Using Data to Understand and Improve Health Outcomes Storyline Outline

Unit Driving Question: How can where you live affect health outcomes from respiratory diseases?

Approximately 15 50-minute class periods

Lesson Question	Phenomena	What Students Do and Figure Out
Lesson 1 Why are there differences in case numbers and health outcomes of respiratory disease at the country, regional, and local levels? Ask questions and consider patterns in data that could explain the differences in case numbers and health outcomes of respiratory diseases at the country, regional, and county levels. Two 50-minute class periods	• **In 2019, Chronic Respiratory Diseases (CRDs) were responsible for an estimated 4.0 million deaths and 454.6 million cases globally**. Source: GBD 2019 Chronic Respiratory Diseases Collaborators. Global burden of chronic respiratory diseases and risk factors, 1990–2019: an update from the Global Burden of Disease Study 2019. eClinicalMedicine. 25 April 2023. doi: 10.1016/j.eclinm.2023.101936. • **In 2019, there were an estimated 2.4 million deaths due to Lower Respiratory Infections (LRIs) and 488.9 million incident cases of LRIs globally.** Source: Safiri S, Mahmoodpoor A, Kolahi AA, Nejadghaderi SA, Sullman MJM, Mansournia MA, Ansarin K, Collins GS, Kaufman JS, Abdollahi M. Global burden of lower respiratory infections during the last three decades.Front Public Health. 2023 Jan 9;10:1028525. doi: 10.3389/fpubh.2022.1028525. PMID: 36699876; PMCID: PMC9869262. • **The 2019 Top 10 Causes of Death Globally by Income Group: Respiratory diseases are in the top five causes of death across income categories, but the order and specific type of disease differ by income group.** Source: WHO • **Case and health outcomes differences in** Respiratory Disease Data for Several US Communities.	High school students, as scientists, ask questions and identify patterns in data to answer the following driving question: Why are there differences in case numbers and health outcomes of respiratory disease at the country, state, and county levels? Students watch a Public Service Announcement about the health risks posed by exposure to air pollution. To begin investigating air pollution's potential health effects, students evaluate information about different categories of respiratory diseases. From there, students analyze data about the Top 10 Causes of Death Globally by Income Group between 2000 and 2019, and note that respiratory diseases are in the top five causes of death across income categories, but the order and specific type of disease differ by income group and geography. To begin to explain these differences, students decide to look at data at a smaller scale – states and counties in the United States. This data introduces additional disparities in both case numbers and health outcomes. Next, students investigate their initial questions about the health effects of air pollution. Finally, students will create an individual initial model to explain the differences in respiratory disease case numbers and health outcomes observed in the data. Students will share these initial models to look for similarities and differences, and to help them surface questions they need to answer to explain the phenomena. **What students will figure out** • Air pollution poses risks to human health. • There are differences in case numbers and health outcomes of respiratory diseases at the country, state, and county levels. • One of the components of air pollution is PM2.5, very small particles that can become trapped in the air sacs of the lungs and pass from there into the bloodstream. PM2.5 can be made up of a variety of substances, including inorganic ions, metallic compounds, elemental carbon, organic compounds, and compounds from the earth's crust.

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Say, "*We have a lot of great ideas about how to continue our investigation! Based on our discussion, we have figured out the following: One component of air pollution is PM2.5 which can enter the body and get stuck in air sacs in the respiratory system. It looks like we need more information about what PM2.5 does once it is 'stuck' there. "*

Lesson 2 How can we investigate the relationship between PM2.5 exposure and respiratory diseases? Apply concepts of statistics and probability to determine the relationship between potential variables that can affect health outcomes of respiratory diseases. Gather, read, and evaluate scientific or technical information from multiple authoritative sources to explain how exposure to PM2.5 can affect the expression of genes that regulate feedback mechanisms in the immune system, which in turn can affect health outcomes of respiratory diseases. Two 50-minute class periods	• The 2019 Top 10 Causes of Death Globally by Income Group: Respiratory diseases are in the top five causes of death across income categories, but the order and specific type of disease differ by income group. Source: WHO • Case and health outcomes differences in Respiratory Disease Data for Several US Communities.	High school students, as scientists, use science ideas about structure and function, variation of traits, and cause and effect to answer the following driving question: How can we investigate the relationship between PM2.5 exposure and respiratory diseases? Students obtain and evaluate information and consider the limitations of data to investigate the relationship between PM2.5 exposure and respiratory diseases. Using evidence from the resources, students revise their initial models to include an explanation of the relationship between PM2.5 and respiratory diseases. **What Students Will Figure Out** • The correlation coefficient is a quantitative measure of the strength of a relationship between two variables. • The data we analyzed from two studies showed a correlation between PM2.5 concentration and hospitalization for respiratory diseases. • Once inside the body, PM2.5 can lead to increased expression of genes that code for cytokines, which can lead to inflammation. • Acute (less than one month) PM2.5 exposure has also been linked to DNA methylation of genes that regulate the immune system. • Long-term PM2.5 exposure has also been linked to increased levels of other molecules that are used to measure inflammation, such as C-reactive protein (CRP). • When considering exposure to PM2.5 or any variable in the environment, it is important to consider whether it is a short-term or acute exposure, or a long-term, chronic exposure. • Asthma, Chronic Obstructive Pulmonary Disease, and Lower Respiratory Infections all involve increased inflammation and narrowing of airways.

