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Building the pipeline: programs to introduce middle school, high school, medical, and veterinary students to careers in epidemiology and public health

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Abstract

Purpose: This report describes Centers for Disease Control and Prevention programs that expose students to epidemiology and public health sciences (EPHS).

Methods: The Science Ambassador workshop targets middle and high school teachers and promotes teaching EPHS in the classroom. The National Science Olympiad Disease Detectives event is an extracurricular science competition for middle and high school students based on investigations of outbreaks and other public health problems. The Epidemiology Elective Program provides experiential learning activities for veterinary and medical students.

Results: As of 2016, 234 teachers from 37 states and territories and three other countries participated in SA workshops. Several are teaching units or entire courses in EPHS. The National Science Olympiad Disease Detectives event exposed approximately 15,000 middle and high school students to EPHS during the 2015e2016 school year. The Epidemiology Elective Program has exposed 1,795 veterinary and medical students to EPHS.

Conclusions: Students can master fundamental concepts of EPHS as early as middle school and educators are finding ways to introduce this material into their classrooms. Programs to introduce veterinary and medical students to EPHS can help fill the gap in exposing older students to the field. Professional organizations can assist by making their members aware of these programs.

Keywords

Teaching; Epidemiology; Public health; Education; Curricula

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Introduction

Previously considered a postgraduate field for masters or doctoral-level students, public health is among the fastest growing undergraduate majors in the United States [1]. Some persons have asked if reasons exist why epidemiology cannot be taught at the middle and high school level [2]. Although the lack of trained teachers, grade-appropriate course materials and space in an already crowded curriculum may be obstacles, these have all been overcome and many high schools now offer courses in epidemiology and public health sciences (EPHS)[1]. In addition to career possibilities, learning about epidemiology empowers students to be scientifically literate participants in decisions concerning public health policy and to make informed decisions regarding their personal health. It can also improve students' mathematical and scientific literacy, expand their understanding of the scientific method, and develop critical thinking and problem-solving skills [3]. Student interest in applied science-related fields, including EPHS, can begin before 10th grade [4] and continue across the education spectrum. To meet the growing demands for early exposure to public health, at least four states (Georgia, California, Tennessee, and Washington) provide high school credit for EPHS courses. The Centers for Disease Control and Prevention (CDC) has successfully promoted teaching EPHS in middle and high schools for approximately 20 years. Two CDC programs, the Science Ambassador (SA) workshop for middle and high school teachers and the National Science Olympiad Disease Detectives (NSODD) event, include middle school teachers and students, respectively. The focus is primarily on applied and field epidemiology, surveillance, control and prevention using examples from outbreaks and other public health problems. To support graduate-level students in transitioning to the field of public health, CDC also sponsors an epidemiology elective practicum for medical and veterinary school students. The Epidemiology Elective Program (EEP) addresses the need for health professionals who can work in both public health and clinical medicine, by providing practical, hands-on experiences in public health. Each of these activities is described in some detail in this article.

CDC Science Ambassador workshop

The 5-day professional development SA workshop at CDC's Atlanta, Georgia, headquarters represents a collaboration between teachers and CDC scientists [5,6]. Since 2004, CDC scientists have presented information regarding current public health topics (e.g., outbreak investigations, surveillance, and emergency response) and worked with teams of teachers to develop effective EPHS lesson plans that use interactive teaching strategies that align with national science standards. These strategies include use of case studies, peer instruction, flipped classroom, inquiry-based labs, cooperative learning, experiential learning, and more. Although these strategies are different from those normally used in undergraduate or graduate settings, they are the same as those used to teach other high school level courses. Lesson plan topics have included infectious disease, chronic disease, epidemiology, statistics, and behavioral sciences. This collaboration has produced approximately 100 technically accurate and timely lesson plans (https://www.cdc.gov/careerpaths/

[1]We consider EPHS to include applied epidemiology (including sources of experimental error such as bias and confounding), public health surveillance, emergency response, and prevention effectiveness.

scienceambassador/resources/lesson-plans/index.html) that are used around the world to bring EPHS-based examples into the classroom [7]. As of 2016, a total of 234 teachers representing 37 U.S. states and territories and three other countries have participated in the program.

