opportunities for physical activity** [Walkability (EPA); Greenspace; blue space, parks; playgrounds (NLCD); recreational facilities (BA, NETS)] **Transportation access** [% Population with transit access; % households with vehicle (ACS)]

Abbreviations: American Community Survey (ACS); Child Opportunity Index (COI); Child Opportunity Index (COI), ESRI Business Analyst (BA); Current Population Survey (CPS); Environmental Protection Agency (EPA); ESRI Business Analyst (BA); Federal Communication Commission (FCC) Broadband service; High School (HS); Household (HH); Institute of Library and Museum Sciences (IMLS); National Center for Education Statistics (NCES); National Establishment Time Series (NETS); National Land Cover Database 2016 (NLCD), 30 m grid; Supplemental Nutrition Assistance Program (SNAP).

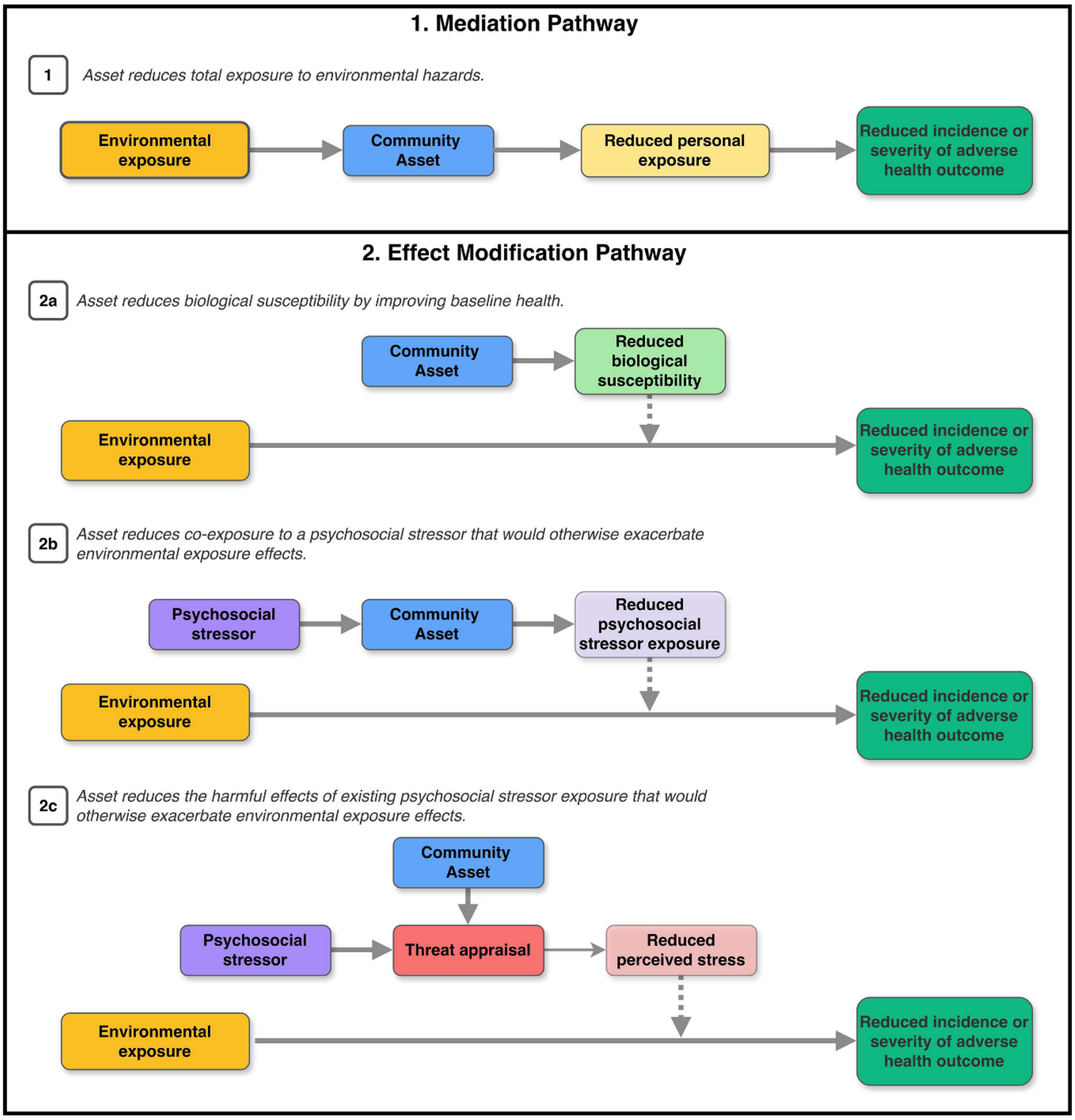

Figure 2. Two hypothesized pathways (mediation and effect modification) and mechanisms within each pathway through which a community asset may reduce the risk of an adverse health outcome associated with environmental exposures.

mitigating the harmful health effects of psychosocial stressors which would otherwise increase susceptibility to environmental agents.