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A lot of our questions are about PM2.5 levels in different countries, states, and counties. Let's investigate that next!

Lesson 3
How can where and how you live affect your exposure to PM2.5?
 	
Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the limitations of data to explain how indoor and outdoor environmental factors have affected geospatial disparities in respiratory disease case numbers and health outcomes.
 	
One 50-minute class periods
	• The 2019 Top 10 Causes of Death Globally by Income Group: Respiratory diseases are in the top five causes of death across income categories, but the order and specific type of disease differ by income group.
	Source: WHO
	
	• Case and health outcomes differences in Respiratory Disease Data for Several US Communities.
		High school students, as scientists, use science ideas about structure and function, variation of traits, and cause and effect to answer the following driving question: How can where you live affect your exposure to PM2.5? Students begin by reflecting on which of their questions about the anchoring phenomena they can answer and which they need to investigate. They also consider how to investigate their questions. Next, students evaluate information and analyze data from multiple sources to explain the differences in case numbers and health outcomes in the respiratory disease data. Finally, students update their models to explain how differences in exposure to PM2.5 from outdoor and indoor pollution connect to the differences in health outcomes from respiratory issues globally and within the US.
		
		What Students Will Figure Out
		
		• Globally, the different income group categories had different levels of exposure to PM2.5 according to data from 2021.
		  ○ LMICs and UMICs had the highest percentages of people breathing unsafe and hazardous air.
		  ○ The percentage of people in LICs and HICs exposed to hazardous levels of PM2.5 was much lower than in LMICs and HMICs.
		• Different counties in the United States had different exposure to PM2.5 between 2016 and 2019.
		  ○ In several cases, counties with higher numbers of deaths from CLRDs or LRIs also have higher PM2.5 levels.
		  ○ There were also cases where the counties that had the highest PM2.5 levels did not have the highest mortality rates from CLRDs or LRIs.
		  ○ Data from 2014 showed racial differences in exposure to PM2.5 in the United States.
		• Since there are some differences within and between US states that can't be fully explained by exposure to PM2.5, PM2.5 might not be the only factor that affects health outcomes from respiratory diseases.

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After analyzing the data, we have concluded that some differences in health outcomes can't be fully explained by exposure to PM2.5.What else is different about these counties?

Lesson 4 What factors contribute to differences in the health outcomes of respiratory diseases within the US? Plan an investigation to examine how additional factors impact differences in health outcomes between communities. Analyze data from a set of communities to identify patterns in access to community resources. Two 50-minute class periods	• We have seen differences in health outcomes at the county level, state, and country level. Sources: Respiratory Disease Data for Several US Communities, WHO • At the country level, we observed differences in health outcomes linked to income. Source: WHO • Now we see income levels are drastically different in different parts of the counties we studied.	High school students, as scientists, design an investigation to identify patterns to answer the following driving question: What factors contribute to differences in the health outcomes of respiratory diseases within the US? Students begin by looking at maps of different communities to find similarities and differences in community resources. To begin to explain these differences, students decide to look at data at a smaller scale – moving from looking at county-level data to neighborhood-level data. Students share their observations about resource availability in different neighborhoods. Finally, students decide they need to collect more data at the neighborhood level before they can define the relationship between the availability of each resource and differences in health outcomes. **What Students Will Figure Out** • Counties are too large to identify cause and effect patterns between PM2.5 levels or income and differences in health outcomes. • Some counties are mostly rural, and some are mostly urban, but some counties have rural, suburban, and urban areas. • There are big differences in income within some counties. • There are other variables, such as access to pharmacies and transportation options, that vary within counties. • By changing the scale of our investigation from the county level to the neighborhood level, we may be able to reduce some confounding variables. • There is a lot of variation in resources available between neighborhoods in the same county. • However, when we look within neighborhoods, they seem to be more uniform and similar in regard to the factors we have examined so far.

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As students finish sharing their observations, ask what questions arose as they analyzed the data. Use talk moves to facilitate the discussion around the goal of thinking about correlation and causation and how confounding variables may make it challenging to identify cause-and-effect relationships. Then, use this conclusion to motivate the need for more data.

Sample Student Responses

- We could see the resources available in the different neighborhoods, but it was hard to make connections to the county-level data about respiratory infections and chronic lower respiratory disease.
- We observed differences between neighborhoods, and these differences seem to be connected to the data we have about income, but are these differences connected to health outcomes?
- Are there other factors we haven't considered yet that also impact the health outcomes we've studied?
- Can we get more detailed data about each of these neighborhoods?