SA program applications have more than quadrupled during the last five years. Workshop sessions involve training in epidemiology and public health, pedagogy and lesson plan development, and tours, walk-throughs, and other special sessions (Table 1). New program components that provide additional structure and support peer mentorship and use of competency-based public health resources have been pilot tested. These include bringing past participants back for a second or third year and having them relate their experiences to first year participants; periodic postworkshop communication with participants; and, increased use of case studies and interactive adult educational methods. Postworkshop activities are also being expanded to meet the growing demand for additional training and support. Participants are encouraged and supported to develop modules or entire courses in EPHS and to train their peers by presenting material at local, state, or national conferences. Previous SA program participants have successfully led efforts to add EPHS to the state high school curricula in California and Washington. If resources become available, CDC intends to expand this program to include a comprehensive EPHS course curriculum and regional training for teachers to support these efforts.

The success of these pilot programs has led to the launch of an inaugural SA Fellowship in 2017. Teacher fellows will attend the 5-day summer workshop and collaborate with CDC scientists and peer teachers who already teach EPHS in their classroom. Teacher fellows will then collaborate with their team and CDC remotely for one year to finalize and pilot EPHS lesson plans in their classrooms, present them at local teacher conferences or meetings, and consult on the development of EPHS-based resource materials for middle and high school teachers nationwide. For teachers wanting to participate in only a short training, SA hopes to provide 3-day teacher trainings in EPHS at sites across the United States by 2020.

National Science Olympiad Disease Detectives event—Extracurricular activities have the potential to introduce young persons to EPHS careers [4,8–11]. The National Science Olympiad (NSO; www.soinc.org) is an extracurricular program dedicated to improving the quality of K-12 science education, increasing interest in science, creating a technologically literate workforce, and providing recognition for outstanding achievement by both students and teachers [9,11,12]. NSO includes a series of regional, state, and national tournaments involving 23 separate science or engineering events. The Disease Detectives event has been a part of the competition since 2000. CDC has provided training and resources for coaches and regional and state event developers, and works with NSO to update rules and content. CDC staff develop events for national tournaments and host first-place high school teams on a tour of its Atlanta, Georgia, headquarters. The majority of the work is provided by the thousands of teacher and parent coaches, event supervisors, and state directors who train, plan, organize, conduct, and manage the program.

The Disease Detectives event started as a high school level competition with a focus on applied epidemiology. Concepts included in *The Principles of Epidemiology in Public*

Health Practice, third Edition [13] represent a substantial amount of the subject matter. NSO Disease Detectives competitions include a written exam and follow a scenario-based, case-study format with objective questions and detailed scoring rubrics. Students compete in teams of two and are encouraged to collaborate and consult with their teammates during competition.

The high school student success with the NSODD event led CDC to sponsor introduction of the event into middle school competition in 2006. The intent was to expose students to the fundamental principles and concepts of EPHS for seven years (three years in middle school and four years in high school) and include more complex and sophisticated principles in the high school competitions (Table 2). In 2012 for example, experimental error, including the concepts of bias and confounding, was introduced into high school competitions, and in 2014 basic descriptive and analytic statistics became part of the competition. Plans are to make NSODD more interactive, possibly by adding a component where teams would propose projects to address specific public health problems before the tournament. During 2015e2016, approximately 7500 middle and high schools competed in NSODD. Because each NSODD team included at least two students, approximately 15,000 middle and high school students were exposed to EPHS.

Our experience demonstrates that, when presented in the proper context, middle and high school students can master the material presented in the majority of introductory epidemiology courses. NSO has demonstrated success in bringing students into public health careers. For the first time, in 2016, the first candidate known to have participated in NSODD as a high school student was accepted into CDC's Epidemic Intelligence Service (EIS) program, a 2-year, post-doctoral program in applied epidemiology (https://www.cdc.gov/EIS/).

CDC epidemiology elective program—Medical and veterinary students have potential to become or work with public health professionals but might not have been exposed to applied EPHS activities during their training. Established in 1975, the CDC EEP provides training for medical and veterinary students in EPHS through applied epidemiology service learning. The EEP also introduces medical and veterinary students to EIS and careers in public health [14].

During their EEP rotation, students engage in applied epidemiology through projects that may include working with surveillance systems, collection and analysis of data, developing guidelines for public health problems, or conducting literature reviews and metaanalyses. If feasible, EEP participants are also deployed with EIS officers to the field for outbreak investigations [15–17]. During the 6- to 8- week rotation at CDC, EEP participants attend CDC seminars, including weekly epidemiology grand rounds presentations given by EIS officers that are based on field investigations or analytic studies (i.e., Tuesday Morning Seminar).

EEP is an effective means to generate interest inpublic health and CDC. From June 1975 through May 2016, 1795 students joined the EEP. Of these, 221 (12.3%) became EIS

officers by July 2016, with 17 in EIS training. Of 204 EEP alumni who graduated EIS by July 2016,134 (65.7%) were employed in public health as their first job after EIS.

