PRECEDE

Public Repository to Engage Community and Enhance Design Equity

USER GUIDE.

Perkins&Will

CONTENTS.

PRECEDE at a Glance

39

Design-relevant public health indicators, exposures, and demographics researched and presented

5

Disciplines collaborated on this tool

91

Design recommendations to optimize occupant and community health researched and presented

Design is Not Neutral

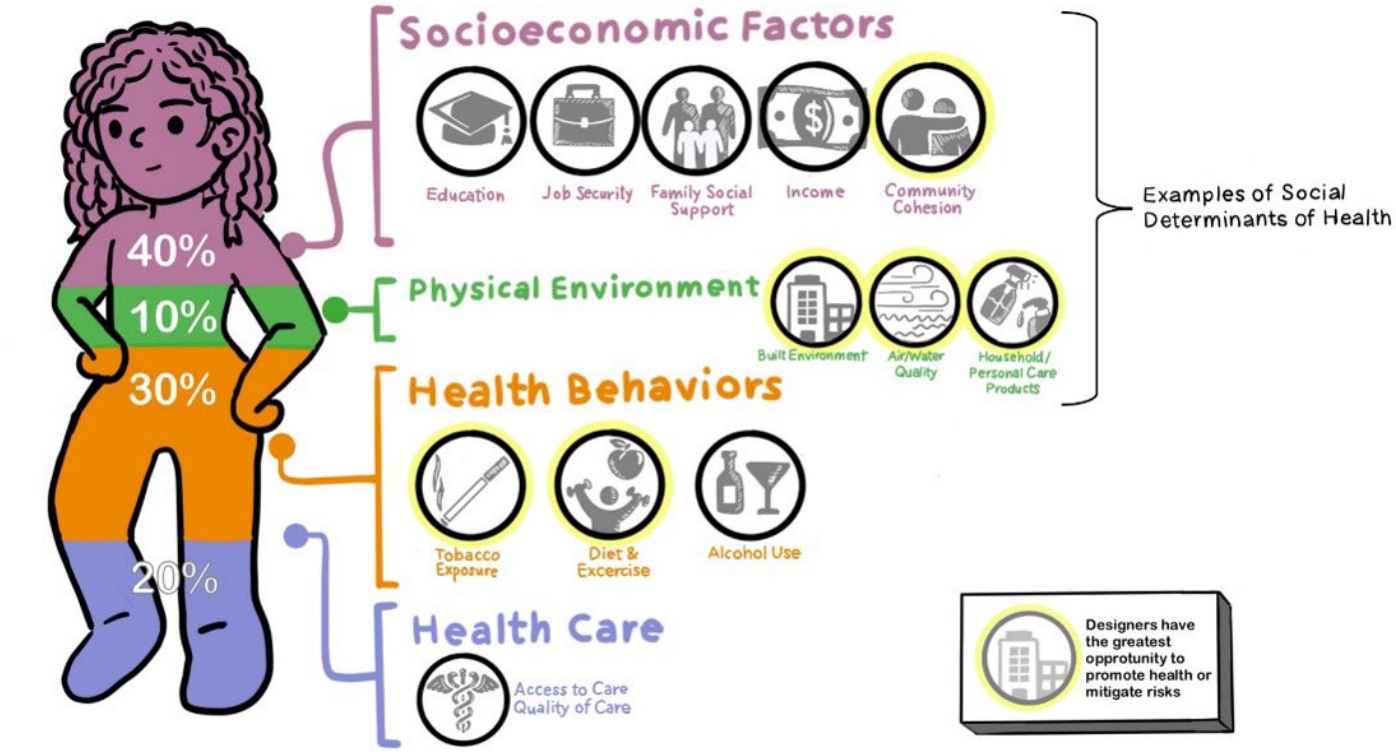
As professionals dedicated to shaping the built environment, our work is not an isolated practice, but one deeply intertwined with our conscious and unconscious perceptions, prejudices, and perspectives. The very structures and spaces we create can either exacerbate these disparities or become instruments of positive change.

As interior designers, architects, and urban planners, it is our responsibility to recognize our role in this narrative and take proactive steps to build healthier, more equitable communities.

Throughout history, conscious and unconscious biases have left lasting scars on the built environment, which have in turn impacted the health of vulnerable populations. Since the 1930's, communities of color have been adversely affected by redlining, a discriminatory policy that systematically denied access to housing loans and resources to Black communities, leading to segregated neighborhoods burdened by environmental hazards. The consequences of redlining continue today, as built environments shaped by this racially discriminatory practice have contributed to profound health disparities among communities of color (Egede et al., 2023). For example, two in five U.S. adults currently live with obesity, a public health crisis that is amplified when looking at the population of Black Americans, where one in two adults live with obesity. (NIDDK, 2021). Similarly, in 2022, hospital admission rates for asthma for Black adults were nearly 4 times that of their white adult counterparts (AHRQ, 2022). An interdisciplinary response from healthy buildings advocates and environmental justice activists is necessary to tailor enduring design solutions and create healthier spaces for all.

Health Equity

The ideal condition in which everyone has a fair and just opportunity to be as healthy as possible. This requires removing obstacles to health such as poverty and discrimination, and the resulting consequences, including lack of access to good jobs with livable wages, diminished quality of education and housing, environmental injustices, and lack of access to quality and affordable health care (Braveman et al., 2017).



↑ *Social Determinants of Health (SDOH) are the conditions where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks (USHHS, 2020). Research shows that SDOH account for up to 55% of health outcomes (Braveman and Gottlieb, 2014); in other words, more than 50% of health outcomes can be traced back to your zip code (Orminski, 2021)! Because designers shape the spaces we occupy we have a great opportunity to promote health and mitigate risk through SDOH design interventions.*

In 2023, researchers, designers, and public health professionals created the Public Repository to Engage Community and Enhance Design Equity (**PRECEDE**) to translate and integrate public health concepts and data into design action. Version 1.0 of **PRECEDE** was created with grant funding provided by the American Society of Interior Design Foundation and Perkins&Will. This publicly available tool is comprised of three distinct components aimed at educating, quantifying, and recommending public health interventions at the earliest stages of the design process.

- **LEARN** provides a fun and informative overview of factors that can influence community health and wellbeing.
- **EXPLORE** connects national datasets to identify health priorities for your community, including the U.S. Census, Environmental Protection Agency, Centers for Health and Disease Prevention.
- **ACT** provides a growing list of recommendations to inform a tailored design response.

At this time, **PRECEDE** serves any project location in the United States via the **EXPLORE** tool. The research team hopes to expand the geographies available with time and funding. However, the health-focus in **LEARN** and **ACT** have international implications across various practice areas.

If **PRECEDE** allows designers to visualize and interpret public health data for different project locations, we can make health-informed decisions as soon as we receive a Request for Proposal. Moreover, if this data is shared publicly and transparently, it can be a tool of advocacy for clients in underserved communities.

Getting Started

Welcome to **PRECEDE**! This User Guide is designed to help you navigate the various tools and get the most out of the information presented. We will provide relevant vocabulary, the methodology behind building each section, and step-by-step instructions for the **LEARN**, **EXPLORE**, and **ACT** pages. As this is Version 1.0 of **PRECEDE**, all the desired functionality of the tool is not currently possible. The **PRECEDE** team hopes you will share feedback with us so we can continually improve the functionality, accessibility, and value of this tool.

PRECEDE is built from a subset of public health databases and tailored to include the public health indicators most relevant to design professionals. While the original public health databases collect and present high-quality data, they are limited in their accessibility and practicality to the design community. The original databases were not constructed with a design audience in mind, and therefore complex public health concepts and terminology are left unexplained, and designers would need to navigate multiple databases to fully understand the public health landscape of their project. **PRECEDE** provides you with one landing page that not only displays, but also explains the public health indicators most relevant to your project location.

Environmental Justice

Equal protection from health risks posed by an individual's or community's environment regardless of race, color, national origin, or income. Environmental justice also requires equal access to the decision-making process to build a healthy environment in which to live, work, learn, etc. (USEPA, 2019). Ample quantitative research and qualitative narratives have established that communities of low socioeconomic status and communities of color are disproportionately exposed to environmental contamination (Brulle and Pellow, 2006; Bullard et al, 2008). Designers must engage with communities to understand current and historical environmental injustices and the community's insights on methods towards environmental risk mitigation.

Before going forward...

This tool is designed to be a conversation starter.

- **PRECEDE** cannot replace authentic engagement. It does not represent the full spectrum of occupant needs and sensitivities. Findings from **PRECEDE** must be supplemented with historical context and community voice.
- Data is limited to what is regularly collected and publicly available. Strategies do not capture all emerging trends or best practices and should not replace local regulations, policies, or health guidance.
- **PRECEDE** highlights key environmental factors and strategies that may be applied globally, but the **EXPLORE** tool is currently limited to data collected in the United States.

This tool is a snapshot.

- **PRECEDE** incorporates a subset of data and built environment factors from vetted databases. While we show the public health indicators most relevant to designers, there is other data included in these original databases that may be relevant to other project stakeholders. If you are interested in other indicators, we highly recommend visiting the source data including CDC Places, EPA EJ Screen, City Health Dashboard, and the U.S. Census.
- **PRECEDE** does not collect data. It is simply reporting data collected by other reputable sources. If the research team believes the data collection is not reliable or accurate, we may remove an indicator.

"Today, zip code is still the most potent predictor of an individual's health and well-being."

Robert Bullard, Father of Environmental Justice

LEARN.

CONTENTS.

LEARN.

Overview

This page can help you better understand key terms and contextual information related to the role of public health and equity themes in design. Let's review clear definitions of relevant terminology and their context for designers.

PRECEDE begins by increasing our fluency in key public health and equity themes. In Environmental Epidemiology, understanding the relationship between exposure and outcome is fundamental to advancing health equity, especially when we consider vulnerable populations.

An exposure refers to any factor (e.g., substance, pollutant, natural condition) that a population is comes in contact with over a period of time. The frequency, duration, and magnitude of an exposure can determine subsequent health outcomes (Lee and Pickard, 2013; Rothman and Greenland, 2005; Ferreira and Patino, 2017). For instance, we may be interested in how exposure to air pollution in a city is associated with the outcome of respiratory disease within that city (Duan et al, 2020). When a person or a population is considered vulnerable, it means that they are more likely to develop a negative health outcome following a harmful exposure. Vulnerable populations may be at greater risk due to:

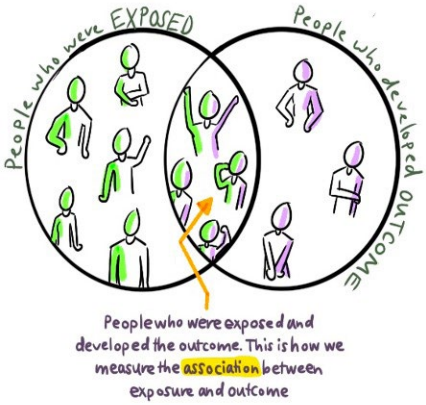
- Physical characteristics (e.g., age, sex, preexisting conditions) that cause them to be more susceptible to health deterioration, or
- Identities that face disparities in health and healthcare access due to structural factors (e.g., low socioeconomic status, institutional and societal racism, gender identity, sexuality) that systematically deny these populations quality care (Smedley et al, 2003; AHRQ, 2006).

The term association is used to describe the statistical relationship between an exposure factor of interest and a specific health outcome (LaMorte, 2021). You have probably heard the phrase: “correlation does not equal causation”. Similarly, while an exposure may be associated with an outcome, we usually cannot say with certainty that the exposure caused the outcome (Rothman and Greenland, 2005).

Understanding the association between exposure and outcome tells us where and how to intervene with design strategies to minimize harmful exposures and decrease the risk of harmful outcomes. **PRECEDE** allows designers to holistically evaluate the setting of a project to determine the community’s magnitude of exposure, the burden of disease outcomes, and the percentage of people who may be a considered a vulnerable population.

EXAMPLES OF EXPOSURES	EXAMPLES OF OUTCOMES	ESPECIALLY FOR...
Air Pollution	**Respiratory Diseases**	**Individuals with existing conditions**
Walkable Neighborhood	**Cardiovascular Diseases**	**School Children**
Extreme Heat	**Poor Sleep Quality**	**Low-income individuals without residential air conditioning**

→ *The association between two variables tells us whether a specific health outcome is more likely in people with a particular exposure. The larger the measure of association the more likely that the exposed will develop the outcome compared to the unexposed.*



LEARN.

Understanding Exposure Categories

Initially, the research team evaluated over 50 health indicators from publicly available databases to identify the exposures and outcomes on which designers work can have the greatest impact.

The final list of indicators was grouped into three categories: Risk Mitigation, Health Promotion, and Climate Adaptation.

Environmental Risk Mitigation
A category of indicators that we would like to reduce our exposure to. Tailored design could reduce the likelihood and/or magnitude of injury, disease, and/or death resulting from exposure to a known or suspected environmental hazards (ETC/CDC, 2000). The ways in which we design the built environment have the potential to exacerbate environmental risks (air-tight offices where there are no operable windows or openings to the outside) (HSE, 2019) or mitigate them (enhanced ventilation and filtration) (Allen et al., 2015).

Health Promotion
A category of indicators that we would like to increase our exposure to. If we enable people and communities to increase control over or increase access to these features there is evidence that it will improve human health. Health promotion goes beyond individual behavior changes and encompasses a wide range of social and environmental interventions (WHO, 2022). The ways in which we design the built environment have the potential to promote occupant health (e.g., incorporation of biophilic design elements) (Terrapin, 2014).

Climate Adaptation
A category of indicators that responds to actual or expected effects of a changing climate to reduce harm by taking advantage of beneficial opportunities (UN, n.d.). Our society is already experiencing the deleterious impact of climate change. Beyond cutting greenhouse gas emissions to slow the pace of global warming, we must adapt to certain unavoidable climate consequences to protect our communities (IPCC, 2022). Certain populations are more vulnerable to adverse effects of climate change due to their susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2022).

