

Public health graduates in the United States

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Public Health Graduates in the United States: Employment Outcomes and Employer Demand

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Public Health Graduates in the United States: Employment Outcomes and Employer Demand

DISSERTATION

To obtain the degree of Doctor at Maastricht University, on the authority of the Rector Magnificus Prof.dr. Rianne M. Letschert, in accordance with the decision of the Board of Deans to be defended in public on Wednesday, December 15, 2021, at 10.00 hours.

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Chapter 1: *Introduction*

INTRODUCTION

PRESENTATION OF THE INVESTIGATED FIELD

Public Health and the Public Health Workforce

The World Health Organization defines *public health* as “the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society”¹, and public health has also been defined as “what we as a society do collectively to assure conditions in which people can be healthy.”² Public health is a broad field, encompassing protection of populations from disease and injury, prevention of disease, and promotion of health. The World Health Organization (WHO) describes public health as delivering the 10 Essential Public Health Operations (EPHO)³, while the US Centers for Disease Control and Prevention (CDC) lists 10 Essential Public Health Services (EPHS),⁴ and the US Public Health National Center for Innovations (PHNCI) describes the functions of local and state government public health departments as Foundational Public Health Services,⁵ including foundational infrastructure and capabilities such as “assessment/surveillance, emergency preparedness and response, policy development and support, communications, community partnerships, organizational administrative capabilities, accountability/performance management”; and specific topic areas which should be addressed such as “communicable disease control, chronic disease and injury prevention, environmental public health, maternal, child and family health, and access to and linkage to clinical care.”⁵

Public health services are delivered by individuals who work in the field; these *public health professionals* have been defined as those who are “educated in public health or a related discipline ...employed to improve health through a population focus.”⁶ Public health professionals comprise the *public health workforce*, and “public health professionals... are essential to preserving and improving the health of the public.”

Notably, the World Health Organization lists *Essential Public Health Operation 7* as “assuring a sufficient and competent public health workforce,”⁷ and mentions that “investment in and development of a public health workforce is an essential prerequisite for adequate delivery and implementation of public health services and activities.” The World Health Organization states, in EPHO 7, “Currently the main focus of WHO/Europe’s work is on health professionals. Further work is needed on public health professional workforce development.”⁷ Similarly, the US Centers for Disease Control and Prevention’s *Essential Public Health Service #8* is listed as: “Build and support a diverse and skilled public health workforce,”⁴ including “providing education and training that encompasses a spectrum of public health competencies, including technical, strategic, and leadership

skills.” As with the health workforce broadly, there is no public health without a public health workforce.⁸

The Role of Public Health Academic Institutions in Preparing the Workforce

In academia, the public health discipline of study is unique in that it is specifically designed to fit the needs of the public health workforce. The seminal report, *The Future of Public Health*, states, “education programs for public health professionals should be informed by comprehensive and current data on public health personnel and their employment opportunities and needs.”² The competencies upon which schools and programs of public health are based, for schools accredited by the Council on Education in Public Health (CEPH), come from surveys of the public health workforce, with a heavy emphasis input from government public health professionals.⁹⁻¹²

Since the creation of public health as a specific discipline of study as proposed in the 1915 Welch-Rose Report¹³, a primary purpose of public health educational programs has been to solve a “fundamental need in the public health service” for trained public health professionals. Even in 1915, it was acknowledged that public health is “an ever widening field,” and while a public health educational program should “not be limited to the use of those who intend to become specialists in public health work,” it is “of first importance to consider and to supply the needs for the education of prospective public health officials.”

However, there have been growing concerns that universities which provide degrees in public health are not as connected as they should be to the public health workforce. In the Institute of Medicine’s 1988 report, *The Future of Public Health*² it was noted:

“Many observers feel that some schools of public health have in recent years become somewhat isolated from the field of public health practice. The result of this changing emphasis may be that some schools no longer place a sufficiently high value on the training of professionals for work in health agencies. The variation in public health practice noted earlier in this report and the limitations on employment opportunities in health agencies for well-trained professionals, restricting opportunities for graduates, have inhibited desirable responses by the educational institutions to the needs of practice. This situation is exacerbated by the fact that most public health workers have not had appropriate formal professional public health training. However, we lack sufficient knowledge about the public health workforce and its needs and opportunities.”

This report was followed by *Who Will Keep the Public Healthy?*⁶ in 2003, which defined the purpose of schools of public health as to “educate the educators, practitioners and researchers as well as to prepare public health leaders and managers,” and recommended that government health departments should “develop plans, in partnership with schools of public health and accredited public health programs... for assuring that public health education and training needs are addressed...(and) engage in faculty and staff exchanges and collaborations with schools of public health.” These reports noted, however, that funding for public health educational programs was

lacking, and that many schools of public health relied on research grants, with little funding available to support partnerships with health departments.

Still, public health educational institutions across the world continue to share the original mission outlined in the Welch-Rose report. In North America, the Council on Education in Public Health states that the goal of schools and programs of public health is “the assurance of professional personnel who are able to identify, prevent, and solve community health problems.”⁹ The Association of Schools of Public Health in the European Region’s goal is to improve the education of public health professionals¹⁴; the Council of Academic Public Health Institutions Australasia’s goal is to ensure academic quality in the training of public health practitioners and researchers,¹⁵ and the Association of Schools of Public Health in Africa has a similar focus¹⁶.

Ultimately, a large part of the function of educational institutions of public health is to prepare *public health graduates (PHGs)*; for the purposes of this thesis, public health graduates are defined as individuals who have earned a university degree in public health or one of its sub-disciplines, including environmental health, epidemiology, biostatistics, occupational health and industrial hygiene, public health education and promotion, community health and preventive medicine, maternal and child health, international public health/international health, health services administration, and health policy, as defined through the US Department of Education’s Classification of Instructional Programs (CIP) schema¹⁷. In the words of the *Future of Public Health*, “many educational paths can lead to careers in public health, but the most direct is to obtain a degree from a school of public health.”²

In the United States, enrollments and graduate numbers of students who earn degrees in one of the specified public health CIP codes can be relatively easily tracked through the US Department of Education. Enrollment in public health degree programs has been rapidly expanding over the last decade in the United States at the graduate and undergraduate levels^{18,19} and is expected to expand even further due to increased awareness of public health caused by COVID-19.²⁰ Academic programs in public health appear to be expanding in other areas of the world as well.⁷

Although there is some research on the connection between academia and the public health workforce^{21,22}, these studies have focused primarily on research partnerships, service learning^{23,24}, or internship/practicum programs²⁵ and until recently did not commonly address the recruitment of public health graduates into the workforce as full-time employees, or the employment outcomes of public health graduates. Some researchers have assumed that expanded enrollments, by themselves, will solve workforce gaps in the government public health workforce.^{19,26} However, altering the

supply of public health professionals “is not simply a matter of training more people in education institutions.”²⁷

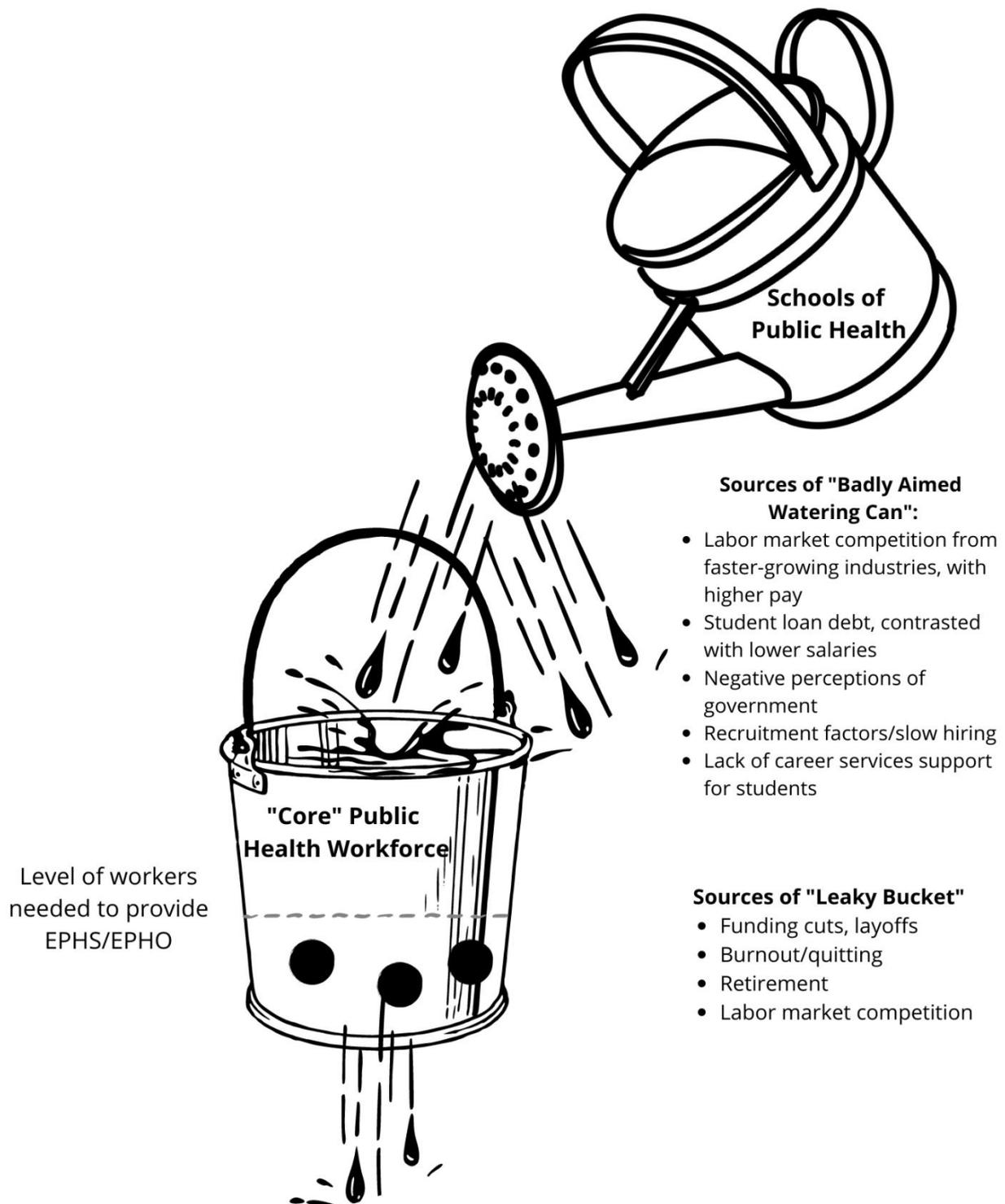
GAPS IN KNOWLEDGE

Most likely because of its complexity, lack of clear definitions, and interdisciplinarity, and possibly due to long-term underfunding for public health workforce research²⁸, there are many gaps in knowledge regarding both the employment outcomes of public health graduates and the needs of employers seeking to hire them. In particular, while concerns continue to be raised about a mismatch between public health educational programs and the workforce²⁹, still, little is known regarding the connection between schools of public health and the public health workforce. In particular, there have been ongoing concerns about a mismatch between public health graduates and what is considered the “core” public health workforce, often defined in the United States as government health departments²⁹. While there has been research on the maldistribution or “mis-employment” of healthcare professionals²⁷ (referring to situations where health professionals do not enter the healthcare workforce, and instead become employed elsewhere), relatively little research has been conducted on possible “mis-employment” of PHGs. Without information about whether public health graduates actually become public health professionals, an essential aspect of public health workforce planning is absent, and we cannot ensure our public health system will be highly functional.

Specifically, it is possible that, even with increased enrollments in public health degree programs, a labor market mismatch could result in “maldistribution” or “mis-employment” of public health graduates, with many graduates either choosing careers which do not contribute to the WHO’s EPHOs³ or CDC’s EPHSs⁴ or even remaining unemployed. We might visualize a potential mismatch between government public health agencies or the “core” public health workforce, and those who graduate with public health degrees, as a badly-aimed watering can and a leaky bucket, where the “water” represents public health graduates, who are needed to provide the key EPHOs/EPHS; the “watering can” represents academic institutions which are preparing the PHGs and offering public health degrees, but this watering can is not directing its water flow only into the bucket; and the “bucket” represents the core public health workforce’s requirements for PHGs, but this “bucket” is filled with holes, constantly losing qualified candidates due to the gravitational pull of competitor employers, or to burnout or retirement. Because this watering can is constantly drawing new water (enrolling new students) and these PHGs need a place to go (and need to find gainful employment, which is an element of the accreditation for public health schools and programs—for example,

CEPH-accredited schools and programs must “place” 80% of their graduates into jobs)⁹, there is some pressure to have the PHGs find employment at any organization that can hire them.

An illustration of what may be taking place is below:



Source: The author.

Additionally, although public health schools are expected to base their curricula on the needs of the workforce,^{9,12} surveys of employers who currently hire public health students are relatively rare. Many of the surveys upon which public health degree competencies are based focus primarily on the government public health workforce, sometimes with little or no input from other sectors which hire public health graduates^{10,12}. Gathering information directly from employers through an analysis of the specific requirements they have of graduates—information which can be gathered through analyzing job descriptions and vacancy postings, or through employer surveys—is even less common, though it has been used in a handful of studies.^{30–32}

Especially in light of urgent needs to invest in the public health workforce due to the Covid-19 pandemic, it is crucial to identify the employment outcomes of public health graduates, and compare them with needs of the employers hiring them to identify whether academic programs successfully prepare their graduates to become part of the public health workforce, and further, whether enough graduates are choosing to enter the “core” public health workforce. If indeed there is a mismatch, many unfilled positions may remain in the core workforce, even if there are more public health graduates, and EPHOs/EPHSs will therefore be unmet. Due to Covid-19, the consequences of an understaffed workforce have rarely been more clear.

RESEARCH OBJECTIVE AND RESEARCH QUESTIONS

The main objective of thesis is **to explore and identify the employment outcomes of public health graduates, as well as the demands of employers who hire these graduates, primarily in the United States, using a scoping review of the literature, secondary data sources such as surveys of public health graduates, surveys of employers, and analysis of job postings.**

Specific research questions include:

1. What is known about employment outcomes of public health graduates in the literature (Chapter 2), from new research (Chapter 3), and about changes in the sectors hiring graduates over time (Chapter 4)?
2. What is known about which occupations exist in the public health workforce, and how have employer demands changed for graduates over time, or as a result of Covid-19? (Chapters 5 and 6)
3. How can possible maldistribution of public health graduates be addressed by policy in the United States? (Chapter 7)

Research to fill these knowledge gaps is important to many stakeholders. First and foremost, without a highly trained, functioning public health workforce, diseases like COVID-19 and many

other public health challenges will continue to cause tremendous health problems and commensurate economic costs; and ensuring enough public health graduates enter the workforce is an important aspect of workforce development. Key decision-makers, such as elected officials who are determining where to invest resources, will benefit from information about the development and education of public health professionals.

Secondly, institutions of higher education will benefit from this research because they can improve their curriculum design, improve their connection with the public health workforce, and ensure that their degree programs meet the needs of current and future employers of their graduates. Considering that a key element of missions of schools and programs of public health is to prepare graduates for the public health workforce, information on the employment outcomes of public health graduates is an important part of evaluating whether these schools are successful in achieving their missions.

Thirdly, government agencies or health departments, as well as other public health employers, can benefit from identifying whether there is competition in the job market for graduates with the key skills they need in their workforce. With this information, they can design effective, evidence-based recruitment strategies to attract and retain trained professionals.

KEY TERMS AND CONCEPTUAL MODELS

Key Terms: Public Health Workforce

Assessing whether PHGs become public health professionals includes defining the public health workforce. One of the challenges in studying the public health workforce is that it is very broad; because public health functions are so broad, and can exist in a diverse range of sectors, the workforce has been called “ill-defined.”³³

Public health work can be conducted by a range of different types of organizations in different *sectors*; sector is defined, for the purposes of this thesis, as the type of organization which employs public health professionals. This can include government (“the public sector”), the nonprofit or voluntary sector, for-profit corporations (also called “industry” or “proprietary companies”), universities/academia, research institutes, and hospitals and healthcare systems, among others.

While it is defined differently in countries around the world, in the United States in particular, the *core public health workforce* has often been defined as existing primarily in government; for example, the Council on Linkages Between Academia and Public Health Practice of the Public Health Foundation mentions “public health may traditionally be thought of as the domain

of government.”³⁴ While it has been acknowledged that public health activities take place outside government, and in the United Kingdom and some other countries, public health has been described as existing in the “core” and “wider” public health workforce^{35,36}, it has also been mentioned that researching or enumerating the public health workforce beyond government may be difficult due to the complexity of defining roles according to their contribution to public health.³⁷

Particularly in the United States, studies of the public health workforce have focused primarily on the “core” workforce of governmental public health workers^{37–39}, partly because this workforce is considered to be uniquely positioned to deliver the Essential Public Health Services⁴⁰, and partly because it is easier to define, and therefore, to enumerate. The bulk of research on the existing government public health workforce has focused on the categorization⁴¹, enumeration^{37,38}, educational backgrounds⁴², training needs,^{43–47} competencies or job task analysis,⁴⁸ and intentions to retire or leave the field^{49–52}, of the current governmental public health workforce, but this leaves out information on the inflow of new hires into this workforce, especially the inflow of new public health graduates and also excludes analysis of the broader public health workforce beyond government. Even the most basic research—a formal enumeration of government public health workforce—has not been fully conducted in the United States since 2014 due to lack of funding³⁸, though concerns about budget cuts, retirements and attrition of this workforce have been raised for more than a decade^{53,54}.

Additionally, the public health workforce is comprised of many different *occupations*, defined as the type of job function or profession an individual worker takes part in; it encompasses the daily tasks of the job, as well as the skills and competencies required to do the work. The public health workforce, while ill-defined, includes a broad range of occupations which require or prefer specific training or graduate degrees in public health, such as epidemiologists, health policy analysts, health educators, program managers and evaluators, environmental health specialists and sanitarians, biostatisticians, and health behavior specialists, among others; but it also includes individuals with training in medicine, nursing, engineering, law, and many other areas of study. Both occupations and sectors can be categorized using a *workforce taxonomy*, which uses consistent definitions of different occupations or sectors to allow better analysis of the workforce.

Conceptual Models

This thesis is grounded by three interrelated conceptual models, at the macro, mezzo, and micro levels of workforce research. At the macro level is the concept of *labor market dynamics*, focusing on systems and processes which impact the supply and distribution of workers in the labor market; at the mezzo level is consideration of *employer needs*, with influences from concepts of

As the World Health Organization's Global Strategy on Human Resources for Health: Workforce 2030⁵⁵ notes, "health systems can only function with health workers," and a plan for the health workforce includes "taking account of labour market dynamics and education policies; to address shortages and improve distribution of health workers." While the WHO Global Strategy and much of the other research on the health workforce focuses on clinical professionals, especially doctors, nurses and midwives (all professions which are generally tracked through licensure and registries), the report also mentions public health professionals (for example, in point #16)⁵⁵.

In the article *The Dynamics of the Health Labour Market*,²⁷ which is also referenced in the WHO Global Strategy on Human Resources for Health, Vujicic and Zurn describe situations in which not enough health workers can be found, and in others, there is a surplus of health workers. The authors argue that such mismatches exist "in large part because policy makers often fail to take into account the behavioural characteristics of individuals who produce health care services (i.e. providers)...and institutions that employ health care professionals." For example, in some cases, there can be a sufficient number of individuals who are *qualified* to work in health care (i.e. the number of individuals with educational credentials that qualify them to work in the field), but not enough of these individuals are also *willing to work* in health care, likely because of low wages or poor working conditions in the field. Therefore, it is not enough to simply count the number of graduates completing a particular degree program without considering the "labor force participation decision" of these graduates.²⁷ This framing has been applied broadly to human resources for health, and can also be used to analyze human resources for *public health*. While Vujicic and Zurn focus on a range of factors which impact the numbers of health workers, this thesis focuses on two specific aspects of this model—the employment outcomes of public health graduates and the needs of employers.

Employer Needs and Perspectives (Mezzo level)

At the "mezzo" level, an assessment of the recruitment needs of employers who seek to hire public health graduates can illuminate which occupations and sectors seek to hire these graduates, and thus shed light on the competition for graduates from sectors which may not be part of the "core" public health workforce.

This "mezzo" level of assessment of employer needs is connected to the field of workforce development. Workforce development includes the concept that labor market information is crucial to developing appropriate training programs, and that employer needs should guide the design of training. Because the role of schools of public health is to develop graduates for the workforce, the recruitment needs of the workforce must be taken into consideration, and by gaining information on

the recruitment needs of employers seeking public health graduates, a “feedback loop” between the workforce and educational institutions can be improved⁵⁶. Workforce development is a concept model which has been applied to the public health workforce,⁵⁷ and is an eclectic field, encompassing theories of adult learning and development.

One way to discern employer needs is through analysis of open vacancies or job postings, since these documents provide specific detail on the current hiring needs of employers. Workforce development programs rely on research conducted by organizations such as the US Department of Labor, which has conducted extensive research on the skills needed in specific occupations and occupational classifications⁵⁸. If we frame schools of public health as workforce development and training institutions whose role is to prepare public health graduates for the workforce, then we may also apply theories related to evaluation of training programs, such as Kirkpatrick’s model of training evaluation.⁵⁹

Vocational Decision-Making and Career Development Theories (Micro)

On the micro level, the third conceptual model underlying this research are models of individual vocational decision-making and career development. Especially in the United States, individual graduates from public health degree programs typically fund their own educational expenses, often incurring large sums of student loan debt, and are free to make employment decisions without restrictions imposed by external parties like government agencies; and in order to determine why graduates may be drawn to jobs outside of public health, it is important to assess what factors might influence these decisions.

Vujcic and Zurn mention that the factors which impact the career decisions of individuals considering entry into the healthcare field include working conditions and salaries in the field, as well as “personal attributes such as desire to help sick people.”²⁷ Although the framing of this dissertation draws primarily from literature reviews, surveys or data collections of employment outcomes of public health graduates, and analysis of job postings, concepts from theories derived from vocational psychology and career decision-making theory can add to our understanding of how individual public health graduates make career choices, which impact their employment outcomes; and, in aggregate, impact labor market dynamics.

Overall, the above discussion suggests that an examination of labor market dynamics, analysis of employer demands assessed from job postings using a workforce development lens, and an assessment of employment outcomes of public health graduates can allow us to better understand whether there are mismatches in the market, and to effectively improve the connection between public health graduates and the workforce.

RESEARCH METHODOLOGY

To achieve the goal of answering the research questions above, this thesis assesses the employment outcomes of PHGs and the employers' demands for PHGs, as opposite sides of the same coin. To assess employment outcomes of PHGs, this thesis relies primarily on a scoping review of the literature, surveys of graduates, and secondary data collection methods. To assess employer demand, an analysis of job postings (i.e. vacancy announcements) from various sources was conducted, because these postings provide insight into the requirements and needs of the employer; and an employer survey was also conducted.

This dissertation, then, is split into three parts: the employment outcomes of public health graduates, the assessment of employer needs/demands, and policy recommendations to address potential mismatches between public health graduates and the workforce. The table below illustrates the research questions and methods used:

	Scoping Review Chapter 2 (Part 1)	Employment Outcomes, Ch. 3 (Part 1)	Employment Trends, Ch. 4 (Part 1)	Taxonomy & Labor Market Competition, Ch. 5 (Part 2)	Employer Needs/Trends: Climate Change Ch. 6 (Part 2)	Policy Levers (Chp. 7)
Chapter Title (abbreviated)	Postgraduate Employment Outcomes of Undergraduate and Graduate Public Health Students: A Scoping Review	First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment	The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students	Labour market competition for PHGs: A comparison of workforce taxonomies with job postings before and during the COVID-19 pandemic	The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us?	Generation Public Health: Fixing the Broken Bridge Between Public Health Education and the Governmental Workforce
Research Question	What is known about employment outcomes of PHGs?	What are the post-graduate outcomes of PHGs, and where do PHGs find employment?	Are graduates of one public health school changing over time, towards employment in for-profit companies?	What ISCO-08 coded occupations exist in the public health workforce? Do current job postings for PHGs align with these occupations?	Do public health employers seek to hire PHGs with training related to climate change?	What policies can be utilized to better connect PHGs and governmental public health workforce organizations?
Methodology	Scoping review of the literature from 1993 to 2020, using the Kirkpatrick model of training evaluation as a framework.	National data collection from public health schools and programs, gathered yearly from 2015 to 2019.	Annual post- graduate survey and data collection from Columbia University graduates.	Schema matching of occupational taxonomies; Analysis of large-scale job postings data.	Analysis of 16 years' worth of job postings; survey of public health employers.	Synthesis of public health workforce literature, policy analysis.

OUTLINE OF THE THESIS

Chapter 1 is the introduction, including an overview of public health, the role of public health educational institutions, the definition of public health graduates, the potential mismatches in the labor market, the concept of the public health workforce and its sectors, occupations, and workforce taxonomies, the concept models of labor market dynamics, employer needs and perspectives, and vocational choice of public health graduates, gaps in knowledge, and the key research questions and methods used to address them.

Chapter 2, Postgraduate Employment Outcomes of Undergraduate and Graduate Public Health Students: A Scoping Review, is a scoping review of the literature, undertaken to gather any articles published from January 1, 1993 (chosen because of a key change to the accreditation of schools of public health in that year) through July 4, 2020, to identify any which provided data on employment status, employment sector/industry, job function, or salary of public health graduates. The article utilized the Kirkpatrick model of training evaluation as a framework, and we conducted a 6-step scoping review: (1) formulating the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, (5) collating and summarizing the results, and (6) consulting stakeholders.

Chapter 3, First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment, is the largest and most recent study conducted of the employment outcomes of public health graduates from institutions which are members of the Association of Schools and Programs of Public Health. This study utilized data collected by 111 schools and programs of public health regarding the known employment outcomes of 53,463 graduates, gathered across 4 years, assessing “first-destination” employment and educational outcome data. Individual schools and programs collected data from their graduates; schools could utilize a core survey instrument or their own data collection instruments. The methods primarily included descriptive statistics and Pearson χ^2 tests.

Chapter 4, The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students, focused on identifying whether data was available on employment outcomes of public health graduates and whether there was a trend towards employment in for-profit organizations. The study utilized a literature review and conducted analyses of data regarding employment outcomes from 5 graduating cohort years of public health graduates at Columbia University’s Mailman School of Public Health, data from several other graduate public health

schools, and data collected in a pilot survey conducted by the Association of Schools & Programs of Public Health (ASPPH).

Chapter 5, Labour market competition for PHGs: A comparison of workforce taxonomies with job postings before and during the COVID-19 pandemic, was undertaken to identify demand from employers for public health graduates by analyzing 38,533 job postings in the United States, in which the employer either required or preferred candidates to have master's level degrees in the public health disciplines. The methods included matching of three public health workforce taxonomies with standardized occupational classification (ISCO-08 and US SOC) codes, then contrasting job postings with the codes to develop a taxonomy which encompasses occupations and sectors which were not previously included in definitions of the public health workforce, as a means of identifying labor market competition for public health graduates. We also assessed differences job postings before and during the COVID-19 pandemic.

Chapter 6, The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us? is a case study focusing on a sub-set of public health employers—those who may wish to hire public health graduates who have training related to climate change. The study included an analysis of current job postings with specific key terms focusing on both climate change and public health, as well as an analysis of 16 years worth of job postings in a public health job board; the study also included a survey of potential employers of public health graduates focusing on climate change to ask for their perceptions of the competencies and skills needed for this future workforce.

Chapter 7, Generation Public Health: Fixing the Broken Bridge Between Public Health Education and the Governmental Workforce, focused on a review of public health workforce research, including analysis of various issues which may impact the career choices of public health graduates, and presented specific policy recommendations for decision-makers regarding investments in future public health workforce research, recruitment programs, support for student loan repayment, and ongoing investment in the existing workforce and its training.

Chapter 8 is the Discussion and Conclusions, including an overall discussion of the key findings, policy recommendations to address the findings, future research questions, limitations and conclusions.

Chapter 9 is the Valorization, outlining the efforts to bring awareness of this research to the public and to key decision-makers.

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Part 1: Employment Outcomes of Public Health Graduates



Chapter 2: Postgraduate Employment Outcomes of Undergraduate and Graduate Public Health Students: A Scoping Review

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Postgraduate Employment Outcomes of Undergraduate and Graduate Public Health Students: A Scoping Review

Abstract

Objectives: A key goal of schools and programs of public health is to prepare graduates for careers in the public health workforce after graduation, but are they achieving this goal? We assessed how the employment outcomes of students earning public health degrees are collected and described in the literature.

Methods: Using the Kirkpatrick model of training evaluation as a framework, we conducted a 6-step scoping review: (1) formulating the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, (5) collating and summarizing the results, and (6) consulting stakeholders. We included articles published from January 1, 1993, through July 4, 2020, that provided data on employment status, employment sector/industry, job function, or salary of public health graduates. We excluded articles that were not written in English and were about dual-degree (ie, doctor of medicine–master of public health) students. We found and reviewed 630 articles.

Results: We found 33 relevant articles. Most articles focused on a single school and combined multiple graduating classes, focused on sub-specializations of public health, or focused on graduates' satisfaction with their curriculum but not employment outcomes. Data were inconsistently categorized and studies were difficult to compare.

Conclusions: Research on public health graduates' employment outcomes is scarce and does not follow consistent protocols. New standards should be adopted to systematize the collection of data on employment outcomes of public health graduates.

In addition to their missions of research and service, schools and programs of public health are charged with preparing public health professionals, defined as “a person educated in public health . . . who is employed to improve health through a population focus.”¹ Schools and programs of public health worldwide share this mission. The focus of the Council on Education for Public Health (CEPH) is “the assurance of professional personnel who are able to identify, prevent and solve community health problems.”² The focus of the Association of Schools of Public Health in the European Region is to improve the education of public health professionals.³ The purpose of the Council of Academic Public Health Institutions Australasia is to assure academic quality in the training of public health practitioners and researchers,⁴ and the Association of Schools of Public Health in Africa has a similar mission.⁵ Thus, if graduates of schools and programs of public health do not find employment in public health after graduation, it can be argued that these schools and programs are not achieving their missions. Because such schools and programs supply trained professionals for the public health workforce, including professionals who contribute to the 10 essential public health services,^{6,7} the employment outcomes of their graduates are a key factor in workforce planning.

Concerns about employment outcomes of university graduates have been growing for several years,⁸ and employment outcomes of public health graduates raise particular concern. Although enrollments in public health degree programs have not increased consistently in other countries,⁹ the number of graduates with a master’s degree in public health in the United States increased from 4481 in 1992 to 17 948 in 2019,^{10,11} and the number of graduates with a bachelor’s degree in public health increased from 759 in 1992 to 17 156 in 2019.^{11,12} Meanwhile, overall employment only grew 1.3% per year from 2010 to 2020¹³ and US governmental public health staffing shrank,¹⁴ potentially leading to an oversupply of public health graduates.

Additionally, since the seminal 1988 report *The Future of Public Health*,¹⁵ concerns have been raised that US schools and programs of public health are not as connected as they should be to the government public health workforce (including federal, state, and local health departments). The report noted, “While . . . public health professionals work in a variety of settings, there is a special relationship with the governmental public health agencies at the local, state, and federal level.”¹⁵ This disconnect is especially important because of a documented shortage of public health workers in the United States.^{16,17} Similar concerns about a possible workforce shortage have also been raised in Europe.⁹ However, even with a large supply of new graduates, a labor market mismatch might occur if too few graduates choose government employment and large retirements of government workers are predicted.^{18,19}

US schools and programs of public health have been required to report employment outcomes to CEPH² since 1993 to maintain accreditation. Other initiatives that measure postgraduate

employment and educational outcomes have also been created, including the National Association of Colleges and Employers (NACE) First Destination Survey of employment outcomes of US college graduates²⁰; the US Department of Education's College Scorecard,²¹ which includes data on college graduates' median salaries and student loan debt in the United States, measured 1 year postgraduation; the Graduate Outcomes Survey in Australia,²² an employment outcomes survey that is similar to NACE; and a new unpublished data collection of postgraduate employment and educational outcomes, measured 1 year postgraduation, by the Association of Schools and Programs of Public Health (ASPPH).²³

However, it is unclear what research has been published on the postgraduate employment outcomes of public health students. One of the authors (H.K.) conducted a search for existing systematic or scoping reviews in the Joanna Briggs Institute Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, and Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) for "public health" and "employment" but found no reviews of employment outcomes of public health graduates. Two review articles were found, neither of which focused on employment; 1 review included multiple health disciplines²⁴ and the other focused on pedagogical evaluation.²⁵ The objective of our study was to examine how employment outcomes of students earning public health degrees at the graduate and undergraduate levels are collected and described in the literature using a scoping review.

To provide a theoretical framework for this study, we selected the Kirkpatrick model,²⁶ which is used to evaluate training programs. This framework was used in 1 review article²⁴ and was used to evaluate other public health education programs.²⁷⁻³⁰ The model describes 4 levels of evaluation: (1) reaction, which focuses on whether participants experience the training as positive, helpful, engaging, and relevant; (2) learning, which is assessing whether participants acquire the expected knowledge, skills, attitude, or self-efficacy; (3) behavior, which is measuring whether participants apply their training in real-world situations; and (4) results, which is determining whether intended outcomes occur as a result of the training.²⁶ We defined the postgraduate employment outcomes of public health graduates as a fourth-level evaluation. Our goal was not to contrast employment outcomes themselves but to determine what research has been conducted and assess how data on employment outcomes have been collected and reported.

Methods

Scoping is used to identify gaps in research, clarify key ideas, and report on the types of evidence used to assess practice in the field.³¹ A scoping review has 6 steps: (1) formulating the research question; (2) identifying relevant studies; (3) selecting studies (using an iterative approach); (4) charting the data (including both numerical summary and qualitative thematic analysis); (5) collating

and summarizing the results, including identifying implications of the findings for policy, practice, or research³⁰; and (6) consulting stakeholders. Scoping reviews differ from systematic reviews in that study quality is not assessed; there is a requirement to identify all literature regardless of study design.³² Scoping reviews have been used to assess the public health workforce in several studies.³³⁻
³⁷ Our scoping review attempted to answer the question, “How are employment outcomes of students earning public health degrees at the graduate and undergraduate levels collected and described in the literature?”

Scoping and Searching/Consultation

We searched a broad range of databases, including Pubmed, Ebscohost, Embase, Web of Science, and Google Scholar (Table 1). We extracted and uploaded all results except those from Google Scholar into Covidence (Covidence), a software that facilitates systematic or scoping reviews. We asked experts from CEPH, ASPPH, and NACE if additional research was available. A researcher from ASPPH supplied 3 additional articles not otherwise identified, 1 of which was included in the final analysis. Additionally, because reports on employment outcomes may be presented on university websites or in reports by professional societies, we searched the gray literature and conducted general Google searches for comparable search terms. The lead author (H.K.) also searched the references of the selected articles and was referred to 2 articles by an informaticist.

We developed the final protocol using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis protocols (Scoping Extension)³⁸ and registered the final protocol with Open Science Framework Registries. All sources were publicly available and did not require institutional review board approval.

Table 1. Results by database in a search for articles in a scoping review with quantified data on postgraduation employment outcomes of graduates of schools and programs of public health, January 1, 1993, through July 4, 2020

Search term	PubMed	Google Scholar	Ebscohost	Embase	Web of Science
((“Education, Graduate”[Mesh] OR “education, graduate”[MeSH Major Topic]) AND (“Public Health/education”[Mesh] OR “public health/education”[MeSH Major Topic]) OR “Students, Public Health”[Mesh] OR “public health graduate*”)) AND (“Employment/statistics and numerical data”[Mesh] OR “Employment/trends”[Mesh] OR “employment/trends”[MeSH Major Topic] OR “Employment”[Mesh] OR “employment outcomes” OR “career mobility” OR “career services” OR careers OR tracking OR placement) OR “Public health careers”	137	50	109	9	209

OR (“master of public health” AND employment) OR ((“public health” graduate (“employment outcomes” OR “career mobility”)) OR (“public health” AND “career services”))					
“Public health careers”	21	687	57	19	30
“Public health” AND “career services”	4	4770	99	4	5
(systematic review[Publication Type]) AND “public health/education”[MeSH Major Topic]	21	9030	1	15	15
(Education, Public Health Professional/methods*[MeSH Terms]) AND program evaluation[MeSH Terms]	34	2560	4	0	68

Identifying and Selecting Variables

We included studies on students who obtained an undergraduate or graduate degree in which their major was public health or a related subdiscipline, such as epidemiology, global health, health policy, or health communication, and that included quantified data on any of the following: status of employment (employed full-time or part-time, unemployed/job seeking, unemployed/not job seeking, or continuing study); employment sector (government, hospital/health care, for-profit, nonprofit); job function; or salary. We excluded articles that focused on students of medicine, nursing, dentistry, social work, or business that did not include outcomes on public health graduates; articles focused on fellowships, internships, or short-term traineeships that did not result in an academic degree; articles that did not include quantitative data on employment (but rather focused on educational satisfaction, qualitative descriptions of curricula, or practica); surveys or expert panels of employers; and articles not written in English. We also excluded articles that focused on dual-degree programs (eg, doctor of medicine–MPH, master of social work–MPH) because the employment outcomes of dual-degree graduates would likely differ from the outcomes of non–dual-degree graduates. Our time frame for the search was all articles published from January 1, 1993, through July 4, 2020; we chose 1993 because it is the year CEPH began requiring students to complete a practicum, which would affect employment.

Box. Inclusion and exclusion criteria used to screen and select articles for inclusion in a scoping review of postgraduation employment outcomes of graduates of schools and programs of public health, from January 1, 1993, through July 4, 2020

<p>Inclusion criteria</p> <ul style="list-style-type: none"> • Population of interest: students who obtained a degree from a school or program of public health (at the undergraduate or graduate level) where the “major” was public health or a related subdiscipline, such as epidemiology, biostatistics, global health, health policy and management, health communication, health education, or environmental health. • Outcome of interest was employment, including quantified data on any of the following: <ul style="list-style-type: none"> ○ Status of employment (employed full-time, part-time, unemployed/job seeking, unemployed/not job seeking, or continuing study); ○ Sector of employment/type of employing organization (eg, government agency, hospital/health care, for-profit company, nonprofit organization); ○ Job function (eg, program management, researcher, public health educator); ○ Job level (entry-level, mid-career, executive) or salary.
<p>Exclusion criteria</p> <ul style="list-style-type: none"> • Articles focused solely on students of medicine, nursing, dentistry, social work, health care business administration, master of health administration or master of business administration in healthcare administration graduates, or other health-related educational programs but that did not also include outcomes on students of public health. • Articles that did not include quantitative information on employment outcomes (but rather focused on items such as satisfaction with the education program or competencies gained, qualitative descriptions of programs, practica, alumni perspectives on the effect of the program on competencies or career growth in general) • Surveys or expert panels of employers who might hire public health graduates but did not specify the employment outcomes of graduates themselves. • Articles not written in English. • Articles written before 1993. • Articles about graduates of dual-degree programs (ie, doctor of medicine–master of public health [MPH], master of social work–MPH)

Two authors (K.S. and H.K.) independently reviewed the titles and abstracts of all articles and made decisions on inclusion by consensus. One author (H.K.) reviewed all articles selected for full review, and 2 authors (O.G. and K.S.) each reviewed half of the total group selected for full-text review.

Data Abstraction and Charting

After consensus was reached, 1 author (H.K.) charted the selected articles in Excel with input and review from 2 other authors (O.G. and K.S.). We contacted the authors of 2 articles to clarify data.

The data chart included study characteristics (geographic location of study participants, population surveyed, whether the survey was of a single school or multiple schools, whether multiple graduating classes were included, the number of surveys and responses), the quality of the study, the Kirkpatrick evaluation level, and the outcomes (including employment status, employment sector/industry, job function, and/or salary). Articles rarely included data for all characteristics.