EEP provides real-world experience in public health and applied epidemiology through service learning and agency seminars. Hands-on activities give EEP participants an understanding of the work of CDC public health professionals. Examples of projects conducted by recent EEP participants include data analysis on the clinical presentation of botulism, developing a risk assessment tool for a study on rabies in Haitian dogs, a qualitative analysis of cancer-control plans and analysis of *Brucella canis* exposure data from diagnostic labs across the United States. Field deployments enable participants to work with EIS officers during outbreak responses, see first-hand how CDC works with partners, and practice their clinical skills in a public health setting. Seminar attendance allows participants to gain the perspective needed to work at the intersection of clinical medicine and public health.

EEP engages students early during their training to prepare them for future careers, whether they choose to work in clinical or public health settings. Students are better able to work collaboratively across disciplines and gain an introduction to the work of public health practitioners, develop a better understanding of prevention, and gain first-hand knowledge of public health systems and approaches used. EEP participants learn about population health and are better positioned to actively participate in and lead the health system.

Conclusion

The work to bring EPHS into middle and high schools has been under way for approximately twenty years. Establishing a firm base at the high school level before moving to later grades and keeping a focus on applied epidemiology is less challenging than has been suggested [18] and may have benefits beyond promoting public health as a career [2,3,19,20]. Most educators do not have an EPHS background; however, as evidenced by the SA program success, many educators have acknowledged the importance of EPHS and found ways to incorporate concepts and principles into the classroom. SA participants have reported good results from team teaching EPHS with courses in English and advance placement statistics. Introducing students to EPHS as early as middle school through the SA program and NSODD and again in professional education programs through EEP will add to the public health workforce and increase awareness of public health among health care professionals and the public. Postgraduate programs such as EEP can expose students missed by middle and high school programs and reinforce those earlier exposures at a time when career decisions are likely to be made. CDC encourages the American College of Epidemiology and other professional organizations to support this trend.

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Table 1

Examples of types of sessions and amount of time allotted to each (total hours per week) in CDC Science Ambassador workshops during 2015, 2016 and 2017

Session type	Hours (hrs)/week per session type by year	Examples of session titles/content included in session type
Epidemiology and public health training	2015–13.25 hrs	Case study on outbreak investigations
	2016–8.25 hrs	Opioid use
	2017–13.25 hrs	Zoonotic diseases
		Prevention effectiveness
		Ethics in public health
		Emergency preparedness and response
Pedagogy and lesson plan development	2015–16.25 hrs	Developing EPHS learning objectives
	2016–17.75 hrs	Developing activity outlines
	2017–15 hrs	Curriculum design
Tours and special sessions	2015–11 hrs	Early AIDS investigations in the United States
	2016–17.5 hrs	Tour CDC museum
	2017–14 hrs	Walk through CDC Emergency Operations Center Panel of experts*

CDC = Centers for Disease Control and Prevention; EPHS = epidemiology and public health sciences.

*The panel of experts includes 4–5 CDC staff representing different job descriptions (e.g., epidemiologist, communications specialist, laboratorian, and administrator) and program areas. Each has 10 minutes to describe their career path, current duties, successes, and failures. The remainder of the time is open to questions from the audience.

Table 2

Examples of types of performance indicators used in middle and high school Disease Detectives events by grade level

Grade Level	
Middle school	**High school**
Describe different modes of transmission	Recognize differences between study designs and determine which is most appropriate for a particular situation
Determine rates (attack, incidence, prevalence, case fatality) from narratives	Interpret measures of risk (e.g. relative risk or odds ratio)
Interpret epi curves and temporal patterns.	Calculate measures based on data that are not given but that can be readily extracted from information
Recognize and discuss categories of disease-causing agents (physical and biological)	Recognize how gaps in information influence the ability to extend conclusions to the general population
Explain differences between endemic, epidemic, and pandemic	Recognize unmentioned factors that may influence results or that may cause experimental error (e.g., confounding and bias)
Recognize various types of prevention and control strategies (e.g. immunization, behavior change, etc)	Convert between rates with different basic units (e.g. incidence per 10,000 persons/year to incidence per 100 persons/week)
Understand how units affect the relative magnitude of a set of rates with different units	Propose a means to evaluate the effectiveness of an intervention or control program
Calculate appropriate measures of risk when given the study design	Determine which statistical test is most appropriate to test a given hypothesis and interpret the results of that test
Complete tables when given all data needed to complete calculations	
Propose a reasonable intervention to a public health problem	
Recognize gaps in information	