a) *Reducing biological susceptibility:* Some assets improve baseline health by supporting health behaviors—if individuals can and do access them. Examples include walkable infrastructure (Hirsch *et al* 2014), playgrounds and recreational facilities (Gordon-Larsen *et al* 2006), healthy food options (Yamaguchi *et al* 2022), and preventive healthcare services.

b) *Reducing co-exposure to psychosocial stressors:* Co-occurring exposure to psychosocial stressors and environmental hazards often occur, and a compelling body of work has demonstrated chronic exposure to social stress increases susceptibility to heat and air pollution. For example, children exposed to community violence have stronger air pollution-related asthma risks compared to those unexposed to community violence (Clougherty *et al* 2007, Clougherty and Kubzansky 2009, Sheffield *et al* 2019, Sharma *et al* 2023). Some assets may reduce susceptibility due to stressor co-exposure by simply reducing total stressor co-exposures. For example, violence prevention programs in the neighborhood (Kondo *et al* 2018) or school (Ozer 2006) may reduce environmental susceptibility due to violence-related chronic stress.

c) *Reducing the harmful health impact of psychosocial stressors*: In addition to preventing co-exposure to psychosocial stressors, we hypothesize that some assets may reduce the adverse health impact of stressors that are already present in the community. That is, in the presence of an appropriate asset, co-exposure to a given social stressor might exacerbate impacts of environmental exposures less. We suggest that specific assets may ameliorate the threat of some stressors, altering stress perception or threat appraisal and leading to a reduction in stress-related susceptibility, even when co-exposure to the stressor has not changed.

Some assets may act through multiple pathways—for example, access to greenspace may protect health by *reducing exposures* to heat and pollution and/or by *reducing susceptibility* through increasing physical activity (reducing biological susceptibility), or reducing psychological stress (reducing psychosocial susceptibility) (Jimenez *et al* 2021).

The temporal relationship between environmental exposure, asset, and health outcome presents additional complexity and avenues for future research (Clougherty and Kubzansky 2009). For the mediation and some effect modification pathways, use or engagement with the community asset must happen after, or contemporaneously with, environmental exposure. Community assets that improve baseline health can be engaged with before, during, or after environmental exposure. There may also be cyclic or recursive mechanisms at play (Clougherty 2022)—an environmental exposure might alter one's engagement with a potentially protective community asset, thereby altering the magnitude of the exposure-outcome association. For example, high summer temperatures might lead community members to stay at home, thereby reducing social capital in the community and in turn (through psychosocial pathways) increasing susceptibility to heat.

4. Selecting and interpreting community assets in epidemiologic research

There are many challenges in selecting appropriate community assets, identifying relevant indicator data for those assets, and interpreting potential pathways of action. For many assets, their mere presence in a community does not guarantee access and use. This presents a challenge when using administrative data, where presence vs absence is often the only piece of information available. In table 2, we outline some conditions researchers may consider when selecting which assets might impact health most strongly. If the necessary conditions for presence and accessibility are not met, then community assets will have less health benefit. Which presence/accessibility conditions are salient depends on the community asset, health outcome, and population in question. For example, noise barriers protect an entire community from road noise, simply by their presence, while the utility of greenspace for healthy physical activity is more directly shaped by accessibility factors such as leisure time and safety.

Adding complexity is that the value of each community asset to any given individual will vary with individual-level attributes such as age, economic resources, and leisure time availability. Some specific caveats on the selection of community asset indicators—especially those derived from administrative data—include:

Scarcity and need can drive asset value. Community assets may be more valuable when scarce or when community need is high—for example, greenspace in dense cities or cars in rural areas. Asset identification should reflect existing community need.

Assets are more than the absence of stressors. The community asset landscape is often patterned by community stressors, though community assets are more than simply the absence of stressors. For example, perceived safety (an appraisal) is related, but not the same, as a low community crime rate. Likewise, wealth confers power, privilege, and status in the US—beyond the material scarcity that may be reflected in community poverty rates.

Some assets are only meaningful in the presence of specific stressors. Some assets only matter when relevant stressors are present, so assessing their benefit requires measuring need. For example, homeless shelter locations may reflect local prevalence of people experiencing homelessness. In other words, some assets may only exist in response to stressor-related needs in the same, or neighboring, communities.

Just because an asset is present in a community does not guarantee that it is accessible to community members. An asset's presence is a necessary, but insufficient prerequisite to being useful to community members. Various aspects of accessibility (outlined in table 2) can alter how individuals interact with an asset. For example, addition of a new supermarket does not necessarily equate to healthier food purchases among residents due to lack of affordability and cultural relevance (Allcott *et al* 2019, Chenarides *et al* 2021). Administrative datasets, which are helpful in determining which assets are physically located in or near a community, generally lack information on each asset's barriers to access (i.e. cost).

Context matters. The value of an asset may vary within and between communities. For example, parks may be seen as safe by some, but unsafe by others, especially by women, or after dark (Kondo *et al*

Table 2. What makes a 'good' community asset? Considerations when selecting potential health-protective assets for assessment in environmental epidemiology research.