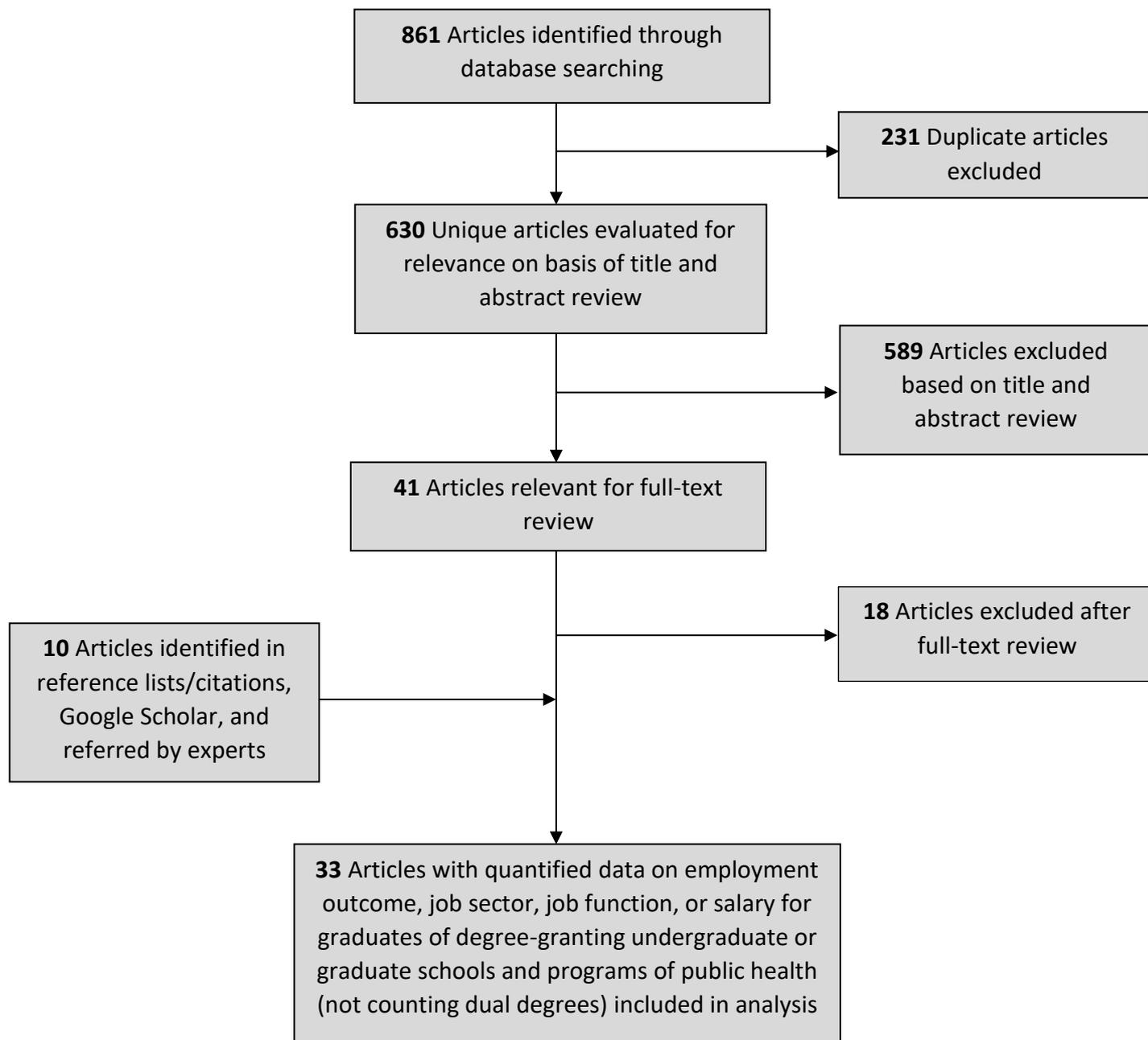
Data Analysis

Because of the inconsistency of research methods used in the articles, comparing outcomes among reports was not possible. Additionally, scoping reviews do not seek to synthesize or aggregate findings from different studies.³² Because this study was a scoping review, we did not formally rate the quality of study designs, but we did use a modified version of the Newcastle-Ottawa Scale, adapted for cross-sectional surveys.³⁹ However, we conducted a narrative/thematic analysis of the research.

Results

A total of 861 articles were uploaded to Covidence, of which 231 were duplicates, resulting in 630 unique articles; 41 articles were found relevant for full-text review, of which 23 were included in the study (Figure). We included an additional 10 articles that met the inclusion criteria, which we found through reference searches, Google, and referral by stakeholders and informaticists, for a total of 33 articles (Table 2).

Figure. Flow chart of the screening process used to identify articles for a scoping review that included quantified data on employment and other postgraduate outcomes of graduates of schools and programs of public health, published from January 1, 1993, through July 4, 2020.



Study Populations: Geographic Locations and Areas of Study

Twenty-three articles or reports focused on graduates of degree programs in the United States. Two articles focused on graduates of schools or programs of public health in multiple countries, 3 focused on Australia, 2 focused on Canada, and 1 each focused on Vietnam, the United Kingdom, and South Africa. Fourteen articles focused on subareas of public health (3 on health communication/education,⁴⁰⁻⁴² 3 on maternal and child health,⁴³⁻⁴⁵ 5 on global health,⁴⁶⁻⁵⁰ 1 on industrial hygiene⁵¹ 1 on nutrition,⁵² 1 on Aboriginal health⁵³); 5 articles focused on undergraduates⁵⁴⁻⁵⁸ and 3 focused on doctoral graduates.^{45,59,60} Two articles focused on postgraduate employment outcomes of a subset of graduates who had previously participated in a volunteer program,^{57,61} and 1 focused on international students.⁶² Four themes emerged: variability in study methods, inconsistency in study timing, disparate quality of studies, and the employment outcomes themselves.

Study Methods

Eighteen studies were surveys of the alumni of a single school or program of public health using mail, telephone, or online survey methods.^{40,44,45,48,50,52,53,55-58,61-66} Three studies were surveys sent to graduate programs^{41,43,67}; 7 were surveys of alumni of multiple schools or programs of public health^{11,42,46,47,49,54,68}; 2 were based on nationally collected surveys of doctoral recipients in the United States^{59,60}; 3 were national data collections from numerous schools and programs of public health^{11,20,22}; and 1 used data from the published websites of multiple schools and programs of public health.⁶³

We found only 4 reports, all published since 2014, that included an analysis of multiple schools in the United States and were not focused on subareas of public health, 2 of which were in the gray literature.^{11,20,23,63}

Study Timing

The timing of survey distribution was inconsistent. Sixteen studies combined all survey responses of alumni from several graduating classes.^{40,42-48,50,51,57,58,62,64,66,69} However, by mixing the employment outcomes of recent graduates with the employment outcomes of graduates who had years of experience, it was not possible to discern how their training affected them during their career. Seven studies used protocols in which a consistently defined cohort year of graduates was surveyed at a consistent and specific number of months postgraduation (typically 6 months or 1 year after graduation); used 1 or multiple graduating cohorts from the same school or program of public health, each measured at consistent time frames postgraduation; and did not mix multiple graduating cohorts into 1 data set.^{11,20,22,23,49,55,63} Seven studies did not indicate clearly which cohorts were

included.^{41,50,52-54,67,68} The data for studies of doctoral graduates using the National Science Foundation's annual Survey of Earned Doctorates, which are collected annually from all doctoral graduates in the United States,^{59,60} were gathered before graduation. One study was unclear about whether the people surveyed were still students or alumni.⁶⁷

Survey Quality and Kirkpatrick Level

Most articles made no attempt to assess differences between responders and nonresponders,^{19,40-45,48-51,54-57,63,68,69} did not describe their survey instrument or its development,^{43-45,48,50-52,54-56,64,68} and did not describe field-testing the survey, institutional review board approval, or statistical methods. Although the standards for designing surveys recommend consulting with experts in the field⁶⁹ and career services professionals often are responsible for gathering employment data,^{11,20,63,68} only 4 studies consulted with such professionals. Some studies did not indicate response rates^{56,68}; the question for 1 survey was, "In what type of organization are you currently (or were you most recently) employed?," which confuses current and past employment.⁴⁰

In nearly all studies, data were self-reported by alumni. Public information such as social media profiles or employer reports was used in only 3 reports.^{20,55,63} The number of graduates surveyed ranged from 8⁵² to 43 903,¹¹ and response rates ranged from 30%⁴⁶ to 100%.⁵²

Most studies were not primarily intended to capture data on employment outcomes. The goal of most of the studies was to evaluate the curriculum of a school or programs of public health, graduates' satisfaction with their studies, or the learning objectives or competencies of the degree program.²⁶ Twelve articles focused primarily on employment outcomes of graduates.^{21,22,40,43,49,59,61-64,67,68}

Employment Outcomes

Few articles provided data on all aspects of postgraduate employment outcomes. Although public health workforce taxonomies exist,⁷⁰ most studies did not follow them. Unemployment rates ranged from 0% to 20%. Ten articles did not indicate the primary employment outcome (eg, employed, unemployed)^{41,42,44,46,47,51,57,60,61,66}; 7 articles did not report on employment sector^{20,46,51,55,57,60,65}; and, when sector was reported, the reports used categories that were too inconsistent to allow comparisons among programs. One article simply stated that graduates were employed "in a range of sectors"⁵⁵ and another conflated job function with industry.⁴⁶

Although the widely varying survey methods and dates of surveys made it impossible to conduct a statistical comparison, it is possible to make some anecdotal comparisons among various surveys. For example, the range of graduates entering government employment appeared to vary by country from a low range of graduates (6.6%-11.6%,^{55,63} both studies in the United States), to a

middle range (60% in Canada,⁶⁵ 62% in Australia,²² and 63% in South Africa⁶⁴), and a high end (100%⁵³ in Australia).

Six articles compared characteristics (eg, employment setting, salary, job level) of students before enrolling into the educational program with postgraduate outcomes^{23,46,47,61,62,66}; 2 articles mentioned graduates moving into national or international organizations from previous careers in local government or nonprofit organizations.^{47,62} Two articles compared employment sector for practica with employment for the same students.^{41,68} Seven articles discussed salary averages.^{11,20,22,23,46,49,55} Only 4 studies discussed job search methods,^{42,49,65,68} and 4 analyzed multiple graduating cohorts for a period of years.^{11,59,60,63}

Discussion

Our scoping review identified little research on the employment outcomes of students who earned public health degrees. Most of the 33 identified studies did not provide useful workforce planning information because they focused on only 1 school, provided information on a subdiscipline of public health, mixed numerous graduating cohorts into 1 data set, or had low response rates. Single-school studies may not be generalizable; 1 article that assessed employment outcomes by sector for multiple schools and programs of public health found that the proportion of graduates entering into different sectors varied greatly by schools and programs of public health.⁶³ Combining numerous graduating cohort years into 1 study mixes graduates who have years of work experience with graduates who are newly entering the job market, making it difficult to differentiate between the effect of work experience and the effect of education on employment outcomes.

Several articles mentioned the dearth of evidence-based evaluations of the effect of public health educational programs on graduates' careers, the public health workforce, or society at large. Zwanikken et al mentioned, "No statistical analysis was performed because of the wide variety of study designs and methods," and noted that "study designs were generally of low quality."²⁴ Evashwick et al stated, "Matching education content and capacity with workforce demand was rarely mentioned."²⁵ This review confirms that these issues also pertain to public health employment outcomes.

Although the studies we reviewed did not follow consistent research methods, new protocols have been developed. NACE developed protocols in 2014 to systematize measurement of employment outcomes to allow comparison of such outcomes among various degree programs. CEPH also clarified its outcomes measures as part of updated accreditation standards in 2016.² In 2015, ASPPH launched a large-scale outcomes reporting effort.¹¹

This scoping review identified several potential improvements for future research. First, a clear definition of graduating cohorts should be established. Second, stakeholders should agree on a

deadline for outcomes surveys to be collected for each graduating cohort. Third, employment status definitions should be consistent. Fourth, schools and programs of public health should set aside resources to collect data on employment outcomes. Fifth, schools and programs of public health should agree on how employment data are reported to the public or to prospective students. Sixth, researchers should connect employment data with workforce needs and assess whether there is an undersupply or oversupply of public health graduates. Seventh, if a labor market mismatch is identified, its causes should be assessed and rectified. Lastly, although data on new graduates' employment outcomes within the first 6 or 12 months postgraduation are important, longer-term longitudinal studies, including tracking graduates' career trajectories and integrating these data with workforce research, should be undertaken to provide an evidence-based workforce planning effort.

Limitations

This study had several limitations. First, we attempted to classify sectors that were named inconsistently in various articles, but some data may have been miscategorized because of different nomenclature. Second, because of the large number of irrelevant results, the Google Scholar results were not input into Covidence and were reviewed by only 1 reviewer (H.K.). It is possible that some relevant articles were missed for this reason. Finally, nearly all studies were cross-sectional, which provided only a snapshot of graduates' status in time rather than providing a longitudinal analysis.

Conclusions

Research on public health graduates' employment outcomes is inconsistent and few broad studies have been conducted. Thus, little evidence is available on the ability of degree programs to produce public health professionals. A new, not-yet-published national data collection, comprising data collected by ASPPH members and analyzed by ASPPH staff members, may fill the gap in research identified in our review; similar efforts could help other countries to assess the employment of their graduates. This new research may allow comparisons among public health disciplines and provide evidence of labor market mismatches. In light of the need for more trained public health workers because of the current coronavirus disease 2019 pandemic, such mismatches could have substantial repercussions on public health. These data could be crucial in advocating for new investments in public health education. Future research, including international studies, longitudinal studies, and qualitative research, would further improve the quality, consistency, and quantity of data on graduates' employment outcomes and expand this understudied aspect of workforce research.

Table 2. Results of a scoping review of articles with quantified data on employment outcomes of graduates of schools and programs of public health, by location, population, timing, Kirkpatrick level,^a and employment outcome (N = 33 articles), January 1, 1993, through July 4, 2020

Study/variable	Abstracted information
Beck et al (2020),¹¹ United States (multiple SPHs)	
Population surveyed	Data collected by ASPPH (43 903 graduates) from 2015-2017; and data collected by NCES for every university in the United States, searchable by major and institution. ASPPH included all participating SPHs; NCES included all universities or colleges in the United States.
Mixed dates of graduation	No (data gathered 1-year postgraduation).
No. surveyed, no of responses	ASPPH: 43 903 graduates of ASPPH-member SPHs. NCES: number of graduates not indicated but results come from federal loan and income data.
Quality assessment and Kirkpatrick level	Selections: nonrespondents not described. Survey instrument: not described; NCES methods referenced. IRB not mentioned. Outcomes: inferential statistics. Kirkpatrick level: 4.
Employment status, no. (%)	ASPPH: 4% of 2015-2017 reported graduates were still seeking a job 1 year after graduation.
Employment by sector	ASPPH: the largest percentage of 2015-2017 master's graduates reported jobs in the sectors of health care (28%), government (19%), and academia (19%). Bachelor's graduates: for-profit firms (34%) or pursuing further study after graduation (25%).
Comment	ASPPH indicates median salaries of \$60 000 for public health master's students. NCES data indicated salaries of public health graduates' first jobs after graduation averaged \$48 866. NCES also reports median student loan debt.
National Association of Colleges and Employers (NACE) (2018),²⁰ United States (multiple SPHs)	
Population surveyed	2018 graduates of undergraduate and graduate public SPHs that reported to NACE; 361 schools in United States participated in NACE survey, but number of those which were SPHs not listed
Mixed dates of graduation	No; data reported by December 31 after graduation for the previous graduating class
No. surveyed, no of responses	Data available on 1948 master's-level graduates and 4085 undergraduates. Response rate unclear; knowledge rate of master's-level graduates was 74.4% and of undergraduates was 67.2%.
Quality assessment and Kirkpatrick level	Selection: no comparison of nonrespondents. Survey instrument: unclear, may vary by school, although website includes guidelines. Outcomes: statistical methods not reported. Kirkpatrick level: 4.
Employment status, no. (%)	Master's-level graduates: 70.9% employed (67.3% full-time, 3.7% part-time); 13.5% continuing study; 12.6% unemployed; 2.2% not seeking employment; 0.5% volunteering. Undergraduates: 42.8% employed (38.0% full-time, 4.8% part-time); 36.7% continuing study; 17.7% unemployed; 0.9% not seeking employment; 1.7% volunteering.
Employment by sector	NA (sector data not collected).

Comment Master's-level graduates: \$56 653 average salary; undergraduates: \$38 370 average salary.

Li and Awofeso (2014),²² Australia (multiple SPHs)

Population surveyed Using data from the 1999-2009 waves of the Graduate Destination Survey (GDS) of all graduates who have completed a higher degree qualification in an Australian university, focusing on master's-level graduates coded as public health (MPH)

Mixed dates of graduation No; cohorts measured at the same time point postgraduation (4 months after graduation), using the Australian GDS

No. surveyed, no of responses Data available for 3465 graduates (unclear how national graduate survey was conducted)

Quality assessment and Kirkpatrick level Selection: mailed survey 4 months after graduation by Graduate Careers Australia and Department of Education. Follow-up telephone calls and emails found no marked difference between respondents and nonrespondents. Survey instrument: used national GDS Code of Practice. Outcomes: descriptive analysis, using retrospective cohort study framework. Kirkpatrick level: 4.

Employment status, no. (%) Employed: 85% (64% full-time, 21% part-time); unemployed: 5%; not seeking or not available for work: 10%, within 120 days of graduation.

Employment by sector Sector: government (62.0%), corporation (26.0%), nonprofit (12.0%). Industry analyzed separately: manufacturing (5.5%), services (15.0%), government (13.0%), education (12.5%), health (53.8%).

Comment Public health graduates had a low unemployment rate and 85% were employed within 120 days of graduation. Article indicates a lack of studies that examine the career pathways of public health graduates, due in part to a lack of data on the public health workforce. Many public health graduates work in non-health-related industries. Many other lucrative options may be available to public health graduates apart from a career as a public health professional. Lists earnings, occupational categories/classification: health care professionals (41.0%), managers (13.0%), business professionals (9.0%); age; sex; salary (\$78 659 average Australian); employment outcome by sex.

ASPPH (2015),²³ United States (multiple SPHs)

Population surveyed 4867 master's and doctoral public health graduates from ASPPH-member and CEPH-accredited SPHs in the United States

Mixed dates of graduation No; surveys sent March–May 2014 for spring 2013 to winter 2013-2014 graduates; results submitted in June 2014 (about 1 year after graduation).

No. surveyed, no of responses Reports available from 4867 graduates

Quality assessment and Kirkpatrick level Selection: response rates ranged from 6% to 100%, with overall response estimated to be 54%. 88% of responses were from schools; 12% of responses were from programs. 64% of responses were from institution-designed surveys, 36% from ASPPH Common Questions survey. Reported data closely mirror annual data collected by ASPPH on the graduate population for 2013. Survey instrument: Common Questions survey or institution-designed survey. Survey was a pilot. Outcomes: descriptive statistics. Kirkpatrick level: 4.

Employment status, no. (%) Employed: 72.4% of master's, 75.1% of doctoral graduates; fellowship/residency: 4.7% of master's, 15.4% of doctoral graduates;

not employed (does not indicate if continuing study): 9.4% of master's, 3.4% of doctoral graduates; not seeking employment: 3.9% of master's, 2.8% of doctoral graduates; unknown: 9.6% of master's, 3.2% of doctoral graduates; continuing study asked separately; of 2685 respondents asked about continuing study, 25.0% overall were continuing study (636, or 26.5% of master's, and 32 or 11.0% of doctoral students). Continued study analyzed by academic department (with epidemiology most likely to be continuing study).

Employment by sector

Master's: 19.4% in government (33.2% federal, 22.7% unspecified, 17.8% state health department, 8.7% local health department, 5.7% state unspecified, 3.6% state not health department, 4.2% local not health department, 3.1% local unspecified, 1.0% government contractor); 14.5% corporation; 14.5% nonprofit; 21.6% health care (of which 12.0% were for-profit corporation in pharmaceutical industry); 21.8% academia; 8.1% other. Doctoral: 13.0% in government (64.6% federal, 12.5% unspecified, 10.4% state health department, 2.1% local health department, 4.2% state not health department, 2.1% government contractor, 2.1% tribal); 12.5% corporation; 7.6% nonprofit; 6.5% health care (of which 38.5% were pharmaceuticals); 52.4% academia; 7.9% other.

Comment

Salaries listed by ranges; \$50 001-\$75 000 most common range for master's and doctoral graduates (35.0%). Report includes employment during school, part-time vs full-time employment by sector; same vs new position postgraduation; percentage considering their job health related; sector by area of study; age ranges, sex, citizenship, race/ethnicity, degree type, area of study, other graduate degrees held; proportion continuing study by area of study; jobs before and after graduation; job titles/functions, debt levels; salary by area of study and sector; salary increase postgraduation. Some SPHs used data collection methods that went beyond the survey, including social media.

Edgar and Hyde (2005),⁴⁰ United States (single SPH)

Population surveyed

Alumni of Emerson College (MA)/Tufts University (MS), master's program in health communication; 119 of 131 graduates from 1994 through 2003 for whom email addresses were available

Mixed dates of graduation

Yes (1994-2003)

No. surveyed, no of responses

Surveyed: 131; responded: 106

Quality assessment and Kirkpatrick level

Selection: no comparison of contactable vs not contactable alumni. Survey instrument: pilot-tested online survey. IRB approved. Kirkpatrick level: primarily competencies, satisfaction (level 2) and outcomes (level 4).

Employment status, no. (%)

Employed: 98%; unemployed: 2%.

Employment by sector

Sectors of current or most recent jobs: government (12%), corporation (36%; 11% public relations firm, 9% pharmacy/biotechnology, 7% insurance, 7% information technology, 2% consulting); nonprofit (9%), health care (15%), academia/research (12%), private practice/self-employed (5%), other (10%).

Comment

Also included employer survey and literature review. Salary: respondents were surveyed on their salary expectations, not salary histories.

Woodhouse et al (2006),⁴¹ United States (multiple SPHs)

Population surveyed	Survey of 27 MPH programs offering health education programs
Mixed dates of graduation	Seems to be no; unclear when surveys were sent to graduates; phrased as “employed after graduation.”
No. surveyed, no of responses	27 SPHs surveyed, 19 responded. Unclear how many student records were included in the responses
Quality assessment and Kirkpatrick level	Selection: 27 CEPH-accredited SPHs. No explanation about nonresponding SPHs. Survey instrument: multiple survey iterations were tested. Outcomes: statistical methods not reported. Kirkpatrick level: student demographic characteristics/ curriculum design, competency (level 2); outcome (level 4).
Employment status, no. (%)	NA
Employment by sector	Government: 40% (39% for practicum); corporation: 8% (5% for practicum); nonprofit (community public health agency): 21% (33% for practicum); health care: 11% (16% for practicum); academia: 14% (6% for practicum); other: 6% (1% for practicum).
Comment	Sector definitions not consistent or clear; no numbers reported. However, article indicates sector of practicum vs employment and mentions the connection of the 10 essential public health services to career. Quote: “Of great concern for the future of public health workforce is the low percentage of all MPH graduates who go to work in public-serving institutions.”

Edgar et al (2015),⁴² United States (multiple SPHs)

Population surveyed	Alumni of 5 SPHs providing health communication master’s degrees; 2 MA, 3 MPH. Data on MPH graduates are analyzed separately from data on MAs and had 105 respondents. SPH included Emerson College, Tufts University School of Medicine, Michigan State University, University of Southern California (USC), The George Washington University.
Mixed dates of graduation	Yes: all graduates of the health communication master’s degree programs from the 5 institutions starting with their first graduating classes and ending with those who received degrees in December 2012 but did ask about first job after graduation (2 schools: 1994-2012; 1 school: 1998-2012; 1 school: 2003-2012; 1 school: 2006-2012)
No. surveyed, no of responses	522 surveyed (of whom 188 were MPH graduates); 398 responded (of whom 105 were MPH graduates)
Quality assessment and Kirkpatrick level	Selection: response rates varied by school. Survey instrument: used previous survey (2005), piloted. IRB approved. Outcomes: statistical methods not described. Kirkpatrick level: 4.
Employment status, no. (%)	Percentage employed not listed; 6.7% were continuing study.
Employment by sector	Number of MPH graduates whose sector was known: 77; state government: 12 (15.6%); federal government: 14 (18.2%); corporation: 17 (22.1%) (including 12 corporate, 3 insurance, 2 pharmaceuticals); nonprofit: 14 (18.1%); health care: 4 (5.2%); academia: 16 (20.8%).
Comment	Includes job search data, salary, satisfaction with career choice, perception of how well the degree prepared graduates for their careers, how graduates chose their degree programs. Notes that 23.8% of graduates found their jobs on websites, 12.7% from practicum, 9.9% from classmates, 9.9% from family/friends, 8.3% from professional

network, 4.4% from faculty, and 2.2% from career center.

Petersen et al (1997),⁴³ United States (multiple SPHs)

Population surveyed	13 MCH programs in schools of public health funded by the Maternal and Child Health Bureau; 12 responded
Mixed dates of graduation	Yes (1990-1994 graduates, across 5 years; data collected upon graduation)
No. surveyed, no of responses	Number surveyed unclear; attempted to reach all graduates. 742 responses (90% of whom had an MPH)
Quality assessment and Kirkpatrick level	Selection: no comparison between respondents and nonrespondents. Survey instrument: description of measurement tool unclear; no indication of pilot survey. Outcomes: self-reported; χ^2 analysis. Kirkpatrick level: competencies (level 2).
Employment status, no. (%)	Employed: 537 (72.4%); students: 50 (6.7%); unemployed: 18 (2.4%); other: 17 (2.3%); retired or deceased: 4 (0.5%); unknown: 116 (15.6%).
Employment by sector	Number for whom sector was known: 523. Government (total): 161 (30.8%) (local government: 67 [12.8%]; state government: 65 [12.4%]; federal government: 29 [5.5%]); corporate (other NGO/consulting): 37 (7.1%); nonprofit: 37 (7.1%); voluntary health agency: 29 (5.5%); health care/hospitals: 67 (12.8%); academia or research: 91 (17.4%); private practice: 46 (8.8%); other: 55 (10.5%).
Comment	Notes job functions. Clinical practice: 144 (19.4%); project management: 96 (12.9%); program specialist: 86 (11.3%); director: 49 (6.6%); researcher: 46 (6.2%); educator: 41 (5.5%); resident: 37 (5.0%); case manager: 21 (2.8%); policy/data analyst: 17 (2.3%); student: 50 (6.7%); unemployed: 18 (2.4%); other: 17 (2.3%); retired or deceased: 4 (0.5%); unknown: 116 (15.6%). The University of Alabama, Birmingham, team used its collective knowledge to develop taxonomy.

Margolis et al (2013),⁴⁴ United States (single SPH)

Population surveyed	Graduates from 5 Maternal and Child Health Bureau-funded training programs at the University of North Carolina (UNC) (1 of which was public health)
Mixed dates of graduation	Yes (1-8 years after graduation)
No. surveyed, no of responses	Number surveyed unclear; total N = 208 (60% response rate). Thus, apparently 347 graduates were surveyed, of which 102 were public health graduates
Quality assessment and Kirkpatrick level	Selection: no clear comparison of nonrespondents. Survey instrument: unclear, no pilot mentioned. Kirkpatrick level: 3, 4 (asked how much time graduates spent on tasks in the maternal and child health [MCH] pyramid).
Employment status, no. (%)	A small percentage (6%-10%) were current students or otherwise not currently employed, whereas 11%-17% were marked "other"; but the percentage who were students, not employed, or "other" was not listed for MPH specifically and outcome could not be calculated.
Employment by sector	State or local government: 10; federal government: 11; corporation: 28; nonprofit: 18; health care: 13; academia: 31. Survey respondents could

choose >1 category.

Comment Lists “contract research organization” as a sector of employment, but these can be for-profit or nonprofit. The authors charted contract research organizations under “corporation.” Connects MCH pyramid to careers.

Koblinsky et al (2015),⁴⁵ United States (single SPH)

Population surveyed Alumni of University of Maryland (UMD) PhD in MCH who took part in a career development course.

Mixed dates of graduation Yes (2004-2014)

No. surveyed, no of responses 53 (number of nonrespondents not listed; implication is that 100% of participants were tracked)

Quality assessment and Kirkpatrick level Selection: data have been collected. (No further information on survey methods, statistical methods, etc.) Kirkpatrick level: 4 (evaluation of career program).

Employment status, no. (%) Employed: 98%; unemployed: 2%.

Employment by sector Government: 7 (13%); corporation including clinical practice: 7 (13%); nonprofit: 10 (19%); academia: 28 (53%).

Comment Indicates tenure-track positions vs non-tenure-track positions. Mentions other surveys previously conducted including a longitudinal study and career satisfaction study.

Gerstel et al (2013),⁴⁶ international/European Union (EU) (Amsterdam, Berlin, Basel) (multiple SPHs)

Population surveyed Master of international health graduates from TropEd Network: 30 universities worldwide (EU, Africa, Asia, Latin America). 3 SPHs responded: Royal Tropical Institute, Amsterdam; Institute of Tropical Medicine and International Health, Berlin; Swiss Tropical & Public Health Institute, Basel, Switzerland.

Mixed dates of graduation Unclear (graduates from 2008 and earlier); likely up to 15 years of respondents.

No. surveyed, no of responses 3 of 7 SPHs participated. 327 graduates surveyed, 177 responded, 99 included in study.

Quality assessment and Kirkpatrick level Selection: nonresponding SPHs lacked time and staff, excluded student respondents if they did not sufficiently use mobility of the network or had less work experience than degree required. Survey instrument: based on previous surveys; pilot not mentioned. Outcomes: descriptive statistics, bivariate and cross-tabulation analysis. Kirkpatrick level: competencies, confidence (level 2).

Employment status, no. (%) NA

Employment by sector Level of employment setting changes before and after graduation; more graduates worked at international level after graduation, fewer at national or local organizations.

Comment Graph unreadable and numbers did not total to the number of respondents; categories did not align with other reports. Report mixed and conflated job functions and type of employer; categories such as curative care, general public health care, prevention, HIV/AIDS, monitoring and evaluation, and noncommunicable diseases are mixed. Pre- and post-job function/sector analysis. Analyzed job function but not industry/sector. Salaries increased for 57% of graduates and

declined for 9% of graduates.

Zwanikken et al (2014),⁴⁷ international (Vietnam, China, South Africa, Mexico, Sudan, the Netherlands) (multiple SPHs)

Population surveyed	MPH graduates in programs geared toward low- and middle- income countries, including Hanoi School of Public Health, Vietnam; School of Public Health Fudan University, China; School of Public Health University of the Western Cape, South Africa; National Institute of Public Health Mexico, Mexico; University of Medical Sciences and Technology, Sudan; Royal Tropical Institute, the Netherlands
Mixed dates of graduation	Yes (graduates from 2005-2010)
No. surveyed, no of responses	1187 sent, 37.5% response rate
Quality assessment and Kirkpatrick level	Selection: noted that response rates did not differ by SPH. Survey instrument: questions based on systematic review and previous questionnaire; field tested. Outcomes: descriptive and bivariate statistical analysis, logistic regression, analysis of variance, analysis of covariance. Kirkpatrick level: application of skills (level 3); impact/outcome (level 4).
Employment status, no. (%)	NA
Employment by sector	Local government (12.5%), state government (10.0%), federal/national government (12.7%), nonprofit (11.9%), health care (12.0%), academia (8.0%), research (7.0%), other (26.0%).
Comment	Indicates before MPH and after MPH for various sectors. However, graphic was hard to read. Notes change in leadership level for 69% of graduates, increased salary for 63% of graduates. Analyzed data by sex, degree, and age as predictor of changes in leadership level.

Dandu et al (2015),⁴⁸ United States (single SPH)

Population surveyed	127 graduates of University of California San Francisco (UCSF) master of global health (1-year MS degree)
Mixed dates of graduation	Yes (classes of 2009-2012)
No. surveyed, no of responses	127 surveyed; 89 responded (including 17 with a previous terminal degree)
Quality assessment and Kirkpatrick level	No description of survey methods or statistical analysis. Kirkpatrick level: primarily 1, also 4.
Employment status, no. (%)	Employed: 70 (79%); continuing study: 64 of 72 graduates without terminal degrees (89%) plan to enroll in further education (33 have enrolled, 31 plan to enroll); unemployed/taking time off: 10 (11%).
Employment by sector	Number for whom sector was known: 70; government: 8 (11%); corporation: 6 (9%); nonprofit: 4 (6%); academia: 46 (66%); other: 6 (9%).
Comment	Note: fellowship/residency was included in employment in academia (37%). Mentions future education plans of 72 graduates who did not have terminal degrees.

Cherniak et al (2019),⁴⁹ United States (multiple SPHs)

Population surveyed	Master of global health, public health with global concentration, or global medicine at 8 US universities that were members of the Consortium of Universities for Global Health
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Mixed dates of graduation	No (206 graduates surveyed from September through December 2016)
No. surveyed, no of responses	256 surveyed; 208 consented to be surveyed (50 excluded for not graduating within the specified time frame); 152 included in final analysis.
Quality assessment and Kirkpatrick level	Selection: comparison of nonrespondents not described. Survey instrument: IRB approved. Pilot test not described. Outcomes: descriptive statistics. Kirkpatrick level: 4.
Employment status, no. (%)	Employed: 102 (67.1%; 50.0% of respondents employed full-time, 17.0% part-time); continuing study: 18 (11.8%); not employed and with no immediate prospects: 29 (19.1%); volunteering: 3 (2.0%).
Employment by sector	114 responses to this question. Government: 14 (12.3%) (national level: 4; international/multilateral organizations: 6; state or local: 4); corporate: 9 (7.9%); nonprofit: 21 (18.4%) (NGO: 18; philanthropy: 2; faith-based organization: 1); health care: 10 (8.7%); academia/research: 58 (50.8%); private practice/self-employed: 1 (0.8%); other: 1 (0.8%).
Comment	Notes job functions: clinical practice (12.2%), other project management (42.2%), public health practitioner (4.4%), data analyst/researcher (11.1%), educator (20.0%), consulting (7.8%), marketing/communications (2.2%). Notes average salary of \$40 000-\$59 000; mentions actual vs desired geographic location and job type/function; documents job search process/how job was found, how many applications and interviews (of 180 respondents, 58 found job through recommendations, 55 through internet, 14 through college career services).

Yount et al (2020),⁵⁰ United States (single SPH)

Population surveyed	MPH alumni and non-degree-seeking mid-career fellows in global health from Emory University
Mixed dates of graduation	Yes (mixed graduates since 2010 with no end date specified)
No. surveyed, no of responses	762 MPH alumni surveyed, 334 responded (43.8%). An additional 19 non-degree-seeking fellows responded and their responses were mixed with the responses of MPH graduates.
Quality assessment and Kirkpatrick level	Selection: nonrespondents not compared with respondents. Survey instrument: pilot test not described. IRB approved, SurveyMonkey survey. Outcomes: categorical data analysis/ logistic regression with gender identity as primary exposure variable. Kirkpatrick levels: 1, 4.
Employment status, no. (%)	Employed (82.0%), continuing study (12.5%), unemployed (3.4%), not applicable (1.2%).
Employment by sector	Government (state, local, federal): 25.4%; United Nations agency: 4.9%; corporate: 4.0%; nonprofit: 19.4%; hospital: 6.7%; academia/research: 28.9%; other: 10.5%. Of 82.0% employed, 45.0% worked in global health, 28.9% in US public health, and 8.5% not in public health.
Comment	Analysis focused on gender disparities in training satisfaction, career agency, and global health employment.

Brosseau and Fredrickson (2009),⁵¹ United States (single SPH)

Population surveyed	Industrial hygiene graduates; school not specified but likely University of Minnesota.
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Mixed dates of graduation	Yes: 15 years (1992-2005)
No. surveyed, no of responses	71 surveyed; 46 responded (66% response rate)
Quality assessment and Kirkpatrick level	Selection: unclear whether a sample vs full set of graduates were surveyed. Survey instrument: not clearly described, mailed survey. Outcomes: statistical analysis of graduate perception of skills but not of employment outcome. Kirkpatrick level: competencies (level 2), outcomes (level 4).
Employment status, no. (%)	NA
Employment by sector	Number for whom sector was known was not indicated, so percentages could not be computed. Immediately after graduation, most were employed in corporate/industrial settings (n = 18), government agencies (n = 15), and consulting companies (n = 8). At the time of survey, the most common employment settings were corporate/industrial (n = 18) and government agencies (n = 13). Only 3 respondents reported working as consultants.
Comment	Status of respondents without indicated sector unclear, number not clearly listed, only 3 sectors listed; lists employment sector “upon graduation” vs “at time of survey.” Also included employer survey.

Fox and Beyers (2011),⁵² Canada (single SPH)

Population surveyed	Graduates of University of Toronto Public Health Nutrition program
Mixed dates of graduation	Mixed 1 or 2 graduating classes (unclear)
No. surveyed, no of responses	Unclear whether describing all 10 initial students who would have completed the program.
Quality assessment and Kirkpatrick level	Selection: appears to track all graduates. Survey instrument: not described. Outcomes: statistical methods not reported. Kirkpatrick level: primarily curriculum description (no level).
Employment status, no. (%)	Employed: 100% (all 10 students currently working in roles related to public health nutrition).
Employment by sector	Government: 8 (6 in local government, 1 in provincial government, 1 in federal government); corporation: 1; unclear: 1.
Comment	Includes number of graduates working in rural and northern Canadian communities as outcome; 10 initial students will have completed the program; unclear if tracking 8 or 10 graduates. Five graduates benefited from advancement in their existing workplaces, and 3 pursued opportunities at new places of employment.

Li et al (2017),⁵³ Australia (single SPH)

Population surveyed	Graduates from Aboriginal population health training program (MPH) at University of New South Wales, 2011-2014
Mixed dates of graduation	Unclear
No. surveyed, no of responses	18 surveyed, 18 responded
Quality assessment and Kirkpatrick level	Survey instrument: exit interviews. No methods/instrument details reported. Kirkpatrick level: primarily curriculum description (no level); and level 4.
Employment status, no. (%)	100% employed by New South Wales Health Department.

Employment by sector	Government: 100%.
Comment	Focus of article is on curriculum design for program serving Aboriginal students. Key informant interviews of employers/stakeholders also conducted.
White (2015),⁵⁴ United States (single SPH)	
Population surveyed	Undergraduates in public health at Tulane University
Mixed dates of graduation	No (2011, 2012, 2013 each surveyed separately, 6 months and again at 1-year postgraduation)
No. surveyed, no of responses	Numbers surveyed or responded not listed.
Quality assessment and Kirkpatrick level	Selection: not listed. Survey instrument: not described. Outcomes: statistical methods not listed. Kirkpatrick level: primarily curriculum description (no level); employment outcomes (level 4).
Employment status, no. (%)	2013 data: employed (16.4%), continuing education (82.2%), unemployed or seeking employment (1.4%), unknown (5.5%). 2012 data: employed (31.7%), continuing education (66.7%), seeking employment (1.6%), not seeking employment (1.6%), unknown (5.8%).
Employment by sector	Not specified: employed in a range of settings.
Comment	Notes: salary range, \$35 000-\$52 000 (2013 graduates). Used NACE methods, gathered data from social media in addition to survey responses.

Wykoff et al (2015),⁵⁵ United States (single SPH)

Population surveyed	Undergraduates with degrees in public health from East Tennessee State University
Mixed dates of graduation	2011, 2012, 2013 graduates; but surveys were each conducted about 18 months after graduation
No. surveyed, no of responses	65 respondents for a response rate of 69.5%
Quality assessment and Kirkpatrick level	Selection: no analysis/comparison of nonrespondents. Survey instrument: not described. Outcomes: statistical methods not listed. Kirkpatrick level: primarily curriculum description (no level); and level 4.
Employment status, no. (%)	Employed: 48 (73.8%); continuing study: 11 (17.0%); seeking employment: 2 (3.1%); not seeking employment: 4 (6.2%).
Employment by sector	Government: 4 (8.3%); corporation: 3 (6.3%); nonprofit: 6 (12.5%); health care: 21 (43.8%); academia: 4 (8.3%); other: 10 (20.8%).
Comment	Mentions employer and preceptor survey.

