Preventive Medicine 121 (2019) 105–108

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Review Article

Recruiting epidemiologists: A developmental perspective on expanding epidemiology exposure for adolescents

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ARTICLE INFO

Keywords:
Adolescent
Curriculum
Epidemiologists
Schools
Students

ABSTRACT

Adolescents are at a unique developmental stage that is well-primed for epidemiology instruction. Although a handful of pioneers have focused on expanding epidemiology instruction to teen audiences, there are still no systematic efforts in the United States to attain this goal. In this paper I posit that epidemiologists and other public health professionals are critical to this effort. Epidemiologists from public health agencies, academia and non-profit organizations can engage in partnerships with schools, such as by offering internships and pairing graduate students/mentees with teachers and adolescent learners. Through these efforts, we can leverage teens' natural interests in risk taking, health and wellness, and community change to learn population-level thinking. I posit that these measures can encourage widespread exposure to epidemiology principles, and also enhance the future of public health disciplines.

1. Introduction

Population thinking is unnatural for the population at large (Marantz, 2008; Morabia, 2014). Consider, for example, that most people who have not received epidemiology instruction will interpret the association between tobacco and lung cancer at the individual level. In other words, upon hearing that smoking and lung cancer are linked, they may think, "If I smoke, I will have lung cancer." Teaching epidemiology to high school students on a wide spectrum, however, may anchor in adolescence the correct interpretation, such as, "If I smoke, my lifetime risk of lung cancer will be much higher than if I do not smoke". The latter statement is correct, but requires population thinking skills. Epidemiologists and other public health professionals assume these skills in their training, although they acknowledge that it not easy to acquire them (Marantz, 2008; Morabia, 2014).

Most students receive their first exposure to epidemiology instruction in graduate school, although they, too, face great difficulties understanding foundational population thinking concepts, such as group comparisons, risk, and probabilities (Morabia, 2014). Would public health disciplines be better served by initiating epidemiology instruction at a younger age? Adolescents, to this end, may be optimally primed in their development for epidemiology education. For example, adolescence is characterized by a tremendous shift in health and wellness, and functioning (CDC, 2011). During adolescence, youth begin experimenting with alcohol and drugs, cigarette smoking, sexual activity, and other risk-taking. Cigarette smoking begins, on average, by 12–13 years of age in the United States (US) (Cavazos-Rehg et al., 2009), almost half of youth are sexually active by age 16 (Substance Abuse Mental Health Services Administration (SAMHSA), 2011), and almost 10% of 14–15 year olds use illicit drugs (de Winter et al., 2016). Adolescence is also a period when poor diet, physical inactivity and other unhealthy lifestyle behaviors develop, therein predicting negative health trajectories into adulthood (Sokol et al., 2017). Even though adolescents may be curious about health and behavior, such as asking themselves questions about the safety and consequences of their behaviors, they are reluctant to seek parental guidance as supervision wanes (Frazier et al., 2015). However, many of their questions about health and behavior address public health issues. Moreover, answering these questions requires looking beyond the individual to groups in order to find effective solutions, a skill that most parents are unlikely to posess. In addition, differences are shown in adolescents' self-rated health trajectories over time across race, gender and poverty status (Jaworska and MacQueen, 2015), suggesting that youth may be receptive to teaching strategies that address population-level questions related to health disparities reduction. We can take advantage of adolescents' interests in risk behaviors, public health and safety by bringing these topics into the classroom, and asking students to think about ways to combat real challenges teens face as a population during this unique

Abbreviations: AP, Advanced Placement; CDC, Centers for Disease Control and Prevention; US, United States

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https://doi.org/10.1016/j.ypmed.2019.02.014
Received 8 November 2018; Received in revised form 11 January 2019; Accepted 8 February 2019
Available online 10 February 2019

developmental window.

The teenage years also represent a period during which youth develop greater autonomy from parents, and stronger bonds with peers (Boustani, 2015; Whitlock, 2007). These changes are accompanied by new behaviors in response to internal and external factors, including a greater prioritization of peer influences (Whitlock, 2007). Simultaneously, youth at this age gain the perspective that they can change their environment, including making an impact on their friends, family, school, and neighborhood (Sawyer et al., 2012). In fact, adolescents are considered powerful change agents through community engagement (Davidow et al., 2018). Educators can draw from these changes and this new perspective to help adolescents make the shift from individual to population level thinking. For example, we can foster student connections between health and disease events in the local community and appropriate methods for studying population health. We can in this way encourage adolescents' engagement in epidemiology instruction by capitalizing on their intrinsic interests in effecting community-level change related to public health and wellness.