Consideration	Description	Example (s)
Presence	Does the asset exist in the community?	• Noise barriers reduce total noise exposure in the community (Barros *et al* 2024). • Tree cover reduces urban heat island effect (Elmes *et al* 2017, Schwaab *et al* 2021).
Availability	Is the asset physically available via proximity and transportation?	• Assets may be more useful if they are closer to one's residence. • Individuals may travel farther for high-value assets.
Awareness	Are community members aware of the asset?	• Knowledge of eligibility requirements influences enrollment for Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and Head Start participation (Davis *et al* 2022).
Financial accessibility	Can community members afford to use the asset?	• Affordability can influence grocery store choice. • Gyms and fitness programs are often expensive.
Temporal accessibility	Do community members have time to use the asset?	• Lack of time as a barrier to park utilization in a trial of 'nature prescriptions'(Razani *et al* 2020).
Physical accessibility	Can community members physically use the asset?	• Ramps or elevators can facilitate public transportation utilization by wheelchair users (Frost *et al* 2020).
Mental accessibility	Does the asset match the language/literacy levels of the community?	• Information to increase awareness about available assets should match the language and literacy of the community.
Belonging	Do community members feel safe and welcome using the asset?	• Racial and ethnic variation in sense of belonging in public parks and greenspaces is documented (Das *et al* 2017, Powers *et al* 2024). • There are gendered differences in perceived park safety (Kondo *et al* 2021). • Perceived stigma reduces WIC and Head Start participation (Davis *et al* 2022).

2021). The value of a community asset for health is also determined by the population of interest—for example, high-quality school buildings most directly impact children, but have different benefits for older adults, or adults without children (e.g. higher quality schools generally drive property values higher). This variation points to the need to consider both direct and indirect effects, which may warrant recruiting and engaging community members to support asset identification and appraisal.

Quality matters. Data on community asset quality is highly valuable but often even more sparse than data for asset identification when using largely administrative data. For example, administrative data may indicate the presence of a park or playground in a community but may not contain information on whether its surface is green or asphalt (with bearing on surface warming, heat exposures, and safety) and rarely contains information on the quality of the space (e.g. broken or missing playground equipment).

Perception matters. Understanding the potential protective effect of assets, if hypothesized to act by buffering impacts of psychosocial stressors, normally requires some attention to perception or appraisal of the asset, often in context of co-existing stressors. This may generally require qualitative input from residents via surveys or focus groups.

Many of the challenges laid out above relate to the limitations of administrative data for identifying and understanding community assets. This discussion highlights that to address some of these challenges, more in-depth data (e.g. assessing playground quality may require an in-person audit) than administrative data can provide may be required. For other challenges, administrative data can be used alongside community input to more clearly identify the most salient community assets and how community members engage with them.

5. On 'top–down' vs 'bottom–up' asset identification

An additional key issue is the method used in determining which assets are most relevant for study and investment. So far, we have discussed using administrative data to identify community assets for environmental epidemiology studies. However, we acknowledge that the field of community development has pioneered various community asset mapping methods—these methods rely on community participation to identify community strengths, over deficits, in development processes (Kretzmann and McKnight 1993). These participatory asset mapping methods prioritize local knowledge—in contrast, 'top–down' methods rely on researcher expertise and preexisting theory (Luo *et al* 2023). However, these approaches are not necessarily mutually exclusive: community input can refine researcher-identified community assets or inform hypotheses about pathways of action. One example of this mixed approach comes from our own work, where to identify community assets relevant to children's climate resilience across New York State, we established a statewide Youth Advisory Panel, comprised of older teens to advise on our selection of climate- and child-relevant community assets (Kainth *et al* 2025). Future work might explore how these two 'top–down' and 'bottom–up' methods can inform one another to aid in assets selection and interpretation, particularly for large-population environmental epidemiology studies.

6. Conclusion and recommendations

Many environmental epidemiology studies highlight community-level determinants of increased health risk associated with environmental exposures, for example, low socioeconomic position and/or high populations of minoritized racial and ethnic groups. We posit that a research agenda that includes a focus on community assets, with attention to potential pathways of action, can identify levers for intervention which are realistic, scalable, and solutions-focused (Garcia *et al* 2024). In the interest of tailoring this framework to specific research settings, future research could explore the most effective ways to engage with community members on asset selection and evaluation or compare the use of objective vs perceived assets in environmental health research. Finally, we have emphasized throughout that a focus on stressors or assets alone provides an incomplete story about how environmental exposures may be exacerbated or mitigated with respect to health outcomes. Further, communities may be more open to discussing strengths and resources, compared to deficits or stressors, providing another advantage to the research and understanding of community assets.

Though we have some evidence that many of the community assets identified in our framework are directly protective to health or are associated with reduced stress and improved baseline health (which act as intermediaries in the pathways outlined in figure 2), documenting how these assets shape resilience to environmental hazards remains a key research gap. We hope the framework and considerations we have proposed can be used to guide the selection and study of candidate community assets for future environmental epidemiology research to contribute to actionable solutions that improve environmental health.

Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors. Because this is a perspective article, no data were used for this paper.

Conflicts of interest

The authors declare they have no conflicts of interest related to this work to disclose.

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