Bass et al (2008),⁵⁶ United States (multiple SPHs)

Population surveyed	Undergraduates from 3 SPHs; 2 include outcomes (Temple University [TU] and University of Southern California [USC]).
Mixed dates of graduation	Unclear (2005, 2006 graduates)
No. surveyed, no of responses	Unclear how many were surveyed. Responses: TU (66), USC (101)
Quality assessment and Kirkpatrick level	Selection/survey: survey not described. Outcomes: no statistical analysis reported. Kirkpatrick level: primarily description of education

programs (no level); 4 (outcomes).

Employment status, no. (%)	Employed: 37 (56.0%) at TU, 28 (27.7%) at USC; continuing study: 9 (13.5%) at TU, 61 (60.4%) at USC; currently applying to graduate schools: 4 (6.0%) at TU, 9 (8.9%) at USC; unknown: 16 (24.2%) at TU, 3 (3.0%) at USC.
Employment by sector	Government: 34 (51.5%) at TU, 2 (2.0%) at USC; other health careers: 0 at TU, 16 (15.8%) at USC; continuing study accounts for additional percentages.
Comment	Notes disciplines of further study of graduates.

Risisky et al (2020),⁵⁷ United States (single SPH)

Population surveyed	Undergraduate public health graduates from Southern Connecticut State University who took part in a service-learning project as part of a program planning course.
Mixed dates of graduation	Yes (mixed graduates from fall 2010 through spring 2016)
No. surveyed, no of responses	255 eligible graduates, of which 75 responded (33%)
Quality assessment and Kirkpatrick level	Selection: respondents described but not compared with nonrespondents. Survey instrument: confidential email survey, IRB approved, pilot tested. Outcomes: descriptive statistics and qualitative analysis. Kirkpatrick levels: 1, 2, 3, 4.
Employment status, no. (%)	One-third in health education/promotion, one-third in another public health field, and one-third working outside of public health. Almost half (45%) had gone on to an MPH degree program. It is not clearly stated but appears that 100% were employed.
Employment by sector	Sectors not indicated.
Comment	Purpose of study was to evaluate effect of service-learning program.

Houghton et al (2001),⁵⁸ Australia (single SPH)

Population surveyed	124 graduates of Adelaide University's bachelor of health sciences program who majored in public health
Mixed dates of graduation	Yes (1992-1999)
No. surveyed, no of responses	Surveyed: 124; responded: 88 (71%)
Quality assessment and Kirkpatrick level	Selection: compared respondents with nonrespondents and found that more recent graduates and graduates still living in Australia were more likely to respond than graduates who lived outside of Australia. Survey instrument: piloted with 2 students, conducted telephone interviews. Outcomes: self-reported. Basic descriptive statistics. Research focus is on use of skills gained through education while employed in public health. Kirkpatrick level: 4.
Employment status, no. (%)	Employed: 71 (81%); continuing study or unemployed: 17 (19%).
Employment by sector	Employed in public health workforce: 52 (59%); employed in areas other than public health: 19 (22%). Public health workforce not defined by sector.
Comment	Focus of study is on whether graduates used competencies gained in their studies, if working in the public health workforce; of those working in public health, job functions were: health research (44%), health program support (10%), health planning and policy (9%), health

education (8%), health management (8%), and health promotion (8%).

Brown-Podgorski et al (2018),⁵⁹ United States (multiple SPHs)

Population surveyed	PhD/DrPH graduates receiving a research doctorate in biostatistics, epidemiology, public health, health policy, or health systems; social and behavioral science included with general public health after 2014.
Mixed dates of graduation	Data gathered at or before graduation for 2003-2015 graduates from NSF Survey of Earned Doctorates.
No. surveyed, no of responses	Data available on 11 771 graduates. Response rate >90%.
Quality assessment and Kirkpatrick level	Selection: comparison of nonrespondents not listed, but response rate >90%. Survey instrument: NSF survey design. Outcomes: statistical methods included χ^2 , analysis of variance, binary and multinomial logistic regression. Kirkpatrick level: 4.
Employment status, no. (%)	Employed in academia: 3642 (34.8%); employed outside of academia: 3295 (31.4%); not currently employed: 3542 (33.8%) (includes negotiating employment, ranging from 10.5% to 12.3% depending on discipline of study; and seeking employment, ranging from 14.9% to 20.8%). Postdoctoral fellowships included as employment.
Employment by sector	Government: biostatistics (6.9%) environmental health sciences (EHS) (19.0%), epidemiology (15.7%), health services (9.8%), general public health (GPH) (11.7%). Corporation: biostatistics (20.4%), EHS (7.8%), epidemiology (6.6%), health services (9.7%), GPH (4.5%). Nonprofit: biostatistics (3.5%), EHS (3.3%), epidemiology (5.6%), health services (12.5%), GPH (6.7%). Academia: biostatistics (37.7%), EHS (32.9%), epidemiology (35.8%), health services (29.8%), GPH (34.3%). Other: biostatistics (2.4%), EHS (2.2%), epidemiology (3.9%), health services (3.7%), GPH (3.2%). Percentages are of total respondents, not of those who were employed; remainder of respondents were seeking or negotiating employment or not seeking employment by choice.
Comment	Compares outcomes by graduation year, area of study, type of university attended, race/ethnicity, and marital status; compares employment outcomes over time by graduating cohort.

Jackson et al (2019),⁶⁰ United States (multiple SPHs)

Population surveyed	All public health PhD/DrPH graduates from 2003-2015 in NSF data
Mixed dates of graduation	No; captured data from 2003-2015, but data were measured upon graduation
No. surveyed, no of responses	Data available on 11 771 graduates, response rate >90%.
Quality assessment and Kirkpatrick level	Survey instrument: NSF survey design. Outcomes: statistical methods included logistic regression and adjusted odds ratios. Kirkpatrick level: 4.
Employment status, no. (%)	Not described.
Employment by sector	Academia: 3737 of 11 771 (31.7%). No other sectors analyzed; analysis comprised of proportion of underrepresented racial/ethnic minority graduates entering this sector.
Comment	Analysis focused on underrepresented racial/ethnic minority doctoral graduates from public health fields and determined the proportion of people from these groups who entered academia.

Horney et al (2014),⁶¹ United States (single SPH)

Population surveyed	MPH graduates of University of North Carolina who had signed up for Epi-Aid, a volunteer program in the local health department.
Mixed dates of graduation	Yes: 2003-2010, but survey asked retrospectively about employment in the 6 months after graduation.
No. surveyed, no of responses	251 surveyed, 223 had correct emails, 83 responded (37% response rate)
Quality assessment and Kirkpatrick level	Selection: noted academic departments of respondents; survey instrument: used retrospective pre- and post-survey, no pilot; also interviewed. IRB exempt. Outcomes: conducted bivariate analysis and qualitative coding. Kirkpatrick level: evaluation of effectiveness of Epi-Aid volunteer program (level 4) but not directly employment outcomes.
Employment status, no. (%)	63 (75.9%) were employed; 20 (24.1%) had no paid employment reported (could include continuing study, not seeking employment, left question blank).
Employment by sector	Governmental public health: 27 (42.9%); other public health: 34 (54.0%); other: 2 (3.2%).
Comment	Tracks pre-enrollment employment with postgraduation employment. Noted correlation between participation in volunteer program and postgraduate career in government. Highlights public health workforce shortage. A key gap for the field exists in the lack of understanding about when and how people make public health career decisions. Asked about 10 essential public health services connected to employment.

Buunaaisie et al (2018),⁶² United Kingdom (single SPH)

Population surveyed	97 international students graduating with an MsC in public health from 1 university in the United Kingdom, University of the West of England, Bristol
Mixed dates of graduation	Yes (10 years, graduates from 2006 to 2016). Asked retrospectively about first job after graduation.
No. surveyed, no of responses	97 surveyed, 48.5% response rate (47 responses; 39 completed full survey)
Quality assessment and Kirkpatrick level	Selection: because the survey was anonymous, could not compare nonrespondents, but demographic characteristics of respondents reflected enrollment. Survey instrument: sequential mixed-methods study (survey and interviews); piloted survey and interviews. Outcomes: descriptive statistics. Kirkpatrick level: 4
Employment status, no. (%)	Employed (63%), self-employed (9%), continuing study (15%), unemployed (2%), volunteering (11%).
Employment by sector	Number for whom sector was known: 38; government: 16 (42%); corporation: 8 (21%); nonprofit: 9 (24%); academia: 5 (13%). Noted pre- and post-degree employment sector. Noted increase in for-profit, university, and national, and international government employment and decrease in local government employment.
Comment	Respondents reported enhanced roles after graduation in areas such as public health policy analysis (74%); planning, implementation, and evaluation of public health interventions (74%); leadership roles

(72%); and research (70%). The common perceived skills that were relevant to the respondents' present jobs were critical analysis (87%), multidisciplinary thinking (86%), demonstrating public health leadership skills (84%), and research (77%). The respondents had mostly worked with local health service providers (38%), local or regional government agencies or NGOs (19% each) before the MSc in public health. But after graduation, a higher proportion reportedly worked in national and international health agencies or private businesses than before the MSc public health degree.

Krasna et al (2019),⁶³ United States (multiple SPHs)

Population surveyed	MPH, PhD, MS, and MHA graduates from Columbia University School of Public Health; comparable data from the publicly visible websites of 11 other graduate SPHs
Mixed dates of graduation	No; data reported by December 31 after graduation for the previous graduating cohort (ie, December 31, 2017, for July 1, 2016–June 30, 2017, graduates) for Columbia University; other schools' reporting was variable
No. surveyed, no of responses	From Columbia, 2904 across 5 cohorts; 2283 graduates whose outcome was known (used “knowledge rate” rather than “response rate”).
Quality assessment and Kirkpatrick level	Selection: notes variable knowledge rate in different cohorts and possible self-selection bias, but nonrespondents not analyzed. Survey instrument: used NACE protocols. IRB approved. Outcomes: χ^2 , Cochran-Armitage trend test, logistic regression. Kirkpatrick level: 4.
Employment status, no. (%)	Employed: 1950 (67%); continuing study: 186 (6.4%); unemployed: 109 (3.7%); not seeking employment: 35 (1.2%); unknown: 621 (21.4%).
Employment by sector	From Columbia, 1932 whose sector was known. Government: 11.6% (2016 graduates), 13.1% (2015 graduates), 12.3% (2014 graduates), 12.5% (2013 graduates), 12.7% (2012 graduates); corporation: 31.3% (2016 graduates), 29.5% (2015 graduates), 23.1% (2014 graduates), 25.0% (2013 graduates), 14.6% (2012 graduates); nonprofit: 56.7% (2016 graduates), 57.4% (2015 graduates), 64.6% (2014 graduates), 62.5% (2013 graduates), 72.6% (2012 graduates). Other schools' sectors varied; government ranged from 8.2% (Harvard University) to 42.1% (University of New England); corporate ranged from 7.0% (University of Pittsburgh) to 43.2% (Yale University); and nonprofit ranged from 44.2% (Yale University) to 79.0% (University of Pittsburgh).
Comment	Note: for-profit included consulting, pharmaceuticals, insurance, technology, and private practice; nonprofit included academia, hospital, and nonprofit. Government included local, state, federal, and military. Salaries mentioned, including differences in salary by sector.

Dlungwane and Knight (2016),⁶⁴ South Africa (single SPH)

Population surveyed	MPH graduates of University of KwaZulu-Natal
Mixed dates of graduation	Yes (survey sent in 2013 for graduates from the last 10 years)
No. surveyed, no of responses	61 surveyed, 45 responded
Quality assessment and Kirkpatrick level	Selection: compares demographic characteristics of nonrespondents. Survey instrument: no pilot or IRB mentioned. Kirkpatrick level: 4.

Employment status, no. (%)	Employed: 100% (3% self-employed).
Employment by sector	Government: 28 (63%); nonprofit: 3 (6%); academia/research: 12 (28%); self-employed: 2 (3%).
Comment	Notes that most students are clinicians; public health graduates are generally older than graduates of other fields; focus is on which skills are applicable on the job.

Britten et al (2014),⁶⁵ Canada (single SPH)

Population surveyed	MPH graduates of 1 SPH, University of Guelph.
Mixed dates of graduation	Unclear: time of graduation was cross-referenced with employment status, but the survey was for 5 years of graduates. Survey sent in February 2013 to all graduates.
No. surveyed, no of responses	60 (>5 years) surveyed; 44 responded, 35 completed; 58% response rate
Quality assessment and Kirkpatrick level	Selection: comparison of nonrespondents. Survey instrument: used logic model to create survey, used informed consent. Retrospective survey of skills before and after the program. Outcomes: descriptive statistics. Kirkpatrick level: curriculum description (no level), satisfaction (level 1), competencies (level 2), outcomes (level 4), to assess if graduates were adequately trained to begin careers in public health.
Employment status, no. (%)	Employed: 21 (61.7%); employed but not in public health: 1 (2.9%); continuing study: 4 (11.8%); unemployed: 5 (14.7%); other: 3 (8.8%). Of 5 unemployed respondents, 4 had graduated in February 2013.
Employment by sector	61.7% employed in public health sector (category clarifies sector as government, nonprofit).
Comment	Article specifies length of job search.

Le et al (2007),⁶⁶ Vietnam (single SPH)

Population surveyed	187 MPH alumni of 1 SPH, Hanoi School of Public Health
Mixed dates of graduation	Yes (10 years, 1996-2006)
No. surveyed, no of responses	187 surveyed, 148 responded (79.1%)
Quality assessment and Kirkpatrick level	Selection: did not aim to select participants on a random basis. Survey instrument: mixed methods (survey/interviews). Outcomes: descriptive and bivariate analysis, multivariate, factor analysis. Kirkpatrick level: satisfaction (level 1); some level 2 (knowledge/competencies). Goals were to elicit opinions of the alumni on the MPH program; assess relevance of knowledge acquired; identify the importance of a range of public health competencies performed by alumni.
Employment status, no. (%)	Percentages not clearly indicated.
Employment by sector	Sectors do not align with other articles. 43.2% working at provincial public organizations (vs 45.3% before MPH training), 38.5% working at national/ministry government organization (vs 30.4% before MPH training), 9.5% working at district level (vs 15.5% before MPH training), 4.7% working for international agencies/NGOs (vs 1.4% before MPH training), 4.0% working for private organization/company and others (vs 5.4% before MPH training). Most alumni are working in preventive medicine public health sector (58.9%), 15.0% in curative

medicine sector, and the rest in other health and non-health fields.

Comment Includes age, gender, geographic location, and before/after sector comparison.

Davis et al (2003),⁶⁷ United States (multiple SPHs)

Population surveyed 48 graduate programs of community health, preventive medicine, or community health education were invited to join the survey; 40 participated.

Mixed dates of graduation NA; survey sent to SPHs; dates of graduation of students accounted for in the survey not specified clearly.

No. surveyed, no of responses Surveyed: 3456 enrolled students and 773 students who graduated in 1998-1999. (Data on employment outcomes/working status were unclear because this is the number of enrolled students; number of students who graduated was unclear; unclear whether employment data reflect actual postgraduation employment or part-time jobs students had while enrolled. Responses: 2269 employed (66% of respondents).

Quality assessment and Kirkpatrick level Selection: comparison of school respondents with nonrespondents but not of student status. Survey instrument: ASSPH (previously, Association of Schools of Public Health) updated an existing survey. Outcomes: no statistical methods listed. Kirkpatrick level unclear; research focus on curriculum description/student demographic characteristics, not outcomes.

Employment status, no. (%) Working status of students was reported, but it is unclear if status of recent graduates is included. Employed: 66% (48% full-time, 17% part-time); percentage unemployed unclear because current students and alumni are mixed.

Employment by sector Somewhat unclear if numbers refer to current students or alumni. Government (public health department): 426 (12%); other health-related employment: 1419 (41%); any other employment: 424 (12%).

Comment Of the 3456 students enrolled in the programs, 2021 (58%) were reported as part-time students. Only 4 programs reported having full-time students exclusively.

Yeager et al (2019),⁶⁸ United States (multiple SPHs)

Population surveyed Public health (MPH and MHA) graduates of 6 SPHs in the United States; SPHs distributed surveys to recent graduates and alumni.

Mixed dates of graduation Multiple cohorts mixed, but graduation date range is unclear; respondents were an average of 3.2 years since graduation.

No. surveyed, no of responses 83 graduates responded (58 MPH, 18 MHA). Response rate not possible to collect because of distribution method of survey.

Quality assessment and Kirkpatrick level Selection: survey instrument: cognitive response testing conducted before distribution. Outcomes: descriptive statistics, coding of themes.

Employment status, no. (%) Employed full-time: 47 (63.5%); employed part-time: 4 (5.4%); fellowship: 8 (10.8%); not employed or not seeking employment (may include those continuing study): 9 (12.2%); not employed or seeking employment: 6 (8.1%).

Employment by sector Government: 8 (17.0% of employed respondents). Other sectors not listed.

Comment

Compares internship setting with postgraduate employment setting; focuses on recruitment process and employment preferences of graduates.

Abbreviations: ASPPH, Association of Schools and Programs of Public Health; CEPH, Council on Education for Public Health; DrPH, doctor of public health; IRB, institutional review board; MA, master of arts; MPH, master of public health; MS, master of science; MSc, master of science; MHA, master of health administration; NA, not available; NCES, National Center for Education Statistics; NGO, nongovernmental organization; NSF, National Science Foundation; PhD, doctor of philosophy; SPH, school or program of public health.

^a The Kirkpatrick model is used to evaluate training programs. The model describes 4 levels of evaluation: (1) reaction, which focuses on whether participants experience the training as positive, helpful, engaging, and relevant; (2) learning, which is assessing whether participants acquire the expected knowledge, skills, attitude, or self-efficacy; (3) behavior, which is measuring whether participants apply their training in real-world situations; and (4) results, which is determining whether intended outcomes occur as a result of the training.²⁶

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Chapter 3: First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment

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First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment

Objectives. To improve understanding of the future public health workforce by analyzing first-destination employment outcomes of public health graduates.

Methods. We assessed graduate outcomes for those graduating in 2015–2018 using descriptive statistics and the Pearson χ^2 test.

Results. In our analysis of data on 53,463 graduates, we found that 73% were employed; 15% enrolled in further education; 5% entered a fellowship, internship, residency, volunteer, or service program; and 6% were not employed. Employed graduates went to work in health care (27%), corporations (24%), academia (19%), government (17%), nonprofit (12%), and other sectors (1%). In 2018, 9% of bachelor's, 4% of master's, and 2% of doctoral graduates were not employed but seeking employment.

Conclusions. Today's public health graduates are successful in finding employment in various sectors. This new workforce may expand public health's reach and lead to healthier communities overall.

Public Health Implications. With predicted shortages in the governmental public health workforce and expanding hiring because of COVID-19, policymakers need to work to ensure the supply of public health graduates meets the demands of the workforce.

Public health academics has grown rapidly in the past 2 decades at both the undergraduate and graduate levels.^{1,2} However, we lack information on postgraduate first-destination employment and educational outcomes of public health graduates. A scoping review found 33 studies or reports since 1993 that included employment or educational outcome data for public health students after graduation.³ Ten were studies of schools outside the United States, 18 were studies conducted by schools of their own alumni, 14 were studies of subdisciplines of public health (e.g., health communication, global health), 8 focused on either undergraduates or doctoral students, and 16 combined multiple cohorts of graduates (often more than a decade's worth of graduates) into 1 analysis, making the assessment of short- and long-term impacts of degrees on graduates' careers impossible. We have identified only 4 broad, recent, US-based studies, 2 of which are in the gray literature, including the results from the pilot project for this study.⁴⁻⁷

An assessment of first-destination outcomes of public health graduates is needed to ensure that there are enough trained public health professionals to fill rapidly changing workforce demands. On the workforce side, researchers have posited that vacancies from retiring governmental public health workers might be filled by the ample supply of recent public health graduates.⁸ On the education

side, an analysis of first-destination outcomes will help match curricula with workforce needs and identify emerging employment sectors. Trends in public health enrollment have changed, particularly with the increase in graduates at all degree levels. It is important for both academia and practice to know that graduates have a wide choice of employment options, stretching beyond government and into academia and the health care, nonprofit, and for-profit sectors.⁶

In 2016, the Council on Education for Public Health, recognized by the US Department of Education to accredit schools and programs of public health, made changes to their criteria that opened the door to curricula that “center learning around application and translation, giving students the opportunity to apply their . . . knowledge to real-life scenarios and job demands.”^{9(p.3)} Further, schools and programs of public health should “educate the educators, practitioners, and researchers as well as . . . prepare public health leaders and managers.”^{10(p. 108)} The public health professional degrees, such as the master of public health degree, are expressly intended to prepare students for public health careers. Determining whether graduates enter the public health workforce and which sectors they join are key parts of evaluating these programs.

In 2014, the Association of Schools and Programs of Public Health (ASPPH) developed data-reporting standards, aligned with the Council on Education for Public Health, to capture the first-destination outcomes of public health graduates within a year after graduation.¹¹ The data set also includes information on graduates’ continued education, fellowships, and other outcomes. We analyzed this new first-destination outcome data set, focusing on employment, to improve our understanding of the future public health workforce.

METHODS

We assessed first-destination employment and educational outcome data reported by members of ASPPH, a membership organization for domestic and international Council on Education for Public Health–accredited schools and programs of public health.¹² We collected first-destination outcome data for 64|592 public health graduates across bachelor’s, master’s, and doctoral degree programs for the graduating years 2015–2018 (Table 1 and Table A). This included 9513 graduates from 55 institutions in 2015, 13|588 graduates from 75 institutions in 2016, 20|394 graduates from 112 institutions in 2017, and 21|097 graduates from 111 institutions in 2018. Across the pooled data, 31% of graduates were from bachelor’s, 63% from master’s, and 7% from doctoral degree programs.

TABLE 1—Number and Percentage of Public Health Graduate Respondents by Characteristic and Year Graduated: ASPPH Members, Graduating Years 2015–2018

Characteristic	2015 (n =9513), No. (%)	2016 (n =13 588), No. (%)	2017 (n =20 394), No. (%)	2018 (n =21 097), No. (%)	Pooled (n =64 592), No. (%)
Degree					
Bachelor's	2184 (23)	3981 (29)	6394 (31)	7150 (34)	19 709 (31)
Master's	6475 (68)	8720 (64)	12 673 (62)	12 645 (60)	40 513 (63)
Doctoral	854 (9)	887 (7)	1327 (7)	1302 (6)	4370 (7)
Area of study					
Allied health	431 (5)	891 (7)	1192 (6)	1505 (7)	4019 (6)
Biomedical sciences	120 (1)	150 (1)	292 (1)	465 (2)	1027 (2)
Biostatistics	443 (5)	576 (4)	862 (4)	923 (4)	2804 (4)
Environmental sciences	585 (6)	674 (5)	1091 (5)	929 (4)	3279 (5)
Epidemiology	1334 (14)	1805 (13)	2516 (12)	2526 (12)	8181 (13)
General public health	1361 (14)	2984 (22)	5185 (25)	5441 (26)	14 971 (23)
Global health	388 (4)	600 (4)	818 (4)	653 (3)	2459 (4)
Health disparities	12 (0)	24 (0)	67 (0)	31 (0)	134 (0)
Health					
education/behavioral sciences	1446 (15)	2147 (16)	2719 (13)	2860 (14)	9172 (14)
Health informatics	0 (0)	3 (0)	58 (0)	38 (0)	99 (0)
Health policy and management	1668 (18)	1820 (13)	2850 (14)	2852 (14)	9190 (14)
Maternal and child health	296 (3)	361 (3)	519 (3)	426 (2)	1602 (2)
Nutrition	335 (4)	349 (3)	396 (2)	415 (2)	1495 (2)
Public health practice	295 (3)	358 (3)	562 (3)	502 (2)	1717 (3)
Other	799 (8)	846 (6)	1267 (6)	1531 (7)	4443 (7)
Reporting institutions					
Unique count of reporting institutions	55	75	112	111	118

ASPPH collects data on first-destination outcome statuses—employed; employed in a fellowship, internship, or residency; pursuing continued education; not employed but seeking employment; not employed and not seeking employment; and unknown. The statuses were mutually exclusive; respondents were asked to select the response that best described their situation. ASPPH members also report detailed employment information, continuing education information, and public health degree debt.

Individual ASPPH member schools and programs collected data from their graduates and reported to ASPPH. ASPPH offered a core survey instrument to members that was developed in tandem with the data-reporting standards. ASPPH members could also use their own data collection instruments, which may have been in-house surveys or surveys based on other nationally accepted first-destination reporting systems, such as the National Association of Colleges and Employers survey.¹³ Members also may have collected information from faculty, social media (e.g., LinkedIn), or elsewhere on the Internet, with the precaution to verify the data collected with these alternative approaches. Consequently, the data can generally be categorized as self-reported graduate outcomes.

Because members have up to 1 year to obtain a first-destination outcome on their graduates, data reported to ASPPH were reported on graduates from the academic years 2014–2015, 2015–2016, 2016–2017, and 2017–2018 (the class of 2014–2015, for example, was defined as graduates from July 1, 2014–June 30, 2015, with the time frame for obtaining an outcome ending in June 2016). We cleaned the data set and standardized it to affirm data-reporting definitions and ensure that survey display logic and skip patterns were adhered to, as well as to identify any incompatibilities in questions individual members asked that may have deviated from the core survey instrument or ASPPH data-reporting standards and definitions.

The data variables included graduate outcome (we refer to this as “first-destination outcome” throughout this article, and this includes employed, pursuing continued education, not employed but seeking employment, etc.), employment type (i.e., full time, part time), employment sector (government, nonprofit, hospital, corporation, etc.), employment sector detail (federal government, local government, etc.), salary, and degree debt. Detailed descriptions of variables and value labels are available in Table D. We calculated descriptive statistics on first-destination outcomes, employment by sector, and employment by sector detail. We also assessed continued education outcomes. We made bivariate comparisons using the Pearson χ^2 test. In further analysis, we focused on the percentage of graduates not employed but seeking employment by area of study, although a

number of areas had relatively few first-destination outcomes. We cleaned the data and analyzed them in Stata 16.1.¹⁴

RESULTS

Across all years and 64|592 alumni, general public health was the most common area of study (23% of graduates), followed by health policy and management (14%), health education or behavioral sciences (14%), and epidemiology (13%).

Among a cohort of 55 institutions reporting for each graduating year from 2015 to 2018, reporting of bachelor’s degree program graduates increased 62% (from 2184 to 3541), master’s degree program graduates increased 21% (from 6475 to 7820), and doctoral degree program graduates increased 6% (from 854 to 903). This was largely driven by an increase in reporting of graduates from the general public health area of study. For bachelor’s degree programs, 31% were general public health in 2015, compared with 47% in 2018 ($P \leq .001$). For master’s degree programs, 10% were general public health in 2015 and 16% in 2018 ($P \leq .001$). For doctoral degree programs, 3.0% were general public health in 2015, and 4.6% in 2017 ($P = .07$).

Of the reported 64|592 public health graduates, 53|463 (83%) had known first-destination outcomes. This was 71% for bachelor’s, 88% for master’s, and 92% for doctoral degree programs. We observed differential success in determining first-destination outcomes by institution. For students graduating in 2018, the interquartile range (IQR) for capturing postgraduate outcomes was 80% to 97% for bachelor’s ($n = 43$ institutions), 85% to 97% for master’s ($n = 110$ institutions), and 94% to 100% for doctoral ($n = 70$ institutions) degree programs. First-destination outcomes are shown in Table 2.

Table 2: Number and percent of public health graduates by degree level and known first-destination graduate outcome, graduating years 2015-2018

		Employed	Fellowship, Internship, Residency	Volunteer or Service Program	Enrolled in Further Study	Not Employed/ Not Seeking	Not Employed/ Seeking	Total reported outcomes	Outcome Unknown
Bachelor	2015	880 (65%)	27 (2%)	8 (1%)	350 (26%)	8 (1%)	79 (6%)	1,352	832
	2016	1,991 (66%)	34 (1%)	24 (1%)	726 (24%)	29 (1%)	198 (7%)	3,002	979
	2017	2,710 (63%)	63 (1%)	59 (1%)	1,163 (27%)	30 (1%)	305 (7%)	4,330	2,064
	2018	2,961 (57%)	78 (1%)	80 (2%)	1,623 (31%)	26 (0%)	452 (9%)	5,220	1,930
Masters	2015	4,294 (77%)	324 (6%)	14 (0%)	690 (12%)	26 (0%)	231 (4%)	5,579	896
	2016	6,237 (79%)	484 (6%)	20 (0%)	818 (10%)	55 (1%)	313 (4%)	7,927	793
	2017	8,531 (79%)	435 (4%)	29 (0%)	1,314 (12%)	80 (1%)	474 (4%)	10,863	1,810
	2018	8,513 (76%)	628 (6%)	34 (0%)	1,393 (12%)	126 (1%)	457 (4%)	11,151	1,494
Doctoral	2015	617 (78%)	118 (15%)	1 (0%)	35 (4%)	6 (1%)	9 (1%)	786	69
	2016	645 (77%)	153 (18%)	2 (0%)	16 (2%)	6 (1%)	15 (2%)	837	51
	2017	975 (80%)	198 (16%)	3 (0%)	21 (2%)	6 (0%)	21 (2%)	1,224	104
	2018	919 (77%)	226 (19%)	0 (0%)	15 (1%)	8 (1%)	24 (2%)	1,192	107
Total		39,273 (73%)	2,768 (5%)	274 (1%)	8,164 (15%)	406 (1%)	2,578 (5%)	53,463	11,129

Across all years, 73% of all graduates with reported first-destination outcomes were employed; 15% were enrolled in further education; 5% had a fellowship, internship, residency, volunteer, or service program appointment; 5% were not employed but were seeking employment, and 1% were not employed and were not seeking employment (by choice). Comparing the 2015 and 2018, respectively, graduating years, the percentages of employed graduates by degree level were 65% and 57% for bachelor's ($P \leq .001$), 77% and 76% for master's ($P = .37$), and 79% and 77% for doctoral ($P = .38$). Twenty-six percent of bachelor's degree program graduates were reported as enrolled in further education for graduating year 2015, compared with 31% in 2018 ($P \leq .001$), 12% of master's in 2015 and 2018 ($P = .82$), and 4% versus 1% of doctoral graduates in, respectively, 2015 and 2018 ($P \leq .001$). Not employed but seeking employment was highest for bachelor's degree program graduates at 6% in 2015 and 9% in 2018 ($P \leq .001$), followed by 4% for master's degree program graduates in 2015 and 2018 ($P = .90$), and 1% versus 2% for doctoral degree program graduates in, respectively, 2015 and 2018 ($P = .14$).

Among those with reported full-time employment, we captured employment sector for 26|422 graduates. Employment sector was not reported for fellowships or internships. Overall, 27% of graduates were employed in health care organizations, 24% for-profit organizations, 19% academic institutions, 17% government agencies, 12% nonprofit organizations, and 1% other sectors or self-employed. The distribution of employment sectors varied by degree level (Table 3). Doctoral degree graduates' top employment sectors were academic institutions (42%), for-profit organizations (21%), and government agencies (16%). Master's degree graduates found employment in health care organizations (29%), for-profit organizations (21%), government agencies (19%), and academic institutions (18%). Bachelor's degree graduates were different from both doctoral and master's degree graduates, with for-profit organizations (38% overall, with 30% of all undergraduates finding employment in for-profit corporations outside consulting, health information technology, and insurance) being the top employment sector, followed by health care organizations (27%), nonprofit organizations (12%), and government agencies and academic institutions, each at 10%.

TABLE 3—Number and Percentage of Full-Time Employed Public Health Graduates by Degree Level and Known Employment Sector: ASPPH Members, Graduating Years 2015–2018

Employment Sector	Bachelor's Degree, No. (%)	Master's Degree, No. (%)	Doctoral Degree, No. (%)	Total, No. (%)
Academic institution	507 (10)	3479 (18)	947 (42)	4933 (19)
Academic	493 (10)	3248 (17)	894 (40)	4635 (18)
Other	14 (0)	231 (1)	53 (2)	298 (1)
For-profit organization	1905 (38)	3978 (21)	467 (21)	6350 (24)
Consulting	240 (5)	1359 (7)	95 (4)	1694 (6)
Health information technology	70 (1)	287 (1)	31 (1)	388 (1)
Insurance	82 (2)	324 (2)	14 (1)	420 (2)
Other	1513 (30)	2008 (10)	327 (15)	3848 (15)
Government agency	518 (10)	3748 (19)	357 (16)	4623 (17)
Federal	141 (3)	834 (4)	175 (8)	1150 (4)
Local	175 (4)	985 (5)	37 (2)	1197 (5)
Other	75 (2)	800 (4)	76 (3)	951 (4)
State	124 (2)	1106 (6)	67 (3)	1297 (5)
Tribal	3 (0)	23 (0)	2 (0)	28 (0)
Health care organization	1351 (27)	5488 (29)	266 (12)	7105 (27)
Hospital	452 (9)	3039 (16)	126 (6)	3617 (14)
Other	899 (18)	2449 (13)	140 (6)	3488 (13)
Nonprofit organization	596 (12)	2401 (12)	182 (8)	3179 (12)
Other	569 (11)	2271 (12)	173 (8)	3013 (11)
Trade association	27 (1)	130 (1)	9 (0)	166 (1)
Other employment sector	64 (1)	61 (0)	10 (0)	135 (1)
Self-employed	23 (0)	68 (0)	6 (0)	97 (0)
Total known sector	4964	19 223	2235	26 422
Unknown sector	369	874	65	1308

Table 4 shows the proportion of alumni with known first-destination outcomes, excluding those enrolled in further education, who were not employed but were seeking employment by degree level and area of study. A higher than average proportion of graduates sought employment in certain areas of study. At the bachelor's degree level, maternal and child health (19%) and allied health, nutrition, and public health practice (each at 11%) had higher than the average of 10% not employed but seeking employment. At the master's level, health disparities (13%), nutrition (11%), global health (8%), environmental sciences (6%), and biomedical sciences (6%) were higher than the average (5%). At the doctoral level, the areas of study above the average (2%) were nutrition (4%) at the highest, followed by general public health, health education and behavioral sciences, biomedical sciences, global health, and maternal and child health (all at 3%).

TABLE 4—Number and Percentage of Public Health Graduates Not Employed but Seeking Employment by Degree Level and Area of Study: ASPPH Members, Pooled for Graduating Years 2015–2018

Area of Study	Bachelor's	Master's	Doctoral
	Degree, No (%)	Degree, No (%)	Degree, No (%)
Allied health	145 (11)	25 (5)	3 (2)
Biomedical sciences	0 (0)	25 (6)	4 (3)
Biostatistics	0 (0)	45 (3)	2 (0)
Environmental sciences	12 (5)	109 (6)	8 (2)
Epidemiology	1 (9)	259 (5)	12 (1)
General public health	373 (9)	151 (3)	5 (3)
Global health	5 (6)	134 (8)	6 (3)
Health disparities	...	12 (13)	...
Health education/behavioral sciences	138 (8)	251 (5)	15 (3)
Health informatics	...	2 (2)	...
Health policy and management	28 (9)	265 (4)	6 (1)
Maternal and child health	46 (19)	43 (5)	2 (3)
Nutrition	18 (11)	66 (11)	3 (4)
Public health practice	13 (11)	40 (4)	0 (0)
Other	255 (17)	48 (3)	3 (2)
Total	1034 (10)	1475 (5)	69 (2)

Note. The table excludes respondents who reported they were enrolled in further study.

Salary data were reported for 9857 full-time employed graduates. The data were reported as absolute values and are presented in ranges in Table B. The median salary among bachelor's degree graduates who were employed full time was \$36|000 (IQR|=|\$30|000–\$46|000). For full-time employed master's degree graduates, the median salary was \$58|000 (IQR|=|\$45|000–\$73|000), and for doctoral degree graduates, it was \$80|000 (IQR|=|\$55|000–\$101|000).

Public health degree debt was captured consistently among those who reported debt, although it was not captured consistently regarding whether a graduate had debt. Consequently, we were able to examine debt levels only for the 6451 responses with reported debt loads (Table C). Among 1574 bachelor's degree program graduates with any debt, 55% had \$25|000 or more debt, as did 80% of 4521 master's degree program graduates and 73% of 356 doctoral degree program graduates. Overall, 44% of graduates with reported debt had more than \$50|000 in debt and 10% had more than \$100|000 (comprising 3% of bachelors, 12% of master's, and 24% of doctoral graduates).

DISCUSSION

First-destination outcomes for public health graduates, particularly employment outcomes, are a key metric in assessing the supply and demand equation of the public health workforce. Graduates' first-destination outcomes provide academia insight into changes in the job market, which may then inform decisions on the degrees and areas of study an institution offers. If first-destination outcome data show changes in employment trends in an area of study, schools and programs of public health may alter their courses and curricula to align with these trends. A school's or program's ability to prepare graduates with the competencies demanded by the workforce may help ensure student success, not only in finding employment that uses their education but also in finding career satisfaction. Further, as public health responds to the COVID-19 pandemic, new competencies may be needed to address such crises.

The variability in employment outcome by area of study is consistent with previous research. It is not surprising that biostatistics graduates have the lowest rates of unemployment, considering that statistics is the eighth fastest-growing occupation in the United States.¹⁵ Global health graduates, on the other hand, have higher than average rates of job seeking, consistent with another study.¹⁶ Higher job seeking in global health graduates may be attributable to current job openings in the field requiring more extensive experience than most recent graduates have.¹⁷

Employment by degree level shows that graduates with advanced public health degrees had better employment outcomes, similar to findings of a national data collection by the National Association of Colleges and Employers.⁵ This study shows that first-destination employment outcomes of public health doctoral graduates are more favorable than had been reported in another study, in which data were collected before or upon graduation.¹⁸ However, questions remain regarding whether bachelor's degree graduates are competing for the same jobs as master's degree

graduates. This study does show that there are differences in employment sectors by degree level, however; an analysis of employer requirements may elucidate the answer further. In addition, there may be demand for different education formats to replace or bolster formal degrees (certifications, micromasters, etc.) that increase the number of public health workers with needed competencies.

Governmental public health remains a key necessity for communities, nations, and the world, as shown in the COVID-19 response. Filling new or vacated government public health positions is crucial.⁸ However, although there has been an increase in bachelor's degree graduates, they do not seem to be filling governmental vacancies at high rates. Historically, master's and doctoral degree graduates have entered governmental public health at higher rates. A study analyzing 2404 public health graduates from 1978 and 1979 showed that 52% of graduates found employment in government,¹⁹ and in a 1992 longitudinal study of 2429 graduates, 42% of graduates in the classes of 1956–1965 found their first-destination employment in health departments, whereas 17% of the classes of 1976–1985 began their careers in health departments.²⁰

If government agencies wish to recruit public health graduates, recent literature suggests they may need to reassess hiring practices to recruit enough trained candidates.^{21,22} Even if only a small minority of current governmental public health employees have degrees in public health²³—although it could be argued that this is also an indicator of underfunding—if there is a workforce shortage, it is uncertain whether there will be enough public health graduates who will enter government agencies to fill the gap. This potential workforce mismatch should be explored further.²⁴

Although it is too soon to know how the COVID-19 pandemic will affect the class of 2020, the hardest hit employment sectors (e.g., restaurant, travel, entertainment, and retail) are less likely to employ public health graduates,²⁵ although furloughs and layoffs in the public sector have begun.²⁶ Additionally, health care systems across the country have been laying off staff, although health care, science, technology, engineering, and mathematics occupations may have smaller numbers of jobs at risk for layoffs.²⁷ Overall, sharp declines in job postings, including for statisticians and other highly skilled professionals, in geographic areas most affected by COVID-19 are concerning.²⁸

There may be new opportunities related to pandemic response, such as epidemiology and contact-tracing efforts.^{29,30} Occupations that were growing quickly before the pandemic, such as data analytics, may continue to grow.³¹ However, informal surveys of college recruiters (not specific to public health; n=246) show that 7.8% to 9.0% have rescinded job offers and 31.0% delayed start dates for full-time hires.³² Anecdotally, informal discussions with career service professionals from several public health schools indicate that 2020 graduates appear to be employed at rates similar to those of previous years. For both traditional public health roles and new COVID-19–related positions, graduates appear to be more flexible about the roles they will accept. Regardless of what we now know about the workforce, recalibration may be necessary after the current pandemic.