In addition, adolescence represents a period in cognitive development that is unique from both childhood and adulthood. For example, research on value-guided learning has shown that as children we begin to acquire basic cognitive skills that support our ability to use values to guide what is learned, a forerunner to goal-directed behavior (Williams et al., 2018). As we age, we continue to hone these skills. Interestingly, however, adolescents demonstrate stronger cognitive skills related to value-guided learning as compared to adults in some areas. For example, when compared with adults, teens show stronger abilities to integrate learning based on prior experiences to inform future behaviors (Williams et al., 2018). In this sense, we should appreciate that adolescent cognitive development may present unique strengths that further facilitate population thinking related to drivers of healthy behaviors.

2. Pioneering approaches to adolescent epidemiology instruction

One mechanism for broadening US adolescents' exposure to epidemiology includes extracurricular student science competitions. For example, the Young Epidemiology Scholars (YES) program developed by the Robert Wood Johnson Foundation and offered from 2003 to 11 (Robert Wood Johnson Foundation, 2011a), provided high school students and their teachers with the opportunity to enter annual nationwide competitions on applying epidemiology methods to public health investigations. YES included almost 5000 youth, awarded $3.7 million in college scholarships to almost 1000 students, inspired 75% of participants to pursue a health or science related undergraduate major, and also resulted in a series of teaching resources for secondary school educators hoping to incorporate epidemiology lessons in their curriculums (Robert Wood Johnson Foundation, 2011b).

Another program, the Science Olympiad, includes an epidemiology “Disease Detectives” extracurricular event developed by the Centers for Disease Control and Prevention (CDC) which provides training and resources for coaches, and hands-on engaging epidemiology exercises for youth. The Science Olympiad has exposed thousands of participants to epidemiology and the public health sciences each year at regional, state and national science and engineering tournaments since 2000 (Cordell et al., 2017). Similarly, some high school students who participated in the Think Like an Epidemiologist Challenge as part of a National Institutes of Health-funded Careers in the Biomedical Sciences program showed improvements in scientific self-efficacy and sophistication of epistemological beliefs (Wilson et al., 2018).

Efforts also have been made to expand epidemiology teaching resources available to secondary school teachers. The CDC's Excellence in Curriculum Integration through Teaching Epidemiology online modules are shown to align with K-12 math and science education standards, including interpreting risks, engaging in comparative reasoning, and lifestyle decision making (Stroup and Thacker, 2007). Also, 6th–8th grade students who participated in a simulated outbreak lesson from the curriculum showed increased awareness of epidemiology-related math and science concepts (Stroup and Thacker, 2007).

In addition, the CDC hosts a 5-day Science Ambassador Fellowship for teachers that includes professional development on outbreak investigations, surveillance, and emergency response. Ambassadors (354 total from 2004 to 2018 across 46 states and territories) produce publicly available lesson plans on epidemiology-relevant topics for high school instructors (Cordell et al., 2017; Cordell et al., 2018). Epidemiology professional development guidelines for 6th–12th grade educators have also been described in the literature (Ma et al., 2008).

3. What are the obstacles to broad scale adolescent epidemiology instruction?

Despite these pioneering experiences and increasing interest, there are still no systematic efforts to facilitate mainstream adolescent epidemiology instruction. This may be due in part to time necessary for instructors to design epidemiology curriculums well suited for secondary students (Hlaing, 2014; Hollm-Delgado, 2014). Most high school teachers have limited course preparation time, so they are not inclined, particularly if they lack training in the field, to develop and integrate epidemiology lessons into their current curriculums, or potentially across disciplines and student levels (D'Agostino, 2018). Also, lesson materials must stay current with a field that is continually shifting and expanding (Hlaing, 2014; Hollm-Delgado, 2014). Furthermore, although secondary school epidemiology teaching materials are available online (Centers for Disease Control and Prevention, 2012), it may be difficult for instructors to feel confident in teaching these lessons without sufficient training and guidance. In fact, many high school teachers may not be familiar with epidemiology, and are likely to require focused training to expand their instructional skill sets in order to effectively teach even basic concepts of the discipline.

4. A modified approach to epidemiology instruction for adolescents

An alternative approach to adolescent epidemiology instruction would be to incorporate a more authentic (i.e. “real world”) and student-centered approach to epidemiology lessons within science, mathematics, social sciences, and even humanities classes. These lessons can serve as an introduction to the discipline by first providing students with opportunities to ask questions about public health and wellness impacting their daily lives and communities, and to practice population thinking skills in order to answer these questions. For example, we might ask students to derive a research question (with teacher guidance and mentorship) about what impacts the likelihood of a disease/condition on a topic of inherent interest to their community. Students can next conduct systematic literature reviews with teacher guidance in order to pose a student-driven study hypothesis. Students can furthermore be asked to consider methods for gathering data in order to identify patterns of disease and risk factors for public health issues relevant to their immediate context. Correspondingly, educators can incorporate student-proposed methods for data collection into lessons that address descriptive versus analytic study designs.

