Using the Pandemic Vulnerability Index Model to Examine the Risk Factors Associated with COVID-9

Introduction

What is This Curriculum?

COVID-19, an emerging infectious disease caused by a novel coronavirus SARS-CoV-2, has caused unprecedented disruptions to billions of human lives. There are many factors involved in the emergence of new infectious diseases or the re-emergence of "old" infectious diseases. While some factors are a result from natural processes such as the evolution of pathogens over time, many are results of human behavior and practices. In addition, many emerging infectious diseases arise when infectious agents in animals are passed to humans (referred to as zoonoses). As human populations expand into new geographical regions, the possibility that humans will come into close contact with animal species that are potential hosts of an infectious agent increases.

This curriculum is designed to guide students as they explore various risk factors involved in the spread and resulting mortality of COVID-19, including biological, socio-economic, and environmental factors. The Pandemic Vulnerability Index (PVI), an epidemiological model developed by researchers at North Carolina State University, the National Institute of Environmental Health Sciences (NIEHS), and Texas A&M University will be used in this module (https://covid19pvi.niehs.nih.gov/). In working with the PVI model, students have opportunities to practice the Next Generation Science Standards (NGSS) Dimension 1: Scientific and Engineering Practices, and Dimension 2: Crosscutting Concepts.

Why Has NIEHS Developed This Curriculum?

Theme two of the NIEHS Strategic Plan 2018-2023 states, "The NIEHS mission directive on information recognizes that the value of Advancing Environmental Health Sciences (EHS) knowledge can only be fully realized through its use by the public, health providers, regulators, and policy holders, to help inform their decisions." NIEHS engages in establishing strong lines of communication and partnerships with community members; educational outreach has been an integral part of this effort. In addition, NIEHS remains committed to uncovering the exposure burdens that combine with other social determinants of health to create health disparities, such as age, gender, education, race, and income.

This curriculum uses the COVID-19 PVI as a model to examine vulnerability to COVID-19 at the county level from multiple perspectives, including infection rate, intervention measures such as social distancing, testing, and social determinants such as health disparities associated with race and socioeconomic status. Goals for creating this curriculum are to: (1) provide a tool for students to examine the spread and health outcomes of a pandemic; (2) promote students' awareness of the impact of various factors (biological, social, behavioral, etc.) on the spread and outcomes (such as death or recovery) of an infectious disease; and (3) assist in the development of prevention and intervention strategies to minimize or avoid exposures to risk factors and their adverse health impacts.

Grade Level

Grades 9-12

Units Included in This Curriculum

- Examining a population's susceptibility to COVID-19 by using the Population Vulnerability Index (PVI) model, https://covid19pvi.niehs.nih.gov/.
- Social determinants of health and COVID-19, Part I: Social determinants.
- Social determinants of health and COVID-19, Part II: Environmental determinants.

Learning Objectives

By the end of this curriculum, students should be able to:

- Describe what a mathematical model is and the purpose of using it.
- Examine the social factors that contribute to the spread of an infectious disease.
- Analyze the environmental factors that contribute to the spread of an infectious disease.
- Suggest intervention strategies to mitigate the impact of an infectious disease on public health.

Alignment to the Next Generation Science Standards (NGSS)

This curriculum integrates multiple science and engineering practices and crosscutting concepts as described in the Next Generation Science Standards:

- Develop and use models.
- Use mathematics and computational thinking.
- Analyze and interpret data.
- Construct explanations (for science) and design solutions (for engineering).

North Carolina (NC) Essential Standards Applied to This Curriculum

- NC **Math 1** Standards
  NC.M1.F-LE.5—Interpret expressions for functions in terms of the situation they model.
  https://files.nc.gov/dpi/documents/curriculum/mathematics/scos/current/math-1.pdf

- NC Essential Standards, **Health Education**, High School
  9.PCH.1.1—Recognize that individuals have some control over risks for communicable and chronic diseases.
  https://files.nc.gov/dpi/documents/curriculum/healthfulliving/new-standards/healthful-living/9-12.pdf

- NC Essential Standards, **American History 2**
  AH2.H.8.3—Evaluate the extent to which a variety of groups and individuals have had opportunity to attain their perception of the "American Dream" since Reconstruction. The student will understand the ideal of opportunity may not always be attainable or equitable for everyone.
  https://files.nc.gov/dpi/documents/files/american-history-2-unpacking-document.pdf

- NC **English Language Arts**, Grades 11-12, Reading Standards for Informational Text
  RI.11-12.7—Integrate and evaluate multiple sources of information presented in different media or formats, including visually and quantitatively, as well as in words in order to address a question or solve a problem.
  https://files.nc.gov/dpi/documents/curriculum/languagearts/parents/standards-11-12.pdf

- NC Essential Standards, **Biology**
  Bio.2.2.1—Infer how human activities (including population growth, pollution, global warming, burning of fossil fuels, habitat destruction, and introduction of nonnative species) may impact the environment.

  Bio.3.4.3—Develop a cause and effect model for the role of disease agents in natural selection including evolutionary selection of resistance to antibiotics and pesticides in various species, passive/active immunity, antivirals, and vaccines.
  https://files.nc.gov/dpi/documents/curriculum/science/scos/support-tools/unpacking/science/biology.pdf

Common Core Standards Aligned with This Curriculum

English Language Arts and Literacy Standards

- CCSS.ELA-Literacy.RI.11-12.3—Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.
  http://www.corestandards.org/ELA-Literacy/RI/11-12/

- CCSS.ELA-Literacy.W11-12.1—Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
  http://www.corestandards.org/ELA-Literacy/W/11-12/

- CCSS.ELA-Literacy.W.11-12.5—Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
  http://www.corestandards.org/ELA-Literacy/W/11-12/

- CCSS.ELA-Literacy.W11-12.6— Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information
  http://www.corestandards.org/ELA-Literacy/W/11-12/

- CCSS.ELA-Literacy.W11-12.7—Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
  http://www.corestandards.org/ELA-Literacy/W/11-12/