Return on investment in higher education is a much-discussed topic that may play a larger part in explaining the vocational decisions of graduates. A recent study found

a net benefit in career outcomes associated with a public health master's degree, although . . . some other master's degrees likely offer greater lifetime earning potentials or lower lifetime debt associated with degree attainment.^{7(p. 1)}

A future analysis of this data set may identify salary differentials among employment sectors and the possible impact of degree debt on vocational choice—perhaps showing graduates with higher debt choosing fields with higher salaries.

Overall, a study of the longitudinal career paths of public health graduates would illuminate the longer-term earnings of public health professionals. Such career path studies would also show whether public health graduates gain government experience at some point in their careers, whether they are moving to higher-paying sectors earlier to pay off debt, whether new and different employers are seeking graduates with public health skills, and the impact of the COVID-19 pandemic on graduates' careers.

Limitations

This study has several limitations of note. The data we analyzed were collected by more than 100 institutions during the first 4 years of ASPPH members reporting graduates' first-destination outcomes. The decentralized approach to first-destination outcomes reporting allows institutions to customize their collection methods, creating possible hard-to-detect issues with standardization. Therefore, we used rigorous data cleaning and member data checking to identify data issues, although data-reporting issues may remain. For instance, we found that some institutions reported unknown graduate debt levels as 0, whereas other institutions reported no debt levels at 0 and unknown debt levels as missing. Additionally, some institutions relied on graduate self-reporting of debt, and even when asked about "public health degree debt," some graduates may have reported all educational debt (including from previous degrees). Relatedly, there are several areas that have high levels of unknown or missing data. About 80% of records had associated graduate outcomes for graduating in 2017, and 83% in 2018.

Of note, 2017 was the first year that all members of ASPPH reported graduate outcomes across all public health degrees. Certain members have higher levels of unknown or missing data; this is problematic as an internal validity consideration. This is particularly the case for bachelor's degree graduates' data, which has greater levels of unknown outcomes. We have analyzed multiple years and examined outcomes by institution (some institutions may have more resources than others for complex data collection on alumni). Sensitivity analyses, excluding institutions with lower reported outcome rates, did not appear to change national estimates. Consequently, generalizability is not

implicated, although greater precision would be achieved with higher levels of reporting. Another caveat with these data is that previous work experience of the graduates is not known. Additionally, we did not directly clarify the factors influencing the career decisions of public health graduates, including salary, debt, or previous internship experience. Finally, employment sector data were not collected for graduates entering into fellowship, internship, or residency programs, which might change the percentages entering certain sectors, along with the salary data, for sectors that rely more heavily on fellowships for recruitment.

Public Health Implications

Postgraduate first-destination employment and educational outcomes of public health graduates have important implications for public health policy and practice. Especially now, public health has an unprecedented opportunity to affect the health and well-being of populations via different employment sectors. Governmental public health has long experienced a workforce shortage owing to underfunding,⁸ but research has shown that public health graduates experience barriers to employment in the sector.²² This new study, showing that only 17% of graduates enter government work, underscores the need for continued policy efforts to increase funding to and encourage employment in the government sector.

Employment data indicate that public health graduates are entering employment sectors at different rates than historical data show and potentially expanding public health's impact—whether these graduates are contributing to the 10 essential services of public health in an obvious way³³ or advancing the sustainable developmental goals and innovating with new technologies for the well-being of diverse populations. With the COVID-19 pandemic, new opportunities for employment may be on the horizon as government, businesses, and communities continue to respond and change their practices.

In addition, with the growth and changes in public health degree programs, it is important to know which areas of study are achieving the best employment outcomes, identify which sectors are recruiting these graduates, and help schools and programs of public health communicate their impact to prospective students, employers, and those who support their educational missions. With more focus on public health and more students studying public health, there will be a better-educated citizenry who “understand and appreciate public health and value its contributions to their lives.”^{34(p 428)} With more graduates embarking on careers both in and outside the traditional public health workforce and being engaged citizens, public health graduates are ready to “[embrace] health as a value worth pursuing and protecting,” which may then lead to healthier communities overall.^{35(p 200)}

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

HUMAN PARTICIPANT PROTECTION

We have reported all data in aggregate with no identifiers; therefore, the Association of Schools and Programs of Public Health determined that this study is not human participant research.

Appendix

Appendix Table A: Number and percent of public health graduate respondents by degree level and area of study, pooled for graduating years 2015-2018

Area of Study	Bachelor's Degree	Master's Degree	Doctoral Degree	Total
Allied Health	3,250 (16%)	626 (2%)	143 (3%)	4,019 (6%)
Biomedical Sciences	269 (1%)	621 (2%)	137 (3%)	1,027 (2%)
Biostatistics	67 (0%)	2,196 (5%)	541 (12%)	2,804 (4%)
Environmental Sciences	450 (2%)	2,431 (6%)	398 (9%)	3,279 (5%)
Epidemiology	12 (0%)	7,133 (18%)	1,036 (24%)	8,181 (13%)
General Public Health	8,760 (44%)	6,051 (15%)	160 (4%)	14,971 (23%)
Global Health	120 (1%)	2,137 (5%)	202 (5%)	2,459 (4%)
Health Disparities Health	134 (1%)	0 (0%)	0 (0%)	134 (0%)
Education/Behavioral Sciences	2,685 (14%)	5,839 (14%)	648 (15%)	9,172 (14%)
Health Informatics	99 (1%)	0 (0%)	0 (0%)	99 (0%)
Health Policy and Management	471 (2%)	8,046 (20%)	673 (15%)	9,190 (14%)
Maternal and Child Health	486 (2%)	1,037 (3%)	79 (2%)	1,602 (2%)
Nutrition	603 (3%)	792 (2%)	100 (2%)	1,495 (2%)
Public Health Practice	185 (1%)	1,456 (4%)	76 (2%)	1,717 (3%)
Other	2,351 (12%)	1,915 (5%)	177 (4%)	4,443 (7%)
Total	19,709 (31%)	40,513 (63%)	4,370 (7%)	64,592 (100%)

Appendix Table B: Distribution of salary for full-time employed graduates with reported salary by degree level, graduating years 2015-2018

Salary Range	Bachelor's Degree (n=1,524)	Master's Degree (n=7,514)	Doctoral Degree (n=819)	Total (n=9,857)
<\$25,000	18%	7%	8%	9%
\$25,001 - \$35,000	32%	5%	2%	9%
\$35,001 - \$45,000	24%	13%	6%	14%
\$45,001 - \$55,000	16%	21%	11%	19%
\$55,001 - \$65,000	5%	19%	8%	16%
\$65,001 - \$75,000	3%	13%	11%	11%
\$75,001 - \$85,000	0%	8%	12%	7%
\$85,001 - \$95,000	0%	3%	12%	4%
\$95,001 - \$105,000	0%	3%	8%	3%
\$105,001 - \$115,000	0%	1%	7%	2%
\$115,001 - \$125,000	0%	1%	5%	1%
\$125,001 - \$135,000	0%	1%	2%	1%
\$135,001 - \$145,000	0%	0%	2%	0%
>\$145,000	0%	4%	6%	4%

Appendix Table C: Distribution of student loan debt among graduates that reported any debt by degree level, graduating years 2015-2018

Debt Range	Bachelor's Degree (n=1,574)	Master's Degree (n=4521)	Doctoral Degree (n=356)	Total (n=6,451)
<\$10,000	14%	5%	8%	8%
\$10,000-\$24,999	31%	15%	19%	19%
\$25,000-\$49,999	38%	27%	21%	29%
\$50,000-\$74,999	10%	28%	19%	23%
\$75,000-\$99,000	3%	13%	9%	10%
\$100,000+	3%	12%	24%	10%

Includes only those who report more than \$0 in debt.

Appendix Table D: Description and value labels for variables.

Graduate Outcome	Employed	Graduates who are employed in a full-time or part-time position.
	Fellowship	Graduates who are participating in a fellowship, post-doctoral fellowship, internship, or residency.

Variable	Value	Definition
Area of Study	Allied Health	Allied Health, audiology, communication sciences and disorders, physical therapy, exercise science, kinesiology
	Biomedical Sciences	Biomedical and laboratory sciences, microbiology, parasitology, immunology, cancer biology, biochemistry, pathobiology
	Biostatistics	Biostatistics, biometry (at schools or programs of public health where epidemiology and biostatistics departments are combined, data are recorded under epidemiology)
	Environmental Science	Environmental sciences, environmental health, toxicology, radiological health, environmental chemistry, water quality, environmental health planning, occupational safety and health, industrial hygiene, occupational medicine, aerospace medicine
	Epidemiology	Epidemiology (at schools or programs of public health where epidemiology and biostatistics departments are combined, data are recorded under epidemiology)
	General Public Health	General public health studies, non-specialized
	Global Health	Global health, international health, tropical medicine
	Health education, behavioral sciences	Health education, behavioral sciences, public health education, health education administration, health behavior, community health sciences, community health practice, health promotion
	Health disparities	Health disparities, race/ethnic disparities, LGBT disparities
	Health Informatics	Health informatics, bioinformatics, informatics, geographic information systems, demography
	Health Policy and Management	Health policy and management, health services administration, hospital administration, health planning, health management, health services research, health law, evaluation research
	Maternal and Child Health	Maternal and child health, women's health, adolescent health, infant and child health
	Nutrition	Nutrition, public health nutrition
	Public health practice and program management	Public health practice and program management, gerontology, dental public health, public health nursing, public health social work, veterinary public health, mental health
Other	All other areas of specialization including urban health, disease control, genetics, clinical research analysis, forensic science	

	Volunteer	Graduates who are participating in a volunteer or service program (e.g. Peace Corps, mission work).
	Continuing Education	Graduates who are not employed and have been accepted to and plan to matriculate into a program of further study or training.
	Not Employed, Seeking	Graduates who are not employed and have indicated that they are seeking employment or engaged in the job search process, or they are seeking and have not enrolled in a program of continuing education/training.
	Not Employed, Not Seeking	Graduates who are not employed and have indicated that they choose not to pursue either employment or continuing education at this time.
	Unknown	Graduates who, despite reasonable efforts on the part of the institution, have not responded to efforts to obtain information about their post-graduation career plans.
Employment Type	Full-Time	Employed full time is generally defined as a position in which the graduate works for 30 hours or more per
	Part-Time	Part-time employment is generally defined as a position in which the graduate works less than 30 hours per week.
Employment Sector Detail	Academia	Academic Institution, which may include elementary, secondary, or post-secondary.
	Government	Government Agency, which may include U.S. Federal, State, Local, or Tribal government agencies; U.S. Military; or non-U.S. government.
	Healthcare	Healthcare Organization, which may include hospital or other healthcare provider; managed care organization; etc.
	For-profit	For-Profit Organization, which may include health insurance company; consulting firm; health IT company; marketing, public relations, or communications firm; pharmaceutical, biotech, or medical device firm; and other industrial, commercial or for-profit firm.
	Non-profit	Non-Profit Organization, which may include association, voluntary, foundation, NGO, or other non-profit organization.
	Self-Employed	Self-employment
	Other	Primary employment sector is not listed.
	Unknown	Primary employment sector is unknown.
Employment Detail	Elementary	Elementary or secondary academic institution
	Post-secondary	Post-secondary institution (Community college, university, etc.)
	US Federal Health and Human Services	U.S. Federal Department of Health and Human Services Agency or Office (CDC, NIH, HRSA, etc.)

US Federal Other	U.S. Federal government (outside the Department of Health and Human Services)
State health department	State health department
State government	State government (not health department)
Local health department	Local (county or city) health department
Local government	Local government (not health department)
Tribal government	Tribal government
U.S. Military	U.S. Military
Government, non-U.S.	Government, non-U.S.
Hospital	Hospital
Managed Care Organization	Managed Care Organization (e.g., HMO, PPO)
Other healthcare provider	Other healthcare provider
Consulting	Consulting firm
Marketing	Marketing, public relations, or communications firm
Health IT	Health Information Technology (IT) firm
Health insurance	Health insurance firm
Pharmaceutical, biotech, or medical device	Pharmaceutical, biotech, or medical device firm
Other for-profit	Other for-profit firm
Trade association	Trade association or similar non-profit
Foundation/NGO	Foundation, non-governmental organization, or similar charitable non-profit
Other non-profit	Other non-profit organization
Employment sector setting not listed	Employment sector setting not listed
Unknown	Employment sector setting is unknown

Salary	Numerical	Amount of annual base salary amount in U.S. dollars.
Degree Debt	Numerical	Amount of federal and private loan debt graduate incurred pursuing their recent public health degree.

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Chapter 4: The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students

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Title: The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students

Abstract

Context: Much has been written about the public health workforce, but very little research has been published—and none in a peer reviewed journal or other report since 1992—regarding the employment outcomes and employment sectors of graduate students pursuing public health as an area of study.

Objectives: Our objectives were to review the literature and analyze data regarding the employment outcomes of public health graduate students, and to examine how public health schools and programs might respond to changes in the sectors hiring their graduates.

Design: We reviewed the literature regarding the employment of public health graduates; analyzed five years' of graduate outcomes from Columbia University's Mailman School of Public Health using logistic regression; and we examined data collected by the Association of Schools and Programs of Public Health (ASPPH).

Participants: The study included data from surveys of 2,904 graduates of Columbia University's Mailman School of Public Health, across 5 graduating cohort years, for whom there was employment sector data available for 1,932.

Results: Much of the research on the public health workforce has defined it as governmental public health. Across each of five graduating classes from Columbia University's Mailman School of Public Health, the odds of for-profit sector employment increased by 23% (2012-2016), while hiring by government agencies declined or remained flat. Publicly-available employment data from the websites of schools of public health and from surveys by ASPPH shows that hiring of new graduates by for-profit corporations now either closely matches or exceeds governmental hiring at many schools of public health.

Conclusions: Public health graduates are increasingly working outside of government, and additional analyses are required to determine whether core competencies of public health curricula reflect the needs of the employers that are hiring public health graduates today.

INTRODUCTION

As a professional field of study, public health is designed to prepare graduates for the public health workforce. Indeed, most would agree that the function of schools and programs of public health is to create future leaders of this workforce¹. While the definition and enumeration of the public health workforce has been a matter of some debate², in most cases the major focus of studies of the public health workforce has been on governmental public health (local, state, and federal health departments)^{3,4} since “public health may traditionally be thought of as the domain of government.”³ Moreover, core competencies of a public health education are primarily based upon input from governmental public health entities. Shifts away from governmental public health have implications for the competencies with which we equip public health graduates.

However, are public health graduates actually finding jobs in government? Very little data have been published regarding the employment outcomes of public health graduates, and these data have not been synthesized. To determine the employment outcomes of and sectors in which public health graduates are working, we undertook a literature review and conducted analyses of data regarding employment outcomes of public health graduates at Columbia University’s Mailman School of Public Health, data from several other graduate public health schools, and data collected by the Association of Schools and Programs of Public Health.

METHODS

Literature review

In order to find any published research on employment outcomes of public health graduates, we conducted a literature review from 2000 to present in PubMed: “public health employment,” “public health workforce,” “public health careers,” “public health personnel,” “public health personnel education,” “MPH employment outcomes,” “Master of Public Health jobs,” “where do public health graduates get jobs,” and “Career outcomes of MPH graduates.” We also conducted similar searches of *Journal of Public Health Management and Practice*, *AJPH*, and the *Annual Review of Public Health 2011-2016*; and used Google for “MPH Employment outcomes” for “gray” literature.

Columbia University and other data

Each graduating class of Columbia University’s Mailman School of Public Health, from 2012 through 2016, was sent an email survey (via SurveyMonkey until 2013, then via Qualtrics), upon graduation and then in the December following graduation, with up to eight reminder emails sent to the graduates; there were 2,904 graduates surveyed across the five years. In addition, for those students who responded that they were job-seeking upon graduation and then never responded to

follow-up surveys, additional data were collected from alumni correspondence with career services staff, from School's staff and faculty who could verify graduates' whereabouts, and from publicly visible information gathered from LinkedIn.com, following generally accepted protocols to gather such data, designed by National Association of Colleges and Employers⁵.

We analyzed associations between employment sector and graduation year using chi-square tests of the association between graduation year and the organization type/industry. We also performed a Cochran-Armitage Trend Test for graduation year and employer organization, combining nonprofit and government organizations into one category and comparing it with for-profit organizations. We then used a logistic regression to analyze the odds of for-profit employment in graduating cohorts. Finally, to find any comparable employment outcomes data, we reviewed the websites of more than 100 CEPH-accredited schools and programs of public health in the United States, and also reviewed data gathered by the Association of Schools and Programs of Public Health (ASPPH)⁶. In their pilot survey year, data was submitted to ASPPH regarding 4,867 graduates, by 57 CEPH-accredited schools and programs of public health. This was the first effort of its kind in decades.

RESULTS

Literature review

We reviewed a total of 91 articles, of which 12 focused on building partnerships between academic institutions and primarily government public health agencies; six focused on public health workforce shortages (primarily focusing on impending retirements in government); 30 focused on the training needs of the existing public health workforce, of which 24 defined the workforce as employees of local, state or federal health departments; 23 on curriculum development for public health schools and programs; 17 on the definition and enumeration of the public health workforce; and two articles were broad-based reviews of the field of public health. No articles could be found—since 1992—that focused on the sectors in which graduates of public health degree programs actually found employment.

Much has been written about the demographic trends, training needs, and current skills of the existing public health workforce⁷. Of the research conducted regarding how to develop a curriculum which matches the needs of the public health workforce, most focuses either exclusively or primarily on government and nonprofit organizations. For example, the *Council on Linkages between Academia and Public Health Practice/Public Health Foundation Core Competencies*⁸ authors, and the Core Competencies Workgroup⁹, are composed primarily of representatives from government or academia, with apparently no members from for-profit companies. The *ASPPH Framing the Future*

Task Force (Blue Ribbon Employer Panel)¹⁰ included 96 employer panel contributors, of which only three (3.1%) were from for-profit industry. *The National Board of Public Health Examiners* survey to create the Job Analysis of the Certified in Public Health¹¹ included 4,850 survey responses, of which 33.9% were from government, 7.3% were for-profit companies, and the rest primarily from academia, hospitals, and nonprofits.

In other large studies of public health workforce (Public Health Workforce Interests and Needs Survey (PH-WINS); the 2015 Forces of Change Survey, and the 2010 report by US Department of Health & Human Services), the public health workforce was defined specifically as government public health, although many researchers would define the workforce as “people who provide essential public health services, regardless of the nature of the employing agency.”¹² A prior comprehensive review of the literature found that “Nearly all of the literature obtained focused on the governmental public health workforce, with virtually no other references to or literature available on private sector public health workers.”¹²

On the other hand, the focus of most articles on MPH education is on how to prepare MPH graduates to work in local health departments/government public health¹³; there were a handful of articles focused on gathering employer input into the design of public health degree programs, but the main focus was research on the training needs and composition of the “public health workforce,” defined in about 80% of articles as governmental public health. Only one article¹⁴ discussed the lack of coursework offered by public health schools/programs regarding for-profit industry.

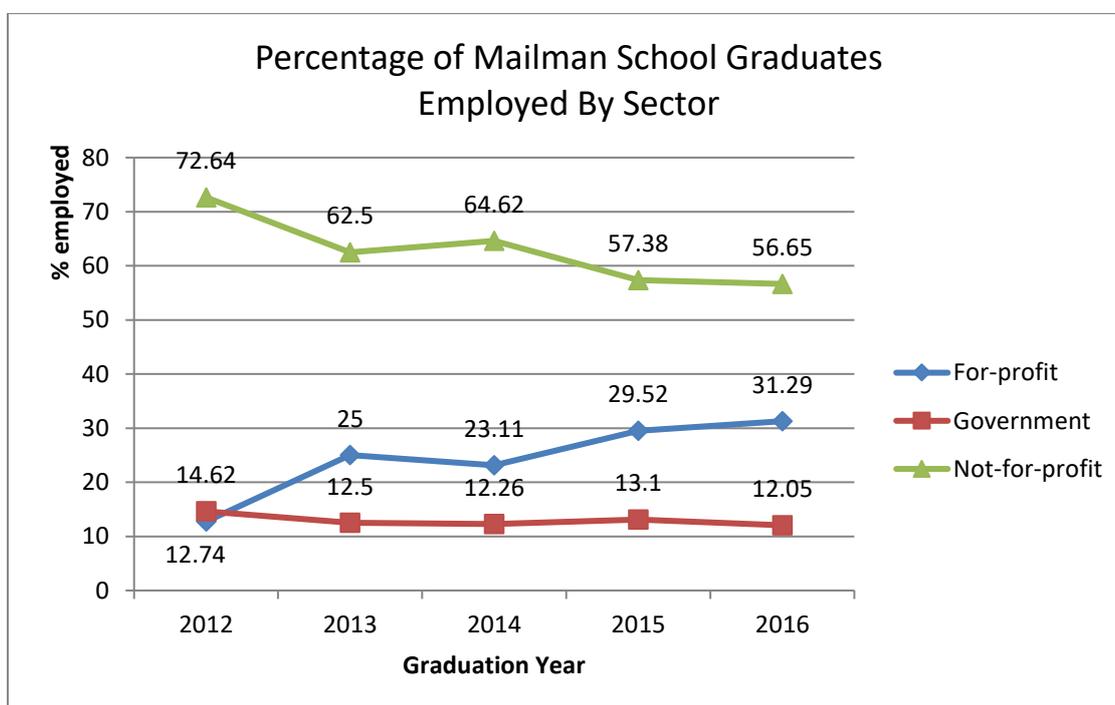
Although no recent published articles could be found in the peer-reviewed literature regarding where public health graduates have found employment, some data is still available. The authors used three main sources of data: five graduating cohorts’ worth of employment outcomes data collected by Columbia University’s Mailman School of Public Health; the publicly-visible information reported on public health schools’ websites; and the new employment outcomes data collection conducted by the Association of Schools and Programs of Public Health (ASPPH). We also were provided with two prior reports of employment outcomes of public health graduates, one from 1982¹⁵ and one from 1992¹⁶.

Columbia University data

Of the combined 2,904 surveyed across the five cohorts, there were 621 non-responders/unknowns, 109 unemployed/seeking, 35 not seeking by choice, 186 continuing study, and 1,950 employed, of which there were 1,932 for whom the employment sector was known.

At the Mailman School, there has been an increase in the proportion of graduates finding “first destination” employment in for-profit sectors (including consulting, pharmaceuticals, insurance, and other for-profit companies such as technology and marketing firms), and flat hiring by government. The total share of graduates (of those graduates who were employed and whose employment sector was known) working in for-profit companies in 2012 was 13.51%, and government was 15.14%; but by 2016, the share going into for-profit companies was 31.46% and government was 11.57% (Figure). Percentages listed in the figure are of the total number of graduates who were employed and whose employment sector was known.

Figure. Percentage of Mailman School Graduates Employed by Sector and Graduation Year



Data indicates the percentages of Mailman School graduates who found their first employment after graduation in different sectors, for the graduating cohorts of 2012, 2013, 2014, 2015 and 2016. Percentages are of the total number of graduates who were employed and whose employment sector was known.

In analyses of associations between employment sector and graduation year, a chi-square analysis of the association between graduation year and the organization type/industry demonstrated significant differences across years ($\chi^2 = 33.29, p < 0.001$). A further Cochran-Armitage Trend Test for graduation year and employer organization type was conducted, combining nonprofit and government organizations into one category and comparing it with for-profit organizations ($T =$

5.27), with a negative linear trend—as graduation year moves from 2012 to 2016, the percentage of students working in for-profit organizations increases. In addition, a logistic regression analysis showed a 1.23 (95% confidence interval (95% CI): 1.13-1.33) greater odds of for-profit employment with successive graduating cohorts.

Statistical analyses of employment outcome, particularly employment in for-profit organizations, were performed using 1,782 observations after exclusion of those with missing value for age, employment status and organization type. Logistic regression was conducted using probability of becoming employed in a for-profit organization as the outcome. Significant predictors were graduation year (OR = 1.20, 95% CI = 1.11-1.30), US citizenship, with citizens being less likely to find employment in the for-profit sector than non-citizens (OR = 0.49, 95% CI = 0.38-0.63), MPH/MS status (OR = 2.14, 95% CI = 1.51-3.03), and department for crude analyses. In adjusted models, controlling for department, degree type, and citizenship, several predictors were associated significantly with employment in for-profit organizations: graduation year (OR = 1.19, 95% CI = 1.09-1.29), US-citizenship (OR = 0.52, 95% CI = 0.39-0.69), MPH/MS status (OR = 2.54, 95% CI = 1.76-3.68), and department ($\chi^2 = 78.58$, $P < 0.001$). Test for goodness of fit suggested that the model fit the data well ($\chi^2 = 6.28$, $p=0.711$). The odds of being employed in a for-profit company for a student who graduated one year later is 1.185 (95% CI: 1.09-1.29) times the odds of being employed in a for-profit company for a student who graduated this year, controlling for department, MPH/MS status, and US-citizenship.

Data from CEPH-Accredited Schools' and Programs' websites and ASPPH

Although all schools and programs which are accredited by the Council on Education for Public Health (CEPH) must report employment data to CEPH, the data schools and programs must report are very basic (including number of graduates who are employed, unemployed, continuing their studies, unknown/non-responders, etc.) and does not include information about employment sectors. There are also no standards regarding how such employment data should be publicly presented by public health schools or programs.

Of the 101 CEPH-accredited schools and programs of public health in the U.S. which were reviewed at the time of this study, only eleven schools had publicly-visible, by-industry employment data listed on their websites. Industry definitions were not typically provided but we assume they are relatively similar across schools. In order to simplify the analysis, we combined various sectors into three categories—government (city/county, state, federal, military, and international); nonprofit (including Health Care System, Hospital/HMO/Clinic, Research/University/Institute,

Nonprofit/CBO/National Association, or NGO), and for-profit (Consulting Firm, Corporation/Private Industry, Biotech/Pharmaceutical, Industrial/Manufacturing, Health Insurance/Managed Care, Private Practice). There are certain categories which could overlap; for example, while the majority of hospitals in the USA are nonprofits, some are for-profit and some are government-run; some insurance firms are nonprofits. We attempted to follow the ASPPH pilot survey data collection definitions where possible.

In the Association of Schools and Programs of Public Health pilot survey's 2014 data for Master's graduates (which could include MPH, MHA, MS etc.), overall governmental hiring was 19.4% and for-profit hiring was 17%. In this survey, there was more granularity requested in the data regarding government employment than any other category; there were nine sub-categories for government employment, but no sub-categories for nonprofits, and four sub-categories for for-profits.

In the much older reports from 1982 and 1992, government hiring was indeed a much greater share of the employment; in the 1982 US Department of Health report, which analyzed public health graduates from 1978 and 1979, a total of 51.9% of graduates found employment in government, 23.9% in the "voluntary" (nonprofit) sector, 13% in "proprietary" (for-profit) and 11.2% in "other" settings¹⁵. In the 1992 Association of Schools of Public Health longitudinal study of graduates, 41.6% of graduates from the classes of 1956-1965 found their first employment after graduation in "health departments" and 5.4% in "industry," while in contrast, 17% of the classes of 1976-1985 found their first employment in health departments and 15.1% in industry (with the remaining graduates finding employment in "medical care," or "education," the only two other categories listed)¹⁶. From this, it appears that government was a larger employer of public health graduates in the past.

According at the publicly-visible employment outcomes data available from the websites of Boston University, Columbia University, Emory, Harvard, New York University (NYU), Tufts, UC Berkeley, University of New England, University of Michigan, University of Pittsburgh, and Yale, it was found that in six of eleven individual schools, for-profit hiring exceeded government hiring in the most recent year reported, sometimes by a wide margin (Table), and government was 17% or less of the hiring in nine of eleven schools. It is important to note that some schools indicated that their data pertained to the MPH specifically, and others did not, so data on MPH, MS, MHA, and PhD or DrPH graduates may be included, and most schools did not list raw numbers of graduates surveyed, numbers for whom data could be found, or numbers of graduates by department. None of these data pertains to undergraduate degrees. Of all the schools of public health that listed data on their

websites, only four listed multiple years of employment outcomes, and no clear trend was visible in terms of increases in hiring by for-profit companies, indicating that there is a chance that changes observed at Columbia may be specific to Columbia. More research into employment trends would be valuable.

IMPLICATIONS FOR POLICY AND PRACTICE

- At Columbia University and nationally, a minority of public health graduate students are now entering government as their first sector of employment. At Columbia, an increasing number are entering for-profit employment. The skills that students of public health offer are in high demand by employers in a broad range of sectors and industries.
- Most research on the public health workforce defines it as governmental public health. Further research into the non-governmental public health workforce and the competencies needed by this workforce is needed.
- As public health challenges become more complex, they are likely to require broad-based, cross-sector solutions. There could be positive value to adding a public health lens to for-profit organizations that may be increasingly hiring public health graduates.
- Schools and Programs of Public Health would be well-advised to invest further in their career services offices, which are well-positioned to gather input from the employers that actually hire their graduates, so they can best work together with employers to build the public health workforce of the future.

DISCUSSION AND CONCLUSION

This set of analyses adds a critical dimension to the discussion of the future of our public health workforce by presenting compelling data on the present employment trends of public health school graduates. We used a combined approach of a literature review, analyses of Columbia University employment outcome data, and data from other schools of public health in the United States.

Limitations

Due to the changes in survey design and survey methodology, the analyses of Columbia data are subject to some limitations. The knowledge rate increased from 48.37% in 2012 to 93.72% in 2016, and the analyses of data are based on the assumption that the distribution of employed organization type was the same for individuals with missing data and for those with known information. If selection bias were an underlying issue and the resulting data were unequally distributed, this would have a large impact on the 2012 and 2013 data.

Trends in Employment and Competencies

If core competencies for public health graduate programs are based primarily on research on governmental agencies, which now comprise between 9% and 19% of employers hiring public health graduates at several schools and the ASPPH pilot data, perhaps future research on core competencies should attempt to gain more insight from other sectors. There are many possible reasons why there may be a trend towards public health graduates finding employment outside the traditional public health fields.

Industry growth rates. The US Department of Labor's Bureau of Labor Statistics data show government either shrinking, or growing more slowly than most other sectors in the next several years¹⁷, with the Federal government expected to shrink by 1.6% per year (2,406,500 jobs), and State/local government to grow by only 0.5% (20,032,200 jobs), whereas Professional/Business Services is growing by 1.8% (21,413,000 jobs expected by 2022); and Health care/social assistance growing 2.6% (21,965,000 jobs). Also, the reported shortage of epidemiologists does not match with US Department of Labor statistics on the growth of this particular occupation¹⁸. Anticipated retirements from government have been a source of concern for decades, but new hiring to replace the wave of retirees has not apparently transpired. Changes in job markets and issues with cuts to local health departments and other labor economics issues^{7,19} may have meant that governmental public health departments are shrinking due to retirements, and that workers are not being replaced.

Increased enrollments mean public health graduates must find work outside traditional public health sectors. The number of CEPH-accredited schools and programs offering public health degrees nationally has increased from 28 schools and 43 programs graduating approximately 5,500 Master's level students per year in 2001²⁰ to 163 CEPH-accredited schools and programs as of 2015, and with 11,932 Master's graduates from 90 ASPPH reporting member institutions in 2017.²¹ Within Columbia University's School of Public Health, the graduating class grew from 521 in 2012 to 669 in 2016. Considering the increased enrollments over time, the actual number of public health graduates entering government may actually be increasing, even if the proportion of graduates entering government is flat over time; but, combined with the slower growth of government employment, as compared with the rest of the economy, it seems very possible that government simply cannot absorb the increased numbers of public health graduates in the workforce.

Salary differentials. Differences in salaries among industries could deter graduates from considering government careers. The relatively lower pay in government employment, as compared to private

and sometimes even nonprofit employment, may be a large factor for students in choosing which job offers to accept. The evaporation of previously common benefits in government such as tuition remission/loan forgiveness, the lower starting salaries, and the possible decline in job security (especially in local government health departments, which saw large-scale layoffs during the 2008 recession) may have dissuaded students from pursuing government employment. Data from Columbia University's Mailman School of Public Health (class of 2016) indicate that government pays among the lowest starting salaries of all sectors, an average of approximately \$5,000 less than the industry-wide salary average for MPH graduates. This could also provide some explanation, if the increase in hiring by for-profit companies has increased solely at Columbia, because 67% of Mailman School graduates are employed in the relatively expensive New York City metropolitan area, and while it contains a large and well-regarded health department, New York City has comparatively fewer federal or state government jobs.

The *generation gap* between “Millennial” generation graduates and the increasingly aging public sector workforce may cause generational differences in values or interests²². The Office of Personnel Management states that the average age of a federal government employee is 47.5²³ and 60.4% of federal employees are 45 years old or older; and the Bureau of Labor Statistics states that the median age of the overall workforce is 42.2 but the median age for public administration employees is 45.6²⁴, the second-oldest employed population by industry after agriculture. Purely because younger employees might share similar interests with others in a similar age range could explain a preference for careers outside government; but students also report a desire for a fast pace of change, the opportunity to see immediate impact, and access to the newest technology, which may not always be available in government workplaces. In addition, government sector employment may take substantially longer to secure compared to private sector employment, is subject to hiring freezes, and may have specific application requirements (e.g. specialized resume designs, examinations, and security clearances) that the private sector does not. A study by Deloitte found that “Young workers interested in public service have innovative new types of careers and employers to choose from, including social entrepreneurship, corporate citizenship jobs, and NGOs.”²⁵ More research is needed to determine whether younger public health graduates have specific preferences when choosing which sectors to consider for employment.

Changing demographics of public health students: the composition of graduates in terms of age, race/ethnicity, gender, citizenship/work authorization, or prior work experience may have changed. According to the Institute of International Education²⁶, there is a national trend of increasing international student enrollment for colleges, with almost doubled total number of international

students in 2015-16 (1,043,839) as compared to the number in 2005-06 (564,766), and their ability to work in federal government, and often in local or state government, is very limited. The percentage of international students enrolling in reporting ASPPH institutions increased from 13.48% in 2010 to 15.05% in 2017²¹.

Changes in the actual degrees being offered and/or changes in departmental enrollment could impact hiring. At Columbia University, there was a positive association between finding employment in a for-profit organization as compared with other types of organizations for biostatistics and health policy and management graduates; logistic regression suggested that, after controlling for the graduation cohort, citizenship, and degree type, department is a significant predictor for the odds of becoming employed in a for-profit organization, with the odds for students from the Health Policy and Management Department being as high as 8.350 (95% CI: 4.851-14.373) times the odds for students from the Population and Family Health Department, following by Biostatistics Department with an odds ratio of 7.126 (95% CI: 3.844-13.210). However, as mentioned, we did still find a trend towards for-profit employment after any enrollment changes were accounted for.

Career Services Efforts. The Mailman School's Office of Career Services expanded its employer outreach efforts starting in 2013, bringing thousands of new employer records to its database. These efforts were informed by surveys of student interests, so student demand could have led to greater outreach to certain types of employers.

Students' skills gaps. Possibly, governmental public health employers find that graduates of public health programs do not have all the skills necessary for their needs, and additional collaborations are needed between schools and programs of public health and health departments in order to fill a skills gap¹³. This is certainly an area for further research.

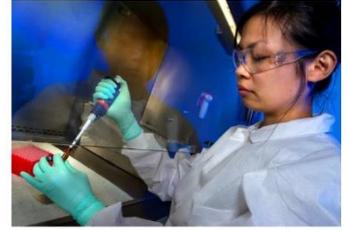
This study highlights the dearth of research on the actual employment outcomes of Public Health graduate students, and the need to make better connections between the organizations that are currently hiring these graduates, and the schools offering the degrees they pursue. With the new data collections for public health graduates' employment outcomes being conducted by the Association of Schools and Programs of Public Health, perhaps new insights will be uncovered regarding whether there are national trends in the employment of public health graduates. What seems clear is that many graduates are entering less traditional sectors, and that schools and programs of public health would be well-served by investing in their career services and field practice offices—the vital link

between schools and their employer partners—to provide feedback on the curriculum and to ensure that students are best prepared to enter the new public health workforce.

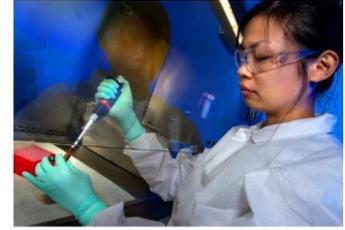
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Part 2: Employer Perspectives and Hiring Demands



Chapter 5: Labor Market Competition for Public Health Graduates in the United States: A Comparison of Workforce Taxonomies with Job Postings Before and During the COVID-19 Pandemic

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Labor Market Competition for Public Health Graduates in the United States: A Comparison of Workforce Taxonomies with Job Postings Before and During the COVID-19 Pandemic

ABSTRACT

A strong public health workforce (PHW) is needed to respond to COVID-19 and public health issues worldwide. However, classifying, enumerating, and planning the PHW is challenging. Existing PHW taxonomies and enumerations focus on the existing workforce, and largely ignore workforce competition for public health graduates (PHGs). Such efforts also do not utilize real time data to assess rapid changes to the employment landscape, like those caused by COVID-19. A job postings analysis can inform workforce planning and educational program design alike. To identify occupations and industries currently seeking PHGs and contrast them with existing taxonomies, authors matched existing PHW taxonomies to standardized occupational classification codes, then compared this with 38,533 coded, US job postings from employers seeking Master's level PHGs from July 1 2019-June 30, 2020. Authors also analyzed 24,516 postings from March 2019-Oct. 2019 and compared them with 24,845 postings from March 2020-Oct. 2020 to assess changing employer demands associated with COVID-19. We also performed schema matching to align various occupational classification systems. Job postings pre-COVID and during COVID show considerable but changing demand for PHGs in the US, with 16-28% of postings outside existing PHW taxonomies, suggesting labor market competition which may compound PHW recruitment and retention challenges.

Introduction

Well before the onset of the COVID-19 pandemic, there was a well-documented healthcare workforce shortage.¹ The World Health Organization (WHO) estimated a shortage of 18 million health workers by 2030 to meet the requirements of the Sustainable Development Goals and universal health coverage targets set by the WHO. Several other direction-setting policy documents have been published including the European Action Plan for Strengthening Public Health Capacities and Services,² the WHO's "Comprehensive health labour market framework for universal health coverage"³ and the WHO Global Strategy on Human Resources for Health.⁴ Concerns regarding workforce shortages due to the migration of healthcare professionals,⁵ retirements or attrition of public health (PH) workers,^{6,7} and lack of information regarding worker supply based on the

postgraduate employment outcomes of public health graduates (PHGs)⁸ have become even more urgent due to the COVID-19 pandemic. The WHO Global Strategy recommends gathering workforce data as “global public good to be shared in the public domain.”⁴

Due to the crucial role of disease prevention in responding to and recovering from the COVID-19 pandemic, assessing the public health workforce (PHW) remains critically important. Categorizing and enumerating clinical health professionals such as physicians, nurses, midwives, etc.^{9,10}, while challenging, is generally made simpler by the licensing and registration for these occupations. The PHW is more difficult to define, classify, and enumerate due to a lack of a consistent definition of PH professionals; lack of licensure or certification of PH professionals in most cases; and lack of central registries of these professionals in most countries, with the exception of the United Kingdom¹¹ and Poland, where registration is optional¹².