HEALTH PROMOTION	ENVIRONMENTAL RISK MITIGATION	CLIMATE ADAPTATION
Greenness (NDVI)	Drought	Drought
Walkability	Extreme Heat	Extreme Heat
	Flooding	Flooding
	Noise Pollution	Greenness (NDVI)
	Ozone	Wildfire & Smoke
	Particulate Matter	
	Traffic Proximity	
	Waste Proximity	
	Wildfire & Smoke	

← *There is cross-over between the three exposure categories.*

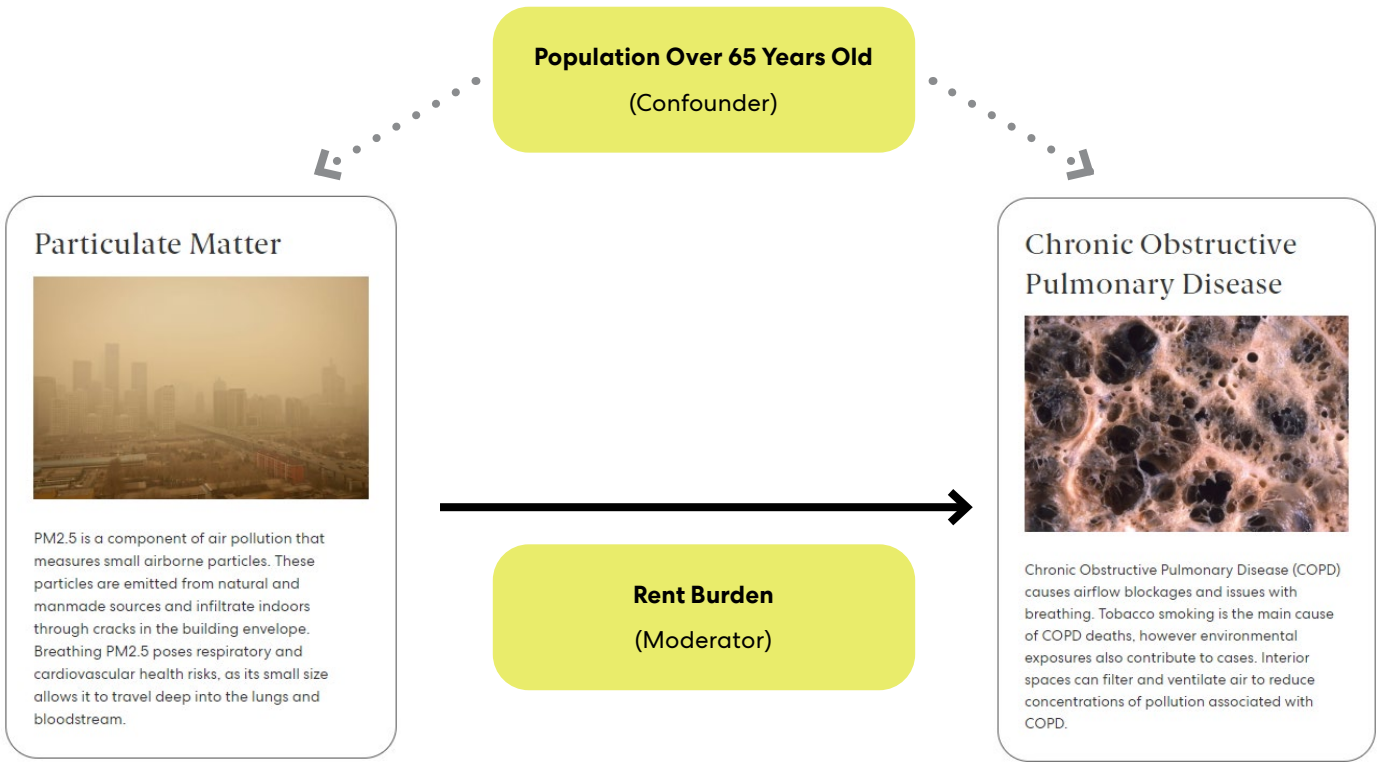
LEARN.

Importance of Demographic Factors

Demography is the study of human populations with respect to their size, structure and dynamics (Timæus, 2005). The size of a population is defined by a group of individuals that coexist within a defined geographic area at a point in time. The demographic characteristics of a population is critical in assessing its vulnerability to certain health risks by highlighting social determinants of health within a population.

When demographic factors are associated with both the exposure (independent variable) and the outcome (dependent variable), they can confound or bias the relationship. For example, an individual over the age of 65 may confound the relationship between air quality and respiratory health outcomes. Being over 65 years old results in a decline of physiological health including lower lung function and respiratory muscle strength. Therefore, if we do not account for the age of the population we cannot tell if high levels of respiratory health issues to poor air quality or increased vulnerability associated with aging.

Demographic factors may also influence the strength of an association between the exposure and outcome. For example, someone rent burdened may be more likely to be exposed to poor indoor air quality, no mechanical ventilation, and have a higher cumulative burden to air pollutants. Therefore, rent burdened people would be more likely to experience higher levels of poor respiratory health outcomes.

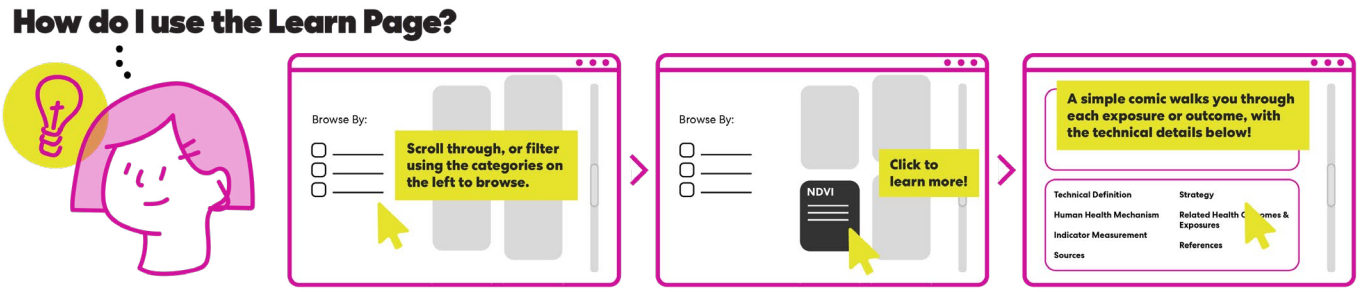


LEARN.

Step-by-Step Guide

The LEARN page is organized by a series of study cards. Think of these as your cheat sheets to understand why these indicators are important to both design and health.

Sorting the study cards can help you find what you need more quickly. Remember, you can always return to the LEARN page after using EXPLORE and ACT to refresh your memory on any of the indicators you came across for your project.



LEARN.

Step-by-Step Guide

01.
Browse by Exposure vs. Outcome

On the left-hand side you will find a menu where you can select ‘Exposures’ or ‘Outcomes’.

- Select Exposures → When you want to reduce the risk of future health conditions
- Select Outcomes → When you want to respond to existing health conditions
- Select Demographics → When you want to understand the social context

02.
Browse by Category

On the left-hand side you will find a menu where you can select exposure types including ‘Health Promotion’, ‘Environmental Risk Mitigation’, and ‘Climate Adaptation’.

- Select Health Promotion → For environmental benefits that may enhance health outcomes
- Select Environmental Risk Mitigation → For environmental threats that may adversely affect health
- Select Climate Adaptation → For indicators associated with current and future climate change impacts

Remember, you also do not have to select anything if you want to simply scroll through all cards.

LEARN.

Step-by-Step Guide

03.

Viewing the Card

On the front of each study card you will find an image depicting the indicator and a short, description of the indicator. Click on the study card to learn more.

When you click on any indicator's study card you will be brought to a page that provides an elaborated explanation:

What is Included?

Definition

- A formal definition adapted from peer-reviewed literature and original data sources.

Human Health Mechanism

- Describes how this indicator influences human health.

Indicator Measurement

- Explains how the indicator is measured and the method of data collection.

Source of Exposure

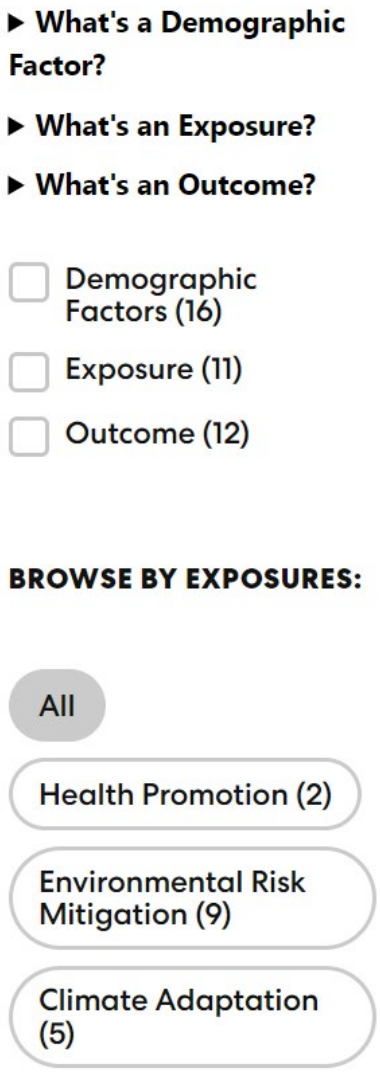
- For exposure indicators, a short description of where these pollutants come from is included. Sources may be mobile (e.g. automotives, planes), stationary (e.g. power plants, industrial facilities), or area sources (e.g. agricultural or urban areas). Sources can also vary temporally such as seasonal, daily, or hourly differences (e.g., wildfire smoke, allergens, rush hour traffic).

Related Health Outcomes

- Only includes related outcomes and exposures found on the **PRECEDE** tool, but in reality, there are many related exposures and health outcomes.

References

- This is not a comprehensive literature review but references used to inform these overviews and citations that could help us learn more.



LEARN.

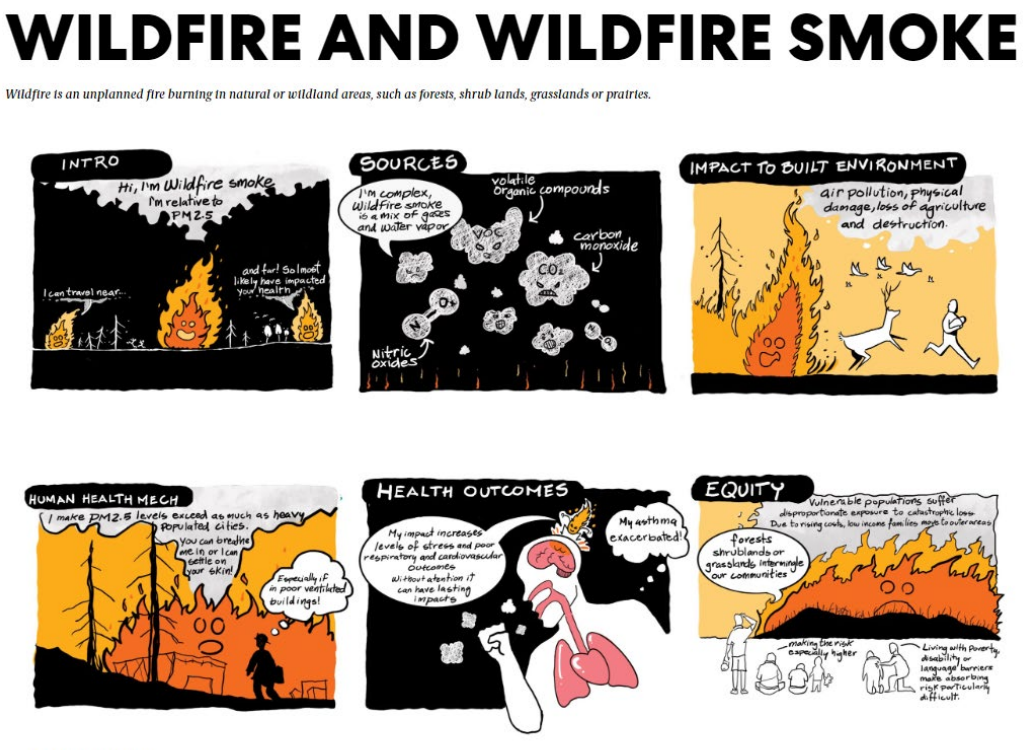
Step-by-Step Guide

03.

Viewing the Card, Continued

The information compiled for each indicator was completed through a comprehensive review of the original database source documentation, public health research about each indicator, and governmental guidance. This literature review is reflected in the references provided on each indicator study card page.

When you click on an exposure or outcome you will also see an illustrated depiction of the indicator. For exposures, it provides information on the exposures including: the sources of exposure, impacts to the built environment, mechanisms of human exposure, health outcomes associated with the exposure, and issues of inequity associated with the exposure. A written transcript of the comic is provided below the image to give more context.



▼ **Click here for caption**

Transcript: Hi, I'm Wildfire Smoke. Although you may not live near a wildfire, I most likely have impacted your health in the last few years. I'm a relative of PM2.5 so I can travel near and far. I'm complex. Beyond the immediate stress of a fire. Wildfire smoke is a mix of particles, gases, and water vapor. I include carbon monoxide, nitric oxides, and volatile organic compounds. Wildfires result in displacement, but my presence can result in PM2.5 levels exceeding some of the most polluted cities. When outside, you can breathe in these particles but if you are in a poorly ventilated building, I can settle in the dust and get on your skin or be ingested. My impact can be both mental and physical: from increased levels of stress to poor respiratory and cardiovascular health outcomes. I can exacerbate asthma. It may seem like the science of the invisible but without attention it can have lasting impacts. Wildfires result in increased air pollution, physical damage, loss of agriculture and destruction of our built environment. Vulnerable populations suffer disproportionate exposure to catastrophic loss from wildfire. Due to rising housing costs, low-income families are having to move to outer areas, where human communities and forests, shrublands, or grasslands intermingle, making the risk for wildfire especially high. Living with poverty, disability or language barriers make absorbing this risk particularly difficult.