Lesson 5 How does access to resources at the neighborhood level impact health outcomes? Analyze data and identify patterns to evaluate how health outcomes may be impacted by various factors that may not have equal effects in all cases. Revise and use a model to examine the impact of factors that contribute to health disparities. Three 50-minute class periods	• Differences in health outcomes at the county level, state, and country level Sources: Respiratory Disease Data for Several US Communities, WHO • Differences in respiratory disease case numbers at the neighborhood level Source: Zip Code Respiratory Disease Data	High school students, as scientists, use science ideas about patterns and cause and effect to answer the following driving question: How does access to resources at the neighborhood level impact health outcomes? Students begin by analyzing zip code-level respiratory disease case data. Next, students analyze census data at the zip code level and attempt to identify patterns and cause and effect relationships. After identifying limitations of the data and recognizing that certain factors do not have equal effects in all cases, they read an article about the factors public health research has identified as contributors to health disparities. Finally, students use the data analyzed and information evaluated in the unit to develop a class consensus model and an individual explanation of the factors contributing to disparities in respiratory diseases at the country, state, county, and zip code levels. **What Students Will Figure Out** • There were differences in the number of respiratory disease cases between the neighborhoods studied. • When we analyzed the census data, we found differences between the neighborhoods, including access to medical facilities, insurance coverage, household size, job types, and income levels. • When we compared the census data to the respiratory disease data, we did not always see consistent patterns. Each factor or potential cause did not always have the same effect. • Research has identified five domains of Social Determinants of Health (SDOH) that contribute to health disparities: economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context. • The data show differences at the zip code level in the five domains of SDOH that could explain the disparities in respiratory disease cases and outcomes identified at the national, state, county, and zip code levels.

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Say, “We have a useful model to help us consider how various factors may contribute to disparities in respiratory disease case numbers and outcomes. The article also gave us some initial ideas about how to design solutions to health disparities in order to move toward health equity. In the next lesson, we will use our model to plan a mitigation strategy for a health disparity of your choice.”

Note: Based on feedback, we have revised and incorporated parts of the former Lesson 6 into this lesson. Lesson 5 now moves into Lesson 7. At this time, we have not changed the numbering on the PDF of Lesson 7.

Lesson 7 What can we do to mitigate negative health outcomes of respiratory diseases for at-risk populations? Analyze patterns in data at different geographic and time scales to select and explain a targeted mitigation strategy for those affected by respiratory issues. Two-50 minute class sessions	**Problem:** • The 2019 Top 10 Causes of Death Globally by Income Group: Respiratory diseases are in the top five causes of death across income categories, but the order and specific type of disease differ by income group. Source: WHO • Case and health outcomes differences in Respiratory Disease Data for Several US Communities	High school students, as scientists, analyze and identify patterns in data to answer the following driving question: What can we do to mitigate negative health outcomes of respiratory diseases for at-risk populations? Students begin by revisiting Lessons 1-6 to consider problems that they are particularly interested in solving. Students identify the focal problem for a mitigation plan project and consider the geographic and time scale of their plan. Additionally, students research the careers and roles involved in public health work and what comprises a public health campaign. Finally, students identify their audience and prepare a presentation to persuade them to enact change. Groups prepare their presentations, receive peer feedback, and make revisions. **What Students Will Figure Out** • By analyzing data to identify patterns, students determine which mitigation strategy to recommend. • If we know the patterns for different conditions, we can develop an outreach strategy to help educate people on how to manage their risk of negative health outcomes from respiratory conditions. • There are many careers and roles that connect to public health.
Navigation *What are the realities public health campaigns often come up against? What challenges do public health campaigns encounter? How do they attempt to overcome them?*		
Lesson 8 How can we effectively communicate actionable public health information? Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the limitations of data to explain the cause-and-effect relationship between access to information and other factors and how humans respond to public health recommendations.	**Problem:** Tobacco use is the leading cause of preventable disease, disability, and death in the United States. An estimated 28.3 million U.S. adults smoke cigarettes, and about 2.80 million U.S. middle and high school students use at least one tobacco product, including e-cigarettes. Each year, nearly half a million Americans die prematurely of smoking or exposure to secondhand smoke. Another 16 million live with a serious illness caused by smoking. Each year, the United States spends more than $225 billion on medical care to treat smoking-related diseases in adults. Source: CDC	High school students, as scientists, obtain and evaluate information and analyze and identify patterns in data to answer the following driving question: How can we effectively communicate actionable public health information? Students begin by considering why people don't follow the advice of public health officials and consider ways they could identify characteristics of successful public health campaigns. Next, students students review the key(s) to effective campaigns and apply those components to their own presentations. Finally, students apply research and feedback to revise their presentation and present it to the selected audience. **What students will figure out** • Common components of successful public health campaigns. • Access to information, the presence of misinformation, access to health care, access to jobs, the complexity of these factors, and other factors influence how humans can and do respond to issues of public health. • These factors (e.g., access to information, access to health care, access to jobs) are structural factors that make up a larger system of issues that affect how people experience public health issues.

Two 50-minute class periods		● There are strategies we can use and questions we can ask to determine if information is verifiable and reliable.