Even achieving consensus definitions for the PHW is difficult. PH professionals have been defined as “people who are involved in protecting and promoting the collective health of whole or specific populations,”¹³ or those contributing to the Essential Public Health Operations (EPHOs)¹⁴, Essential Public Health Services¹⁵, or Foundational Public Health Services (FPHS)¹⁶, which are different, but related, models describing core functions of public health systems. The workforce is “characterized by its diversity and its complexity and includes people from a wide range of occupational backgrounds.”¹⁷ Not only is this workforce diverse in its occupations, it is diverse in its employment settings or sectors. While the “core” PHW has often been defined as existing within government agencies,^{18,19} it has also been acknowledged that PH work takes place in academia, the voluntary/nongovernmental organization sector (i.e. charities, non-for-profit organizations), healthcare, and corporations (for-profit companies), and that many people contribute to the “wider” PHW, which can include people whose work indirectly contributes to public health efforts^{20,21}

The PHW is undergoing particular strain in the COVID-19 context. Especially in the US, PHW and leadership are being subject to harassment in a highly politicized and polarized COVID-19 response environment. COVID-19 associated burnout is compounding an already-stressed and chronically underfunded workforce that has decreased by approximately 20% since the onset of the Great Recession in 2008^{22,23}. When employers from outside the PHW, who seek to hire candidates with the skills provided by a public health education, offer higher wages or a better work environment for PHGs, this can entice PHGs away from finding employment in the PHW and can compound PHW shortages, resulting in a workforce crisis.

Existing taxonomies and enumerations use a needs-based approach

Several attempts have been made to define and enumerate the PHW, often beginning with creating PHW taxonomies which include categories of occupations—including job functions or

titles—which contribute to EPHOs. In workforce research, occupations are categorized or classified, described and quantified using standardized metrics and surveys designed by expert industrial psychologists or labor market researchers. For example, the International Labour Organization (ILO) uses International Standard Classification of Occupations (ISCO-08) codes^{24(p)}, the US Bureau of Labor Statistics (BLS) uses Standard Occupational Classification (SOC) codes²⁵, and the UK uses its own SOC codes²⁶ to classify occupations. Although such codes can be imperfect—the WHO global strategy advocates that the ILO revise the ISCO “for greater clarity on delineation of health workers and health professions”⁴—mapping the occupations in a workforce taxonomy to these codes allows researchers to use consistent, standard definitions of workers’ roles, and is important for labor market projections and assessment of educational requirements.⁴

To create a PHW taxonomy, many researchers use a needs-based framework—focusing first on the EPHOs and the staff needed to provide them—or use surveys of the existing PHW to determine which occupations exist therein. A recent systematic review article synthesized articles focused on enumerations and definitions of the PHW over a nearly two-decade period.²⁷ This article includes a new proposed taxonomy based on a synthesis of occupation-specific terms and job titles collected from the reviewed articles, which researchers matched to ISCO-08 codes based on their judgements of job titles. Additionally, while several articles within the systematic review list occupations by name, only two sources highlighted in the review specifically focus on PHW occupational taxonomies, one by the University of Michigan/Centers for Disease Control and Prevention (referred to here as “UM”)¹⁹ and one by the Centre for Workforce Intelligence (CfWI) in the United Kingdom.^{18,20}

These workforce taxonomies have primarily been created through a multi-step, “top-down” process, beginning with the high-level definition of EPHOs,^{15,28} followed by a literature review (often including a “job analysis” of job descriptions provided by current PH professionals), followed by data extraction or qualitative coding, review of key terms by experts, focus groups, and finally pilot testing/surveys of the PHW²⁹; or scoping, literature review, data collection, and stakeholder engagement.¹⁸ The taxonomies generally only include occupations that the researchers defined as contributing to EPHOs, and sometimes define PHW even more narrowly; for example, the UM taxonomy emphasizes occupations in the governmental PHW.

Insufficiencies of current PHW taxonomies

While these taxonomies are an important step in PHW categorization and enumeration, they may leave out relevant occupations due to their focus on the existing PHW and how it is defined. These taxonomies, themselves, also may not be sufficiently robust in describing the landscape of PHW employment because they do not take supply of PHG into account, nor the labor market

competition³⁰ for PHG: “partial health workforce policies...designed on the basis of needs-based estimates and focused on training more health workers” are “not sufficient in addressing health worker shortages.”³

New research in the United States indicates that PHG may be increasingly finding employment in the for-profit sector and other fields which may not contribute to EPHOs; assessment of the current PHW and its need for PHG is not enough if it ignores this “leaky pipeline”³¹⁻³⁴ or loss of PHGs to occupations and sections that do not contribute to the EPHOs.

Additionally, the existing taxonomies do not clearly delineate the occupations which require formal education in PH versus those that do not. Workers included in PHW taxonomies can include everyone from medical doctors and scientists, to nurses, to sanitarians, to typists and office clerks because they are involved in, or support, the delivery of public health services and protections. To ensure we can assure “a competent public health workforce,”³⁵ it is essential to know how many individuals with formal education in PH (PHGs) are needed in the PHW, and for which specific occupations, then contrast with PHG employment outcomes and detailed data on labor market competition. This manuscript employs a theoretical framework which includes an analysis of both the existing PHW, the supply of PHGs, and employer competition to hire them, adapted from prior healthcare workforce research³⁰ for this article (Appendix Figure 1).

FIGURE 1: Diagram of Labor Market Dynamics for PHGs

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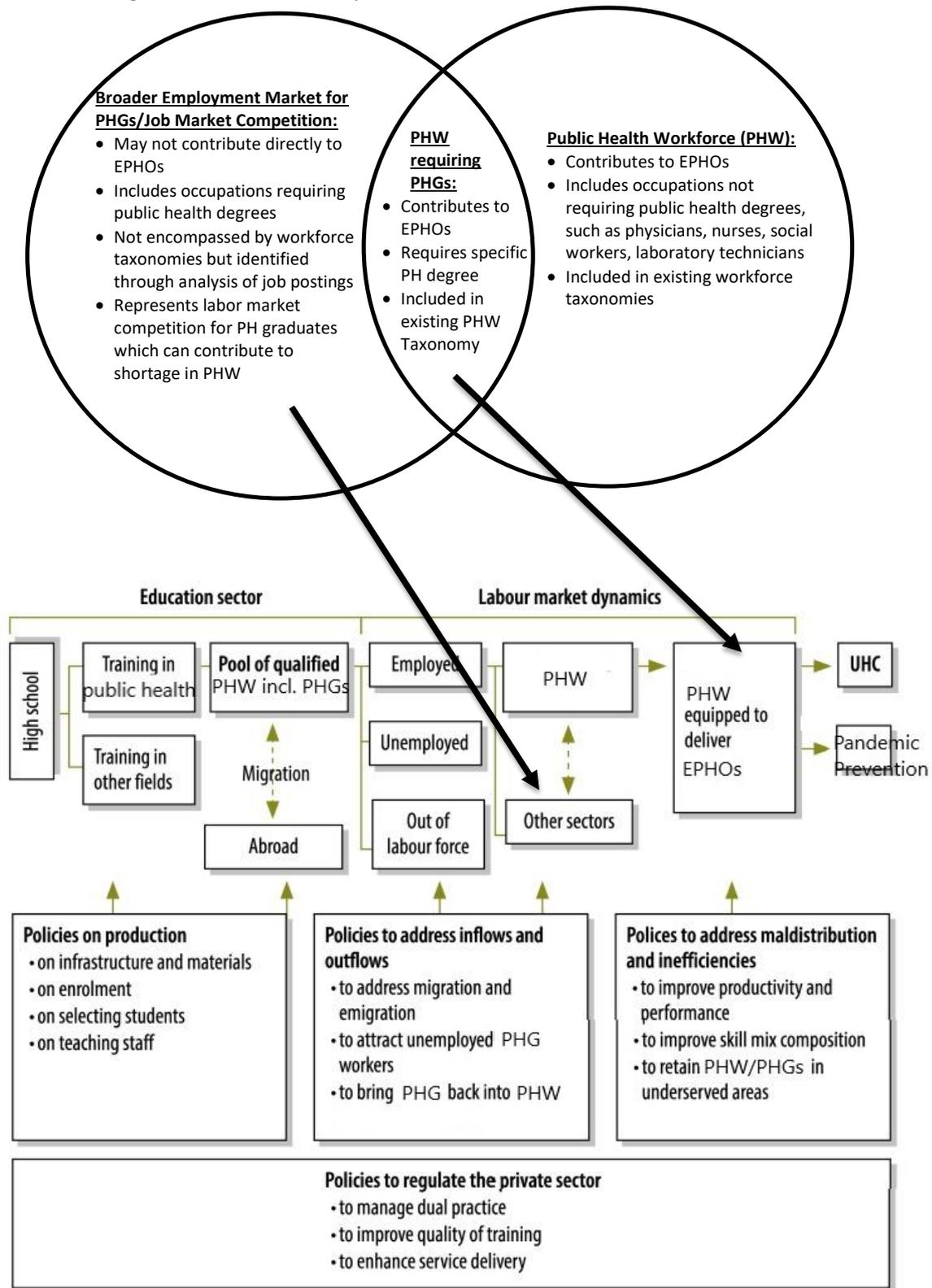


Diagram adapted from Vujicic M, Zurn P. The dynamics of the health labour market. Int J Health Plann Manage 2006; 21: 101-15
<http://dx.doi.org/10.1002/hpm.834> PMID: 16846103.

Utility of job postings analysis to classify PHW

One method of determining the labor market demand for PHGs is to analyze job postings/advertisements for these graduates, and compare them with the existing definitions and taxonomies for the PHW. Job postings typically include the job title, a description of the employing organization, an overview of job tasks or functions, and a list of required or desired skills, experience, education, or other credentials. Because job descriptions are designed to clearly describe the skills and qualifications needed to perform a job, they are a useful source of insight into current hiring needs. Although job postings are not created for the purposes of workforce research, many studies have been conducted which leverage the rich, text-based information from job postings—approximately 85% of which are posted on the internet³⁶—to infer employer needs and workforce trends. Several research studies on PHW have utilized job descriptions analysis to discern employer demands.^{37–41}

New technologies and methodologies allow for ISCO-08 and SOC coding of large-scale job postings data, thereby creating a list of occupations for which employers are currently seeking PHGs. Utilizing job postings data, to contrast with existing taxonomies, also provides data-driven, “real time” insights more quickly than periodic surveys or expert opinion.

This article seeks to more consistently map the occupations identified in existing PHW taxonomies to ISCO-08 and US SOC codes, then contrast them with job postings data which illustrate occupations and sectors currently seeking to hire PHGs. By identifying the job postings targeting PHGs which are not part of existing taxonomies, we can reveal new occupations or sectors which may be drawing PHGs away from the occupations that past researchers have defined as contributing to the EPHOs, thus assessing the labor market competition for PHGs. This research can also identify possible workforce gaps, and provide insights to academia to innovate their curricula. Finally, through an analysis of job postings in two time frames, before COVID-19 and during the COVID-19 pandemic, we can assess whether demand for PHGs has changed during the COVID-19 pandemic.

Methods

To assess which jobs seek PHGs aside from those in existing PHW taxonomies, researchers first matched PHW taxonomies with ISCO-08 codes, then contrasted job postings with the codes; and assessed differences in proportions of postings before and during the COVID-19 pandemic.

Mapping existing taxonomies to Standardized Occupational Classifications

The ILO’s ISCO-08 codes classify occupations into 441 categories, while the US Department of Labor’s Standard Occupation Classification (referred to here as “USSOC”) codes, revised in 2018,

include 867 different detailed occupations.²⁵ The US Department of Labor offers a SOC to ISCO-08 “crosswalk” to match the codes to one another.⁴² The UK’s Office for National Statistics (ONS) has its own SOC codes (referred to here as “UKSOC”), with 583 unique codes matching to 28,749 job titles and subtypes²⁶; and a UKSOC to ISCO-08 SOC crosswalk exists.

Two of the existing taxonomies, UM⁴³ and the CfWI Core workforce report^{18,20} did not include matches to SOC codes in their descriptions. Therefore, the lead researcher matched the job titles, or, when available, job descriptions, to their respective SOC codes, and then to ISCO-08 codes. For UM, the researcher referenced earlier studies which matched the titles which were later used for the taxonomy with USSOC codes⁴⁴⁻⁴⁶ and verified the proposed taxonomy with one of the authors of the original taxonomy. We also utilized a SOC-matching system developed by the US National Institutes of Health to match the available descriptions of the jobs in the UM taxonomy with USSOC codes.⁴⁷ In cases where more than one USSOC code matched a job from the UM taxonomy, or where more than one job title from UM matched the same USSOC code, both are included in the table (Appendix Table 1). In cases where no USSOC code match could be found, this is indicated in the table.

For the CfWI taxonomy of the Core PHW in the UK, the lead researcher referred to the detailed descriptions of each occupation in the report and attempted to match them to UKSOC 2010 codes using a qualitative approach, and further, utilized the UK ONS Occupation Coding Tool, which matches job titles to UKSOC 2010 codes⁴⁸, which then match to ISCO-08. Additionally, CfWI included a report on the “wider” PHW, which utilized discussions with various professional association members to determine which other occupations were considered “engaged” in PH. CfWI mapped these to UKSOC 2010 code, which the researcher cross-matched to ISCO-08 codes using the UK’s ONS crosswalk⁴⁹. For the purpose of this study, we included only those occupations listed as “active” in their engagement (“public health was explicitly part of their job”).

The taxonomy proposed in the systematic review article²⁷ was already matched to ISCO-08 codes by the article’s authors.

Utilizing a job postings database

This manuscript utilizes a commercially-available job postings database, maintained by Burning Glass Technologies (BG). BG is a data vendor which compiles millions of job postings every year using “bots” which search more than 40,000 different sources, tracking 3.4 million job postings at any time.³⁶ Data from this site has been used in many other workforce studies,^{40,50-52} including analysis of COVID-19’s impact on the labor market.⁴⁰

BG utilizes machine learning and natural language processing technology to match job postings data with the employer’s required or desired Classification of Instructional Program (CIP)

codes⁵³, which are developed by the US Department of Education to categorize areas of academic study; to allow searchability by the level of education required; and to match jobs with industries/sectors and USSOC codes.

We conducted three BG queries. We delimited all queries to job openings posted in the United States, for which, according to the BG algorithms, the employer desired or required a Master's level degree, with any of the CIP codes which match PH degrees, including 51.22 (including General Public Health, Environmental Health, Health/Medical Physics, Occupational Health/Industrial Hygiene, Public Health Education/Promotion, Community Health/Preventive Medicine, Maternal and Child Health, International PH/International Health, Health Services Administration, Behavioral Aspects of Health); 26.1309, Epidemiology; and 26.1102, Biostatistics.

One query was for 40,707 job postings from Jul. 1, 2019 - Jun. 30, 2020, of which 38,533 were USSOC-coded. The second and third queries were designed to compare jobs across all sectors before and during COVID-19, including jobs posted March 1, 2020 through Oct. 31, 2020 (n=24,845, the "COVID-19 era"), and March 1, 2019 through Oct. 31, 2019 (n=24,516 the "pre-COVID-19 era"). We compared occupations and sectors from the COVID-19 using two-proportion independent sample z tests with $\alpha=.05$.

Results

Mapping existing taxonomies to ISCO-08 and SOC codes

The three main taxonomies had varying levels of specificity (Appendix Table 1). The most detailed was the UM taxonomy, with a total of 69 job titles (three titles not originally in the taxonomy, "Pharmacist," "Emergency Medical Services Worker," and "Other Business Support Services" were added, because they were included in a US PHW survey based on the taxonomy)⁵⁴. Matching the UM codes to USSOC and ISCO-08 codes revealed some discrepancies. There were three titles for which a USSOC code could not be found: "Population Health Specialist," "Implementation Specialist," and "Adult protective services/Community worker." Several titles could map to multiple USSOC codes, and in some cases, several UM codes could map to one SOC code, for example, "Health officer," "Subagency-level director: Bureau, department, division, or branch," and "Deputy director (agency or subagency level)" all match to the USSOC "Chief Executives."

The CfWI "Mapping the Core" taxonomy encompassed 11 job titles, each of which could include a large number of sub-titles. When matching the titles to ISCO-08 codes using the ONS Occupation Coding Tool⁴⁸ and subsequently matching UK SOC codes to ISCO-08 codes, however, multiple titles matched to the same ISCO-08 codes (e.g., "Public health consultants and specialists,"

“Directors of Public Health (DsPH),” “Public health managers,” and “Public health practitioners” all matched to ISCO-08 2269, “Health professionals not elsewhere classified”).

Some of the CfWI titles were too broad to clearly match to a particular SOC or ISCO-08 code—for example, “Information workers” could refer to individuals who analyze data, but could also mean communications specialists. CfWI also excluded several occupations which appear in other taxonomies, including “midwives, general practitioners (GPs), community pharmacists...staff across the NHS and local government fulfilling a public health function as part of their job...staff supporting public health teams (e.g. business support staff, administration staff...).”¹⁸ The CfWI “Understanding the wider public health workforce” report, in contrast, lists 75 different UKSOC occupations for which the workers were seen as engaged actively in PH, encompassing 56 ISCO-08s, but 34 (such as “prison guards,” “butchers,” and “athletes”) matched no occupations in the other taxonomies nor the BG postings and were excluded to reduce confusion.

The taxonomy by Watts et. al.²⁷ included 103 titles, the majority of which were mapped to ISCO-08 codes by the authors using job titles alone, but multiple titles were matched to the same ISCO-08 code; removing duplicates, there were 33 unique ISCO-08 codes, and 7 job titles which were not matched to an ISCO-08 code. Two titles, “Emergency Preparedness” and “Quality Improvement Specialist” were not matched to ISCO-08 codes, but could be matched to USSOC codes due to their greater specificity.

A few “consensus” occupations could be clearly identified across the UM, CfWI, and Watts taxonomies. These included “Health Services Managers” (ISCO-08 1342); “Environmental and occupational health inspectors” (3257); “Environmental and occupational health and hygiene professionals” (2263, including health educators); “Social work and counselling professionals” (2635); “Biologists, botanists, zoologists and related professionals” (2131, including Epidemiologists, Microbiologists); “Statisticians” (2120); “Community health workers” (3253); “Nurses” (2221); “Systems analysts” (2511); and “Medical and pathology laboratory technicians” (3212), illustrating the interprofessionalism of the PHW.

Contrasting existing taxonomies with Burning Glass Data

There were a total of 38,533 SOC-coded job postings in the US, where a Master’s level PHG was sought, in the BG data from July 1, 2019-June 30, 2020, within 315 different USSOC occupations. We excluded those occupations with 50 or fewer job postings in the data collection, thus analyzing 92 unique SOC coded-occupations, representing a total of 36,225 postings from the sample. The jobs postings data also included postings by industry/sector.

Overall, there were 32 unique USSOC coded occupations in BG (corresponding to 29 unique ISCO-08 occupations) which were not included in the UM, CfWI “Core” or “Wider” taxonomies, or

Watts taxonomies, representing 10,089 jobs, or 28% of the BG postings. Of these jobs, 4,335 were for “Managers, All Other” (ISCO-08 1114/USSOC 11-9199). When these are excluded, 16% of the BG jobs did not match existing taxonomies (See Table 1 and Appendix Table 1). Table 1 compares job titles/occupation naming used in the occupational taxonomies and contrasts them with the number of job postings within each US SOC code/ISCO-08 code, from the BG data from 2019-2020, with the list sorted by number of job postings in BG.

In the July, 1 2019-June 30, 2020 BG data, 33,563 were coded by industry/sector; the top industries were Health Care and Social Assistance (n=10,476 postings or 31.2%); Educational Services (7,606, 22.7%); Public Administration/Government (4,127, 12.3%); Finance and Insurance (3,312, 9.9%), Professional, Scientific, and Technical Services (3,507, 10.4%), Manufacturing (2,251, 6.7%), Other Services (except Public Administration) (1,089, 3.2%), Information (282, 0.8%), Administrative and Support and Waste Management and Remediation Services (264, 0.8%), and Retail Trade (261, 0.8%).

TABLE 1: Comparison of Top 10 Most Sought Jobs for Public Health Graduates, By Public Health Taxonomy, SOC, AND ISCO-08 Codes

ISCO-08 CODE	ISCO-08 TITLE	USSOC CODE	USSOC TITLE	“No Two Workforces” ²⁷ Titles	UM Title ¹⁹	CfWI CORE Title ¹⁸	CfWI “Wider” WF Title ²⁰	BG jobs # 2019-2020
1342	Health services managers	11-9111	Medical and Health Services Managers	Agency Leadership, Coordinators, Directors Of Public Health, Health Care Administrators, Health Management, Health Planners, Health Policy Makers, Health Promotion Managers, Managers, Public Health Manager	1.1.5. Program director	Public health consultants and specialists		4,636
1114	Senior officials of special-interest organizations	11-9199	Managers, All Other					4,335
2120	Mathematicians, actuaries and statisticians	15-2041	Biostatisticians (15-2041.01)/Statisticians (15-2014)	Biostatisticians, Statisticians	1.2.23. Statistician	Intelligence and knowledge professionals		3,241
2221	Nursing professionals	29-1141	Registered Nurses (including Public Health Nurse)	Health Visitors, Licensed Practical Or Vocational Nurse, Nurses, Nursing Home Health Aide, Nursing Technicians, Primary Healthcare Registered Nurses, Public Health Nurse, Registered Nurses, School Nurses, Social Nursing, Community Health Nurses	1.2.14.1.1. Public health or community health nurse	Public health nurses; Health Visitors; School Nurses		1,956
2519	Software and applications developers and analysts not elsewhere classified	15-1199	Computer Occupations, All Other			Intelligence and knowledge professionals		1,833
2120	Mathematicians, actuaries and statisticians	15-2031	Operations Research Analysts	Biostatisticians, Statisticians				1,340
2131	Biologists, botanists, zoologists and related professionals	19-1041	Epidemiologists	Biologists, Epidemiologists, Food Safety Epidemiologists, Health Services Researchers, Microbiology, Parasitology, Public Health Scientists, Researchers	1.2.6. Epidemiologist	Public health scientists		1,237
2310	University and higher education teachers	25-1199	Postsecondary Teachers, All Other	Academic Public Health Specialists		Public health academics	Higher education teaching professionals	1,223
2421	Management	13-1111	Management					

	and organization analysts		Analysts					835
2263	Environmental and occupational health and hygiene professionals	21-1091	Health educators	Environmental Health Experts, Environmental Public Health Workers, Occupational And Environmental Health Specialists	1.2.8. Health educator	Environmental health professionals		810

Comparing pre-COVID and “COVID Era” jobs

There were 24,845 job postings from March 1, 2020 through Oct. 1, 2020 (the “COVID era”), and 24,516 postings from March 1, 2019 and Oct. 1, 2019 (“pre-COVID”).

Significant differences were observed in the proportion of job postings by industry or sector comparing the two time frames, including a decrease in positions in Colleges, Universities, and Professional Schools ($p < .0001$) and General Medical and Surgical Hospitals ($p < .0001$), and increases in Insurance Carriers ($p < .0001$), and Pharmaceutical and Medicine Manufacturing ($p < .0001$). (Appendix Table 2).

Comparing COVID-era and pre-COVID postings, there were significant increases in postings for Epidemiologists and Statisticians, Medical and Health Services Managers, Natural Sciences Managers (including research managers), Sales Managers, Chief Executives, Computer Occupations, Private Detectives (a USSOC occupation mapping Contact Tracers, which does not yet have a USSOC code), Architecture and Engineering Managers (including project managers), Biologists, Compliance Officers, and Community Health Workers. General management occupations, and roles in education and social services declined. (See Appendix Table 2).

TABLE 2: Comparison of COVID VS pre-COVID Era Industries/Sectors and Jobs

NAICS Code	Industry	COVID (March 1, 2020- Oct. 31, 2020)		Pre COVID (March 1, 2019- Oct. 31, 2019)		
		Job Postings	%	Job Postings	%	
6113	Colleges, Universities, and Professional Schools	3,757	19.9%	4,986	25.51%	***
6221	General Medical and Surgical Hospitals	3,229	17.1%	3,889	19.90%	***
5241	Insurance Carriers	2,854	15.1%	2,040	10.44%	***
9211	Executive, Legislative, and Other General Government Support	1,478	7.8%	1,528	7.82%	
3254	Pharmaceutical and Medicine Manufacturing	1,353	7.2%	917	4.69%	***
5417	Scientific Research and Development Services	1,258	6.7%	1,113	5.69%	**
6211	Offices of Physicians	574	3.0%	793	4.06%	***
6241	Individual and Family Services	381	2.0%	357	1.83%	
5416	Management, Scientific, and Technical Consulting Services	298	1.6%	347	1.78%	
8133	Social Advocacy Organizations	290	1.5%	299	1.53%	
	All other	3,407	18%	3,276	17%	**
	Total	18,879	100%	19,546	100%	

Notes: *** p<.0001, ** p<.01, *p<.05

Note: A total of 18,879 jobs from March 1, 2020 to Oct. 31, 2020, and 19,546 jobs from March 1, 2019 to Oct. 31, 2019, were assigned NAICS codes in Burning Glass. 764 postings from the COVID era, and 644 from the pre-COVID era are excluded from the table, but not from the statistical analysis, because they existed in industries with 30 or fewer postings in one of the time points.

Discussion

This article has sought to consistently map PHW occupations with SOCs, contrast them with jobs requiring PHGs, and finally, illuminate labor market competition for PHGs, while offering insights into COVID-19's impact on hiring of PHGs. While competition for PHGs has been hinted at in past research, it is more clearly illuminated here, and these findings can be used to both create policies to reduce workforce gaps, and also innovate educational curricula.

Mapping taxonomies to ISCO-08 and SOC codes, while challenging, provides key insights into PHW labor market dynamics; but these codes do not always clearly align with public health occupations, making it more difficult to gain a complete picture of the PHW. There is clear competition for PHGs outside the PHW as it has been traditionally defined; for example, though the US PHW has often been defined as governmental, government comprised only 12% of job postings for PHGs.

Mapping to Standardized Occupational Classifications: using new tools

Job analysis—a specific method in industrial psychology—is a critical element in taxonomy creation. New tools exist, which can ensure taxonomies match accurately to SOCs based on complete job descriptions. These include machine learning tools such as the US National Institutes of Health “SOCcer” tool⁴⁷, large-scale, coded datasets such as BG, or even direct inquiries with the BLS or ONS. The existing taxonomies were mainly created both through discussions with experts in the field and with surveys, by using lists of job titles without complete job descriptions for each occupation, or using job categories which are too broad to match to specific occupations.

The suggestion by Watts and colleagues that differences in taxonomies reflect differences in PH systems is reconfirmed by this investigation. For example, there are several occupations absent from the UM taxonomy, but which appear in other taxonomies or in BG. These include roles in academia, such as “Postsecondary Teachers” and “Social Science Research Assistants.” Conversely, CfWI includes academia as a core part of the PHW. However, while different countries have different taxonomies, we observe there is still some consensus between different taxonomies regarding which occupations are a core part of the PHW.

Evidence of labor market competition for PHGs

It is notable that there were 24,845 job postings in the “COVID era”, and 24,516 postings “pre-COVID era.” The BLS's monthly Job Openings and Labor Turnover Survey (JOLTS), which tracks the number of monthly job postings in the US, indicates that there were consistently fewer job

postings in 2020 than 2019 each month (e.g., 15.9% fewer job openings in March 2020 compared with March 2019; 30.7% fewer in April, and 26% fewer in May)⁵⁵, which suggests that the job market for master's level PHGs has not been as negatively impacted by the COVID-19 pandemic as compared with the broader job market.

The fact that 4,127 positions in Public Administration (government) were posted in the 2019-2020 BG data set is notable because there were 17,948 Master's-level PHGs in 2019 in the US. New data show approximately 19% of Master's level PHGs enter into government after graduation, giving approximately 3,410 PHGs entering government, a shortfall of approximately 717 PHGs, and preliminary evidence of a long-suspected labor market mismatch.^{32,33,56} This mismatch—in which not enough PHGs are entering government to fill critical PHW shortages—may have serious repercussions for the ability of the governmental PHW to respond to public health crises including COVID-19.

The occupations from BG that do not exist in current taxonomies provide researchers with insight into labor market competition. The large percentage of computer-related occupations in BG outside the taxonomies may reflect employers seeking epidemiology or biostatistics students, such as corporations seeking data scientists. There are also several business-related occupations (sales, marketing, operations research) which appear in BG but not existing taxonomies, reflecting occupations in the for-profit sector seeking PHGs—an indicator of job market competition which could negatively impact the ability of PHG to fill a PHW shortage. Conversely, several occupations in PHW taxonomies had very few BG postings, reflecting occupations in the PHW not requiring a PHG.

COVID-19 and changes in industry/sector

In addition to ongoing labor market competition, COVID-19 appears to have impacted the job market for PHGs, and there are several possible explanations for these changes. The insurance industry markedly increased hiring in the COVID era. In the United States, health insurance firms were one of the few sectors to experience fewer financial challenges due to COVID-19, because elective medical procedures were halted during lockdowns, reducing insurance claims. Hospitals had the opposite challenge; significant revenue comes from elective procedures, cancelled due to COVID-19. Education sector hiring has declined, reflecting financial challenges. Pharmaceutical firms are growing due to investments in COVID-19 treatments and vaccines. Finally, hiring in government stayed quite similar, pre-COVID vs. COVID-era—possibly reflecting funding priorities made by policymakers in the US during the time period being analyzed.

Recommendations and future PHW research

In order to improve PHW research, we suggest advocacy efforts to BLS and ILO ensure inclusion of codes that encompass critical PH occupations, since several occupations in PH do not match to ISCO-08 or SOC codes. And while the use of SOCs, by themselves, to enumerate the PHW is controversial due to the “ill-defined” nature of the workforce^{44,57} and the fact that simply counting the number of people in an occupation does not illuminate the PHW because many work outside PH (e.g., the vast majority of nurses are not PH nurses), these codes are still helpful in gathering in-depth occupational information.

To truly assess labor market competition for PHGs, this analysis should be combined with efforts to enumerate the current PHW, assess what proportion of the workforce work in occupations which require PH education (according to SOC-based educational benchmarks⁵⁸), compare the current level of PH education within each occupation, and determine expected attrition,⁷ then contrast the current PHW with population needs based on EPHOs, and finally determine employment outcomes of PHGs. Such an assessment can allow workforce planners to determine whether there are enough PHGs contributing to EPHOs; this article’s analysis can clarify which industries are “poaching” PHGs from EPHO-related jobs. This can guide policy levers to alter the job market by ensuring competitive wages, reducing barriers to entry into the traditional PHW³⁴, and creating more effective recruitment programs for PHGs to compete with new sectors. Additionally, in order to ensure PHGs understand and are committed to their role in contributing to the EPHOs, there can be stronger efforts to connect PHGs to a professional identity which is directly connected to the EPHOs; a professional identity or ethos is also important for the existing PHW. This study illustrates that PHW is comprised of a very diverse range of different occupations, making it more difficult to create a unified professional identity. Efforts towards professionalization, including credentialing, registration, consistent competencies, and a strong professional board or association, can help connect PHGs to a stronger, more unified PHW²¹. Simultaneously, PHGs who do decide to enter the “wider” PHW can advocate for better PH principles wherever they go, bringing the voice of public health to settings beyond traditional PH.

Uses by academia

Higher education institutions may not wish to see themselves as “vocational preparation” programs whose only role is to respond to employer demands, but if they ignore *current* employer demand, their curricula may be seen as outdated by their graduates’ employers. Universities preparing PHGs can utilize this analysis to discern real-time job market requirements of employers. The jobs with the fastest increases in hiring during the COVID-19 era focus on statistics and epidemiology, program management, computer-related positions, community health workers, and individuals managing clinical trials or research programs. An increased need for Chief Executives

highlights the need for leadership training to meet the COVID-19 pandemic's management challenges or replace retiring PH executives; and "private detectives" may reflect the hiring of contact tracers/disease investigators. Social workers and physicians are needed to provide direct services and to help with prevention efforts for COVID-19; the increase in market research and compliance may reflect new research around behavior change communication or enforcement of COVID-19-related regulations. The increase in Engineering Managers might reflect the need to bring PH expertise to the design of buildings to ensure healthy airflow and reduce the transmission of an airborne virus. Ensuing curriculum meets employer demands for leadership, statistics, market research, program and research management, computer programming/data science, business skills, and operations research can ensure PHGs have relevant skills for today's job market.

Career advising for PH students can also be enhanced by referring students to information on the occupations referenced in this taxonomy; each USSOC occupation is described in detail on a comprehensive career guidance website, O*Net Online⁵⁹, which includes alternative job titles, job descriptions, lists of job tasks, technology and tools used, knowledge, skills and abilities, detailed work activities, work context, level of required education or training, credentials or certifications, work styles and values, related occupations, salary ranges, and projected labor market growth, providing one of the richest and most accurate sources of occupational data available. A new career guidance intervention could be designed, similar to the UK's PHORCaST program,⁶⁰ based on the occupations listed here, which in turn could help encourage students to consider PH studies and contribute to the EPHOs. Universities can also utilize these results to portray to prospective students why a PH degree can offer career satisfaction.⁵⁶

Limitations

The BG data was gathered from the United States. BG does have data collections from Europe, which may help future researchers. BG's coding algorithms are proprietary. It is possible that the jobs in the dataset are not truly reflective of who is hiring PHGs. More research is necessary, including hand-searching actual job posting samples from BG to validate their methodology. It is possible BG might undercount certain sectors due to the way the jobs are posted online. Jobs posted through government contractors may be miscategorized or undercounted. Also, large-scale/mass hiring efforts may take place through only a single job posting, which could undercount surge hiring efforts.

BG leaves out qualitative information which might be gleaned by hand-coding or using a text-based analysis to discern current skills needed by employers. This can be especially critical for the COVID-19 era jobs, which may reflect new and emerging occupations without ISCO or SOC codes. Further research, including qualitative analysis or employer surveys, would further illuminate

skills requirements. Also, occupations are only one of multiple elements which should be considered when researching the workforce; sector, mission/subject area, and funding source are all factors to consider.

Several occupations, including policy analyst, advocacy, and contact tracing do not map clearly to ISCO-08 or SOC codes. Some taxonomy occupations are not clearly defined such as “population health specialist,” and without a job description, may be impossible to match to a code. More research to finalize the mapping should be conducted, using full job analysis.

This “demand side” approach may illustrate workforce gaps, but should be used in combination with needs-based workforce and funding assessments for PHW hiring, to gather a more complete picture of PHW gaps.

Conclusions

A complete analysis of the PHW should include the supply of PHGs and labor market competition for them. By understanding who is hiring PHGs, we can intentionally design policies and recruitment initiatives to fill workforce gaps. And while universities offering PH degrees design them to prepare students to contribute to EPHOs, the competencies gained by their students are clearly in demand in fields which may or may not contribute to EPHOs³².

COVID-19 has altered the labor market for millions of people, including PHGs. illuminated the critical role of a trained PHW. By more fully understanding this workforce, leaders can advocate to effectively harness the energy and commitment of new PHGs to contribute to EPHOs to heal our world.