← *When we speak the same language, we can collectively address health disparities with joy, determination, and depth. Throughout PRECEDE you will find resources that simplify public health information, such as the comics found in the Learn tool. It is not that we do not take this work seriously, but we also take health literacy extremely seriously and want to create an inclusive environment where everyone can participate.*

EXPLORE.

CONTENTS.

EXPLORE.

Overview

This section can help you identify public health data for a specific site. You can refine your search by state, county, or census tract level and filter by a variety of health factors.

EXPLORE helps you quickly identify community health priorities by integrating a network of reputable national data sources into one easy to search platform. If community health priorities are identified early in the design process, it increases the opportunities for tailored, health-based design decisions throughout. **EXPLORE** informs a deeper community engagement process to improve the health and well-being of occupants, and the community at large.

PRECEDE V.1 includes a Microsoft PowerBI dashboard that embeds 40 different indicators from U.S. Centers for Disease Control and Prevention, U.S. Environmental Protection Agency, U.S. Global Change Research Program, United States Geological Survey, and U.S. Census Bureau (i.e. American Community Survey). Using Application Programming Interface (APIs) and Tables from websites, **EXPLORE** summarizes and quantifies demographic, exposure, and health indicators for any location in the United States. The research team has used Python and R to data clean and align numerical data with geographical data. The information is visualized using ArcGIS and Mapbox. For more information about the source of each indicator please review the metadata on the **EXPLORE** page.

PRECEDE credits multiple existing data dashboards for providing a strong foundation and highlighting the need for a national, design-oriented data resource. City Health Dashboard created by NYU Langone Health in 2018, provides data for over 950 U.S. cities and offers comparative statistics to national average. Early partnership with City Health Dashboard highlighted the need for public health indicators in the design process, however project opportunities often exceeded the urban environment, including suburban and rural communities.

Currently, **PRECEDE** V.1 only incorporates publicly available demographic, environmental, and health data with the hope expand to other human experience themes (e.g. social, behavioral, or disability inclusion) as resources and partnerships allow. If you are new to working with public health data, there are a couple of key considerations when interpreting the findings.

EXPLORE.

Key Considerations

KEY CONSIDERATIONS	EXAMPLE IN ACTION	TAKEAWAY
Public health data provides useful estimates. Measured over politically defined areas for standardized measurement, public health data does not capture small local variations or specific indoor environments.	Within a census tract there can be diverse communities, age groups, topography, or building types. If a census tract shows average levels of air pollution, it could be due to one part of the community being exposed to high levels of air pollution from traffic when the other part of the community is buffered by trees and has low levels of air pollution.	Always validate the results with the intended users of the space and ensure it serves their needs and priorities.
Data is influenced by the sample collected. Health outcomes and census data aims to be a representative sample of the community, but collection efforts can miss sensitive or vulnerable populations such as unhoused people, indigenous communities, individuals with disabilities, children, or pregnant people (US Census Bureau, 2022). Some voices may be underrepresented and bias the findings.	For English language learners they may be less likely to access healthcare, feel comfortable completing English surveys, or be underrepresented due to citizenship status.	If the data is based on self-reported surveys may impact the reported prevalence of health outcomes for this community.
Missing data or low values can mean different things. It can be due to poor response rate, low number of people experiencing the health outcome of interest, low number of people living in that area (e.g., downtown business districts) or protecting privacy.	Data collection during periods of environmental or personal distress (e.g., COVID, displacement due to extreme weather) may limit the number of people who report their information. If recent events disrupted or impacted health outcomes in your community of interest, then the results of EXPLORE may be less relevant to the population you serve.	Health priorities should be established with the community before design teams research or implement strategies.
Data collections and methods may not be as inclusive as they should be to accurately capture diverse voices required to advance design equity.	Individuals with disabilities face discrimination, stigma, and lack of recognition, and during the data collection process it can limit our understanding of their lived experience and how the built environment can best respond.	Disability inclusion should always be a design priority because disability can occur at any time throughout our life and can support dignity and independence as we age in place.
The data does not tell us about intersectional identities. Individuals may identify with multiple vulnerable population qualifiers (Shi et al., 2008), such as low socioeconomic status, preexisting health conditions, initialized and societal racism, and lack of healthcare coverage (Smedley et al., 2003; AHRQ, 2006).	Compared with working-age adults without disabilities, those with a chronic disability are less likely to work, more likely to earn below the federal poverty level, and pay 3 to 7 times higher healthcare costs (Kennedy et al., 2017).	Vulnerable populations are restrained in their ability to adapt and absorb health challenges, therefore it is useful to identify health priorities for the most vulnerable occupants of your space to achieve health equity.

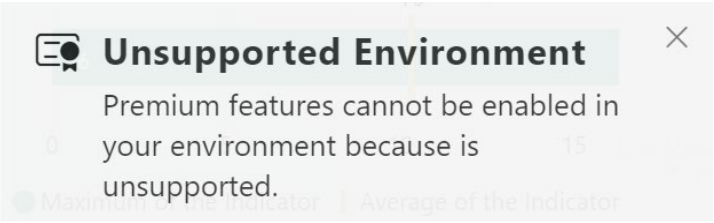
EXPLORE.

Getting Started

EXPLORE will save you time and support a more efficient, data-informed approach. **PRECEDE** V.1 has a small learning curve but we have few tips and tricks to get you started.

Tool Tips and Tricks

- When you arrive on the **EXPLORE** page, scroll down to expand the tool to “Open in full-screen mode” for easier viewing.
- Always click on your community of interest after you 'Search' for it. The map will zoom to your location, but it will not update the data until you select your neighborhood. This allows you to quickly compare the data in surrounding areas by simply clicking on the other census tracts.
- For more information about data sources, see Appendix Two or check out the metadata on the **EXPLORE** page.
- If you want to compare State and County data, zoom out to see states beyond the continental U.S.
- As you switch between Indicators (demography, exposure, outcome) the map zoom extents will reset. However, if you have searched a specific address your location marker will remain.
- Hover over each state or county to compare Indicators and Average Rank.
- **EXPLORE** has not been optimized for mobile devices.
- If you see this error you can ignore it:



EXPLORE.

Selecting the Appropriate Granularity

Data granularity tells us what precision or level of detail is most helpful to see. **EXPLORE** offers three levels of granularity: State (most coarse understanding), County (more refined and highlights state-wide variability, and Census Tract (most refined, local understanding). Each geographic scale can teach you something unique about your project location.

We recommend selecting 'Census Tract'

Census tracts are relatively small statistical subdivisions of US counties that generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. The primary purpose of census tracts is to provide a stable geographic unit for the presentation of statistical data for comparison across decennial censuses (US Census Bureau, 2022). Most national datasets collect health indicators at the census tract level.

Census tracts only serve as a proxy measure for neighborhood-level but does not reflect human or community defined boundaries of a neighborhood. Be aware that census tracts have a limited ability to approximate the elastic nature of "real" neighborhoods (Lee et al., 2008). In particular, urban census tract boundaries may not delineate along neighborhoods, as resident's perceptions of the name, size, and boundaries of the same neighborhood can vary markedly (Chaskin, 1995; Lee and Campbell, 1997; Sastry et al., 2002). Moreover, because census tracts are designed to remain stable over multiple decades, they often fail to capture trends in neighborhood gentrification that can occur in rapid time frames (Barton, 2014).

Project teams should note that census tract level measures only tell us information about the health status of individuals living in that tract. In reality, individuals travel extensively beyond their census tract of residence, whether it be to go to school, work, shop, etc. (Jones and Pebley, 2014). By directly clicking on other surrounding census tracts you will be able to compare surrounding community health data and provide a more nuanced understanding of potential health needs.

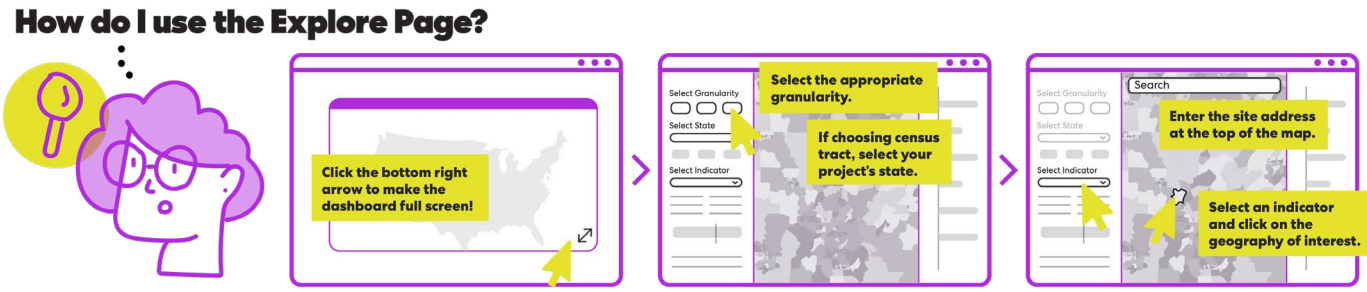
Census tracts can be compared to other datasets outside of **PRECEDE** and will provide your project team and community partners with the most granular data available for these metrics.

EXPLORE.

Step-by-Step Guide

The EXPLORE page is an interactive dashboard.

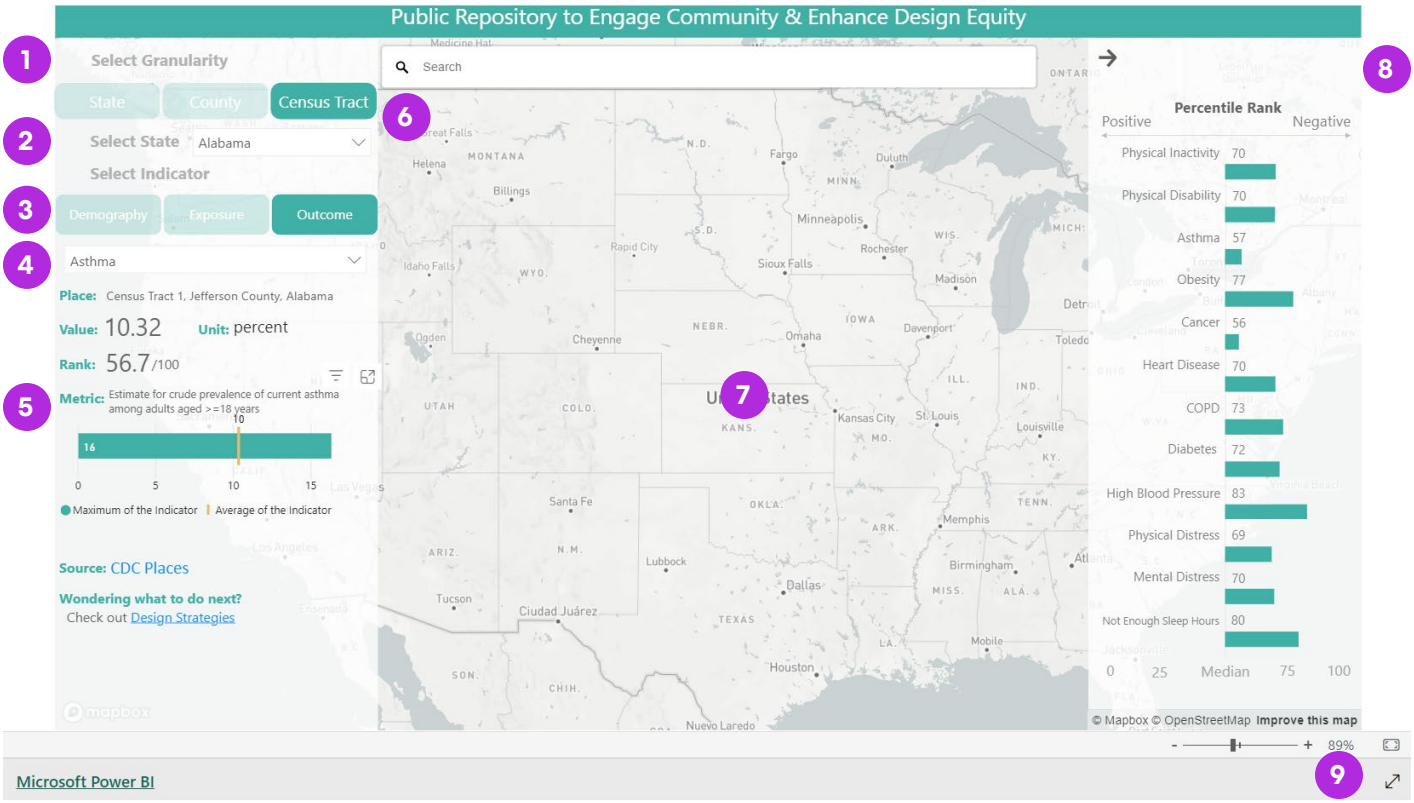
Remember, you can always return to the EXPLORE page after using LEARN and ACT to refresh your memory on any of the indicators you came across for your project.



EXPLORE.