Teaching epidemiology to teens in this way may be more attainable and sustainable than current approaches because youth would drive their own learning, and teachers would serve as mentors and facilitators on research questions jointly framed by student and instructor. This approach is derived from empowerment education theory, which is well-established in the pedagogical literature (Rudd and Comings, 1994; Wallerstein and Bernstein, 1988; Wallerstein, 2002; Novak, 2002) and universal to best practices and robust instruction (Wallerstein and Bernstein, 1988; Novak, 2002; Ritchhart et al., 2011; Duckworth, 1996). Empowerment learning emphasizes advancement in status (social, health-related, or otherwise), through active

participation and engagement in community change. This approach also provides instructors with the ability to shape students' inquiries and related assignments within the context of the course matter at hand. Regardless of the topic area and instructional objectives, educators can provide youth with explicit and authentic opportunities to engage in population thinking.

5. What can epidemiologists do to support adolescents' exposure to epidemiology?

Epidemiologists and public health professionals can play a critical role in the success and sustainability of secondary school epidemiology instruction. Adolescents can interact with and be mentored by members of the field from public health agencies, universities, and non-profit organizations through guest lectures, supervision on research projects and career guidance. Correspondingly, public health professionals would need to welcome and embrace opportunities to support school teachers and students in broadening exposure to epidemiology. Two examples of established programs for youth to gain firsthand public health and research experience in Epidemiology include NYC Ladders for Leaders (NYC Department of Youth and Community Development, 2019) and Pencil (2019). In more rural settings, it may be possible to establish distance-learning mentorships, such as through regular Skype communication with a public health professional, attending departmental meetings remotely, and using various other online platforms (e.g. GoToMeeting; WebEx) that permit screen sharing and video conferencing to facilitate simultaneous viewing and discussion of teaching materials.

Also important, epidemiologists can forge partnerships between their home institutions and secondary schools (Wilson et al., 2018). Some authors, in fact, have called for university-secondary school collaborations as a mechanism for public health promotion and disparities reduction (D'Agostino, 2018). For example, graduate students can aid high school educators by serving as teaching assistants, such as in developing curriculum content and mentoring youth directly. Public health schools and administrators could facilitate this process by including high school teacher support as a way for graduate students to fulfill capstone and other field work requirements. Likewise, public health agencies could engage adolescents by offering high school internships and job shadowing. There is, in fact, increasing interest from the field for expanding epidemiology education at the high school level (Stroup and Thacker, 2007; D'Agostino, 2018; Fine et al., 2013; Bracken, 2014). The CDC also has supported high school epidemiology education for two decades (Cordell et al., 2017), and provides a model for public health organization-educator partnerships to inform curriculum and state science learning standards (Cordell et al., 2018).

Epidemiologists can also partner with high school teachers who may have prior experience in teaching select public health concepts as part of advanced curriculums. For example, many advanced placement (AP) courses, including AP Environmental Science, Biology, and Human Geography, address topics such as population dynamics, migration, and ecology, and their relationship to disease and research design. These teachers could attend brief (i.e. 2-day) trainings on implementing the instructional approach outlined here for a wider student body (i.e., not only advanced students). Lead teachers could then support/co-teach with more junior faculty to disseminate the approach across student levels and disciplines within the school. Similar trainings and implementation structures have received extremely positive feedback across 13 districts in Texas by teachers, students and administrators aiming to promote high school student exposure to epidemiology (Texas Science, Technology, Engineering and Mathematics (T-STEM) Centers, n.d.). School teachers and administrators also are more likely to participate in this effort if provided with adequate assistance and guidance (Wilson et al., 2018). This is particularly the case given sufficient overlap between the instructional approach described here exposure to epidemiology, and current national education standards, including fostering student scientific thinking and authentic practice (National Research Council, 2012; National Research Council, 2013).

On a final note, it is necessary to expand dedicated funding sources to promote the success of these partneships to expand high school epidemiology education. The CDC, for example, devoted additional funding in 2017 to the expansion of their epidemiology training program for high school educators from one week to a year-long fellowship (Cordell et al., 2018). Similarly, funding for scholarships, grants and fellowships would also be necessary to support graduate mentees, faculty mentors/partners, and high school student researchers/interns in these efforts.

6. Conclusions

In this article I have framed adolescence as an optimal developmental period for initiating epidemiology instruction. We can leverage teens' natural interests in risk taking, public health and wellness, and community change to learn how to think on a population level. Epidemiologists and public health professionals can play a vital role in this process by partnering with high schools, supporting adolescent learners via mentoring and internships, and pairing graduate students/mentees with teachers to assist with curriculum and instruction. I posit that these efforts will promote broadscale access to population thinking, and furthermore enhance the future of public health disciplines.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

N/A.

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