APPENDIX TABLE 1: Full Comparison of Public Health Taxonomies and BG Postings, Linked to ISCO-08 and USSOC Codes

Appendix Table 1: Full Comparison of Public Health Taxonomies and BG Postings, Linked to ISCO-08 and USSOC Codes

ISCO-08 CODE	ISCO-08 TITLE	USSOC CODE	USSOC TITLE	No Two Workforces Titles	UM Title	CfWI "Core" Title	CfWI "Wider" WF Title	BG jobs # 2019-2020
1112	Senior government officials	11-1011	Chief Executives		1.1.1. Public health agency director	Directors of Public Health (DsPH)		310
1112	Senior government officials	11-1011	Chief Executives		1.1.2. Health officer	Directors of Public Health (DsPH)		Duplicate
1112	Senior government officials	11-1011	Chief Executives		1.1.3. Subagency-level director: Bureau, department, division, or branch	Directors of Public Health (DsPH)		Duplicate
1112	Senior government officials	11-1011	Chief Executives		1.1.4. Deputy director (agency or subagency level)	Directors of Public Health (DsPH)		Duplicate
1112	Senior government officials	11-9161	Emergency Management Directors	Emergency Preparedness Staff	1.2.4. Emergency preparedness/Management worker			85
1112	Senior government officials	11-1021	General and Operations Managers		1.4.2.2. Facilities or operations worker			677
1114	Senior officials of special-interest organizations	11-9199	Managers, All Other					4335
1114	Senior officials of special-interest organizations	11-2031	Public Relations and Fundraising Managers					303
1211	Finance managers	11-3031	Financial Managers	Financial Operations				150
1212	Human resource managers	11-3131	Training and Development Managers		1.4.2.4.1. Training/Workforce development personnel			52
1212	Human resource managers	11-3111	Compensation and Benefits Managers					72
1219	Business services and administration managers not elsewhere classified	11-3011	N/A Multiple possible matches (11-3011.00 Administrative Services Managers, etc.)	Business Operations	1.4.1. Administrator /1.4.2. Business support			287
1219	Business services and administration managers not elsewhere classified	11-3061	N/A No clear match (11-3061.00 Purchasing Managers)	Business Operations	1.4.2.3. Grants or contracts specialist			5
1221	Sales and marketing managers	11-2022	Sales Managers					400
1221	Sales and marketing managers	11-2021	Marketing Managers					219

1223	Research and development managers	11-9121	Natural Sciences Managers					739
1223	Research and development managers	11-9041	Architectural and Engineering Managers					182
1321	Manufacturing managers	11-3051	Industrial Production Managers					301
1330	Information and communications technology service managers	11-3021	Computer and Information Systems Managers		1.2.10. Information systems manager/1.2.10.2. Information technology specialist	Intelligence and knowledge professionals		50
1341	Child care services managers	11-9031	Education Administrators, Preschool and Childcare Center/Program					58
1342	Health services managers	11-9111	Medical and Health Services Managers	Agency Leadership, Coordinators, Directors Of Public Health, Health Care Administrators, Health Management, Health Planners, Health Policy Makers, Health Promotion Managers, Managers, Public Health Manager	1.1.5. Program director	Public health consultants and specialists		4636
1344	Social welfare managers	11-9151	Social and community services managers		1.1.6. Public health manager or program manager	Public health consultants and specialists	Social services managers and directors	340
1345	Education managers	11-9033	Education Administrators, Postsecondary			Public health academics	Senior professionals of educational establishments	476
1345	Education managers	11-9032	Education Administrators, Elementary and Secondary School			Public health academics		81
1345	Education managers	11-9039	Education Administrators, All Other					78
2113	Chemists	19-2031	Chemists	Chemists				40
2120	Mathematicians, actuaries and statisticians	15-2041	Statisticians (15-2014), including Biostatisticians (15-2041.01)	Biostatisticians, Statisticians	1.2.23. Statistician	Intelligence and knowledge professionals		3241
2120	Mathematicians, actuaries and statisticians	15-2031	Operations Research Analysts	Biostatisticians, Statisticians				1340
2120	Mathematicians, actuaries and statisticians	15-2011	Actuaries	Biostatisticians, Statisticians				4
2120	Mathematicians, actuaries and statisticians	15-2041.02	Clinical Data Managers		1.2.10.3. Data manager	Intelligence and knowledge professionals		Duplicate

2131	Biologists, botanists, zoologists and related professionals	19-1042	Medical Scientists, Except Epidemiologists	Biologists, Epidemiologists, Food Safety Epidemiologists, Health Services Researchers, Microbiology, Parasitology, Public Health Scientists, Researchers	1.2.11.4. Scientist or medical technologist	Public health scientists		479
2131	Biologists, botanists, zoologists and related professionals	19-1022	Microbiologists (including Public health laboratory scientist)	Biologists, Epidemiologists, Food Safety Epidemiologists, Health Services Researchers, Microbiology, Parasitology, Public Health Scientists, Researchers	1.2.11.4. Scientist or medical technologist ("Laboratory Scientist/Medical Technologist")	Public health scientists		33
2131	Biologists, botanists, zoologists and related professionals	19-1041	Epidemiologists	Biologists, Epidemiologists, Food Safety Epidemiologists, Health Services Researchers, Microbiology, Parasitology, Public Health Scientists, Researchers	1.2.6. Epidemiologist	Public health scientists		1237
2131	Biologists, botanists, zoologists and related professionals	19-1020	Biologists	Biologists, Epidemiologists, Food Safety Epidemiologists, Health Services Researchers, Microbiology, Parasitology, Public Health Scientists, Researchers		Public health scientists		165
2131	Biologists, botanists, zoologists and related professionals	19-1029	Biological Scientists, All Other	Biologists, Epidemiologists, Food Safety Epidemiologists, Health Services Researchers, Microbiology, Parasitology, Public Health Scientists, Researchers		Public health scientists		94
2131	Biologists, botanists, zoologists and related professionals	19-1011	Animal Scientists	Biologists, Epidemiologists, Food Safety Epidemiologists, Health Services Researchers, Microbiology,		Public health scientists		3

				Parasitology, Public Health Scientists, Researchers				
2133	Environmental protection professionals	19-2041	Environmental Scientists and Specialists, Including Health		1.2.5. Environmental health worker	Environmental health professionals		94
2143	Environmental engineers	17-2081	Environmental Engineers	Engineers, Health Engineers, Sanitary Engineers	1.2.5.2. Engineer			44
2149	Engineering professionals not elsewhere classified	17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors					54
2164	Town and traffic planners	19-3051	Urban and Regional Planners				Town planning officers	73
2211	Generalist medical practitioners	29-1063	Internists, General	Family Doctors, Physician Assistants, Physicians, Social Medicine	1.2.17. Physician		Medical practitioners	0
2211	Generalist medical practitioners	29-1069	Physicians and Surgeons, All Other, including Preventive medicine physicians 29-1069.09	Family Doctors, Physician Assistants, Physicians, Social Medicine	1.2.17.1. Public health or preventive medicine physician			58
2211	Generalist medical practitioners	29-1069	Physicians and Surgeons, All Other, including Preventive medicine physicians 29-1069.09	Family Doctors, Physician Assistants, Physicians, Social Medicine				Duplicate
2212	Specialist medical practitioners	29-1069	Physicians and Surgeons, All Other, including Preventive medicine physicians 29-1069.09	Doctor, Public Health Consultants, Public Health Physicians, Public Health Practitioners, Public Health Specialists, Specialist Doctors				Duplicate
2221	Nursing professionals	29-1141	Registered Nurses (including Public Health Nurse)	Health Visitors, Licensed Practical Or Vocational Nurse, Nurses, Nursing Home Health Aide, Nursing Technicians, Primary Healthcare Registered Nurses, Public Health Nurse, Registered Nurses, School Nurses, Social Nursing, Community Health Nurses	1.2.14.1. Registered nurse	Public health nurses; Health Visitors; School Nurses	Nurses	Duplicate

2221	Nursing professionals	29-1141	Registered Nurses (including Public Health Nurse)	Health Visitors, Licensed Practical Or Vocational Nurse, Nurses, Nursing Home Health Aide, Nursing Technicians, Primary Healthcare Registered Nurses, Public Health Nurse, Registered Nurses, School Nurses, Social Nursing, Community Health Nurses	1.2.14.1.1. Public health or community health nurse	Public health nurses; Health Visitors; School Nurses		1956
2221	Nursing professionals	29-1141.04	Registered Nurses, specifically Clinical Nurse Specialists (29-1141.04)	Health Visitors, Licensed Practical Or Vocational Nurse, Nurses, Nursing Home Health Aide, Nursing Technicians, Primary Healthcare Registered Nurses, Public Health Nurse, Registered Nurses, School Nurses, Social Nursing, Community Health Nurses	1.2.14.1.2. Clinical services registered nurse (in PH WINS, "Other Registered Nurse – Clinical Services")	Public health nurses; Health Visitors; School Nurses		Duplicate
2221	Nursing professionals	29-1171	Nurse Practitioners	Health Visitors, Licensed Practical Or Vocational Nurse, Nurses, Nursing Home Health Aide, Nursing Technicians, Primary Healthcare Registered Nurses, Public Health Nurse, Registered Nurses, School Nurses, Social Nursing, Community Health Nurses	1.2.14.1.3. Advanced practice nurse	Public health nurses; Health Visitors; School Nurses		84
2222	Midwifery professionals	29-1161	Nurse Midwives	Midwives			Midwives	7
2230	Traditional and complementary medicine professionals	29-1199	Health Diagnosing and Treating Practitioners, All Other					Duplicate USSOC code but different ISCO-08 code
2240	Paramedical practitioners	29-1071	Physician Assistants		1.2.18. Physician assistant			37
2250	Veterinarians	29-1131	Veterinarians (including Public health veterinarian)	Animal Control	1.2.25.1. Public health veterinarian		Veterinarians	0
2261	Dentists	29-1029	Dentists, all other (including Public health dentist)	Dental Therapists, Dentist, Oral Health Care, Public Health Dental Worker	1.2.16.1. Public health dentist			0

2261	Dentists	29-1029	Dentists, all other (including Public health dentist)	Dental Therapists, Dentist, Oral Health Care, Public Health Dental Worker			Dental practitioners	Duplicate
2262	Pharmacists	29-1051	Pharmacist	Pharmacists	Pharmacist		Pharmacists	22
2263	Environmental and occupational health and hygiene professionals	21-1091	Health educators	Environmental Health Experts, Environmental Public Health Workers, Occupational And Environmental Health Specialists	1.2.8. Health educator		Environmental health professionals	810
2263	Environmental and occupational health and hygiene professionals	29-9011	Occupational Health and Safety Specialists--NOTE, SOC CODED AS 29-9011 or as 19-5011	Environmental Health Experts, Environmental Public Health Workers, Occupational And Environmental Health Specialists,			Environmental health professionals	581
2265	Dieticians and nutritionists	29-1031	Dietitians and nutritionists	Dieticians, Nutritionists, Public Health Dieticians, Public Health Nutritionists	1.2.15. Nutritionist or dietitian			239
2269	Health professionals not elsewhere classified	29-1199	Health Diagnosing and Treating Practitioners, All Other	Allied Health Professional			Podiatrists; Health professionals n.e.c.; Occupational therapists	93
2269	Health professionals not elsewhere classified						Public health consultants and specialists; Directors of Public Health (DsPH); Public health managers; Public health practitioners	
2310	University and higher education teachers	25-1199	Postsecondary Teachers, All Other	Academic Public Health Specialists			Public health academics	Higher education teaching professionals 1223
2310	University and higher education teachers	25-1072	Nursing Instructors and Teachers, Postsecondary	Academic Public Health Specialists			Public health academics	317
2310	University and higher education teachers	25-1071	Health Specialties Teachers, Postsecondary	Academic Public Health Specialists			Public health academics	201
2310	University and higher education teachers	25-1054	Physics Teachers, Postsecondary	Academic Public Health Specialists			Public health academics	0
2320	Vocational education teachers	25-1194	Vocational Education Teachers, Postsecondary				Further education teaching professionals	51

2351	Education methods specialists	25-9031	Instructional Coordinators				Education advisers and school inspectors	144
2356	Information technology trainers	13-1151	Training and Development Specialists					106
2359	Teaching professionals not elsewhere classified	25-3099	Teachers And Instructors, All Other, Except Substitute Teachers				Teaching and other educational professionals n.e.c.	284
2359	Teaching professionals not elsewhere classified	21-1012	Educational, Guidance, School, and Vocational Counselors					216
2411	Accountants	13-2011	Accountants		1.4.2.1. Accountant or fiscal worker			113
2412	Financial and investment advisers	13-2051	Financial Analysts					89
2412	Financial and investment advisers	13-2052	Personal Financial Advisors					51
2421	Management and organization analysts	13-1111	Management Analysts					835
2422	Policy administration professionals	13-1199	Business Operations Specialists, All Other (NOTE: USSOC does not have a clear code for this)	Policy Analysts			Intelligence and knowledge professionals	53
2423	Personnel and careers professionals	13-1071	N/A Multiple possible matches 13-1071.00 Human Resources Specialists, 11-3121.00 Human Resources Managers, 43-4161.00 Human Resources Assistants, Except Payroll and Timekeeping		1.4.2.4. Human resources personnel			372
2423	Personnel and careers professionals	13-1141	Compensation, Benefits, and Job Analysis Specialists					62
2431	Advertising and marketing professionals	13-1161	Market Research Analysts and Marketing Specialists					82
2432	Public relations professionals	27-3031	Public Relations specialists		1.2.7. Health communicator/1.2.7.1. Public information specialist	Public health managers		179
2511	Systems analysts	15-1111	Computer & Information Research Scientists	IT Workers	1.2.10.1. Public health informatics specialist	Intelligence and knowledge professionals		670
2511	Systems analysts	15-1121	Computer Systems Analysts	IT Workers		Intelligence and knowledge professionals		210

2512	Software developers	15-1132	Software Developers, Applications					119
2514	Applications programmers	15-1131	Computer Programmers			Intelligence and knowledge professionals		223
2519	Software and applications developers and analysts not elsewhere classified	15-1199	Computer Occupations, All Other			Intelligence and knowledge professionals		1833
2521	Database designers and administrators	15-1141	Database Administrators		1.2.10.3. Data manager	Intelligence and knowledge professionals		114
2529	Database and network professionals not elsewhere classified	15-1122	Information Security Analysts					80
2611	Lawyers	23-1011	Lawyer		1.4.3. Attorney or legal counsel			0
2631	Economists	19-3011	Economists	Economists, Health Economist	1.2.2. Economist			124
2632	Sociologists, anthropologists and related professionals	19-3041	Sociologists			Public health consultants and specialists; Public health scientists		13
2633	Philosophers, historians and political scientists	19-3094	Political Scientist (includes Policy Analyst)		1.2.19. Policy analyst	Public health managers		323
2633	Philosophers, historians and political scientists	19-3099	Social scientists and related workers		1.2.21. Program evaluator	Public health managers		331
2635	Social work and counselling professionals	21-1011	N/A multiple possible SOC codes/titles fit taxonomy: SOCs 21-1011, Substance Abuse and Behavioral Disorder Counselors; 21-1022, Healthcare Social Workers; 21-1019, Counselors, All Other; and OPM occupational categories 0185–Social Work, 0186–Social Services Aid and Assistant, 0187–Social Services, 0180–Psychology, and 0181–Psychology Aid and Technician	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.2.1. Behavioral health professional		Social workers; Probation officers; Welfare professionals n.e.c.; Counsellors	24
2635	Social work and counselling professionals	21-1014	Mental Health Counselors	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.2.1.1. Behavioral counselor			76

2635	Social work and counselling professionals	21-1022	Healthcare Social workers	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.2.22. Social worker/Social services professional			73
2635	Social work and counselling professionals	21-1023	Mental Health and Substance Abuse Social Workers (S/I/A);	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.2.22. Social worker/Social services professional			26
2635	Social work and counselling professionals	21-1021	Child, Family, and School Social Workers	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.2.22.1. Social services counselor	Public health practitioners		52
2635	Social work and counselling professionals	21-1011	Substance Abuse and Behavioral Disorder Counselors	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.2.22.1. Social services counselor	Public health practitioners		Duplicate
2635	Social work and counselling professionals		N/A NO SOC MATCH FOUND	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.2.22.2. Adult protective services/Community worker	Public health practitioners		
2635	Social work and counselling professionals	21-1019	Counselors, All Other	Behavioral Health Professional, Behavioral Health Staff, Social Workers	1.3.6. Peer counselor			10
2635	Social work and counselling professionals	21-1099	Community and Social Service Specialists, All Other	Behavioral Health Professional, Behavioral Health Staff, Social Workers				80
2635	Social work and counselling professionals	21-1029	Social Workers, All Other	Behavioral Health Professional, Behavioral Health Staff, Social Workers				62
2641	Authors and related writers	27-3042	Technical Writers					83
3111	Chemical and physical science technicians	19-4099	Life, Physical, and Social Science Technicians, All Other; Including Quality Control Analysts (19-4099.01)	Quality Improvement Specialist	1.4.2.5. Quality improvement worker			105
3111	Chemical and physical science technicians	19-4099	Quality Control Analysts (note: 19-4099.01)		1.2.11.3. Quality control worker	Public health managers		Duplicate
3141	Life science technicians (excluding medical)	19-4091	Environmental Science and Protection Technicians, Including Health; Multiple titles: Sanitarian/Environmental Science and Protection Technician		1.2.5.1. Sanitarian or inspector/1.2.5.3. Technician	Environmental health professionals		42

3212	Medical and pathology laboratory technicians	29-2011	Medical and Clinical Laboratory Technologists	Lab Technicians, Laboratory Assistant, Laboratory Worker, Scientific Laboratory Staff	1.2.11. Laboratory worker	Public health scientists		7
3212	Medical and pathology laboratory technicians	29-2012	Medical and Clinical Laboratory Technicians	Lab Technicians, Laboratory Assistant, Laboratory Worker, Scientific Laboratory Staff	1.2.11.2. Technician (in PH WINS, "Laboratory Aide or Assistant")			72
3221	Nursing associate professionals	29-2061	Licensed Practical and Licensed Vocational Nurses		1.2.14.2. Licensed practical or vocational nurse	Public health practitioners		0
3252	Medical records and health information technicians	29-2071	Medical Records and Health Information Technicians	Public Health Informatics, Public Health Information Specialist				0
3253	Community health workers	21-1094	Community Health Workers	Community Health Workers, Health Care Educators, Health Prevention Workers, Health Promotion, Health Promotion Specialists, Public Health Workers, Village Doctors	1.3.2. Community health worker	Public health practitioners		106
3253	Community health workers	21-1094	Community Health Workers	Community Health Workers, Health Care Educators, Health Prevention Workers, Health Promotion, Health Promotion Specialists, Public Health Workers, Village Doctors	1.3.3. Disease intervention specialist	Public health practitioners		Duplicate
3253	Community health workers	21-1094	Community Health Workers	Community Health Workers, Health Care Educators, Health Prevention Workers, Health Promotion, Health Promotion Specialists, Public Health Workers, Village Doctors	1.3.4. Health navigator			Duplicate
3257	Environmental and occupational health inspectors and associates	29-9012	Occupational Health and Safety Technicians	Assistant Health Inspector, Food Inspectors, Health Inspector, Hygienists	1.2.5.1. Sanitarian or inspector	Environmental health professionals		84

3258	Ambulance workers	29-2041	Emergency Medical Technicians and Paramedics		1.2.3. Emergency medical technician/Emergency medical services worker (note--there are 2 categories for this in PN-WINS)		Paramedics; Ambulance staff (excluding paramedics)	0
3258	Ambulance workers	29-2041	N/A Multiple matches Emergency Medical Services Worker		Emergency Medical Services Worker: in PH WINS but not taxonomy			Duplicate
3259	Health associate professionals not elsewhere classified	29-2099	Health Technologists and Technicians, All Other					149
3314	Statistical, mathematical and related associate professionals	19-4061	Social Science Research Assistants					604
3322	Commercial sales representatives	41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products					185
3334	Real estate agents and property managers	11-9141	Property, Real Estate, and Community Association Managers					147
3339	Business services agents not elsewhere classified	13-2099	Financial Specialists, All Other					52
3341	Office supervisors	43-1011	N/A Multiple possible matches: First-Line Supervisors of Office and Administrative Support Workers (43-1011.00), Clinical Research Coordinator (11-9121.01), Community Health Worker (21-1094.00)		1.4.5. Coordinator			199
3343	Administrative and executive secretaries	43-6011	Executive Secretaries and Executive Administrative Assistants	Administrators, Office Support Staff	1.4.4.1. Administrative assistant			33
3351	Customs and border inspectors	13-1041	Compliance Officers/Environmental Compliance Inspectors (13-1041.01)		1.2.12. Licensure/Regulation/Enforcement worker			178
3351	Customs and border inspectors	13-1041.07	Regulatory Affairs Specialists		1.2.12. Licensure/Regulation/Enforcement worker			Duplicate
3351	Customs and border inspectors	13-1041.06	Coroners		1.2.13. Medical examiner			Duplicate

3411	Legal and related associate professionals	33-9021	Private Detectives and Investigators (Note: This is likely a code for Contact Tracers)					94
3412	Social work associate professionals	21-1093	Social and Human Service Assistants	Preventive Youth Healthcare			Youth and community workers; Child and early years officers; Housing Officers; Welfare and housing associate professionals n.e.c.	153
3422	Sports coaches, instructors and officials	27-2022	Coaches and Scouts				Sports coaches, instructors and officials	55
3423	Fitness and recreation instructors and program leaders	29-9091	Athletic Trainers	Fitness Instructors			Fitness instructors	7
3512	Information and communications technology user support technicians	15-1151	Computer User Support Specialists					99
4110	General office clerks	43-9061	Office Clerks, General				Local government administrative occupations; 4114 Officers of non-governmental organisations	78
4120	Secretaries (general)	43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive		1.4.4.2. Secretary (43-6014.00 Secretaries and Administrative Assistants, Except Legal, Medical, and Executive; 43-6013.00 Medical Secretaries)			189
4131	Typists and word processing operators	43-9022	Word Processors and Typists	Typists				0
4222	Contact centre information clerks	43-4051	Customer Service Representatives (Including Patient representatives, 43-4051.03)		1.3.4. Health navigator	Health visitors		121
4227	Survey and market research interviewers	43-4111	Interviewers, Except Eligibility and Loan					83
5153	Building caretakers	37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	Disinfectors	1.4.2.2.1. Custodian			0

5222	Shop supervisors	41-1011	First-Line Supervisors of Retail Sales Workers					55
5322	Home-based personal care workers	31-1011	Home Health Aides		1.3.5. Nursing and home health aide	Health visitors	Care workers and home carers; Senior care workers	0
5414	Security guards	33-1099	First-Line Supervisors of Protective Service Workers, All Other					69
5419	Protective services workers not elsewhere classified	33-9011	Animal Control Workers		1.3.1. Animal control worker		Protective service associate professionals n.e.c.	1
7543	Product graders and testers (excluding foods and beverages)	51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers					88
9112	Cleaners and helpers in offices, hotels and other establishments	37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	Disinfectors				Duplicate
uncoded		uncoded		Employees At Local Health Agencies				
uncoded		uncoded		Health Assistant				
uncoded		uncoded		Health Protection Officer				
uncoded		uncoded		Health Technicians				
uncoded		uncoded		Sociomedical Assistants				
#N/A	#N/A		N/A NO SOC MATCH FOUND		1.2.20. Population health specialist	Public health consultants and specialists		
#N/A	#N/A		N/A NO SOC MATCH FOUND		1.2.9. Implementation specialist	Public health managers		
#N/A	#N/A		Other Business Support Services		Other Business Support Services: in PH WINS but not taxonomy			

NOTE: Table compares job titles/occupation naming used in “No Two Workforces are the Same: A Systematic Review of Enumerations and Definitions of Public Health Workforces,” the University of Michigan Public Health Workforce Taxonomy (UM), CfWI “Mapping the Core Public Health Workforce,” and “Understanding the wider public health workforce in England,” matched to ISCO-08 codes and USSOC codes; and contrasts with the number of job postings within each US SOC code/ISCO-08 code in Burning Glass from 2019-2020. List is sorted by ISCO-08 code. Where more than one taxonomy name matches to the same ISCO-08 or SOC code, the number of postings in the “BG jobs #2019-2020” column is marked “Duplicate” to prevent over-counting; USSOC codes in BG were given at the six-digit level of detail; where a sub-occupation (8 digits) was mentioned in a taxonomy, it is included but the BG jobs # is listed as “duplicate.” Positions which exist in Burning Glass but not in any public health workforce taxonomy are shaded in gray. “PH-WINS” refers to the Public Health Workforce Interests and Needs Survey, which draws upon the UM taxonomy

APPENDIX TABLE 2: Comparison of COVID VS pre-COVID Era Occupations

Appendix Table 2: Comparison of COVID VS pre-COVID Era Occupations

Analysis of 24,845 job postings from March 1, 2020 through Oct. 1, 2020 (the “COVID era”), and 24,516 postings from March 1, 2019 and Oct. 1, 2019 (“pre-COVID”), from US employers seeking Master’s level public health graduates, from Burning Glass, SOC-coded; comparison between time periods using independent sample z-tests. Notes: *** p<.0001,** p<.01, *p<.05

COVID Era				Pre-Covid Era		
USSCO C Code	Occupation Title	Number of Job Postings, COVID	% Postings, COVID	Number of Job Postings Pre-Covid	% Postings, Pre-Covid	
11-9111	Medical and Health Services Managers	3132	12.6%	2949	12.0%	
11-9199	Managers, All Other	2638	10.6%	2965	12.1%	***
15-2041	Statisticians	2274	9.2%	1794	7.3%	***
29-1141	Registered Nurses	1274	5.1%	1272	5.2%	
19-1041	Epidemiologists	1260	5.1%	663	2.7%	***
15-1199	Computer Occupations, All Other	978	3.9%	1105	4.5%	**
15-2031	Operations Research Analysts	898	3.6%	874	3.6%	
25-1199	Postsecondary Teachers, All Other	683	2.7%	730	3.0%	
15-1111	Computer and Information Research Scientists	668	2.7%	664	2.7%	
21-1091	Health Educators	562	2.3%	570	2.3%	
11-9121	Natural Sciences Managers	499	2.0%	416	1.7%	*
13-1111	Management Analysts	462	1.9%	584	2.4%	**
11-1021	General and Operations Managers	443	1.8%	422	1.7%	
29-9011	Occupational Health and Safety Specialists	348	1.4%	337	1.4%	
11-2022	Sales Managers	339	1.4%	285	1.2%	*
19-4061	Social Science Research Assistants	323	1.3%	424	1.7%	**
19-1042	Medical Scientists, Except Epidemiologists	288	1.2%	301	1.2%	
11-9033	Education Administrators, Postsecondary	263	1.1%	395	1.6%	***
11-1011	Chief Executives	242	1.0%	190	0.8%	*
19-3099	Social Scientists and Related Workers, All Other	190	0.8%	228	0.9%	*
11-3011	Administrative Services Managers	186	0.7%	179	0.7%	
21-1094	Community Health Workers	183	0.7%	19	0.1%	***
11-9151	Social and Community Service Managers	181	0.7%	285	1.2%	***
11-2031	Public Relations and Fundraising Managers	179	0.7%	199	0.8%	
15-1131	Computer Programmers	167	0.7%	131	0.5%	*
11-9041	Architectural and Engineering Managers	162	0.7%	46	0.2%	***
29-1031	Dietitians and Nutritionists	162	0.7%	207	0.8%	*
19-3094	Political Scientists	160	0.6%	222	0.9%	**
15-1121	Computer Systems Analysts	159	0.6%	162	0.7%	
11-2021	Marketing Managers	152	0.6%	191	0.8%	*
11-3051	Industrial Production Managers	146	0.6%	188	0.8%	*
25-1072	Nursing Instructors and Teachers, Postsecondary	144	0.6%	166	0.7%	
33-9021	Private Detectives and Investigators	139	0.6%	39	0.2%	***
25-3099	Teachers And Instructors, All Other, Except Substitute Teachers	138	0.6%	199	0.8%	**
43-1011	First-Line Supervisors of Office and Administrative Support Workers	135	0.5%	175	0.7%	*
19-1020	Biologists	127	0.5%	68	0.3%	***
11-9141	Property, Real Estate, and Community Association Managers	127	0.5%	106	0.4%	
29-2099	Health Technologists and Technicians, All Other	112	0.5%	65	0.3%	**

43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	111	0.4%	173	0.7%	**
27-3031	Public Relations Specialists	110	0.4%	118	0.5%	
13-1041	Compliance Officers	109	0.4%	81	0.3%	
11-3031	Financial Managers	109	0.4%	119	0.5%	
21-1012	Educational, Guidance, School, and Vocational Counselors	103	0.4%	163	0.7%	**
25-1071	Health Specialties Teachers, Postsecondary	100	0.4%	102	0.4%	
13-1141	Compensation, Benefits, and Job Analysis Specialists	97	0.4%	39	0.2%	***
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	97	0.4%	127	0.5%	*
19-3011	Economists	83	0.3%	71	0.3%	
21-1093	Social and Human Service Assistants	79	0.3%	112	0.5%	*
15-1132	Software Developers, Applications	78	0.3%	89	0.4%	
21-1029	Social Workers, All Other	73	0.3%	30	0.1%	***
29-1199	Health Diagnosing and Treating Practitioners, All Other	73	0.3%	57	0.2%	
29-1171	Nurse Practitioners	72	0.3%	55	0.2%	
13-1151	Training and Development Specialists	72	0.3%	62	0.3%	
13-2099	Financial Specialists, All Other	70	0.3%	35	0.1%	**
29-1069	Physicians and Surgeons, All Other	69	0.3%	44	0.2%	*
13-1161	Market Research Analysts and Marketing Specialists	67	0.3%	43	0.2%	*
15-1141	Database Administrators	65	0.3%	58	0.2%	
19-4099	Life, Physical, and Social Science Technicians, All Other	64	0.3%	88	0.4%	*
25-9031	Instructional Coordinators	63	0.3%	102	0.4%	**
19-1029	Biological Scientists, All Other	58	0.2%	62	0.3%	
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	57	0.2%	55	0.2%	
19-2041	Environmental Scientists and Specialists, Including Health	56	0.2%	66	0.3%	
11-9161	Emergency Management Directors	55	0.2%	48	0.2%	
19-3051	Urban and Regional Planners	53	0.2%	50	0.2%	
27-3042	Technical Writers	53	0.2%	59	0.2%	
21-1022	Healthcare Social Workers	52	0.2%	35	0.1%	
25-2022	Middle School Teachers, Except Special and Career/Technical Education	51	0.2%	44	0.2%	
13-2051	Financial Analysts	51	0.2%	55	0.2%	
11-9032	Education Administrators, Elementary and Secondary School	50	0.2%	67	0.3%	
11-3111	Compensation and Benefits Managers	7	0.0%	131	0.5%	***
11-9039	Education Administrators, All Other	25	0.1%	84	0.3%	***
21-1014	Mental Health Counselors*	46	0.2%	75	0.3%	**
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	23	0.1%	74	0.3%	***
15-1151	Computer User Support Specialists	40	0.2%	67	0.3%	**
29-2012	Medical and Clinical Laboratory Technicians*	23	0.1%	62	0.3%	***
43-4051	Customer Service Representatives	41	0.2%	57	0.2%	
43-4111	Interviewers, Except Eligibility and Loan	38	0.2%	56	0.2%	
21-1099	Community and Social Service Specialists, All Other	46	0.2%	52	0.2%	
21-1021	Child, Family, and School Social Workers	22	0.1%	51	0.2%	**

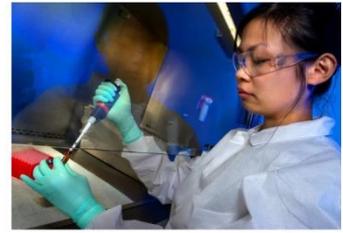
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Chapter 6: The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us?

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The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us?

Abstract: Climate change is acknowledged to be a major risk to public health. Skills and competencies related to climate change are becoming a part of the curriculum at schools of public health and are now a competency required by schools in Europe and Australia. However, it is unclear whether graduates of public health programs focusing on climate change are in demand in the current job market. The authors analyzed current job postings, 16 years worth of job postings on a public health job board, and survey responses from prospective employers. The current job market appears small but there is evidence from job postings that it may be growing, and 91.7% of survey respondents believe the need for public health professionals with training in climate change may grow in the next 5–10 years. Current employers value skills/competencies such as the knowledge of climate mitigation/adaptation, climate-health justice, direct/indirect and downstream effects of climate on health, health impact assessment, risk assessment, pollution-health consequences and causes, Geographic Information System (GIS) mapping, communication/writing, finance/economics, policy analysis, systems thinking, and interdisciplinary understanding. Ensuring that competencies align with current and future needs is a key aspect of curriculum development. At the same time, we recognize that while we attempt to predict future workforce needs with historical data or surveys, the disruptive reality created by climate change cannot be modeled from prior trends, and we must therefore adopt new paradigms of education for the emerging future.

1. Introduction

Climate change is acknowledged to be a major threat to public health [1,2]. Just as public health practice must constantly adapt to emerging viral outbreaks, non-communicable diseases, or other health threats, it must also be prepared for the diverse threats to human health posed by climate change. Several reports and large-scale commissions [3–10] point to the need for training for the health workforce, including the public health workforce, in skills and content to help lead efforts to mitigate and manage the impacts of climate change on health.

A 2008 report by the Association of Schools and Programs of Public Health (ASPPH) mentioned climate change as a key, new area of public health education [11]. The 2016 Council on Education in Public Health (CEPH) competencies for public health education include areas of focus, which allow public health professionals to protect human health from climate change impacts, such

as analyzing data, discussing structural bias, assessing “population needs, assets and capacities that affect communities’ health” and “applying systems thinking” [12].

Many competencies required for environmental health science students, such as “approaches for assessing, preventing and controlling environmental hazards that pose risks to human health and safety” [13] are applicable to climate change. However, knowledge of climate change specifically is not yet a core competency of public health degrees in the United States. New initiatives exist, such as the Global Consortium on Climate and Health Education, which now has 193 members [14] and recently proposed a set of Core Climate and Health Competencies for Health Professionals [15]. Additionally, the Association of Schools of Public Health in the European Region (ASPHER)’s 2018 Competencies does list climate change as a competency within “Population Health and Its Material-Physical, Radiological, Chemical and Biological-Environmental Determinants” [16] and the Council of Academic Public Health Institutions Australia (CAPHIA)’s Foundation Competencies for Public Health Graduates in Australia include “identify and describe the impacts of climate change and implications for ecologically sustainable development” and “climate change theory” [17].

To further identify existing research on the skills, competencies, and job market for individuals with training in both public health and climate change, we conducted a brief narrative review of the literature, primarily focusing on a keyword search of Google Scholar of “climate change” AND “public health” AND “workforce”, which yielded 28,100 results, and “climate change” AND “public health” AND “jobs”, which yielded 86,000 results; we also conducted a search of Pubmed.com for “public health education” AND (“climate change” OR “global warming”). Inclusion criteria included a focus on expected hiring needs for professionals with training in both climate change and public health. Articles that did not include information related to issues with workforce or training needs were excluded.

To identify competencies needed in a future workforce, and to ensure training aligns with labor market demand, it is accepted practice to rely on input from public health employers and organizations. Many ASPPH competencies are based on “blue ribbon panels” of employers [18], as are the Core Competencies for Public Health Professionals developed by the Council on Linkages Between Academia and Public Health Practice [19]. Similar employer input is needed to understand which skills current employers expect of public health graduates with respect to climate change. While employer surveys have been conducted in several public health workforce research articles [20–25], analysis of job postings—a potential key indicator of current employer requirements—has only rarely been used in the public health field [26–28]; this, combined with a survey of employers, can provide a fuller labor market analysis than has been conducted in the past.

Through our analyses, we can attempt to estimate current and future hiring trends for public health professionals with training in climate change-related competencies, as well as continue to

identify the training needed to help address the threat of climate change. For those institutions creating new training programs focusing on both climate change and public health, it will be important to assess whether their graduates will be in demand in the labor market, and if so, which sectors are most interested in hiring candidates with these skills. We attempt to address the questions: Which employers currently seek graduates with training in both climate change and public health; and is the demand for such graduates likely to grow?

2. Materials and Methods

In order to best discern whether there is a growing need for professionals with a combination of training in both public health and climate change, the researchers conducted an analysis of current job postings; and to create projections into the future, we conducted an analysis of 16 years worth of job postings in a public health job board. Finally, we conducted a survey of potential employers of public health graduates focusing on climate change to ask for their projections of the skills needed for this future workforce.

2.1. Data Sources

2.1.1. Analysis of Current Job Postings on Indeed.com (Job Board Aggregator)

In order to determine what types of organizations are currently hiring candidates in the USA with a combination of skills or experience in both public health and climate change, on 14 December 2019, the authors conducted a search of Indeed.com, a job board aggregator, which “crawls” multiple job posting websites to gather millions of job postings into one, searchable database [29]. The rationale for searching Indeed.com is that job postings on the site are pulled from a broad range of thousands of job posting sites (including organizations’ job sites as well as job boards), providing a snapshot of any jobs—not only within traditional public health organizations—that include a combination of relevant keywords, allowing an assessment of the scope of the existing job market and whether current jobs fit the training of public health graduates. Indeed.com allows for Boolean search operators. The authors searched for jobs with the following keywords: (“climate change” OR “global warming”) AND (“public health” OR “environmental health” OR epidemiology OR “health policy”). A total of 172 jobs were found on Indeed.com; duplicates were removed, for a total of 159 positions. We then conducted a “scrape” (download) of the results using a commercially available web scraping tool called Scrapestorm [30], to identify the industries/sectors of the jobs with this combination of phrases. The Indeed.com main site primarily identifies jobs in the United States.

The resulting Excel file of organizations, job titles and descriptions, were then analyzed using the National Cancer Institute’s SOCCer (Standardized Occupation Coding for Computer-assisted Epidemiological Research) system [31], “a publicly available application that was developed to assist epidemiological researchers incorporate occupational risk into their studies”, to create Standard

Occupational Classification [32] codes for the downloaded search results; those results with a lower degree of certainty in the automated coding system were hand-coded by the authors.

The industries/sectors of the employer organizations were also hand-coded, using a taxonomy in alignment with the new ASPPH employment outcomes data collection [33]. For context, an Indeed.com search of only the keywords “climate change” OR “global warming” conducted on December 19, 2019, found 2423 results. Thus, approximately 6.6% of the search results on Indeed.com related to climate change have an overlap with public health (159 of 2423). An Indeed.com search for (“public health” OR “environmental health” OR epidemiology OR “health policy”) on 27 December 2019, found 37,490 jobs, so approximately 0.4% of public health-related jobs also mentioned climate change or global warming.

2.1.2. Analysis of 16 Years Worth of Job Postings on Publichealthjobs.org

The authors were provided access to 32,093 job postings posted into the free job board managed by ASPPH, publichealthjobs.org (previously publichealthjobs.net) dating from 17 July 2003–23 April 2019 [34]. This job board is frequently used by public health employers; it receives approximately 8.16% of all Internet traffic for the search terms “public health jobs” [35] and has been used for other analysis [26]. Of the 30,991 job postings for which the geographic location was known, 11.2% were from countries outside the United States. Unlike Indeed.com, which searches for job postings across numerous job posting websites throughout the Internet, the Publichealthjobs.org website requires employers to manually post their positions into the site, creating a self-selecting group of job postings that are specific to public health. The job description and requirements sections of the job postings were searched for the keywords “climate change” OR “global warming”. Duplicates were removed. An analysis of the proportion of all postings that included either of the target phrases was conducted on a year over year basis from 2003 to 2019, using R coding [36].

2.2. Survey of Relevant Employers

In order to assess the views of current employers who are likely to need candidates with training in both public health and climate change, the authors created an online survey using Qualtrics [37]. The survey questions were created through consultation with experts in both climate change and public health education, and included both closed-ended and open-ended questions (see Appendix A for survey questions). Questions regarding specific competencies were based on the current curriculum of Columbia University’s Climate and Health Certificate program. The survey and outreach methods were approved by the Columbia Human Subjects Review Board. Respondents were identified by the Columbia University Mailman School of Public Health Office of Career Services, which utilized its existing job posting database, a directory of approximately 5900 contactable employers who had posted a job or internship with Columbia University School of Public Health, or otherwise engaged with the career center, since 2012. These records are maintained

using a secure vendor software hosted by the GradLeaders [38] company, and are accrued in a variety of ways: career services staff members conduct ongoing, targeted outreach by attending conferences and events such as the American Public Health Association conference, career fairs (including those focused on environment and sustainability), professional association memberships, online directories, leveraging faculty connections, and connecting to recruiters and alumni via LinkedIn.com and other social media platforms. Staff focused employer outreach efforts using input from ongoing surveys of students and engagement with academic departments and student organizations. A subset of 450 employer contacts from the jobs database was identified based on past job postings with keywords such as “climate change”, as well as by targeting employers in industries and sectors related to environmental health.

Additional, new contacts were identified by using specific keyword searches on LinkedIn such as: Job Title search for (sustainability OR resilience OR mitigation OR adaptation OR carbon) and the general keywords of “Climate Change” AND “health”; and attempts were made to diversify industries of respondents. This allowed the authors to identify 100 new contacts; of these contacts, 12 were directly contacted via LinkedIn “InMail” messages and 51 by using publicly available information; 37 could not be contacted directly. Twenty-one alumni of the Columbia School of Public Health’s Climate Change and Health Certificate program were also surveyed. Three contacts were referred by faculty at Columbia. A total of 537 active contacts were identified from all sources; contacts were primarily based in the USA.

The survey was distributed in January, 2019, with two reminders sent, once in January and once in March, 2019, and the survey was closed on 9 April 2019. Survey respondents were offered an opportunity to win a \$50 gift card as an incentive for responding to the survey, and they were also encouraged to forward the survey to others in their network. Ninety seven individuals responded. Ten respondents were excluded because they were current graduate students or postdoctoral researchers, as opposed to professionals employed in the field. In addition, the survey was forwarded to other contacts in many cases, and a link to the survey was also posted on several online discussion boards including the Planetary Health Online Community and Planetary Health Education Subgroup on Hylo [39]. Contrasting the survey recipients with responders, we found that 75 respondents came from our survey outreach and 12 were not on the survey distribution list. Of the 87 respondents, five were US-based international non-governmental organizations, one was a multilateral government organization, one was an international consulting firm, one was a US government agency focusing on global health, and seven were NGOs and corporations based in other countries including China, Mexico, the UK, Kenya, Haiti, and Ecuador. Thus 15 of 87, or 17% of the respondents were international.

A statistical analysis of the responses was conducted. To evaluate the perceived usefulness of skills among employers in the public health field, we designed a mixed version of questions in which the responses are ordinal consisting of seven levels or text. The survey questionnaire comprises fourteen Likert-scale items to assess the usefulness of specific skills; in the later analysis stage we removed the “other” category, so only thirteen were left for the factor construct. We used qualitative methods to analyze the information from the open-ended responses. For the ordinal Likert-scale data, we first measured the internal consistency of the questionnaire, which was performed using the whole sample with Cronbach’s α values reported to be ≥ 0.60 . Then we conducted a frequency description to identify if there was any ceiling effect or floor effect in the data. Finally, we used exploratory factor analysis and confirmatory factor analysis to identify the internal structure of the inventory. The factor analysis [40] is made up of two fundamental stages: (1) estimating the number of factors that should be extracted to represent the variability of the skillsets efficiently and (2) interpreting the meaning of the extracted factors and representing them in terms of theoretical structures that reflect the skillsets dimensions/sub-domains. In the analysis, factor loadings above ± 0.40 were retained and listed in Table 4. We also assessed the trend of the annual number of public health job postings mentioning climate change or global warming as a function of year using Poisson regression. The total annual number of jobs was specified as an offset, and cross validation using continuous subsets of the total record was performed to determine if the results are unduly sensitive to a specific year or years. The descriptive and inferential statistical analyses were conducted using SPSS 24.0 [41] and R [36].

3. Results

3.1. Literature Review

Overall, there are many articles on the intersection between “climate change” and “public health,” but relatively little on labor market projections. Several articles directly mentioned how public health nurses or health professionals can become involved in climate change response, prevention, adaptation, and mitigation, policy [42], risk management, disaster preparedness, vector-borne diseases, heat-related diseases, the evidence base for climate change adaptation, etc. [8,9,43,44]. One article focused on elements of workforce development including “undergraduate through postgraduate training” in health, professional development of existing workforce, and training of policy-makers [44]. There were three articles on the Australian response to climate change events such as bushfires, extreme heat, and poor air quality, as well as rural health services [5,7,45]. Other articles mention the training needs of governmental public health workers relating to climate change [46], or specific sub-areas of training such as nutrition [47], or the importance of communication [48], or focus generally on why climate change training is needed in public health education [49].