Step-by-Step Guide

1. Select Granularity
2. State Drop Down
3. Select Indicator
4. Individual Indicator Drop Down
5. Individual Indicator Metrics
6. Address Search Bar
7. Map
8. Percentile Ranking
9. Full Screen Mode



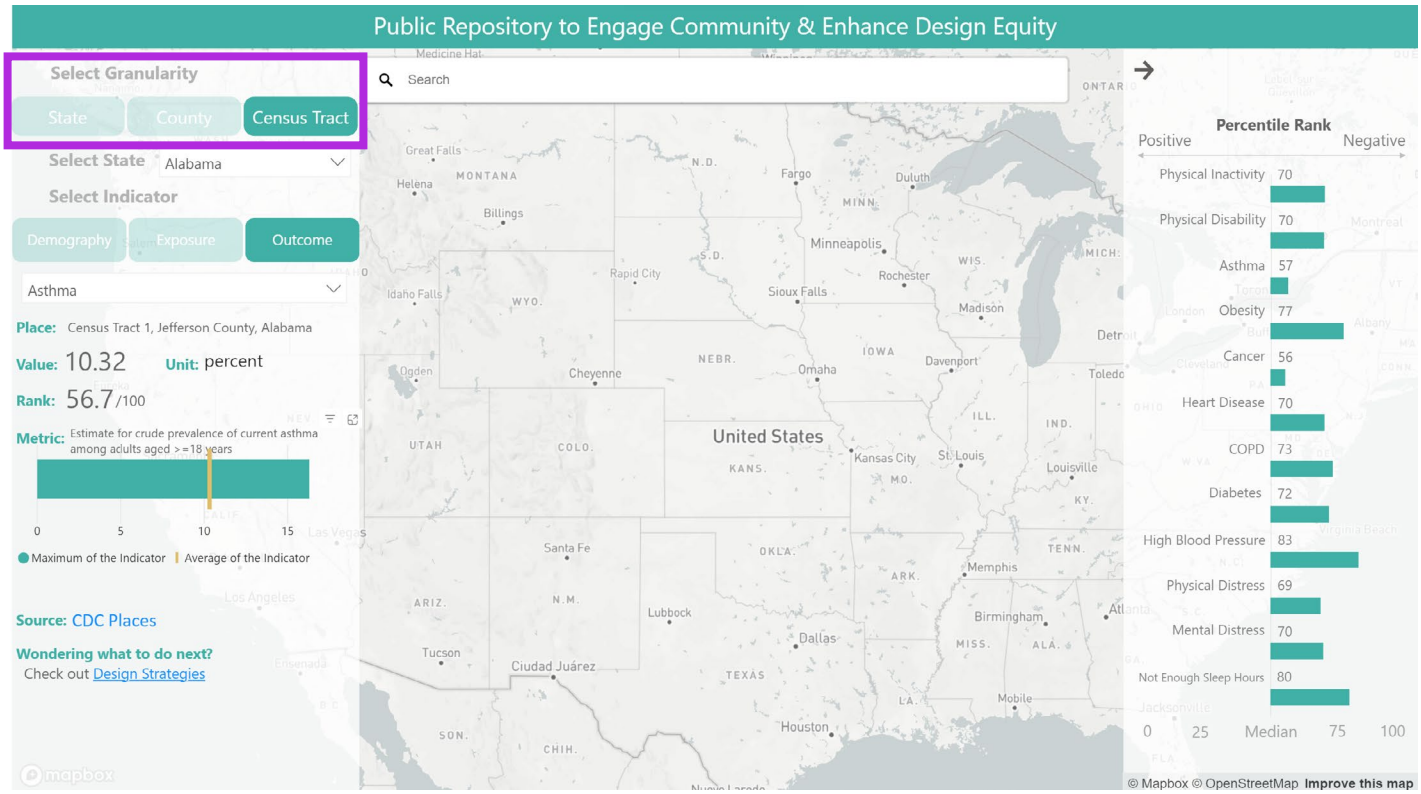
EXPLORE.

Step-by-Step Guide

01.

Select Your Granularity

Select “Census Tract” as your granularity



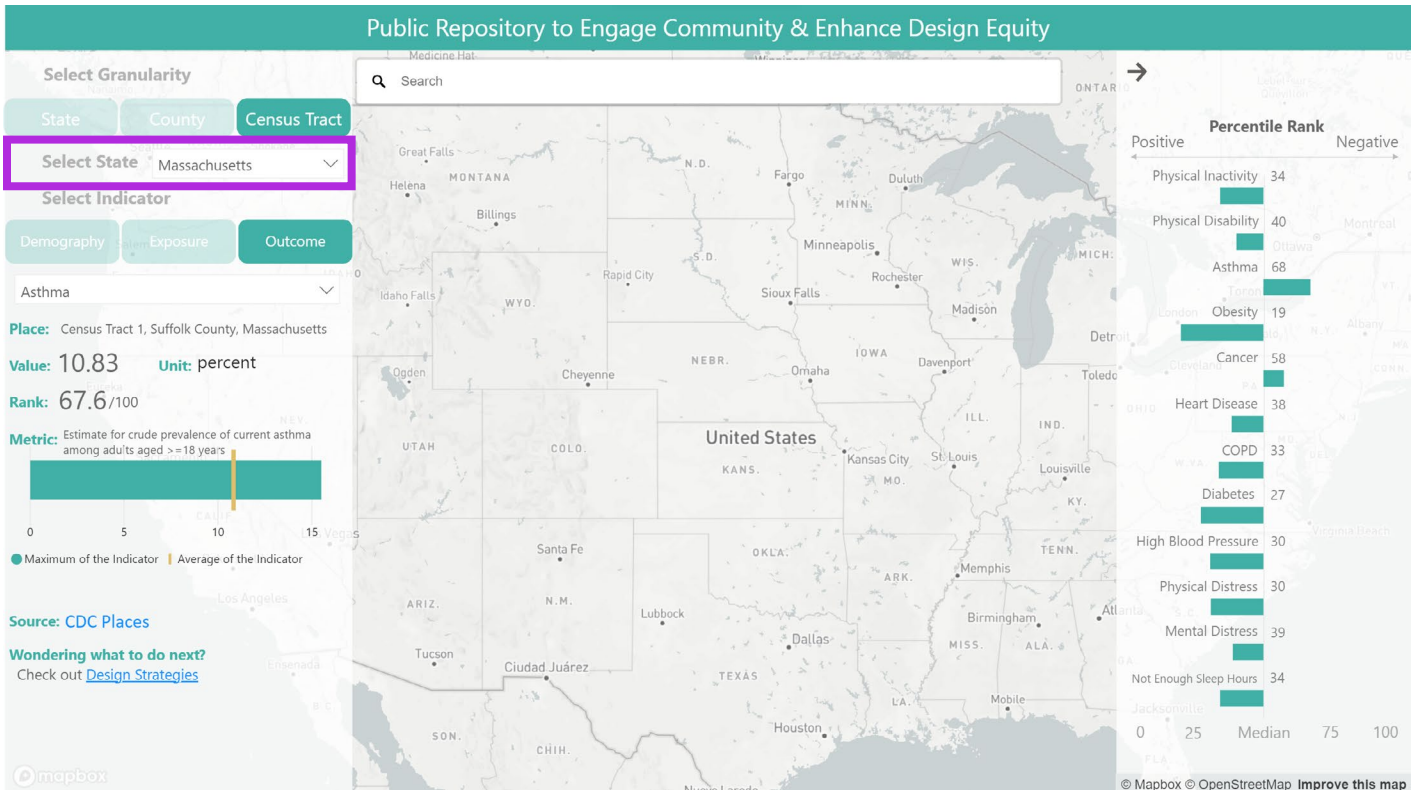
EXPLORE.

Step-by-Step Guide

02

Select Your Project's State

Choose your project site's state from the drop-down menu. Alabama is the default. States are listed alphabetically. This helps the tool run smoothly and only visualize the most important data to you.



EXPLORE.

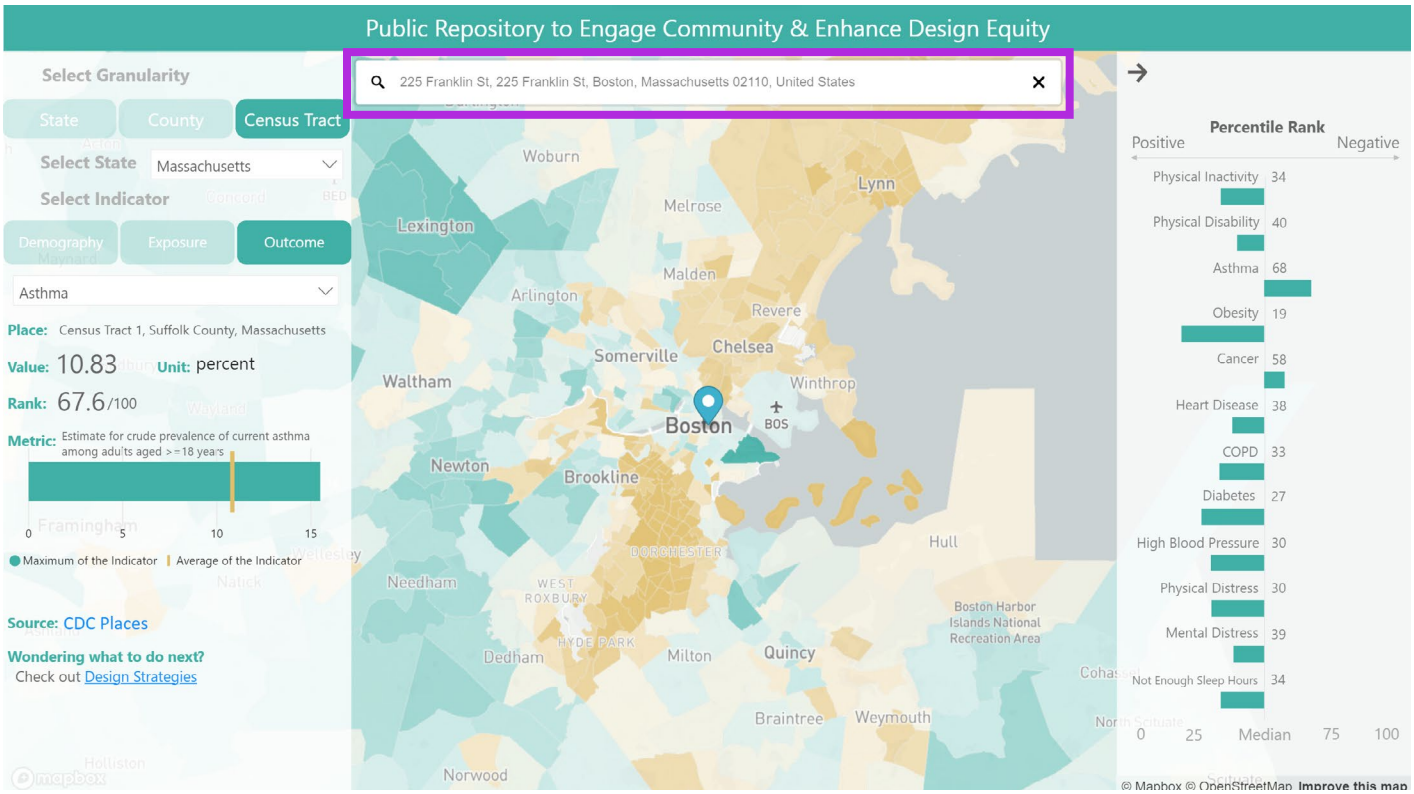
Step-by-Step Guide

03

Type in Your Project's Address

Now using the search bar type the address of your U.S.-based project site. Addresses will begin to populate from around the world but **PRECEDE** V.1 only has the capacity for United States data.

Once you have entered your site address, hit 'Enter' and **PRECEDE** will bring you to your location on the map.



EXPLORE.

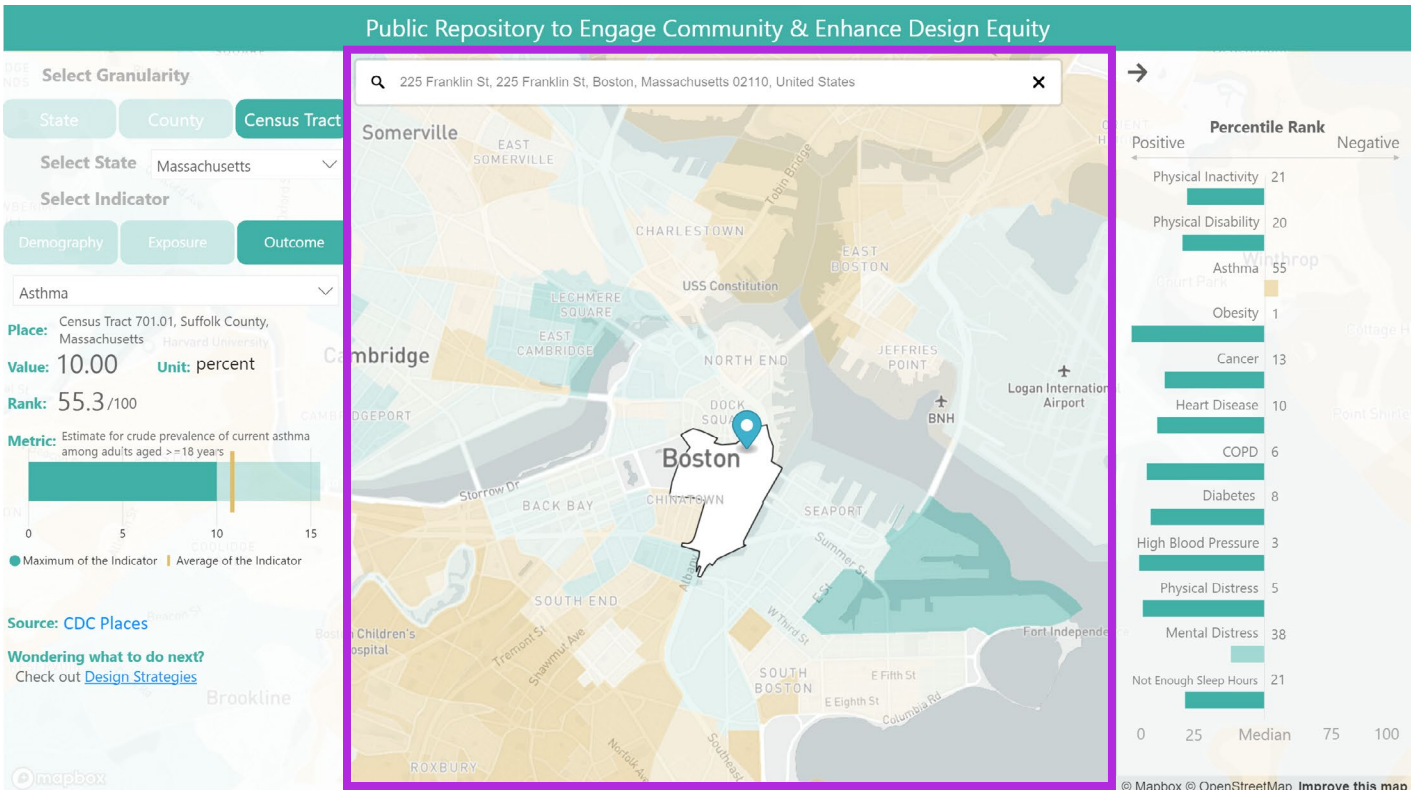
Step-by-Step Guide

04

Select your Project's Census Tract

When selected, your census tract will be white with a black outline. You will notice 'Place' indicates a new census tract. You are now ready to start exploring the data.

NOTE: You must click on your census tract on the map for the graphs to update accordingly. If 'Place' indicates 'Census Tract 1' for your State, you have most likely not selected your project's Census Tract.



EXPLORE.

Step-by-Step Guide

05

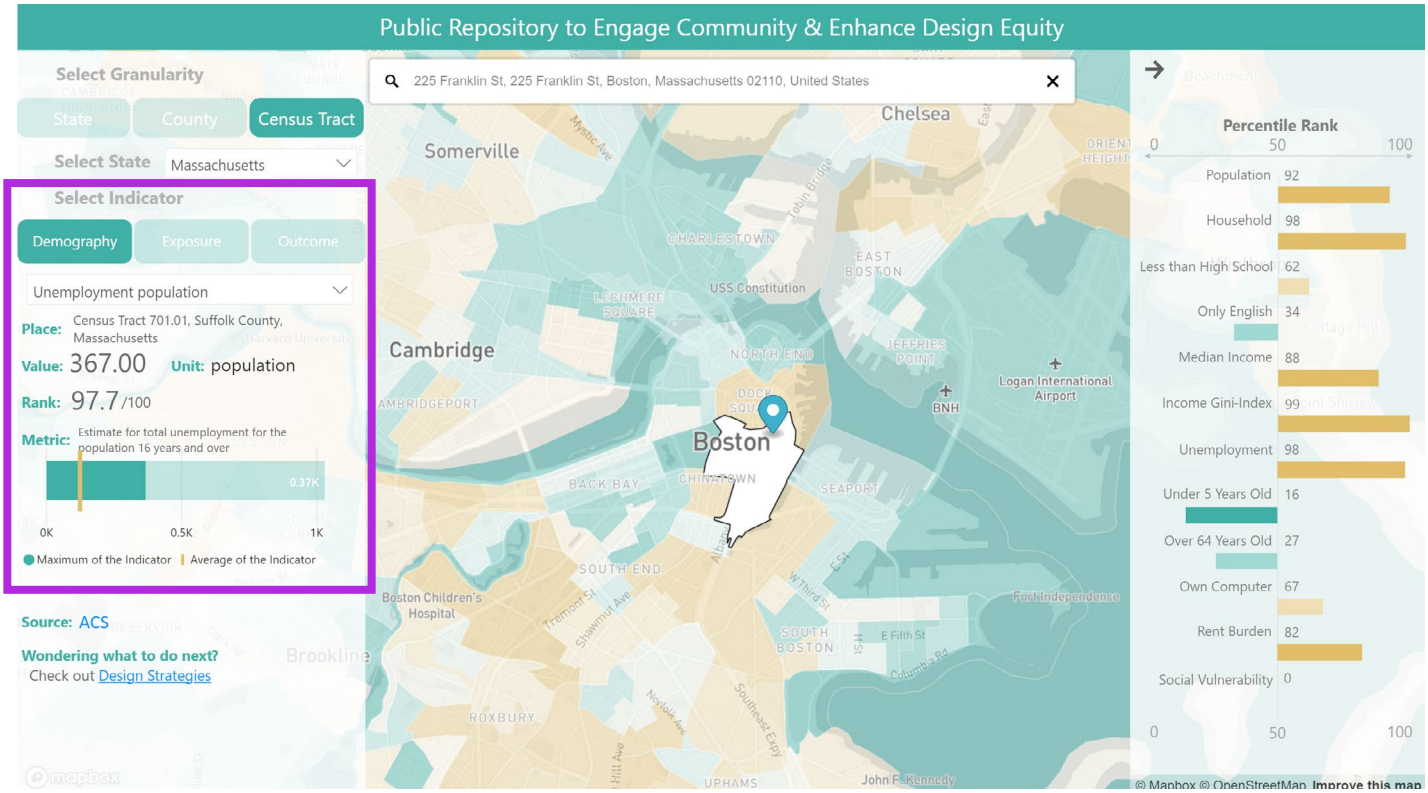
Selecting Indicators

Once you have selected 'Census Tract' as your granularity, the default list of indicators to appear will be 'Outcome' with 'Asthma' at the top of the list.

Select Indicators from Demography, Exposure, or Outcome and use the dropdown menu to get more detailed information about each indicator.

- Place: The location you have selected
- Value: The measured quantity
- Unit: The unit of measurement for the selected indicator
- Rank: Ordinal rank within the selected granularity. The rank is based on the granularity, i.e., rank among states if you choose state granularity, rank among counties if you choose county granularity, or rank among census tracts in your state.
- Metric: Definition of the selected indicator as defined by the data source

To change the indicator, toggle between Demography, Exposure, and Outcome. You may need to re-search the site address, but the data will update on the bar charts. For more information about data sources, see Appendix Two.



EXPLORE.

Step-by-Step Guide

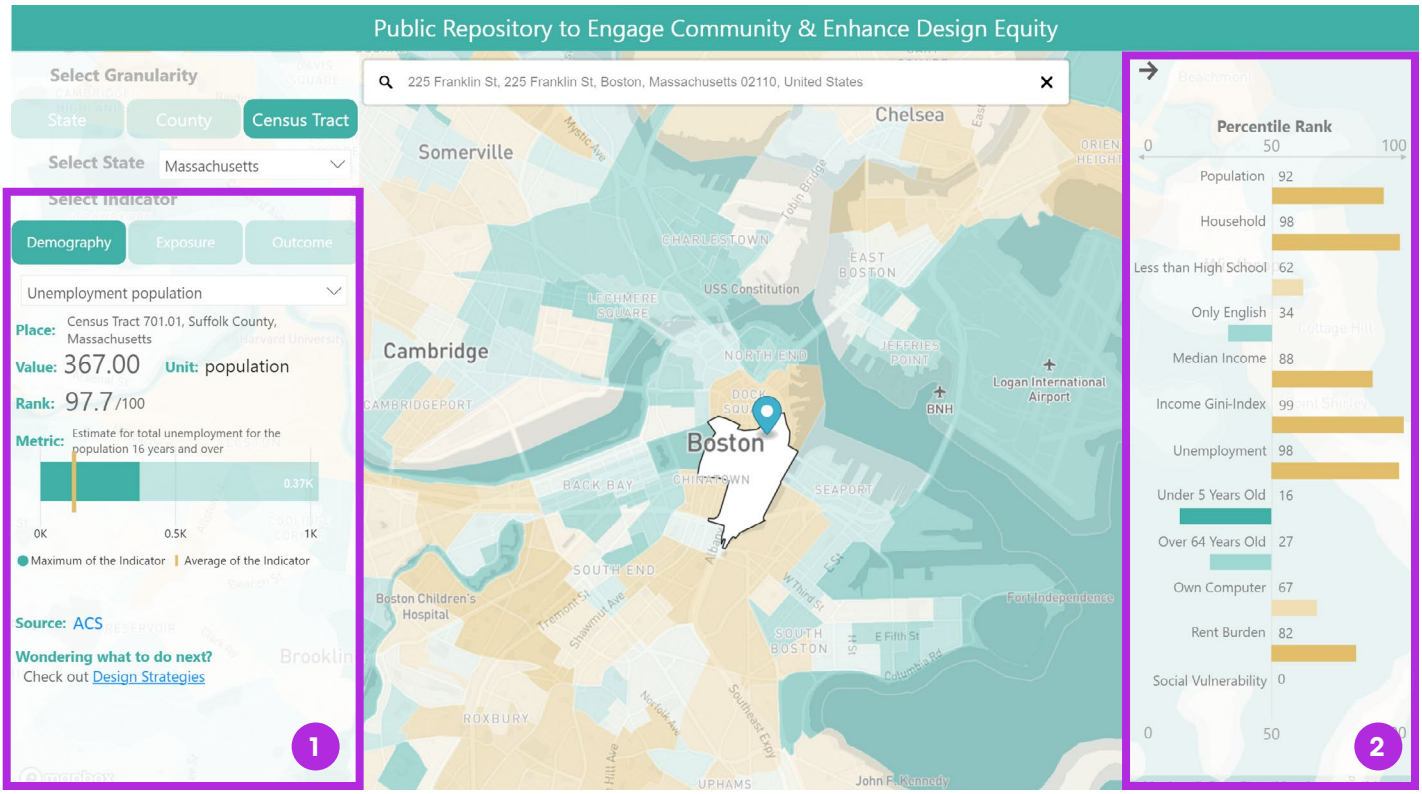
06

Interpreting Data

If you have checked out LEARN, then you know how these indicators are related to human health and the built environment.

There are two areas of the dashboard to look for data based on the indicator you have selected.

1. The bar chart and data on the left tells you the measured value of the data. This data is essential to assess the health risk or priority. For example, a low value of $PM_{2.5}$ may appear to be a high percentile (show on the table on the right) because there are strict ambient air quality standards under the Clean Air Act that keep air pollutant levels low.
2. The table on the right shows percentile rank. Percentiles are commonly used in public health to tell us the percentage of individuals reaching this value compared to others in the group. If census tract is selected, then the percentile tells us how our census tract compares to other census tracts in the same state. If county or state is selected, percentiles are compared to all other counties or states, respectively.



EXPLORE.

Step-by-Step Guide

07

Identifying health priorities by focusing on Exposure and Outcome

When examining the data health priorities may be identified by the highest percentile rank. Be sure to double check the value and how it relates to the maximum of the indicator.

0-25th percentile
Dark Green
Least health concern

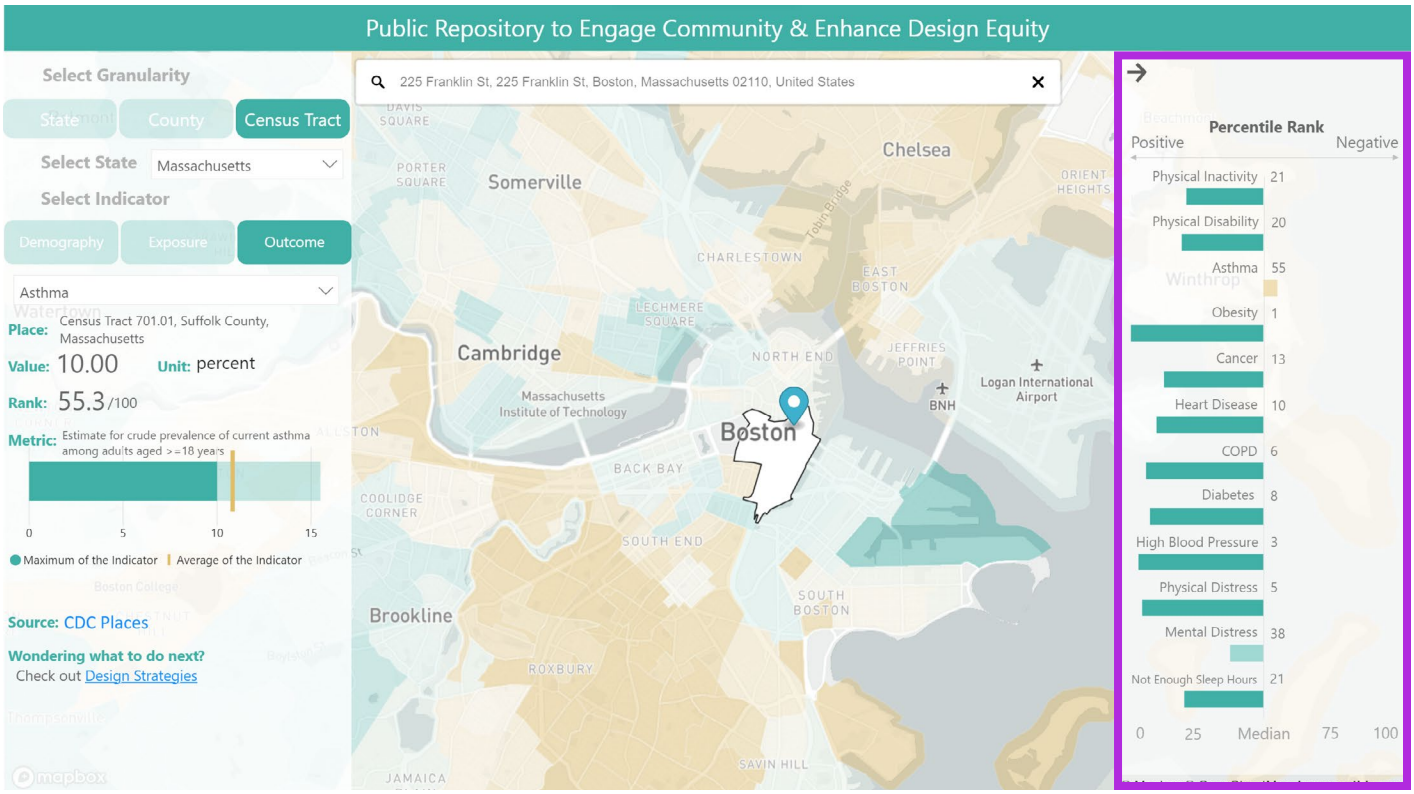
25th-50th percentile
Light green
Low to moderate concern

50th-75th percentile
Pale yellow
Moderate to high concern

75th-100th percentile
Dark yellow
Greatest health concern or priority

Interpreting Percentile Example

The annual average concentration of $PM_{2.5}$ in Colorado is in the 25th percentile, so 25% of US state's annual average $PM_{2.5}$ concentrations are below Colorado's concentration and 75% of US state's annual average $PM_{2.5}$ concentrations are above Colorado's concentration (US EPA, 2014a). A percentile rank simply assigns a value between 1 and 100 that corresponds to the measurement's percentile. Accordingly, Colorado has a percentile rank of "25".