Several articles provided action plans related to climate change and public health, which would require workforce training [50,51]. These examples include diagnosing and investigating health problems and hazards; monitoring health status to identify and solve community health problems; focusing on disaster preparedness [4]; dealing with emerging infectious diseases influenced by climate change [4]; informing, educating, and empowering the public on these issues; evaluating the intervention effectiveness of population-based health services; and monitoring workforce strain due to climate change [52]. Overall, it is difficult to find quantitative public health employment data, but many of the articles mention the importance of training, workforce development, and education to prepare and integrate climate change into public health efforts.

3.1.1. Analysis of Current Job Postings on Indeed.com

The search of job postings from Indeed.com yielded the following distribution by industry:

corporation 32 (20%); nonprofit 76 (47.8%); government 17 (10.7%); and university/academia 34 (21.4%). In terms of occupational codes, the occupations with the largest numbers represented in the data set are listed in Table 1.

Table 1. Most common occupations in Indeed.com postings by the Standard Occupational Classification (SOC) code.

SOC Code	Occupation Title	Number
21-1099	Community and Social Service Specialists, All Other	36
25-1071	Health Specialties Teachers, Postsecondary	12
23-1011	Lawyers	11
19-2041	Environmental Scientists and Specialists, Including Health	9
27-3031	Public Relations Specialists	7
29-9012/29-9011	Occupational Health and Safety Technicians/Specialists	5
41-3099	Sales Representatives, Services, All Other	5
25-1053	Environmental Science Teachers, Postsecondary	5
19-3041	Sociologists	4
17-3029	Engineering Technicians, Except Drafters, All Other	4
11-1021	General and Operations Managers	4

It is worth noting that the Standard Occupational Classifications do not include “community organizer”, “grassroots activist”, or “campaign organizer” as categories, so positions with these titles—the largest single group of positions in the data set—were coded as “Community and Social Service Specialists, All Other”. There were a total of 17 faculty positions, 12 within schools of public health, and 5 in environmental or biological sciences. Environmental and occupational health roles—those most likely to be a fit for graduates with a Master’s degree in public or environmental health—totaled 14 positions out of 159. Other common occupations included attorneys (primarily at government agencies related to environmental protection as well as legal advocacy nonprofits), public relations and fundraising, sales, and engineering roles. These data suggest that pursuing doctoral-level education, or combining a public health degree with either law or engineering, might best qualify candidates with an interest in both public health and climate change in today’s job market, at least in the USA.

3.1.2. Analysis of 16 Years Worth of Job Postings on Publichealthjobs.org

The proportion of the 32,093 jobs from publichealthjobs.org from July 2003–April 2019, which mention either “climate change” or “global warming” consistently was a very small percentage of the total, but the percentage increased over this time period ($p < 0.0001$, Poisson regression). Cross validation found this trend to be positive and statistically significant for all 12-year or longer continuous subset time periods. The data can be seen in Table 2 and is illustrated in Figure 1.

Table 2. Analysis of Data from Publichealthjobs.org/.net from 2003–2019.

Year	Total N Job Postings	Number of Jobs Mentioning “Climate Change”	Percentage
2003	116	0	0%
2004	899	0	0%
2005	998	0	0%
2006	1307	0	0%
2007	2006	1	0.05%
2008	2080	7	0.34%
2009	2044	5	0.24%
2010	2323	4	0.17%
2011	2095	1	0.05%
2012	2236	6	0.27%
2013	2236	4	0.18%
2014	2780	11	0.40%
2015	3213	12	0.37%
2016	2232	10	0.45%
2017	2041	6	0.29%
2018	2903	12	0.41%
2019	584	8	1.37%

We can observe that a salient change occurred over time on jobs related to climate change from Table 2. Overall, the total number of jobs increased since 2006, and the variability remained stable since then.

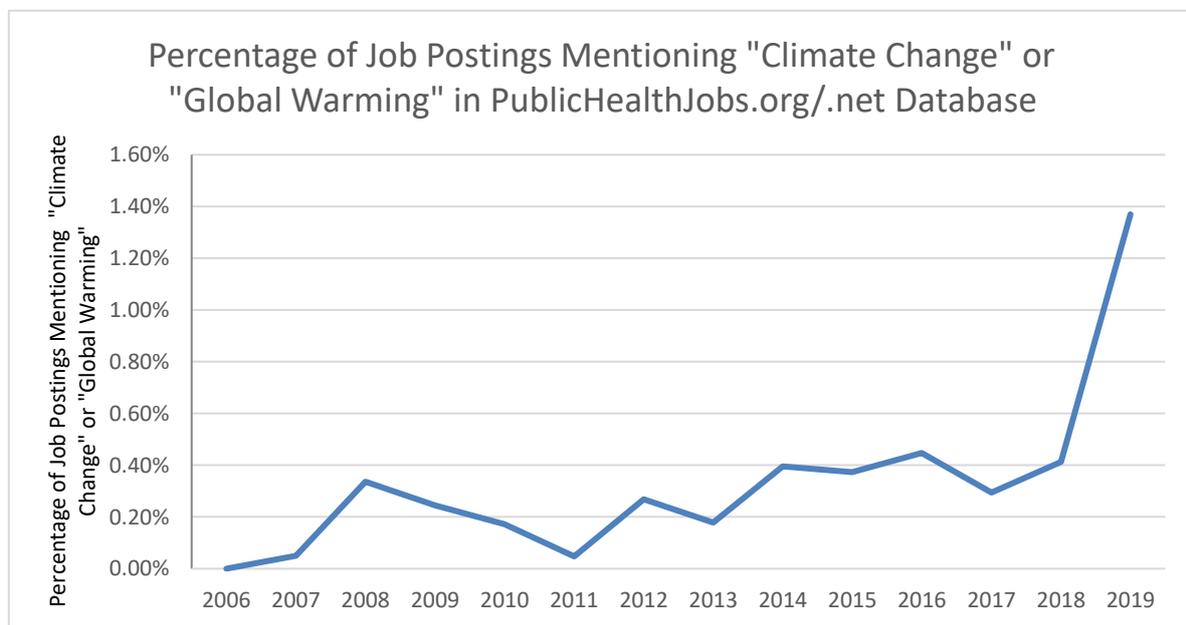


Figure 1. Percent of job postings mentioning “Climate Change” or “Global Warming” in the PublicHealthJobs.org database.

3.1.3. Survey of Relevant Employers

As is often the case with surveys, the survey responders did not fully reflect the recipient population. In particular, government agencies and universities responded at a higher rate than the

survey recipient population, while corporations, hospitals, and nonprofits responded at a lower rate (see Table 3). Comparing the survey recipients and respondents with those organizations that were actively posting positions in Indeed.com related to both climate change and public health, we can see that the populations were not quite the same; the Indeed.com search found a comparable percentage of corporations, a higher percentage of universities and nonprofits, and a lower percentage of government agency positions in comparison with the survey recipients and responses. Therefore, it is difficult to determine whether the survey is an accurate representation of the organizations currently hiring public health graduates.

Table 3. Survey recipients vs. responders vs. Indeed.com postings.

	Survey Recipients		Survey Responders		Indeed.Com Job Postings	
	Number	Percent	Number	Percent	Number	Percent
Corporation	194	36.13%	21	24.14%	32	20%
University	43	8.01%	9	10.34%	34	21.40%
Government	113	21.04%	32	36.78%	17	10.70%
Hospital	10	1.86%	1	1.15%	0	0
Nonprofit	172	32.03%	23	26.44%	76	47.80%
Unknown	5	0.93%	1	1.15%	0	0.00%

With this limitation in mind, we might still gather some conclusions. Fifty of Seventy three (68.5%) of the responders who answered the question, “Has your organization hired people with a Master of Public Health or PhD in Public Health in the past” responded “yes”. Eighty six individuals responded to the question, “Do you expect the need to hire people with a background in climate and public health to grow in your organization in the next 5–10 years?” and of these, 33 indicated “yes”, 34 “maybe”, 6 “no”, and 13 “don’t know”. Excluding the “don’t know” responders, we could determine that 91.7% of respondents believed that there might be a need for public health and climate change-trained individuals in their organizations in the future.

In addition, an analysis of the thirteen-item Likert scale questions regarding skills, which would be useful to the employer organization, was conducted. See the frequency of responses in Figure 2.

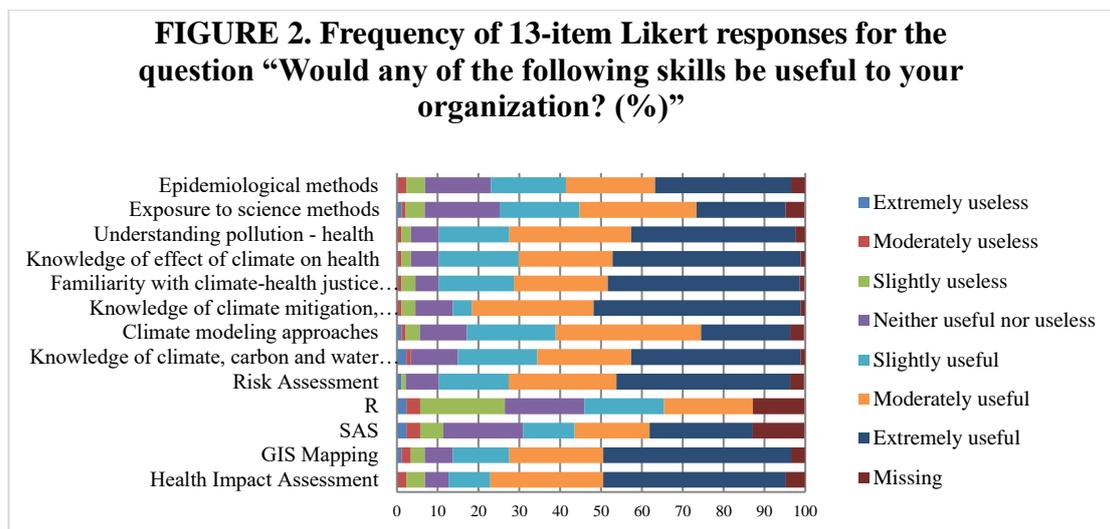


Figure 2. Frequency of 13-item Likert responses for the question “Would any of the following skills be useful to your organization?” (%). R and SAS refer to statistical analysis software.

To standardize the questionnaire data, we considered the numeric data and text data separately. For numeric data, we found that the 13-item Likert scale response shows a high internal consistency of 0.879, which is described by Cronbach’s alpha. From Figure 2, it is shown that no ceiling effect or significant floor effect was detected, suggesting it should be well-qualified as a valid measure of skill outcomes for public health employers.

A three-factor solution (all loadings ≥ 0.40) showed the best model fit to the survey data set. The Scree plot of the final exploratory factor analysis (EFA) solution is shown in Figure 3; we can observe that the eigenvalues of the model dropped below 1.0 when the component number reached 4, which is acknowledged as the rule of thumb cut-off point in deciding the internal structure. Thus, we set our final internal structure as a 3-factor EFA solution; this solution explained 70.16% variance by these three extracted factors and represents 13 items selected from the scale (only Likert Scale questions were included; text question and the “other” category question were filtered). In Table 4, all factor loadings were within the range of 0.456–0.928.

Only two items had a cross-loading on more than one item with loadings >0.50 (Item 9 and Item 10), and we followed guidelines and discarded them in the final model. As shown in Table 4, the proposed model structure includes three dimensions and 13 items.

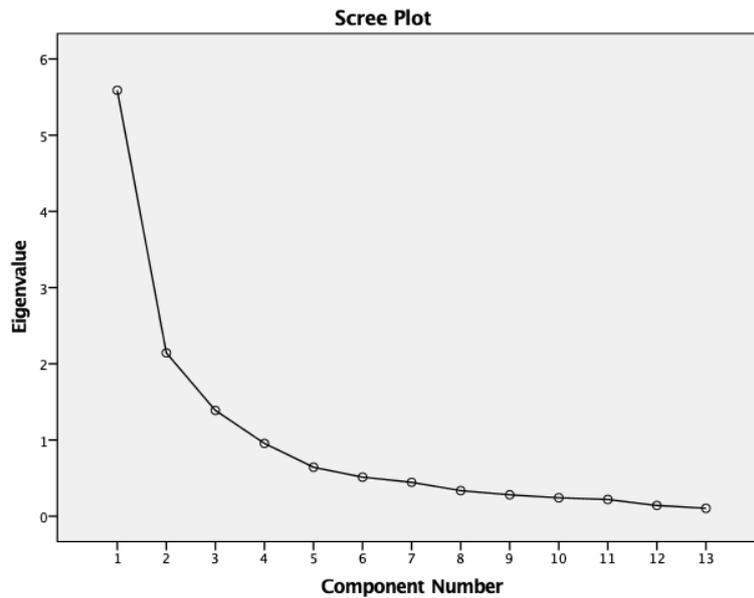


Figure 3. Scree plot of the final exploratory factor analysis (EFA) solution (three factors on 13 items).

Table 4. Pattern matrix of the EFA solution (three factors, 13 items).

	Item	Factor		
		1	2	3
1	Health Impact Assessment	0.820		
2	GIS Mapping	0.607		
3	SAS			0.810
4	R			0.890
5	Risk Assessment	0.456		
6	Knowledge of climate, carbon and water cycles		0.928	
7	Familiarity with climate modeling approaches		0.885	
8	Knowledge of climate mitigation, adaptation and climate-health co-benefits		0.850	
9	Familiarity with climate-health justice issues	0.507	0.686	
10	Knowledge of direct, indirect and downstream effects of climate on health	0.655	0.501	
11	Understanding pollution-health consequences, causes and sources	0.791		
12	Exposure to science methods	0.772		
13	Epidemiological methods	0.645		

Rotation converged in 6 iterations.
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

After the psychometric validation, we finalized the model with a 3-factor structure, with 11 items, and labeled them according to the theoretical context of each question. The first category was labeled as Population Health Exposure, included six items covering a range from population health analytical skills to general understanding of research methods, and also had a strong consistency of 0.83 (Table 5). The second category, in particular, targeted at the Climate-Related Knowledge and its intercorrelation with health status, showed a high consistency of around 0.9. The final category separates two Statistical Programming Language skills from other concrete skills, and included the two most popular statistical programming tools, R and SAS, which also retained a Cronbach’s alpha value of 0.76.

Table 5. Pattern matrix of the EFA solution (three factors, 13 items).

Item	Would any of the following skills be useful to your organization?	Factor		
		Population	Climate-	Statistical

	(%)	Health Exposure	Related Knowledge	Programming Language
1	Health Impact Assessment	0.820		
2	GIS Mapping	0.684		
3	SAS			0.829
4	R			0.914
5	Risk Assessment	0.534		
6	Knowledge of climate, carbon and water cycles		0.941	
7	Familiarity with climate modeling approaches		0.900	
8	Knowledge of climate mitigation, adaptation and climate-health co-benefits		0.838	
9	Understanding pollution-health consequences, causes and sources	0.776		
10	Exposure to science methods	0.799		
11	Epidemiological methods	0.666		
	Cronbach's α	0.832	0.897	0.761
	Rotation converged in 5 iterations.			
	Extraction Method: Principal Component Analysis.			

The weighted sum score is calculated by using the weighted variance percentage, ranges from -1.34 to 0.63.

Open-ended comments in response to the question “What expertise or skills do you think will be needed to address the issue of climate change and human health in the next 10–20 years?” were coded using qualitative analysis methods, using categories identified by two of the authors (one with a background in higher education career services and the other with training in environmental health), and were independently coded by two research assistants to improve inter-rater reliability. Themes that emerged are listed in Table 6. Example quotes are included in Appendix B.

Table 6. Open-ended survey responses.

Skill	Number of Respondents Mentioning This Item
Communication/writing skills	19
Climate change knowledge	17
Public health expertise/training	17
Financing/Budgeting/Economic evaluation	13
Policy expertise/thinking	12
Critical thinking/Logical thinking/Systems thinking	12
Ecological/Agricultural/Geological/Environmental knowledge	11
Resilience and adaptation: Cross disciplinary understanding	9
Analytical skills	7
Marketing/Promoting/Advocacy	6

Survey question: “What expertise or skills do you think will be needed to address the issue of climate change and human health in the next 10–20 years?” (open-ended responses, coded).

4. Discussion

The current state of the job market for public health graduates with training in climate change can be described as “emerging”. From the Indeed.com job description data analysis, we can see there are relatively few roles—even in search results from a broad-based job board with keywords focusing on public health and climate change—currently available for a graduate with a master’s level public health degree and a focus in climate change. Notwithstanding, it is likely that graduates would benefit from training in climate change-related competencies, even if the overt focus of their

job is not directly related to climate change. Additionally, resonating with Wals, Corocoran, and others who frame educational institutions as change leaders, graduates with training in both climate change and public health can influence their institutions from within, to create systemic change in grappling with global warming.

The analysis of publichealthjobs.org data seemed to show that while jobs within public health that mention climate change or global warming were a very small proportion of the total, the fraction of such job postings had shown a statistically significant ($p < 0.0001$) increase over the last 16 years. This trend should be monitored by those involved in public health education and career placement of public health graduates, bearing in mind that while prior trends are often used to predict the future, they are not always the best indicator of future trends in a quickly changing world.

While “approaches for assessing, preventing and controlling environmental hazards that pose risks to human health and safety” [13] is not yet a core competency of public health degrees in the United States, the employer survey indicates that a large majority of respondents believe that there may be a growing need for graduates with training in climate change and health. The survey indicates that key skills include knowledge of climate mitigation, health equity and climate justice, an understanding of “downstream” effects of climate change, risk assessment, and technical skills in statistics, GIS mapping, and the carbon cycle. Comments from the responders indicate key themes focusing on these areas as well as communication (especially persuasive communication), finance/budgeting, cross-disciplinary collaboration and systems thinking, analytical skills, and an understanding of climate impacts on mental health, which resonate with Frankson et al.’s [53]. One Health Competency Domains including management, communication and informatics, values and ethics, leadership, team and collaboration, roles and responsibilities, and systems thinking. These skills also appear to be in alignment with the competencies proposed by ASPHER, CAPHIA, and the Global Consortium on Climate and Health Education.

Importantly, the scope and framing of this study focused primarily on the role of educational institutions in preparing graduates to solve the problems of today, and to meet the demands of today’s employers. Universities, however, not only provide education, produce research, and perform service to their communities; in addition, “higher education can play a pivotal role in turning society toward sustainability” [54]. This is an especially essential role in the face of massive and unpredictable global issues such as climate change. Universities create innovation, and can use their often privileged place in society to advocate for a sustainable future and to equip all of their graduates with understanding of their own environmental impact, both in the personal lives and in their careers. The challenges of climate change are profound enough to require an epistemological change; “sustainability is not just another issue to be added to an overcrowded curriculum, but a gateway to a different view of curriculum, of pedagogy, of organizational change, of policy and

particularly of ethos” [54]. Additionally, following Scharmer’s Theory U, we note that knowledge itself is not in short supply; instead, there is a “knowing-doing gap: a disconnect between our collective consciousness and our collective action” and our entire “mental and social operating system” must be upgraded from “ego-awareness to eco-awareness” [55]. Therefore, while this article focused on historical trends and current and near-term workforce needs to attempt to predict, shape, and model the need for public health students with training in climate change, the disruptive reality created by climate change likely cannot be modeled through such methods. Education should therefore help graduates develop new capacities, allowing them to deal with disruptions and lead a transformational change. The issues of sustainability are so far-reaching that it can be argued that educational institutions must reframe their full mission, using sustainability as their foundation.

Limitations

There are several limitations to the analysis. Indeed.com may not capture all jobs; some jobs are never posted; and the US-focused part of the site was the only section of the site analyzed. A re-examination of these findings over a longer period of time would be helpful. The publichealthjobs.org database has a self-selection bias towards employers specifically recruiting for public health, though this is part of the reason this database was selected for analysis; and the number of job postings mentioning climate change or global warming was sparse, but is useful in indicating trends over time. The employer survey was distributed to a convenience sample of employers, with certain industries/sectors overrepresented and with a likely bias towards those in the United States (especially those based near New York City). While the response rate of 14% appears to be low, it is comparable with other employer surveys in the public health field, where studies have included rates as low as 13.4% [20] and 19.5% [23]. It is important to note, as those in public health have observed from responses to crises such as Ebola and Zika outbreaks [56], funding—and thus the need to use this funding to quickly hire highly trained public health professionals—can change quickly, if and when current events or policy priorities shift. Thus, prior trends (such as a 16 year retrospective analysis of job postings) cannot be assumed to be an accurate indicator of future job market growth. Finally, there is a need for further research in this area; competencies required for tackling climate change also require students and employers to identify and adapt to uncertainty and change, and universities have a special role to play in creating transformative change and disruption using their own critical analyses.

5. Conclusions

Climate change is a growing threat to human health. While the current job market for candidates with training in both climate change and public health is relatively small, it appears to be growing; and it is likely that training in climate change competencies will increasingly benefit a range of public health organizations as climate change impacts continue to grow. Schools of public health can

incorporate the skills and competencies related to climate change into their curricula and consider making them an integral/foundational part of the curriculum, if such training is not yet currently required. Employers, too, may benefit by taking note of the special intersection of skills and competencies offered by public health graduates with training in climate change-related issues. Graduates with such training can bring their paradigm-shifting lens to the work they do within any public health-related organization. Future research, including analyzing job postings, graduate employment outcomes, labor market projections, and employer surveys, could benefit curriculum development for educational institutions in countries around the world, and educational institutions could also remain at the forefront of the paradigm-shifting change that impacts the future public health workforce. By listening to the voices of current employers and assessing labor market trends, while also taking a wider view regarding the role of educational institutions in creating a sustainable world, these institutions can develop the skills and mindset needed to protect the public’s health from emerging challenges such as climate change.

Supplementary Materials: Survey Questions

Climate and Health Jobs of the Future Survey

Start of Block: Default Question Block

Q1 What is your name?

Q2 What is your organization’s name?

Q3 What is your job title?

Q4 What is your email address?

Q5 Has your organization hired people with a Master of Public Health or PhD in Public Health in the past?

- Yes (1)
- No (2)
- Don’t know (3)

Q6 Would any of the following skills be useful to your organization?

	Extremely Useful (1)	Moderately Useful (2)	Slightly Useful (3)	Neither Useful Nor Useless (4)	Slightly Useless (5)	Moderately Useless (6)	Extremely Useless (7)
Health Impact Assessment (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

GIS Mapping (2)	<input type="radio"/>						
SAS (3)	<input type="radio"/>						
R (4)	<input type="radio"/>						
Risk Assessment (5)	<input type="radio"/>						
Knowledge of climate, carbon and water cycles (6)	<input type="radio"/>						
Familiarity with climate modeling approaches (7)	<input type="radio"/>						
Knowledge of climate mitigation, adaptation, and climate-health co-benefits (8)	<input type="radio"/>						
Familiarity with climate-health justice issues (9)	<input type="radio"/>						
Knowledge of direct, indirect and downstream effects of climate on health (10)	<input type="radio"/>						
Understanding pollution - health consequences, causes and sources (11)	<input type="radio"/>						
Exposure science methods (12)	<input type="radio"/>						
Epidemiological methods (13)	<input type="radio"/>						
Dynamic model approaches to climate and health (14)	<input type="radio"/>						
Other (please list) (15)	<input type="radio"/>						

Q7 Do you expect the need to hire people with a background in climate and public health to grow in your organization in the next 5–10 years?

- Yes (1)
- Maybe (2)
- No (3)
- Don't know (4)

Q8 What expertise or skills do you think will be needed to address the issue of climate change and human health in the next 10–20 years?

End of Block: Default Question Block

Appendix B. Example Quotes from Employer Survey

1. 1. “Broad, widely applicable skills such as finance and budgeting, communication, writing, the ability to influence without authority, etc. are the types of skills that can augment knowledge of climate change and health, especially in programmatic positions at nonprofits.”
2. “Big Data Management and Analysis, Environmental Economics/valuation of non-market goods, Ecological design/principles of ecosystem resilience.”
3. “Ability to work across sectors (health, education, housing, private, public, etc.), experience or knowledge of a variety of financing schemes”
4. “Understanding and addressing the underlying conditions that make people more at-risk to climate related health impacts”
5. “Systems thinking, racial justice and inequity of all types, social sciences and human behavior”
6. “Behavioral change, mental health and climate change, transformational resilience”
7. “Increasingly a “triple bottom line” concept is growing in importance, and indicators such as health benefits, reduced asthma rates and other indicators are being quantified and considered when investing in energy efficiency or renewable energy projects.”
8. “Being able to bake climate change mitigation strategies into existing government processes of long-term planning, land acquisition, landscape design, and construction. Human-centered design.”
9. “Knowledge of agricultural impact of climate change; ideas on addressing nutrient deficiency amidst chronic natural disasters and crop failure, new agricultural techniques for disaster risk reduction”
10. “Climate change communications, movement building, disaster preparedness, mental health support related to climate issues”
11. “Organizational, Planning, GIS, TIC’s, Big Data Platforms access and knowledge, Lab analysis and interpretation, Creation, Code and Registration of Data.”
12. “data management and analytical skills; knowledge of the general principles of health education and/or environmental health; knowledge of SAS and/or ArcGIS software; Understanding connections between local public health, community planning, natural resources, and environmental justice; engaging stakeholders from diverse communities; facilitating multi-disciplinary work groups”
13. “an ability to leap beyond sustainability concepts into true resilience - for instance, ensuring climate-migrant receiving communities are places of restorative justice where the social safety net is ready to handle those traumatized by the move. This is universal need - Louisiana to Bangladesh.”
14. “Methodology for quantifying the public health and health equity benefits (e.g., premature deaths avoided, disease burden reduced, health care cost savings, etc.) associated with climate mitigation and adaptation strategies and programs. For example, how effective are our state climate programs and investments for clean mobility/transportation, affordable housing, sustainable communities, workforce development, etc. in producing health and equity benefits?”
15. “Climate adaptation strategies; understanding of funding opportunities for infrastructure investment; GIS mapping of energy use/GHG/flooding; hydrology and hydrogeology”
16. “We need a paradigm sheet in developing a holistic curriculum at all levels which fully integrates in great depth the nexus between climate change and human health.”
17. “Courses that include economic assessment of alternatives proposed for climate change adaptation and mitigation.”
18. “Data Analysis, Satellite imagery, epidemiology”
19. “Legislative writing skills”
20. “Experience observing/tracking climate change related migration”
21. “Cross disciplinary understanding of food systems, economic development, human health (including genomics, microbiome), botanics (biodiversity), soil health”
22. “Incorporating the relevant evidence into actual policy, something that’s sorely lacking today.”
23. “Mental health and psychosocial impacts will be far more widespread and last far longer than physical health impacts-- prevention and treatment methods-especially prevention-will be the most critical needs, though few people in the public health field have grasped this yet.”
24. “Need effective fundraisers. Also need to train/develop workforce and get local funding for climate-health ambassadors.”
25. “Cost benefit analysis; valuation of “non market” benefits/costs”
26. “Cross-sectoral collaboration and policy making approaches; disaster epidemiology; best practices for local implementation of climate and health related assessments, interventions, and policies; health in all policies; root cause analysis; systems thinking”
27. “Mitigating exposure to environmental toxins.”

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Chapter 7: Generation Public Health: Fixing the Broken Bridge Between Public Health Education and the Governmental Workforce

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Generation Public Health: Fixing the Broken Bridge Between Public Health Education and the Governmental Workforce

INTRODUCTION

With more than a half a million lives lost and counting, the COVID-19 pandemic in the United States has resulted in the loss of tens of millions of jobs and gravely disrupted children's education. The pandemic has laid bare long-term underinvestment in the public health workforce, including staff losses and underfunding for public health education. The "American Rescue Plan Act of 2021" will invest \$7.66 billion to recruit, hire, and train individuals in health departments and related entities.¹ However, for this effort to succeed, we must assess workforce needs, increase access to education for future public health professionals, alleviate the burden of high student loan debt, improve and expand hiring programs for public health graduates, and invest in the existing public health workforce.

The Role of Public Health Professionals

Public health professionals work to keep whole communities healthy. Public health is a diverse field and employs professionals in numerous job functions within government agencies, research institutes, universities, hospitals, nonprofit organizations, and corporations. Government agencies, including federal government, local health departments (LHDs), and state, tribal, and territorial health departments (SHDs) play unique roles in the public health system, including disease surveillance, reporting, screening, treatment and counseling; laboratory testing; vaccine inventory and distribution; food safety; behavioral health; regulatory inspection and licensing; emergency response; maternal/child health and newborn screening; HIV and substance use disorder prevention; and nutrition.

Beyond preventing and controlling infectious disease like COVID-19, public health professionals prevent chronic diseases like cancer, diabetes and heart disease, and promote the opportunity for health. It has been estimated that for every dollar spent on public health, we save \$14.30 on healthcare and other costs.² However, without ongoing investment, a public health workforce cannot be sustained.

The Declining Public Health Workforce: Decades of Underinvestment

The public health workforce is a critical element of the public health system and infrastructure, but a reduction in the number of public health workers in the core government public health workforce is well-documented. In 2000, the workforce was estimated to be just under 500,000 workers, or 160 workers per 100,000, which represents a decline from 219 per 100,000 in 1979³. In 2014—the most

recent formal enumeration--the number had decreased further to an estimate of 290,988 (range: 231,464–341,053)⁴. Recent estimates indicate a loss of more than 20% of SHD and LHD workers since the Great Recession⁵. Funding has followed a crisis-and-neglect pattern, with investments increasing temporarily after emergencies such as the World Trade Center attacks, and then again shrinking, resulting in an inability to sustain a highly-trained public health workforce as a basis for a vibrant public health system⁶. Lack of funding means SHDs and LHDs cannot fully provide the Foundational Public Health Services (FPHS), a “minimum package” of public health services.⁷

Workforce losses are expected to worsen. A 2017 survey found that 22% of the government public health workforce was planning to retire by 2023 and 24% were considering leaving for other reasons.⁸ Recent media reported that harassment related to COVID-19 has led at least 190 senior health officials to leave the field⁹, but the overall workforce crisis has been documented for decades.^{10,11} Additionally, the current workforce does not represent the demographics of communities they serve, likely rendering them less effective⁸.

Public health challenges are becoming more complex due to increased availability of large-scale data, the “infodemic,” climate change, and the aging of the population. Responding to these challenges can require strategic decision-making, understanding of scientific evidence for prevention and health promotion, collaboration across sectors, data analytics, financial management, and systems thinking. Rebuilding the US public health system requires a new generation of highly-trained diverse public health professionals to create a healthier America.

These professionals will need a public health education. The current governmental public health workforce has not only lost staff, but is also likely under-trained. Public health degrees are uniquely designed to meet the needs of the public health workforce, yet only 14% of governmental public health professionals today have formal education in public health.¹² At the nonsupervisory and manager levels, workers with public health degrees reported fewer competency gaps¹³. Public health graduates develop competencies not integral to other disciplines, such as epidemiology, biostatistics, health systems and policy analysis, health program planning and evaluation, and health communication. While not every employee of a health department needs a public health degree, a 2021 study matching public health workforce taxonomies with US Department of Labor Standard Occupational Classifications (SOC) codes identified 56 SOC-matched occupations in government public health agencies, of which 34 were found in a dataset of job postings requiring or preferring master’s level public health graduates.¹⁴ Several occupations listed in the American Rescue Plan, including epidemiologists, program managers, communication and policy experts, social support

specialists and disease intervention specialists¹ either require public health degrees, or are particularly suited for public health graduates.

Public Health Graduates Can Face Loan Debts Which Preclude Government Careers

According to the National Center for Education Statistics, in 2019, the median debt of public health graduates nationally is \$52,263, but first-destination earnings are approximately \$48,866.¹⁵ While the Public Service Loan Forgiveness program was designed to encourage graduates to consider lower-paying jobs in the public or nonprofit sector, it has provided loan forgiveness to only 1% of those who applied¹⁶.

Degree programs in medicine, nursing, mental health, veterinary medicine, education and law have scholarship and loan repayment or forgiveness programs like the National Health Service Corps, encouraging students to consider lower-paying careers in underserved communities. PhD programs often offer funding or loan repayment. However, few, if any, such programs exist for public health graduates. Therefore, the student debt burden makes salary a significant factor in career decision-making for public health students,¹⁷ especially for students from lower-income backgrounds. This ultimately reduces diversity and talent in the public health workforce, weakening its effectiveness.⁸

Lower salaries, in the absence of functioning loan forgiveness programs, may also deter students from public service. In a recent study, government positions for 666 Master's-level public health graduates from 2018-2019 paid a median of \$55,000 and average of \$58,000, while 2,578 graduates in all other sectors received a median of \$60,001 and average of \$68,332¹⁸. Additionally, the better benefits or job security which once attracted students to government employment have declined due to reductions in traditional benefits such as pension plans, government shutdowns and furloughs, and negative media coverage of government. Loan repayment programs for new federal workers are now rarer. Meanwhile, the for-profit sector is increasingly hiring public health graduates¹⁹, and new research shows that younger staff are more likely to leave the government public health workforce in search of higher-paying jobs.²⁰ An analysis of the employment outcomes of 53,463 public health graduates over four years (2015-2018) conducted by the Association of Schools and Programs of Public Health (ASPPH) found that only 17% entered into government as their first post-graduate employment, in contrast to health care (27%), corporations (24%), academia (19%), non-profits (12%) and other sectors (1%)²¹. An analysis of 33,563 jobs posted from July 2019-June 2020 for public health master's graduates found labor market competition, especially from pharmaceutical and insurance firms.¹⁴ Even with increased enrollments in public health degree programs, it is unlikely that enough public health graduates are entering government to address unmet needs.

Public Health Graduates Face Barriers to Entry Into Government

While many public health students are motivated to work in government, they encounter barriers to entry beyond lower salaries, including concerns about career paths, employee empowerment, and opportunities for innovation within government.¹⁷ The hiring process for many government agencies is lengthier than in other sectors, averaging 98.3 days in the federal government in 2018²² while the national average was only 35-41 days²³ in 2019; further, it often requires candidates to use different application procedures, such as specialized resume formats or civil service examinations²⁴. Unless hiring processes are streamlined, significant efforts are needed to educate students about the government recruitment process, yet many schools and programs of public health lack staff to provide this guidance.

RECOMMENDATIONS

The combined loss of public health workers and the mismatch with new graduates' career choices has a direct impact on the health and lives of all Americans. In order to ensure a highly trained, diverse public health workforce and replace retiring workers, while adding to the capacity to handle the COVID-19 pandemic and other public health challenges, we offer several recommendations.

Recommendation 1: New Workforce Research

Existing public health workforce research primarily focuses on enumeration and training of the existing workforce. The National Center for Health Workforce Analysis (NCHWA) within HRSA's Bureau of Health Workforce funds a network of Health Workforce Research Centers; however, they focus on a breadth of health professions but not on public health disciplines specifically. The last formal enumeration study was in 2014⁴. Large-scale surveys⁸ and assessment of FPHS⁷ should be complemented with research on the number and types of workers needed in specific public health occupations to provide the FPHS, the educational or training requirements for these occupations, analysis of labor market competition for public health graduates and related occupations¹⁴, and the impact of unpaid internships and student debt on career choice. New research, like the "Staffing Up" study being conducted by the Public Health National Center for Innovations and de Beaumont Foundation, should be supported, and NCHWA or a similar agency should fund new Public Health Workforce Research Centers, housed in academic institutions with research infrastructure, which should collaborate with public health practice organizations and produce annual reports.

Recommendation 2: Scholarships, Loan Repayment or Loan Forgiveness

A proposal, H.R. 6578 — 116th Congress (2019-2020), Public Health Workforce Loan Repayment Act of 2020²⁵, would provide loan forgiveness for approximately 1,000 public health students entering into government employment each year. This is far less than is needed even to replace retirees, without accounting for new hires needed to handle COVID-19. The National Association of County and City Health Officials (NACCHO) leads an informal coalition of public health, health care, and labor groups that support initiatives like H.R. 6578, and other organizations recommend reforms to Public Service Loan Forgiveness. Existing loan forgiveness repayment for clinicians should also encourage work in public health.

Recommendation 3: Investment in Pipeline Programs, Recruitment Marketing, Hiring Reforms, and Connections Between Academia and Government

Recruitment Pipelines/Partnerships: Some recruitment pipelines exist which facilitate students' entry into government, such as the Presidential Management Fellowship, the CDC's Epidemic Intelligence Service and Public Health Associate Program, and the Council of State and Territorial Epidemiologists' Fellowship program. However, each of these programs only hires approximately between 30 to 200 graduates per year into public health agencies. Such programs should be reviewed to ensure they attract diverse candidates, and they should be significantly expanded and connected more directly with LHDs/SHDs.

In the corporate world, paid internships—field experiences designed to provide real-world applications of academic training for currently enrolled students—are a mainstay of college recruitment and are often designed to convert students to full-time hires. In contrast, internships or practica in government public health are frequently unpaid, excluding students who are eager to work in public service but cannot afford to do so. Additionally, the Council on Linkages Between Academia and Public Health Practice encourages Academic Health Department partnerships to connect academia with governmental public health agencies to enhance the capacity of the organizations and improve the pipeline into governmental public health, and these partnerships should be supported further. Investment, as part of the Rescue Plan, in partnerships between public health degree programs and local, state or federal health departments, expanded internship-to-job recruitment pipelines, and new programs to encourage diverse and previously untapped populations to join the public health workforce, will help alleviate the workforce gap. The Biden Administration's proposed US Public Health Job Corps could fund public health interns, support service learning, and create a hiring pathway into government which centers equity and inclusion.

Hiring Reforms or Hiring Exemptions: In addition to new pipelines, the slow, complicated hiring process in government agencies should either be streamlined, or public health hires should be provided an exemption to typical hiring protocols—a critical hiring authority. An analysis of civil service hiring policy should be conducted, including assessment of possible disparate impacts on diverse candidates. The newly relaunched National Consortium for Public Health Workforce Development, with its emphasis on governmental public health pipeline and recruitment improvements, can advocate for reforms.

Recruitment Marketing Campaigns and Career Guidance: A recruitment marketing campaign, implemented by a new partnership between academia and government, can improve student perceptions of government careers. This campaign should focus on the meaningfulness of public service and benchmark with other successful college recruitment programs like the Peace Corps, Teach for America, or private sector talent acquisition programs. Career advisors who guide public health students should be key partners in this effort. Currently, a career guidance website is being developed by the Kennedy Krieger Institute, to guide potential students towards public health careers and raise awareness of the field.

Clinician/Specialist Training in Public Health: New training and recruitment programs must also be established for clinical and other professionals to enter public health careers. Part of the recruitment campaign described above should include efforts to entice nurses, physicians, veterinarians, laboratory professionals, informaticists, and other relevant professionals to obtain education or training in public health, in exchange for graduates' commitment to working in government public health for a specified period.

Recommendation 4: Sustained Investment in the Current Public Health Workforce

After assessing the training needed in specific public health occupations, new training requirements can be implemented for the current workforce. Partnerships with existing training entities, combined with expanded, funded partnerships with academia (including funding for subsidized Master's-level education or other credentialing through formats for working professionals) will help the current workforce gain the skills needed to tackle the greatest public health crisis in a hundred years and to develop healthier communities. Barriers to training, such as staff not being permitted to take time away from regular tasks to take part in training, should be addressed. There should also be new investments by HRSA or related agencies to support public health faculty to design curricula that best match governmental workforce needs.

To improve retention, salaries in SHDs/LHDs must be benchmarked with competing sectors and increased. Morale must be improved via leadership training, clearer career pathways, mentoring programs, and policies encouraging innovation²⁰. Collaboration between organizations such as NACCHO, ASTHO, and ASPPH is essential to create a unified public health workforce recruitment and training plan. Most importantly, expanded funding for the public health workforce must become permanent.