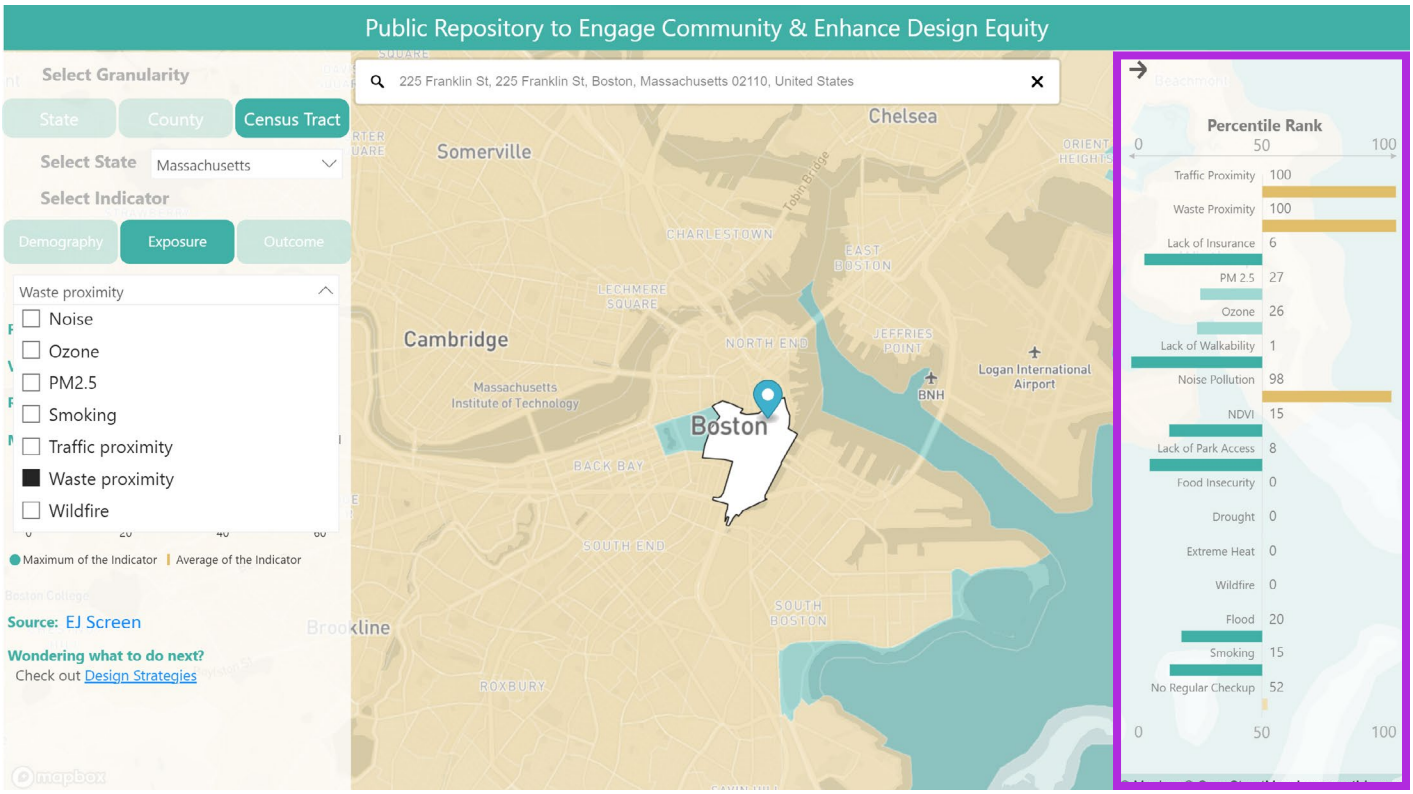
EXPLORE.

Step-by-Step Guide

08

Identifying health priorities by focusing on Exposure and Outcome

When examining the data health priorities may be identified by the highest percentile rank. Be sure to double check the value and how it relates to the maximum of the indicator.



EXPLORE.

Want a Deeper Dive?

PRECEDE integrates a subset of metrics from a variety of geospatial databases by using available APIs. As healthy equity enthusiasts, we encourage you to explore more:

- CDC Places is an interactive map of the U.S. with estimates of different health metrics (Health outcomes, Prevention, Health Risk Behaviors, and Health Status). CDC Places allows users to search by address and compare census tract results to the national average.
- City Health Dashboard from NYU Langone is a data visualization tool at the city and census tract level for health outcomes, social and economic factors, health behavior, physical environment, and clinical care.
- EJScreen from the U.S. Environmental Protection Agency combines environmental and demographic information and allows users to compare local outcomes to state and national results.

ACT.

CONTENTS.

ACT.

Overview

This page can help you respond to the data from EXPLORE by aligning design strategies with specific health concerns. These strategies are backed by research, and should provide a starting point from which to tailor your unique design.

ACT is an expanding compendium of design recommendations to optimize both occupant and community health. Whether you are an architect looking to optimize natural lighting in a healthcare facility, an interior designer seeking to craft spaces that promote mental well-being, or an urban planner working to create inclusive communities, this resource kickstarts your design process.

ACT V.1 includes a Microsoft PowerBI dashboard that embeds 91 different design strategies from scientific research; WELL Building Standard, version 2; U.S. Green Building Council RELi, v2.0; Fitwel Standard, v3; U.S. Green Building Council LEED ID+C and BD+C, v4.1; Terrapin Bright Green; SITES Rating System, v2. The research team correlated each design strategy with a scale of impact – Policy, Urban Realm, Site, Building, Interior, Operations. The research team also correlated each design strategy with relevant Outcome(s) or Exposure(s).

ACT.

Deepening Action with Community Engagement & Validation

ACT's design recommendations will be supplemented by your design approach. In the **PRECEDE** Community Engagement & Validation Guide, you will find ways to prioritize design strategies with community input. Validation is the process of presenting research findings to community stakeholders in the interest of achieving consensus towards action. Until we share our data with the individuals impacted by it, we cannot assume that it is valid.

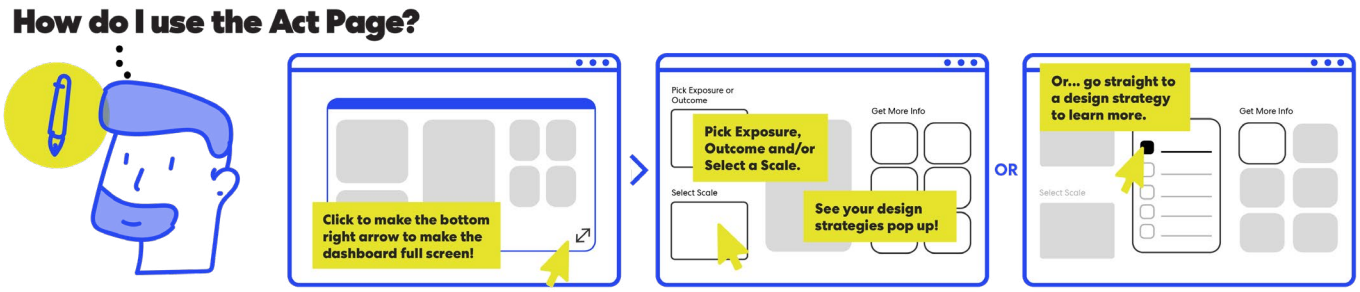
We validate in order to create a shared vision with community or building occupants. Publicly accessible data can rapidly visualize risk factors and public health challenges, but validation presents a path for action.

ACT.

Step-by-Step Guide

The ACT page is an interactive dashboard.

Remember, you can always return to the ACT page after using LEARN and EXPLORE to refresh your memory on any of the indicators you came across for your project.



ACT.

Step-by-Step Guide

01.
Pick Exposures & Outcomes from the “Explore” Phase

- Select one indicator at a time to quickly narrow design recommendations.
- You can change the indicator at any time

02.
Select the Project Scale

- Select the project type you are working on to filter the strategy list. This may help identify the most appropriate strategies for your project.

03.
Select the Design Recommendations

- Click on the design recommendations to learn more and access available references.

04.
Get More Information

- Dive deeper into the strategies and read short descriptions of each.

Tool Tips and Tricks

- To choose multiple exposures and outcomes, hold down the 'Control' key and left-click with your mouse.
- To choose multiple project scales, hold down the 'Control' key and left-click with your mouse.
- To further refine design recommendations, hold down the 'Control' key and left-click with your mouse.

ACT.

Contribute to Design Recommendations

Help the **PRECEDE** team expand the design recommendation list by sharing validated strategies. It is as simple as selecting relevant health indicators and sharing the research article, white paper, standard/certification, or study that validates your strategy. Please feel free to share your contact information, so the research team can contact you with additional questions or opportunities.

GLOSSARY.

PRECEDE
Fundamentals

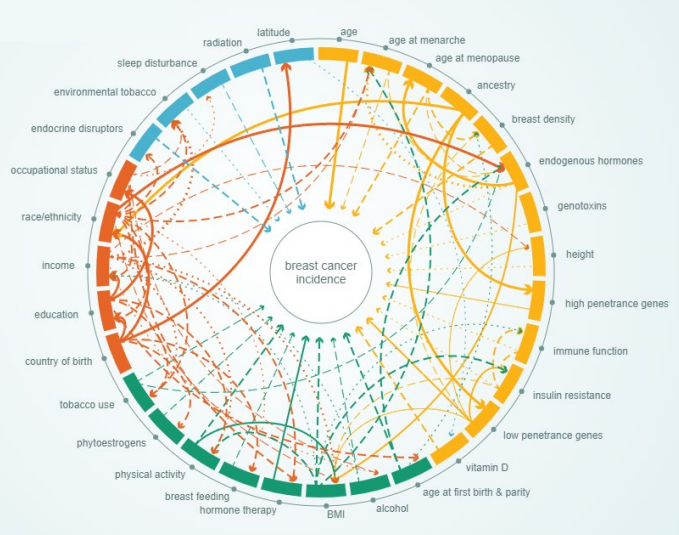
Air/Water Quality
The degree to which air or water contains solid and/or dissolved pollutants. Poor air/water quality contains high levels of pollutants and is dangerous to human health and ecosystems (UCAR, n.d.). Because there are effectively limitless numbers of natural and artificial pollutants that may be present in air or water, air/water quality is a vague term meant to broadly characterize the concentration of known pollutants harmful to human health and the ecosystem present in the air or water at a particular location.

Allostatic Load
The cumulative burden of chronic stress and the resulting activation of the body's physiological stress response systems. Environmental exposures, such as noise and air pollution, may increase our allostatic loads; as well as social determinants of health, such as low socioeconomic status, persistent discrimination, and low educational attainment (Guidi et al., 2020)(Thomson, 2019). High burden of allostatic load, sometimes called allostatic overload, is associated with poorer health outcomes, including metabolic syndrome, cardiovascular disease, cancer, and mental health consequences (Guidi et al., 2020).

Built Environment
Any man-made or modified building, infrastructure, or area where we may live, work, commute, learn, play, etc. (US EPA, 2017). Our modern society spends most of our time surrounded by the built environment (at least 90% of our day is spent indoors). As designers, we have the potential to create health promoting buildings, infrastructure, and private and public areas (US EPA, 1989)(Renalds et al., 2010).

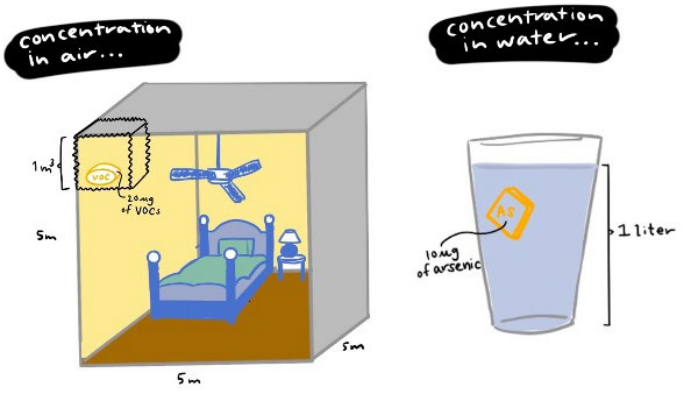
Carcinogen
A substance, organism, or agent capable of causing cancer. Carcinogens may occur naturally in the environment (e.g., ultraviolet rays from sunlight, VOCs from wildfire smoke) or human generated (e.g., automobile exhaust fumes or industrial waste) (Hutter, 2023). It is estimated that 5% of human cancers are caused by viruses, 5% by radiation, and the remaining 90% by chemical exposures. Of these, an estimated 30% are caused using tobacco products and the rest by chemicals associated with diet, lifestyle, and the environment (Malarkey et al., 2013). Designers have the opportunity to decrease people's exposure to carcinogens by i) eliminating the incorporation of known or suspected carcinogens in building or furnishing materials, ii) designing systems that reduce or eliminate the infiltration of carcinogenic chemicals from the outdoor environment into the indoors, and iii) designing the built environment to influence occupants' behavior to avoid exposure to carcinogens (e.g., ban smoking within a building, ensuring occupants have access to healthful foods).

Chronic Disease
A condition that persists one year or more and requires ongoing medical attention and/or limits activities of daily living. Examples of chronic disease include cancer, cardiovascular disease, and diabetes (CDC, 2022b). Most chronic diseases are caused by a complex web of societal, biological, environmental, and behavioral factors (Hiatt et al., 2020). Designers have the potential to influence certain environmental (e.g., optimizing indoor air quality), behavioral factors (e.g., incorporating active design elements), and physical factors (e.g., utilizing healthy building and furnishing materials) that are associated with the development of a chronic disease (Hiatt et al., 2020).



PRECEDE
Fundamentals

Concentration
Quantity of a substance (usually a pollutant or toxicant) contained in a standardized quantity of environment media (e.g., air, soil, or water) (Macnaught et al., 1997). For instance, VOCs are typically measured in micrograms per meter cubed (µg/m3), and the concentration tells us the mass of total VOCs contained within a one cubic meter (m3) of air. In order to interpret if a substance's concentration is of concern to human or ecological health, we must understand i) the naturally occurring concentration of a substance in the medium (sometimes referred to the background concentration) (ATSDR, 2022); and ii) the concentration of a substance needed to elicit a human or ecological response (referred to potency or toxicity) (US EPA, 2014b).



Confounding Factor
Any characteristic of a population that causes an over- or under-estimation of the association between exposure and outcome (Meuli and Dick, 2018). For instance, the association between exposure to $PM_{2.5}$ concentrations in a city and the outcome of prevalence of lung disease within that city might be overestimated if that city has a high percentage of smokers. In this case, the percentage of smokers is the confounding factor. Confounding factors are extremely common in non-clinical studies as exposure factors and health outcomes cannot be observed in a vacuum (Meuli and Dick, 2018). Designers should holistically evaluate the setting of a project to determine what confounding factors may be at play in a community and ensure they are considering all design-relevant indicators.

Displacement
While individuals or groups may be displaced from their country or community due to a variety of reasons, we focus here on the displacement of peoples due to environmental degradation or destruction, often directly or indirectly caused by climate change (IOM, 2011). For instance, entire coastal tribal communities in Alaska, Louisiana, and the Pacific Islands have been forced to relocate due to accelerated rates of sea level rise, land erosion, and/or permafrost thaw brought on by climate change (Maldonado et al., 2013). Displacement is associated with decreased mental health outcomes due to an individual's severance from their livelihood and culture (Silove et al., 2017). While some climate change displacement may be unavoidable, a key component of climate adaptation is ensuring communities forced to relocate have economic, cultural, and educational opportunities in place to support the relocated population (WHO, 2021). Designers should engage with communities to understand the risks of climate change displacement for the region and determine if design strategies exist to mitigate the risk of displacement.

Infectious Disease
Illnesses caused by germs (such as bacteria, viruses, and fungi) that enter the body, multiply, and can cause short-term or long-term infections. Some infectious diseases are contagious, spread by contact between two people, and other infectious diseases are spread by germs carried in air, water, food, or soil. They can also be spread by vectors (like biting insects) or by animals to humans (CDC, 2020). The built environment has a large impact on the prevention and containment of infectious disease in both direct (e.g., indoor air purification) and indirect (e.g., influencing behaviors that affect disease transmission) ways (Pinter-Wollman et al., 2018) (Nagare et al., 2021).

Inflammation
The defense response of the body's immune system to recognize and remove harmful and foreign stimuli and begin the healing process. Inflammation can be either acute (e.g., healing a paper cut) or chronic (e.g., development of a chronic condition that triggers the inflammation response). Chronic inflammatory diseases are the most significant cause of death in the world and include: stroke, chronic respiratory diseases, heart disorders, cancer, obesity, and diabetes (Pahwa et al., 2023). These chronic diseases are caused by a complex web of societal, biological, environmental, and behavioral factors (Hiatt et al., 2020). See chronic diseases to understand how design influences may influence the development of these diseases and potentially reduce chronic inflammation.

Large Quantity Generators (LQGs) and Treatment, Storage, and Disposal Facilities (TSDFs)
Facilities that generate, transport, treat, store, and dispose of hazardous waste under US EPA's Resource Conservation and Recovery Act (RCRA) regulations (US EPA, 2005). Living in proximity to hazardous waste generators (LQGs) and hazardous waste processing facilities (TSDFs) is associated with reproductive complications, cardiovascular and respiratory diseases, and increased all-cause mortality (Brender et al., 2011).

Nitrogen Oxides (NOx)
Compounds containing nitrogen and oxygen, which are considered air pollutants. Wildfires account for about 15% of nitrogen oxide (NO) and nitrous oxide (N2O) emissions and do so by releasing nitrogen oxides trapped in soil (Stephens and Homyak, 2023). Exposure to nitrogen oxides effects the upper respiratory tract and lungs, and at high concentrations can cause severe damage and at low concentrations can cause acute and chronic irritation (Ricciardolo et al., 2004). Moreover, nitrogen oxides mixing with wildfire smoke can cause ozone production to increase, therefore contributing to global greenhouse gas accumulation (Hakeem et al., 2017).

Oxidative Stress
A physiological phenomenon caused by the imbalance of metabolic byproduct accumulation (specifically, reactive oxygen species) and the body's ability to detoxify these byproducts. Reactive oxygen species circulate in the body as normal by-products of metabolism. However, environmental exposures (i.e., ultraviolet rays, radiation exposure, pollutants, and heavy metals) contribute to greatly increased production of these byproducts, therefore causing the imbalance that leads to cell and tissue damage, and ultimately has been linked to the formation of cancer, stroke, and a general speeding up of the aging process in the body (Pizzino, 2017).

Pollutants/Toxicants
Chemicals and other new types of engineered materials or organisms not previously known to the Earth system as well as naturally occurring elements (for example, heavy metals) mobilized by anthropogenic activities with the potential to cause severe ecosystem and human health problems at varying scales (Persson et al., 2022). For the purposes of **PRECEDE**, these terms are used interchangeably.

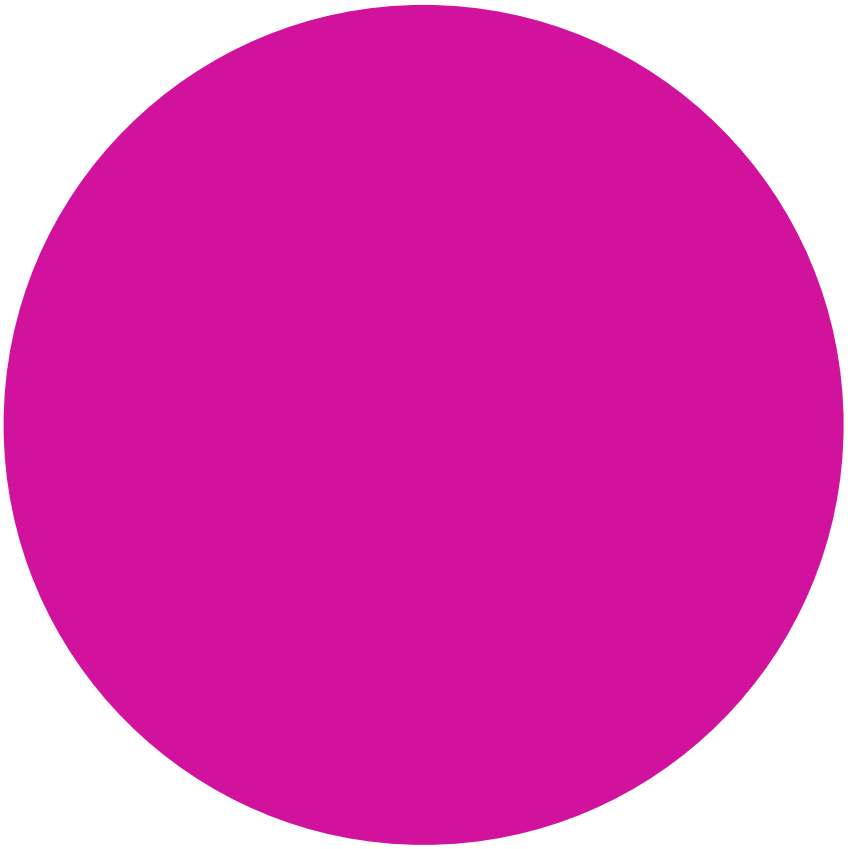
PRECEDE
Fundamentals

Social Determinants of Health
The conditions where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks (US HHS, 2020). Social Determinants of Health (SDH) may promote positive health outcomes or increase the risk of negative health outcomes; thus, these factors play a huge role in achieving health equity. Some examples of SDH are income stability, education access and quality, job security, food security, health care access, etc. (WHO, 2023). Research shows that SDOH account for up to 55% of health outcomes (Braveman and Gottlieb, 2014); in other words, more than 50% of health outcomes can be traced back to your zip code (Orminski, 2021)! Because designers shape the spaces we occupy we have a great opportunity to promote health and mitigate risk through SDOH design interventions.

↑ **Source:** *https://health.gov/healthypeople/priority-areas/social-determinants-health annotated*

Volatile Organic Compounds (VOCs)
Compounds that have a high vapor pressure and low water solubility, meaning that they very easily can diffuse into air and dissolve into water, making them common air and water pollutants (US EPA, 2018). VOCs include a wide variety of chemicals, some of which may have short- and long-term adverse health effects. VOCs come from both outdoor and indoor sources of pollution. Combustion causes the release of VOCs, so automobile exhaust and wildfire smoke both result in VOC contamination in air (Kiest, 2023). That said, concentrations of VOCs are consistently higher indoors (up to ten times higher) than outdoors and can be emitted from a variety of household products, such as cleaning products, paints, and furnishings. Designers may suggest low-VOC emitting products, and potentially allow for a "off-gassing period" where occupants are not allowed in the building when painting occurs or new furnishing is installed (e.g., after carpet installation) (Maroni, 1998).

Zoning Ordinance
The set of rules that dictate the allowed shape, density, and use of development in an area. Zoning determines where various categories of land use (i.e., residential, commercial, or industrial) may go in a community. The location of noxious land uses and the pollution they generate have ramifications for the public health of the surrounding community. When industrial use zones are located within or near large residential populations they tend to be concentrated in poor and minority



REFERENCES.

References

Agency for Healthcare Research and Quality (AHRQ). National Healthcare Quality and Disparities Reports (NHQDR). datatools.ahrq.gov. Published 2022. Accessed November 2, 2023. https://datatools.ahrq.gov/nhqdr

AHRQ. National Healthcare Disparities Report, 2006. Rockville, MD: US Department of Health and Human Services; 2006.

Allen JG, MacNaughton P, Laurent JG, Flanigan SS, Eitland ES, Spengler JD. Green Buildings and Health. Curr Environ Health Rep. 2015;2(3):250-258. doi:10.1007/s40572-015-0063-y

Agency for Toxic Substances and Disease Registry (ATSDR). PHA Guidance Manual: Considering Background Concentrations. www.atsdr.cdc.gov. Published April 12, 2022. Accessed October 18, 2023. https://www.atsdr.cdc.gov/pha-guidance/selecting_sampling_data/considering-background-concentrations.html

Barton M. An Exploration of the Importance of the Strategy Used to Identify Gentrification. Urban Studies. 2014;53(1):92-111. doi:https://doi.org/10.1177/0042098014561723

Braveman P, Arkin E, Orleans T, Proctor D, Plough A. What Is Health Equity? Robert Wood Johnson Foundation; 2017:2.

Braveman P, Gottlieb L. The Social Determinants of Health: It's Time to Consider the Causes of the Causes. Public Health Reports. 2014;129(2):19-31

Brender JD, Maantay JA, Chakraborty J. Residential proximity to environmental hazards and adverse health outcomes. Am J Public Health. 2011;101 Suppl 1(Suppl 1):S37-S52. doi:10.2105/AJPH.2011.30018

Brulle RJ, Pellow DN. Environmental justice: human health and environmental inequalities. Annu Rev Public Health. 2006;27:103-124. doi:10.1146/annurev.publhealth.27.021405.102124

Bullard R, Mohai P, Saha R, Wright B. Toxic Wastes and Race at Twenty: Why Race Still Matters after All of These Years. Environmental Law. 2008;38(2):371-411. Accessed October 20, 2023. http://www.jstor.org/stable/43267204

Centers for Disease Control and Prevention (CDC). National Diabetes Statistics Report. CDC.gov. Published 2022a. https://www.cdc.gov/diabetes/data/statistics-report/index.html

CDC. About Chronic Diseases. CDC.gov. Published July 21, 2022b. Accessed October 19, 2023. https://www.cdc.gov/chronicdisease/about/index.htm

CDC. Who We Are | NCEZID | CDC. CDC.gov. Published July 7, 2020. Accessed October 20, 2023. https://www.cdc.gov/ncezid/who-we-are/index.html#:~:text=Infectious%20diseases%20are%20illnesses%20caused

Chaskin RJ. Defining neighborhood: History, theory, and practice. Chicago: Chapin Hall Center for Children at the University of Chicago; 1995.

Duan RR, Hao K, Yang T. Air Pollution and Chronic Obstructive Pulmonary Disease. Chronic Diseases and Translational Medicine. 2020;6(4). doi:https://doi.org/10.1016/j.cdtm.2020.05.004

Egede LE, Walker RJ, Campbell JA, Linde S, Hawks LC, Burgess KM. Modern Day Consequences of Historic Redlining: Finding a Path Forward. Journal of General Internal Medicine. 2023;38(6). doi:https://doi.org/10.1007/s11606-023-08051-4

European Topic Centre on Catalogue of Data Sources (ETC/CDS). European Environment Agency Glossary: Environmental Risk. Published 2000. Accessed October 18, 2023. https://www.eea.europa.eu/help/glossary/eea-glossary/environmental-risk#:~:text=Likelihood%2C%20or%20probability%2C%20of%20injury

References

Ferreira JC, Patino CM. Types of Outcomes in Clinical Research. Jornal Brasileiro de Pneumologia. 2017;43(1):5-5. doi:https://doi.org/10.1590/s1806-37562017000000021

Guidi J, Lucente M, Sonino N, Fava Giovanni A. Allostatic Load and Its Impact on Health: a Systematic Review. Psychotherapy and Psychosomatics. 2020;90(1):1-17. doi:https://doi.org/10.1159/000510696

Hakeem KR, Sabir M, Ozturk M, Akhtar MS, Ibrahim FH. Nitrate and Nitrogen Oxides: Sources, Health Effects and Their Remediation [published correction appears in Rev Environ Contam Toxicol. 2017;242:E1]. Rev Environ Contam Toxicol. 2017;242:183-217. doi:10.1007/398_2016_11

Hiatt RA, Engmann NJ, Balke K, Rehkopf DH. A Complex Systems Model of Breast Cancer Etiology: The Paradigm II Conceptual Model. Cancer Epidemiology Biomarkers & Prevention. 2020;29(9):1720-1730. doi:https://doi.org/10.1158/1055-9965.epi-20-0016

Health and Safety Executive (HSE). OC 311/2: Sick Building Syndrome. Hse.gov.uk. Published 2019. https://www.hse.gov.uk/foi/internalops/ocs/300-399/oc311_2.htm

Hutter C. Carcinogen. Genome.gov. Published October 21, 2023. Accessed October 24, 2023. https://www.genome.gov/genetics-glossary/Carcinogen

Intergovernmental Panel on Climate Change (IPCC). Annex II: Glossary. Möller V, van Diemen R, Matthews J, Méndez C, Semenov S, Fuglestvedt J, Reisinger A, ed(s). In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contributions of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY, USA: Cambridge University Press; 2022: 2897- 2930. doi:10.1017/9781009325844.029.

International Organization for Migration (IOM). Glossary on Migration. Perruchoud R, Redpath-Cross J, (eds.). In: 2nd edn. International Organization for Migration (IOM). Geneva, Switzerland: IOM; 2011:

Jones M, Pebley AR. Redefining Neighborhoods Using Common Destinations: Social Characteristics of Activity Spaces and Home Census Tracts Compared. Demography. 2014;51(3):727-752. doi:https://doi.org/10.1007/s13524-014-0283-z

Kennedy J, Wood EG, Frieden L. Disparities in Insurance Coverage, Health Services Use, and Access Following Implementation of the Affordable Care Act: A Comparison of Disabled and Nondisabled Working-Age Adults. Inquiry. 2017;54:46958017734031. doi:10.1177/0046958017734031

Kiest K. Understanding Volatile Organic Compound Emissions from Wildfires in the Western US with Modeling Comparisons. Climate Program Office. Published June 16, 2023. Accessed October 25, 2023. https://cpo.noaa.gov/Understanding-Volatile-Organic-Compound-Emissions-from-Wildfires-in-the-Western-US-with-Modeling-Comparisons/

LaMorte W. Association versus Causation. Published April 21, 2021. Accessed October 19, 2023. https://sphweb.bumc.bu.edu/otlt/MPH-Modules/PH717-QuantCore/PH717-Module1A-Populations/PH717-Module1A-Populations6.html

Lee TA, Pickard AS. Chapter 4: Exposure Definition and Measurement. Velentgas P, Dreyer NA, Nourjah P, Smith S, Torchia M, ed(s). In: Developing a Protocol for Observational Comparative Effectiveness Research: A User's Guide. Rockville, MD, USA: Agency for Healthcare Research and Quality (US); 2013.

Lee BA, Reardon SF, Firebaugh G, Farrell CR, Matthews SA, O'Sullivan D. Beyond the Census Tract: Patterns and Determinants of Racial Segregation at Multiple Geographic Scales. Am Sociol Rev. 2008;73(5):766-791. doi:10.1177/000312240807300504

Maantay J. Zoning, equity, and Public Health. American Journal of Public Health. 2001;91(7):1033-1041. doi:https://doi.org/10.2105/ajph.91.7.1033

Lee B, Campbell K. Common ground? Urban neighborhoods as survey respondents see them. Social science quarterly; 1997:922-936.

Malarkey DE, Hoenerhoff M, Maronpot RR. Chapter 5: Carcinogenesis: Mechanisms and Manifestations. In: Handbook of Toxicologic Pathology. 3rd ed. (Haschek WM, Rousseaux CG, Wallig MA, eds.). Academic Press, Cop; 2013:107-146.

Macnaught AD, Wilkinson A, Union I. Compendium of Chemical Terminology : IUPAC Recommendations. Oxford Blackwell Science; 1997.

Maldonado JK, Shearer C, Bronen R, Peterson K, Lazrus H. The Impact of Climate Change on Tribal Communities in the US: displacement, relocation, and Human Rights. Climatic Change. 2013;120(3):601-614. doi:https://doi.org/10.1007/s10584-013-0746-z

Maroni M. Health Effects of Indoor Air Pollutants and Their Mitigation and Control. Radiation Protection Dosimetry. 1998;78(1):27-32. doi:https://doi.org/10.1093/oxfordjournals.rpd.a032328

Meuli L, Dick F. Understanding Confounding in Observational Studies. European Journal of Vascular and Endovascular Surgery. 2018;55(5):737. doi:https://doi.org/10.1016/j.ejvs.2018.02.028

Nagare R, Woo M, MacNaughton P, Plitnick B, Tinianov B, Figueiro M. Access to Daylight at Home Improves Circadian Alignment, Sleep, and Mental Health in Healthy Adults: A Crossover Study. International Journal of Environmental Research and Public Health. 2021;18(19):9980. doi:https://doi.org/10.3390/ijerph18199980

National Institute of Mental Health (NIMH). What is Prevalence? www.nimh.nih.gov. Published 2020. Accessed October 18, 2023. https://www.nimh.nih.gov/health/statistics/what-is-prevalence

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Overweight & Obesity Statistics. National Institute of Diabetes and Digestive and Kidney Diseases. Published September 2021. Accessed November 2, 2023. https://www.niddk.nih.gov/health-information/health-statistics/overweight-obesity#:~:text=the%20above%20table-

Onur I, Velamuri M. The gap between self-reported and objective measures of disease status in India. PLoS One. 2018;13(8):e0202786. Published 2018 Aug 27. doi:10.1371/journal.pone.0202786

Orminski E. Your Zip Code is More Important than Your Genetic Code. National Community Reinvestment Coalition. Published June 30, 2021. Accessed November 6, 2023. https://ncrc.org/your-zip-code-is-more-important-than-your-genetic-code/#:~:text=Up%20to%2060%25%20of%20your

Pahwa R, Goyal A, Jialal I. Chronic Inflammation. In: StatPearls. Treasure Island, FL, USA. StatPearls Publishing; 2023. Accessed October 25, 2023. https://www.ncbi.nlm.nih.gov/books/NBK493173/

Persson L, Carney Almroth BM, Collins CD, et al. Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. Environmental Science & Technology. 2022;56(3). doi:https://doi.org/10.1021/acs.est.1c04158

Pinter-Wollman N, Jelić A, Wells NM. The Impact of the Built Environment on Health Behaviors and Disease Transmission in Social Systems. Philosophical Transactions of the Royal Society B: Biological Sciences. 2018;373(1753):20170245. doi:https://doi.org/10.1098/rstb.2017.0245

References

Pizzino G, Irrera N, Cucinotta M, et al. Oxidative Stress: Harms and Benefits for Human Health. Oxid Med Cell Longev. 2017;2017:8416763. doi:10.1155/2017/8416763

Renalds A, Smith T, Hale P. A Systematic Review of Built Environment and Health. Family and Community Health. 2010;33(1):68-78. Accessed October 20, 2023. http://www.jstor.org/stable/44954260

Ricciardolo FL, Sterk PJ, Gaston B, Folkerts G. Nitric oxide in health and disease of the respiratory system. Physiol Rev. 2004;84(3):731-765. doi:10.1152/physrev.00034.2003

Rothman KJ, Greenland S. Hill's Criteria for Causality. Encyclopedia of Biostatistics. Published online February 15, 2005:2. doi:https://doi.org/10.1002/0470011815.b2a03072

Sastry N, Pebley A, Zonta M. Neighborhood definitions and the spatial dimension of daily life in Los Angeles (CCPR Working Paper 033-04). Los Angeles: California Center for Population Research, University of California–Los Angeles; 2002.

Shi L, Stevens GD, Lebrun LA, Faed P, Tsai J. Enhancing the Measurement of Health Disparities for Vulnerable Populations. Journal of Public Health Management and Practice. 2008;14(6):S45-S52. doi:https://doi.org/10.1097/01.phh.0000338386.59565.dc

Silove D, Ventevogel P, Rees S. The contemporary refugee crisis: an overview of mental health challenges. World Psychiatry. 2017;16(2):130-139. doi:10.1002/wps.20438

Smedley B, Stith A, Nelson A, eds. Unequal Treatment: Confronting Racial and Ethnic Disparities in Health care. Washington, DC: Institute of Medicine; 2003.

Stephens EZ, Homyak PM. Post-fire Soil Emissions of Nitric Oxide (NO) and Nitrous Oxide (N2O) across Global ecosystems: a Review. Biogeochemistry. 2023;165(3):291-309. doi:https://doi.org/10.1007/s10533-023-01072-5

Tenny S, Boktor SW. Incidence. PubMed. Published 2020. https://www.ncbi.nlm.nih.gov/books/NBK430746/

Terrapin. 14 Patterns of Biophilic Design. Terrapinbrightgreen.com. Published September 12, 2014. Accessed October 18, 2023. https://www.terrapinbrightgreen.com/reports/14-patterns/#nature-health-relationships

Thomson EM. Air Pollution, Stress, and Allostatic Load: Linking Systemic and Central Nervous System Impacts. Journal of Alzheimer's Disease. 2019;69(3):597-614. doi:https://doi.org/10.3233/jad-190015

Timæus I. Demography. In: Encyclopedia of Biostatistics. Armitage P, Colton T, ed(s). Chichester, England, UK: John Wiley & Sons; 2005;2:1127-1131.

University Corporation for Atmospheric Research (UCAR) Center for Science Education. What is Air Quality? scied.ucar.edu. Accessed October 25, 2023. https://scied.ucar.edu/learning-zone/air-quality/what-is-air-quality

United Nations (UN). Climate Adaptation. United Nations. Accessed October 18, 2023. https://www.un.org/en/climatechange/climate-adaptation?gclid=Cj0KCQjwhL6pBhDjARIsAGx8D5-NDfDf6cmA4vLKLDbqSojJ42hJf0JiA1R0A7YHnsqTYDjd7klfDI8aApsIEALw_wcB

US Census Bureau. Glossary. Census.gov. Published April 11, 2022. Accessed October 19, 2023. https://www.census.gov/programs-surveys/geography/about/glossary.html#:~:text=Census%20Tracts%20are%20small%2C%20relatively

US Department of Health and Human Services (US HHS). Social determinants of health. Healthy People 2030. Published 2020. Accessed October 18, 2023. https://health.gov/healthypeople/priority-areas/social-determinants-health

US Environmental Protection Agency (US EPA). Environmental Justice. US EPA. Published February 6, 2019. Accessed October 19, 2023. https://www.epa.gov/environmentaljustice

US EPA. Volatile Organic Compounds' Impact on Indoor Air Quality | US EPA. US EPA. Published November 6, 2018. https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality

US EPA. Basic Information about the Built Environment | US EPA. US EPA. Published April 13, 2017. https://www.epa.gov/smm/basic-information-about-built-environment

US EPA. EJScreen Data. www.epa.gov. Published September 15, 2014a. https://www.epa.gov/ejscreen/download-ejscreen-data

US EPA. Conducting a Human Health Risk Assessment: Step 2: Dose Response. US EPA. Published July 21, 2014b. https://www.epa.gov/risk/conducting-human-health-risk-assessment#tab-3

US EPA. Introduction to United States Environmental Protection Agency Treatment, Storage and Disposal Facilities.; 2005. Accessed October 25, 2023. https://www.epa.gov/sites/default/files/2015-07/documents/tsdf05.pdf

US EPA. Report to Congress on indoor air quality: Volume 2. EPA/400/1-89/001C. Washington, DC; 1989.

World Health Organization (WHO). Social Determinants of Health. World Health Organization. Published 2023. Accessed October 18, 2023. https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1

WHO. Health Promotion. World Health Organization. Published 2022. Accessed October 18, 2023. https://www.who.int/westernpacific/about/how-we-work/programmes/health-promotion

WHO. Mental Health and Forced Displacement. World Health Organization. Published August 31, 2021. Accessed October 19, 2023. https://www.who.int/news-room/fact-sheets/detail/mental-health-and-forced-displacement

THE TEAM.

The Team

Perkins&Will Research Team

David Cordell
FASID, LEED AP, WELL AP

Erika Eitland
MPH, ScD

Amina Helstern
LEED ID+C, NCIDQ, Fitwel

Tyrone Marshall
MS, LEED AP BD+C, NOMA

Devika Tandon
AIA, NCARB, LEED Green Associate, EcoDistricts AP, WELL AP

Eunice Wong
RPP, MCIP, LEED AP ND

Julio Brenes

Jenna Bracaglia
AIAS

External Collaborators

Kate Hardock
MPH

Yoji Toriumi

Jonathan Yedahm Lee

Funding Provided By

American Society of Interior Design Foundation (ASIDF)

Perkins&Will

PRECEDE

Public Repository to Engage Community and Enhance Design Equity

V1.0.11.29.2023

Perkins&Will