CONCLUSION

Public health is at a critical inflection point in the United States. A trained, qualified public health workforce is a crucial element of the health of Americans. We can no longer rely on “emergency” based, short-term, earmarked funding which disappears when a crisis ends. Without long-term investment in education for new public health professionals and programs easing entry into government careers, a recovery from COVID-19 and improvements in the public’s health will be impossible. The time has come for unified action to leverage the power, passion, and public service motivation of public health students, and the current public health workforce. The health of our nation depends on it.

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Chapter 8: Discussion and Conclusions

SUMMARY

This thesis comprises three main components: the first section discusses employment outcomes of PHGs; the second focuses on employer insights and requirements, occupational taxonomies, and competition for graduates; and the third section synthesizes findings and offers policy recommendations (summarized in Appendix Table 1).

Part One

The first section of the thesis focuses on the employment outcomes of public health graduates.

Chapter 2: Postgraduate Employment Outcomes of Undergraduate and Graduate Public Health Students: A Scoping Review

The aims of this study were to determine what research has been conducted on employment outcomes of public health graduates, and to assess how data on employment outcomes have been collected and reported. Notably, the study found there were only 33 articles relevant to employment outcomes of public health students published since 1993, and also that the existing research was inconsistent in study design and did not allow comparisons between different cohorts of graduates or provide information that could be useful for workforce research. Many surveys did not focus intentionally on gathering employment outcomes data—such data were gathered in the course of investigating another research question, such as graduates' satisfaction with the curriculum. The findings revealed a paucity of research on employment outcomes, and inconsistent and often poor-quality research on the topic. It demonstrates a clear gap in understanding of critical components of public health workforce development, and serves as the basis for the rest of the project.

Chapter 3: First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment

The aim of this study was to determine whether graduates enter the public health workforce and which sectors they join, as well as to gather other data on employment outcomes, salary and continuing study after graduation. The study analyzed data from 64,592 public health graduates across bachelor's, master's, and doctoral degree programs for the graduating years 2015–2018. Overall, the largest sector of employment was health care (27%) with 24% in for-profit companies, 19% in academic institutions, 17% in government agencies, 12% in nonprofit organizations, and 1% in other sectors or self-employed. This study was the first of its kind in the US in the 21st century; the last time a field-wide first-destinations outcomes study was conducted in public health was in the 1980s.

Chapter 4, The New Public Health Workforce: Employment Outcomes of Public Health

Graduate Students' aims were to identify whether public health graduates were finding employment in government, and to determine what other data on employment outcomes was available at the time of publication, which took place prior to the publication of the article in Chapter 3. The study included information on employment outcomes trends over five graduating cohort years from Columbia University Mailman School of Public Health as well as data from publicly-available websites of CEPH-accredited public health schools. A trend towards increased percentages of graduates finding employment in for-profit corporations was observed. This was the first study in the United States to show detailed graduate outcomes for public health alumni within a school. Since its publication, a number of other schools have published, or are in the process of publishing, similar case studies.

Part Two

The second section of the thesis focuses on the job market for public health graduates, including analysis of job postings and an employer survey.

Chapter 5, Labour Market Competition for Public Health Graduates in the United States: A Comparison of Workforce Taxonomies with Job Postings Before and During the COVID-19

Pandemic. The study examines how COVID-19 changed demand for public health workers using a novel (commercial) data source on job postings, and uses these data to create an improved occupational taxonomy for the field. Data clearly showed labor market competition from outside the traditionally defined public health sectors, and illustrated the diversity of occupations for which employers seek PHGs. Additionally, there were significant changes in the industries and occupations seeking public health graduates, when contrasting two time periods, one before the COVID-19 pandemic, and one during the beginning of the pandemic.

Chapter 6, The Future Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us?

As a “case study” example of how employer feedback (such as an analysis of job postings and an employer survey focusing on job market projections and important competencies) might be used to better inform public health curricula, this study assesses whether there is potential future need by employers for public health graduates with specific training in climate change. Using over 16 years of job postings data from a public health-specific job board (publichealthjobs.org), queries were conducted for jobs with the phrases “climate change” or “global warming.” Additionally, in a survey of employers, 91.7% of respondents indicated that there will be an increased need for public health professionals with training in climate

change within the next 5-10 years, and respondents identified key competencies needed. This study illustrates how employer feedback may be used to ensure competency requirements are relevant to future employer needs.

Part Three

Chapter 7, Generation Public Health: Fixing the Broken Bridge between Public Health Education and the Governmental Workforce is a policy discussion paper, synthesizing a broad range of research on the dearth of information about the governmental public health workforce, the lack of funding for this workforce and the shortage of workers, and the relatively small percentage of public health graduates finding employment in government. The paper highlights barriers which can prevent public health students from entering government, such as high loan debt in the absence of loan forgiveness or repayment programs for public health students, and recruitment factors such as a slow or complicated hiring process. The paper provides a series of concrete recommendations, focusing on new research on the public health workforce, scholarships or loan repayment for public health students, investment in recruitment marketing, hiring reforms, pipeline programs, academic-governmental public health department partnerships, and sustained, long-term investment in the governmental public health workforce.

GENERAL DISCUSSION

This thesis has added new knowledge regarding the employment outcomes of PHGs and employer demand for them, which can help shed light on the role of academia in building the public health workforce. These findings can contribute to broader research on the public health workforce, bringing us closer to a clear image of labor market dynamics and a possible mismatch between PHGs and the workforce, and also have implications for public health educational curricula. The COVID-19 pandemic has brought more urgency to the need to better understand the existing public health workforce and academia's role in preparing public health professionals, especially for critical roles such as those in government public health departments.

There are three key themes in this project: 1) An ill-defined workforce; 2) Labor market dynamics; and 3) A disconnect between practice and academia.

Theme 1: An Ill-Defined Workforce

The research in this thesis envisions employment outcomes and employer demand as two sides of the same coin. Academia can use the findings to illuminate whether their programs succeeded in preparing PHGs for the workforce, to determine which of their graduates are more

employable than others, and to improve their responsiveness to workforce needs. Employers, conversely, can use the findings to determine how best to compete to hire PHGs.

While this research has focused on employment outcomes of PHGs and the needs of employers seeking to hire them, this thesis is in alignment with other research on the public health workforce, which many have noted is *challenging to conduct*¹. The research in this thesis resonates with statements by the World Health Organization focusing more broadly on the health workforce, acknowledging that most research focuses on healthcare providers and clinicians, and that very little research has been conducted on public health workers specifically², as well as findings by other researchers^{3,4} that the workforce is broad and ill-defined. This thesis echoes prior literature stating that the public health workforce *cannot be defined by sector or occupation alone*, and that enumeration is problematic.

While most research on the public health workforce in the United States focuses on government public health agencies as the “core” workforce, studies acknowledge that public health efforts take place in a range of other types of organizations such as nonprofit organizations, academia, and the private sector. The few large-scale studies aiming to quantify the US public health workforce, such as the enumeration conducted by Gebbie et. al. in the year 2000,⁵ acknowledge that it is difficult to enumerate public health professionals outside of government; and more recent studies deliberately focus on only government agencies, partly because it is more feasible to focus on this more clearly-defined population⁶. The bulk of research on the public health workforce in the United States focuses on the existing governmental workforce. In other countries, the workforce can be defined differently; for example, in the UK, the “core” workforce includes both government and academia.⁷ To attempt to define the public health workforce as “those whose work contributes to EPHOs/EPHSs” would require clearer definitions of which organizations contribute to EPHOs/EPHSs.

Public health work also includes many *occupations*; the work is conducted by professionals with many backgrounds and professional identities, and unlike physicians, nurses, etc., the professionals in these occupations are not typically licensed or tracked in registries in the United States nor in most other countries, making them harder to enumerate and research.⁴ Therefore, while this thesis adds new information on both the sectors hiring PHGs and the occupations employers wish to hire them for, ultimately, we cannot necessarily define a public health professional as *Who Will Keep the Public Healthy?* originally defined one, as someone who is “educated in public health or a related discipline ...employed to improve health through a population focus,”⁸ especially since only 14% of governmental public health workers have degrees in public health⁹. We cannot define the public health workforce only as PHGs, though these PHGs comprise an important element of the

workforce. ***Rather, a public health professional may be defined not purely by occupation and sector or even by an intersection of the two; but rather, defined by whether the professional is contributing to a function, service or operation***^{10,11} which contributes to population health. Because this makes workforce research far more complex, we may still need to use sector or occupation as a proxy for assessing a PHG's contribution to the public health workforce.

Theme 2: Labor Market Dynamics

An additional theme across several of the thesis chapters is that of a possible labor market mismatch between PHGs and the workforce—especially the government workforce--such as the one referred to in Vujicic and Zurn's article, *The Dynamics of the Health Labour Market*¹²². In this article, Vujicic and Zurn describe much of the research on human resources for health (HRH) as focusing on assessments of the numbers of health workers needed to address the health needs of particular populations—a focus on “what ought to be.” However, in many cases, not enough health workers can be found, and in others, there is a surplus of health workers, especially if workforce planners fail to consider the career choices of potential workers. A mismatch can occur if graduates with the required training for the workforce, are not willing to work in the health sector. Adapting this model for the public health workforce, therefore, it is not enough to count the number of PHGs without considering the “labor force participation decision” of these graduates.¹² As Vujicic and Zurn's stated, “What is clear, and what policy makers must understand, is that altering the supply of health care professionals in a country is not simply a matter of training more people in education institutions,”¹² and the same is likely to be true of public health graduates. An adapted version of Vujicic and Zurn's model, focusing on the public health workforce is below; the arrow in green illustrates how employment outcomes and job postings might be used to provide curriculum feedback to academia.

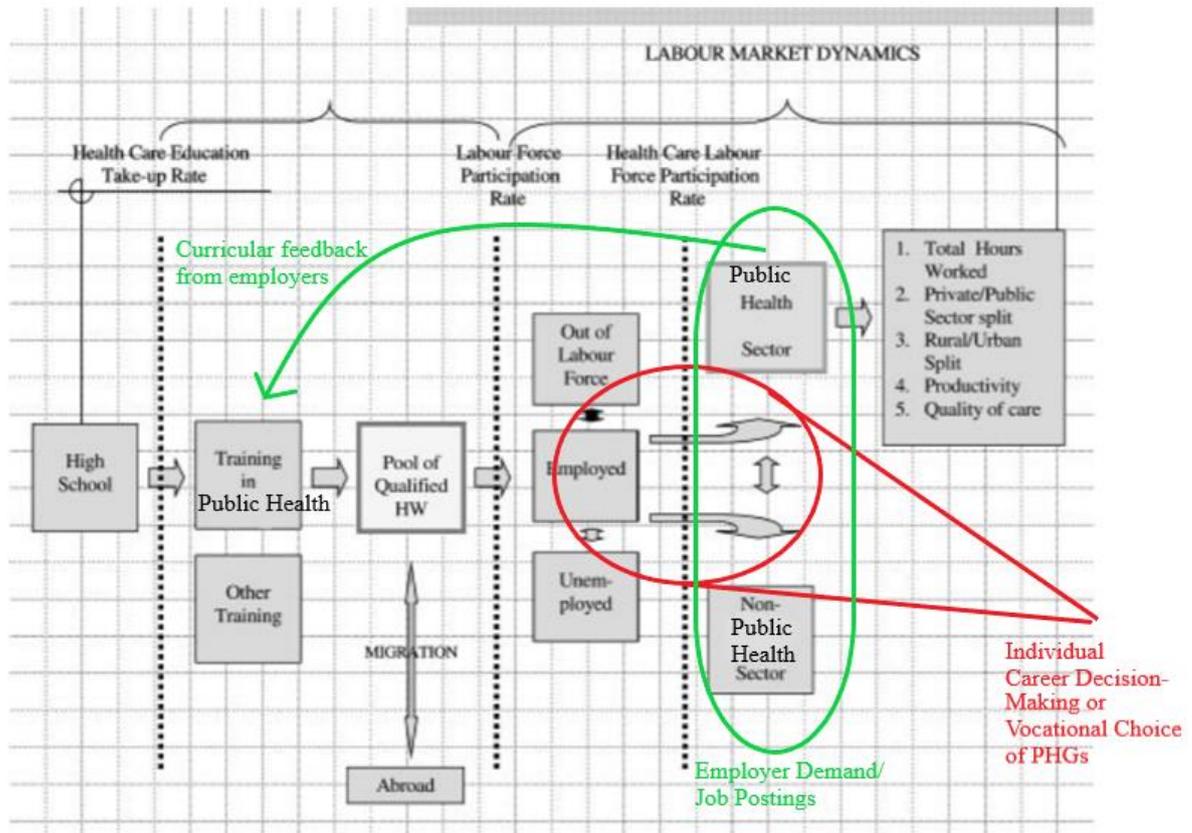


Figure 2. Decisions affecting the supply of human resources for health

Source: Adapted from Vujicic M, Zurn P. *The dynamics of the health labour market. The International Journal of Health Planning and Management.* 2006;21(2):101-115. doi:<https://doi.org/10.1002/hpm.834>

The finding that only 17% of PHGs enter government resonates with the framing of Vujicic and Zurn, in that public health graduates may choose not to enter government because “working conditions” (such as burnout or harassment) or economic factors make this type of employment less favorable; labor market competition is another factor.

Another theme is the *competition* to hire PHGs from sectors outside of government—some of which may still contribute to EPHSs, but many of which may not. The increases in PHGs finding employment in the corporate sector in Chapter 4 mirror those from job postings in Chapter 5.

Theme 3: Academia and the Workforce May Not Be Connected

This thesis adds to ongoing discussions—since 1988’s *The Future of Public Health*¹³-- regarding the *possible disconnect* between academic institutions and the workforce, especially the

government public health workforce. One reason may be the broadening missions of academic programs in public health, as well as their increased enrollments^{14,15}. While historically, going back as far as the Welch Rose report¹⁶, public health schools in the US were designed to prepare graduates to work in government health departments, schools and programs of public health have expanded their missions significantly over the years. Many public health schools in the US now receive most of their funding from government research grants, with other funding from tuition revenues, philanthropic donations, and, for publicly funded institutions, tax revenues from state governments. However, this funding is not tied directly to the employment outcomes of graduates, reducing the incentive of academia to connect to the workforce. Because their accreditation includes a requirement that 80% of graduates should find employment within one year of graduation¹⁷, U.S. public health schools experience pressure to find employment for their increasing numbers of graduates, whether or not that employment is connected to governmental public health agencies, or even public health generally. Schools of public health in the US are required to gather employer feedback and report their graduates' employment to CEPH,¹⁷ yet the studies in this thesis are some of the first recently published, comprehensive reports on employment outcomes, and likely the first attempt to use large-scale job postings to provide curricular feedback. This is an illustration of the lack of a coherent feedback loop between employers and academia. Therefore, the problems mentioned in *The Future of Public Health*¹³, do not seem to have been resolved.

The finding that only 17% of graduates find employment in government adds to the question of whether “enough” graduates are finding employment in this workforce. A key theme in the literature on the government public health workforce in the USA is reductions in funding, and commensurate reductions in staff.^{18–21} There are similar findings regarding workforce reductions in public health in Europe.⁴ Public health funding in the US has been cut repeatedly²⁰, decimating the public health workforce and arguably rendering the workers, at least in certain occupations, as lower-paid than their counterparts in other sectors who do similar work.²² Concurrently, many public health workers were considering retiring or leaving the field, even prior to the COVID-19 pandemic.^{19,22} Due to the added stresses of the pandemic, even including the type of harassment identified by the WHO's Global Strategy for Human Resources for Health,² many more public health officials have left the workforce.²³ Other studies have illustrated burnout in the field,²⁴ and even an increase in depression, anxiety, post-traumatic stress disorder, and suicidal ideation in the workforce²⁵. Due to COVID-19, it has become obvious that many public health departments are understaffed and lack the basic funding to keep up with modern technology.²⁰ In addition, even before COVID-19, one study found that “staff younger than 30 years constituted 6% of the workforce but 13% of those who left.”²² To replenish this workforce, the US federal government has recently committed \$7.4 billion

to hire new workers.²⁶ However, other factors beyond lack of funding could contribute to an ongoing disconnection between academia and the government workforce, in spite of this new funding—for example, individual career decision-making of PHGs can be influenced by difficulties applying for jobs in certain sectors, work conditions such as low morale or lack of access to cutting-edge technology, or concerns about opportunities to learn.²⁷

THE WAY FORWARD: RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the research in this dissertation, there are several recommendations regarding future research. These recommendations are especially timely in the US because of the Biden Administration's investment in the public health workforce.²⁶ In order to ensure this funding has a positive impact on the health of the public, several urgent actions might be taken by policymakers, and these actions should be based on evidence and research. Many of the recommendations may be helpful for other countries also seeking to expand, or even to better understand, their public health workforce^{28,29}.

Recommendations

- 1. More Clearly Define Public Health Professionals and the Public Health Workforce***
- 2. Improve Standard Occupational Classifications (SOCs) and NAICS***
- 3. Improve Research on Government Workforce***
- 4. Improve Research on Public Health Workforce Beyond Government, and Competition for PHGs outside Government***
- 5. Improve Research to Provide Feedback to Academia***
- 6. Research on Individual PHGs' Career Decision-Making***

1. More Clearly Define Public Health Professionals and the Public Health Workforce

Without a finer-grained, perhaps qualitative study of PHGs and their employers to better assess which specific employers and occupations contribute to EPHSs, we may still use the findings in this thesis to attempt to better understand PHGs and their impact on the workforce by using sector or occupation as a proxy measure of contribution towards EPHSs. Qualitative research could include surveys of graduates or analysis of job postings text. Similar concerns regarding the definition and

professionalization of the PHW have been raised in Europe; and WHO has included public health as a discipline within primary care, when instead it most likely should be considered separately.³⁰

2. Improve Standard Occupational Classifications (SOCs) and NAICS

To have a clearer image of the current workforce and the role of PHGs within it, clearer matching with Standard Occupational Classifications can be beneficial; but these SOC codes are not ideal for public health occupations. Improvements in workforce taxonomies must be paired with improvements in the actual Standard Occupational Classifications themselves, to ensure that these codes better map with public health occupations, several of which are missing in the existing classification schemes. The WHO Global Strategy on Human Resources for Health, recommendation #85, suggests “The International Labour Organization (ILO) to revise the International Standard Classification of Occupations³¹ for greater clarity on delineation of health workers and health professions.”³² Several studies have mentioned that Standard Occupational Classifications do not always align clearly with public health occupations^{32,33}. Similarly, the US Department of Labor does not provide reports on the public health workforce by North American Industry Classification System (NAICS) codes³⁴. Improving the use of these codes could greatly improve public health workforce research. Better harmonization of the ISCO-08, US SOC, and other nation’s SOC coding systems, especially in regards to public health-related occupations, would also help ensure research is more coherent internationally.

3. Improve Research on Government Workforce

Basic enumeration and research on required staffing levels: Basic research on the government public health workforce needs more investment; the most recent full enumeration of the government public health workforce in the United States took place in 2014.³⁵ In addition to basic enumeration of workers in local, state, and federal health departments, there is a need for clearer estimations of staff need and attrition by occupation, which can be used to improve planning for the workforce, and perhaps to provide incentives for public health graduates within specific “shortage” disciplines to enter the government workforce. Similar challenges in the basic definition and enumeration have been noted internationally, as described by a recent systematic review of enumerations in eleven countries.³³ To plan for a sustainable workforce, even more basic information is needed, for example, on how many public health professionals, for example per 100,000 population, are needed to deliver the Essential Public Health Operations or Foundational Public Health Services³⁶. The WHO Global Strategy on Human Resources for Health mentions “it is

acknowledged that this threshold reflects only physicians, nurses and midwives, an inherent limitation caused by the paucity of data on other cadres.”²

Research on attrition and unfilled job postings: By using large-scale surveys of the public health workforce such as those gathered by the Public Health Workforce Interests and Needs Survey (PH-WINS)^{37,38}, which focused on government public health workers in the United States, and cross-referencing with Standardized Occupational Classification codes, we can determine which occupations exist in the public health workforce and what the US Department of Labor recommends in terms of education levels for each. PH-WINS³⁸ also assesses both the educational attainment and projected attrition or retirement by occupation within the government public health workforce.

Substitution effects and sources of new hires: Additional research on new hires in health departments can illustrate if there are substitution effects between different disciplines of study, whether public health departments may be forced to hire people with less education than needed, or whether health departments are able to hire PHGs from other sectors. Deeper research might show whether candidates without public health degrees are indeed equally competent as compared with PHGs for certain occupations.

Salary benchmarking: Also, by using standardized occupational taxonomies, health departments can also *benchmark salaries* in government with national averages for the same occupations, potentially providing evidence to advocate for higher salaries.

Research on “recruitment factors”: Another element of workforce planning is to assess the hiring process and the experience of PHGs as they move through this process. These can include the specific efforts which employers make to attract the attention of potential candidates (ranging from simply posting jobs on job posting boards, to attending career fairs, to developing proactive recruitment pipeline programs such as internships or fellowships which can convert to permanent hires); the design of “employer branding” methods and recruitment campaigns, to develop a positive impression of their organization as a good place to work; and what is also called the “candidate experience” – the process that a job applicant must go through in order to successfully be considered an applicant for a position. The time required to hire a new graduate can be a critical factor.

Research on recruitment factors tends to fall into the arena of human resources or employer perspectives, and is an under-researched aspect of the connection between graduates and postgraduate employment, though a few articles exist³⁹⁻⁴¹.

4. Improve Research on Public Health Workforce Beyond Government, and Competition for PHGs outside Government

Beyond assessments of the governmental public health workforce and potential workforce gaps, assessments of the non-governmental public health organizations which support EPHSs are an area of almost unexplored territory in research. We know that many PHGs find employment in this workforce, and some find jobs outside of public health entirely, but it is unclear how many PHGs contribute to EPHS as opposed to being “mis-employed.”

Competition from other sectors: To better understand why PHGs may choose careers in the non-governmental workforce or even outside public health, it is important to assess the impact of two key factors—competition from other sectors, and recruitment factors. Looking at the overall job market, several of the sectors which are seeking to hire public health graduates are indeed growing much more rapidly than government, and with far fewer regulatory restrictions on their hiring processes than government agencies experience.⁴²

Using new data on **employment outcomes of PHGs, including salary of PHGs in different sectors**, we can assess whether salaries vary by industry/sector, including controlling whether these differences exist regardless of students’ area of study or level of degree program. Additionally, we may be able to **assess whether student loan debt** has any correlation with students’ industry of employment and/or salary. With year-over-year cohort-based data, it will also be possible to assess whether there are significant trends over time, including changes by industry, salary, outcome etc. New studies regarding the employment outcomes have been conducted in Europe and Australia can contribute to a better understanding of this key aspect of workforce research.^{28,29,43}

5. Improve Research to Provide Feedback to Academia

Future research can be conducted with the Burning Glass (BG) job postings data set, to **assess the market demand for public health graduates** among the broad base of employers seeking to hire them; but also the more selective/public health-specific job postings from employers who have manually posted their jobs in the PublicHealthJobs.org/publichealthjobs.net. The existing data could be analyzed to assess **year-over-year differences in public health job postings by sector, industry, raw volume, occupational classification/SOC code**, and salary, going back for the last several years, to assess whether there are trends in recruitment for particular disciplines within public health or changes by sector over time, providing academia with insights on which sub-disciplines of public health are growing in demand. In addition to gathering more data from employers, there should **be more transparency regarding employment outcomes of graduates; new, consistent protocols related to the reporting of employment outcomes** should be created and implemented across schools of public health, including internationally.

With the ASPPH data collection, we may be able to assess whether *employment outcomes vary for students in specific degree programs* or disciplines of study. We can also begin to assess whether schools are creating an *oversupply of certain graduates or an undersupply of others*. Outcomes research should be part of broader national and international efforts to create *consistent protocols* on the gathering and reporting of employment outcomes of graduates⁴⁴⁻⁴⁶. Ideally, an international standard to measure employment outcomes of public health graduates, in sync with existing protocols and taxonomies,⁴⁷ can be used in efforts to close the gaps between academia and employment.

Additional research on *whether career guidance for PHGs is sufficient* is also needed. It seems that the key moment when a PHG decides which jobs to pursue after graduation is often left unsupported. While the Council on Education in Public Health (CEPH), requires accredited schools and programs of public health to provide some form of career guidance to students to improve their employability, and to measure the satisfaction of students with whatever advising is provided, there is no clear guidance on how many staff should offer such advising nor what their credentials should be.¹⁷

6. Research on Individual PHGs' Career Decision-Making

Finally, to better understand the career decisions of individual PHGs—which ultimately become a key factor in labor market dynamics, and which can be used to design effective recruitment campaigns—we can more deeply research how PHGs make career choices. While there have been two recent studies of career interests of public health graduates^{27,48}, more research could be conducted on the career development and vocational decision-making of public health students, especially to build an effective recruitment campaign. Career theories which can be used include John Holland's⁴⁹ theory of vocational choice, considered an “integrative framework for organizing individual differences variables that are used in counseling psychology,”⁵⁰ which is mapped to the US Standard Occupational Classification codes used in Chapter 5, as well as standard career assessments^{51,52}; the theory of Public Service Motivation⁵³⁻⁵⁵—the concept that individuals who are drawn to work in public service are motivated by “altruistic or ideological goals such as helping others or doing something worthwhile for society,”⁵⁶ related to Vujicic and Zurn's concept of the desire to “help sick people”; and theories related to economic and lifestyle factors, some of which has been included in research on the public health workforce^{39-41,57,58}.

RECOMMENDATIONS FOR POLICY & PRACTICE

In order to positively impact the public health workforce, identify and address any hiring gaps, effectively hire workers into government public health, bolster connections between academia and the workforce, policy decisions must be made. These policy suggestions must be made in the context of the public health system within the countries where the suggestions are implemented. For example, in the United States, the public health system is highly decentralized, with cities, counties, tribes, territories, states, and the federal government delivering many different services. The higher education system which prepares PHGs in the US is also decentralized, primarily relies on individual students to fund their education through student loans or scholarships, and does not deliberately or intentionally tie the number of graduates to the number of job openings, instead leaving individual students to make complex decisions about their education and careers to their own devices. Many stakeholders will need to be consulted to effectively implement these recommendations within this context.

Recommendations Related to Government Public Health Workforce

The public health workforce in the United States, already defunded over at least a decade, is in a crisis situation. Expanded funding, while required to renew the workforce, is unlikely to be sufficient, in itself, to develop a sustainable and resilient workforce, much less to create a strategy to quickly respond to future disasters. Development of a strategic recruitment, retention, and succession plan for each local and state health department, as well as federal government public health agencies, is urgent to deal with short staffing, attrition, and an impending retirement wave.^{18,19,22,59} A well-researched workforce development plan can ensure that a new generation of graduates is both recruited and retained for the long term. Rather than a reactive, short-term effort to increase the staff of the workforce, which inevitably could be followed by additional budget cuts, ***permanent investment is required*** as well as a ***strategic plan*** to ensure a sustainable workforce with additional surge capacity for future public health disasters or pandemics. The research in this thesis can become part of the design of such a plan. The plan should take into consideration benchmarking of recruitment processes and salaries with the competing sectors seeking to hire PHGs. A workforce plan should investigate whether the current 14% of the government workforce with degrees in public health⁹ is sufficiently trained in the field to manage today's complex public health challenges.

Designing Effective Recruitment Campaigns: If \$7.4 billion is to be spent on hiring new staff, then funding, most likely from federal sources, will be needed to ***create a recruitment campaign***, leveraging new research on recruitment factors and labor market competition, to create an evidence-based strategy. Smaller, lower-resourced health departments which do not have an

established human resources department or internship program should be provided resources externally to develop such programs, including an “out-of-the-box” marketing solution, an easy-to-use job application and onboarding system, a training and development program specifically designed for their current interns and new hires, and low-cost and easy-to-use employee engagement tools to improve retention, especially of younger hires. An example of a recruitment-related website is that of the UK’s National Health Service, which includes career guidance and opportunities in public health.⁶⁰ Recruitment resources are still needed on the local level, too; as funding to hire new graduates has been cut in local health departments, as well as resources to provide paid internships or even to attend career fairs on college campuses⁶¹, connections between universities and local public health agencies have diminished over time, and this must be reversed.

Recruitment Process Improvements. Perhaps the most challenging recommendation to implement relates to “recruitment factors” such as slow hiring timelines and complex, often antiquated application processes in government. Because there are nearly 3000 local health departments in the United States as well as more than 50 state and territorial health departments, multiple federal agencies and sub-agencies, and tribal health departments, each of which has different regulations related to hiring mechanisms, this is perhaps the most difficult challenge to address, but simply because it is difficult does not mean it should be ignored. Similar challenges may exist in other countries, and similar efforts to streamline hiring processes may improve recruitment efforts in other countries also.

Recommendations for Academia and Policies Related to Academia

Closing the Loop: Improving Public Health Education and Connection to the Workforce Through Employer Input: In addition to actively building a better workforce strategy for the public health workforce, more should be done to create a feedback loop between the workforce—including both the government and non-government workforce--and academia. It seems clear from this research that academic institutions which produce public health graduates are expected to play a crucial role in developing professionals to work in the governmental public health workforce, and that better connections should be made between these graduates and the government workforce. It also seems clear that academic institutions do not always see this as their critical role. And schools and programs of public health must also serve the non-governmental workforce. Because the pursuit of higher education, at least in the United States, is considered an individual choice, it can also be argued that schools and programs of public health should not unduly pressure their graduates to

pursue employment in any particular sector, but rather, should respect each student's career priorities.

If a key goal of public health degree programs is to produce graduates for the governmental public health workforce, then **additional investment** is also needed to make this feasible. Specifically, although academic health departments⁶²⁻⁶⁴ and other partnerships between government agencies and academia have been encouraged for many years, and while many health departments offer an internship program⁶¹ for students at public health schools in their geographic location, such partnerships receive very little funding. In the US, academic institutions receive few financial incentives to establish these partnerships, and in many institutions, the faculty are rewarded primarily for publishing research and gaining external research grants, with their service to their community or partnership with public health agencies given less weight when it comes to promotion or tenure decisions⁶⁵. **New funding to bolster the connection** between academia and government health departments, including financial support for faculty who collaborate with health departments, combined with scholarships or **student loan forgiveness** for students who pursue careers in government could improve this connection. In other countries where academic institutions are more closely tied to the core workforce, this may not be an issue.

Using Employer Input/Job Postings to Improve Curriculum and Enrollment Strategy:

Although employer input is required for CEPH accreditation¹⁷, many schools of public health in the US do not gather this feedback except every five years when their reaccreditation process takes place. While academia is a sector which values creativity, experimentation, and future-thinking, it is also important to consider employer input when designing professional degrees. **Ongoing surveys of employers**, such as the one used in Chapter 6 on climate change, is important to add information about the key competencies needed for public health students, and such surveys should be at least an annual endeavor of schools of public health and should be part of annual reporting to accrediting bodies. In addition to using surveys of employers, **analysis of job postings** can be an ongoing aspect of curriculum development for schools and programs of public health. With large-scale data from job postings now more easily available, there seems to be little excuse for building a curriculum in a vacuum. Additionally, while the research for this thesis used data from Burning Glass job postings in the United States, **the data collection could be re-run to encompass job postings in Europe or potentially other regions**, allowing organizations like ASPHER to benefit from this analysis. This could also open the door to international comparisons of the public health workforce in different regions, which could be important in regard to migration and its impact on labor markets.

Cross-Referencing Curriculum with SOC-Coded Occupational Competencies. Schools and programs of public health can ensure that their curriculum meets current employer needs by

conducting an assessment of the competencies provided in their curricula and comparing these competencies with information from job postings for roles requiring public health degrees. Using “big data” sources like Burning Glass or other technologies like the NIH’s SOCcer system⁶⁶, job postings can now be matched with Standardized Occupational Classifications; and these SOC-coded occupations have very detailed descriptions provided through research from the U.S. Department of Labor⁶⁷, including expected education levels, skills, competencies, typical job functions and activities, and even specific technology skills requirements⁶⁷. (Burning Glass results in Europe may be coded by ISCO-08 or other similar schemes.) By cross-referencing curricula with data on competencies from SOC research, schools and programs of public health can ensure that their degree programs provide students with the required skills and competencies for each occupation that employers are currently seeking to recruit public health graduates to work in. Rather than relying on surveys and focus groups of a narrowly-defined, existing public health workforce,⁶⁸ or “blue ribbon panels”⁶⁹ which may gather data only from a self-selecting group of public health employers – skewing heavily towards government – this method may be a more evidence-based way of gathering input into public health degree program competencies.

Using Employment Outcomes for Curriculum Design and Enrollment Decisions:

Employment outcomes data are new, rich sources of potential for future research. There are many unanswered questions which could be explored by analyzing the new, large-scale data collection conducted by the Association of Schools and Programs of Public Health. Additionally, individual schools and programs of public health, such as Columbia University’s, may have more in-depth information, including information not collected by ASPPH, such as job function, geographic location, and even information on whether graduates consider their employment to be related to public health or not. Using employment outcomes data, schools of public health could also determine whether to limit enrollment for students in disciplines experiencing underemployment, or even to question whether the longstanding increases in enrollment in public health degree programs is sustainable or suitable for the job market.

Provide Improved Career Guidance for PHGs: Currently there is no website that provides career guidance for public health students, with the exception of several for-profit/commercial marketing websites which often lead students towards proprietary, online schools. ***A free, easily accessible career guidance website*** which helps students learn about public health careers, and also potentially guides them towards careers in government, will help provide resources for the students attending the many schools and programs of public health which do not have a career guidance professional specifically focused on public health students. Such a project is currently being

implemented by the Kennedy Krieger Institute and funded by the Centers for Disease Control and Prevention; a similar site is hosted by the UK National Health Service^{60,70}.

Building a Stronger Voice for Public Health – Development of a Professional Identity in Public Health Students and in the Workforce

Because of its interdisciplinary nature and the fact that it encompasses so many different occupations, the public health workforce often seems to lack a coherent “voice” or lobby to advocate for itself.⁷¹ Similarly, public health students do not always clearly identify with their field.⁴ Additionally, many public health professionals perceive themselves as scientists or public servants, and as generally apolitical, but this identity has been sorely tested, at least in the United States, due to COVID-19.

Further, because the occupations within public health are varied, attempts to formulate public health as its own profession have been limited. An occupation can become a “profession” “based on both their functional traits and their power to convince elites, especially governments, to grant special status.”^{72,73} However, with more than 90 occupations being identified as seeking candidates with graduate degrees in public health, and with many others existing within public health workforce taxonomies, it is difficult to encompass public health as its own profession.⁷⁴ Academic institutions should do more to help their graduates develop a sense of themselves as public health professionals.

One of the most difficult experiences for many US-based public health professionals from the COVID-19 pandemic has been the politicization of public health. During the Trump Administration, unfortunately, many public health scientists in the US were silenced, causing the reputation of previously “gold standard” public health institutions like the US Centers for Disease Control and Prevention to change from “gold to tarnished brass”⁷⁵ In fact, many of the strongest voices promoting public health measures came from academia. Government employees in the United States are often prohibited from lobbying or conducting advocacy, at least during their work hours. Because of this, and also because they represent so many different disciplines and focus on so many different policy issues, many public health professionals have been victimized by the politicization of the COVID-19 pandemic. Many have received death threats and other types of harassment². Similarly, while there are powerful student associations for medical and other clinical students, such as the American Medical Students Association, which commonly engage in lobbying efforts on topics such as loan repayment for physicians who work in lower-resource areas through programs such as the National Health Service Corps⁷⁶, there is no unique organization representing public health students in the US. While there is a student chapter of the American Public Health Association, it does not

exclusively represent public health students, and in fact many of the leaders are medical students. Public health students should be given more opportunities to identify themselves as their own profession, including having their own student society and advocating on behalf of the public health workforce.

LIMITATIONS

There are several limitations to the research conducted in this thesis. First, much of the research is more quantitative, and many gaps can be filled by additional qualitative analysis such as key informant interviews of career services professionals working with public health students, thematic analysis of job postings text, or focus groups of key employer organization leaders. Second, because public health is so interdisciplinary, it is difficult to be sure which occupations truly require public health degrees, and which merely prefer them; and there are likely to be many roles in public health organizations where staff members take on multiple occupations at once (for example, public health nurses who are working on epidemiology studies). Third, the ASPPH employment outcomes data collection did not gather information about occupations, but only about employment status and sector. This makes it more difficult to attempt to determine whether graduates are contributing to the Essential Public Health Services. Fourth, chapter 4 includes data primarily gathered from Columbia University, and it is unclear whether the trends observed can be generalized more broadly. Fifth, the matching of occupations using Burning Glass Technologies and other systems to code occupations with SOC codes or industry codes uses a proprietary technology, and it is difficult to be sure how accurate the matching truly is. Additionally, “cross walking” US SOC codes with ISCO-08 codes is not entirely accurate, and some occupations in public health do not currently have specific standardized occupational classifications. Also, the majority of the jobs which were analyzed in chapters 5 and 6 were from the United States, so it is hard to know whether observations might be generalized for other regions. Sixth, the employer survey in chapter 6 had a relatively low response rate. Finally, most of the research is focused on the US context, and drew conclusions based on these results, but hopefully some of the methods and approaches can be used in other settings to improve understanding of the public health workforce in Europe and other regions of the world.

CONCLUSIONS

The public health workforce is at a critical inflection point. After many years of budget cuts and neglect, attention is being paid to the workforce and at least in the US, funding is being devoted to its sustainability. The connection between academia and the workforce is still lacking investment

and relies primarily on volunteer efforts, but still, there is a chance that a new generation of public health graduates will be inspired to contribute to the Essential Public Health Services due to the devastation wrought by COVID-19. Too often, the employment outcomes of PHGs seem to be left to chance; deliberate efforts to connect PHGs to workforce needs will be needed to address gaps and replenish the workforce. If future efforts are based on evidence and research, if investments are made to better establish connections between academia and the workforce, and if workforce planners and academic institutions include the voice of employers and the vocational interests of public health students into strategic workforce planning, there is a unique opportunity to replenish the public health field with new talent. The health of the public depends on it.

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Appendix

Appendix Table 1: Summary of dissertation findings

	Scoping Review Chapter 2 (Part 1)	Employment Outcomes, Ch. 3 (Part 1)	Employment Trends, Ch. 4 (Part 1)	Taxonomy & Labor Market Competition, Ch. 5 (Part 2)	Employer Needs/Trends: Climate Change Ch. 6 (Part 2)	Policy Levers (Chp. 7)
Chapter Title (abbreviated)	Postgraduate Employment Outcomes of Undergraduate and Graduate Public Health Students: A Scoping Review	First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment	The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students	Labour market competition for PHGs: A comparison of workforce taxonomies with job postings before/during COVID-19	The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us?	Generation Public Health: Fixing the Broken Bridge Between Public Health Education and the Gov. Workforce
Research Question	What is known about employment outcomes of PHGs?	What are the post-graduate outcomes of PHGs, and where do PHGs find employment?	Are graduates of one public health school changing over time, towards employment in for-profit companies?	What ISCO-08 occupations exist in the public health workforce? Do current job postings for PHGs align with these occupations?	Do public health employers seek to hire PHGs with training related to climate change?	What policies can be utilized to better connect PHGs and governmental public health workforce organizations?
Methodology	Scoping review of the literature from 1993 to 2020, using the Kirkpatrick model of training evaluation as a framework.	National data collection from public health schools and programs, gathered yearly from 2015 to 2019.	Annual post-graduate survey and data collection from Columbia University graduates.	Schema matching of occupational taxonomies; Analysis of large-scale job postings data.	Analysis of 16 years' worth of job postings; survey of public health employers.	Synthesis of public health workforce literature, policy analysis.
Results/Findings	Of 630 articles, 33 were relevant. Data is scant, inconsistently collected, analyzed and reported.	Outcomes data on 64,592 PHGs, for graduating cohort years 2015–2018 were analyzed. Outcomes varied by degree level, area of study, and graduation year.	Data from 2904 Columbia University PHGs across 5 graduating cohorts showed the odds of finding employment in for-profit companies increased 23% per year over 5 years.	3 public health occupational taxonomies were contrasted with ISCO-08 codes. 38,533 job postings were analyzed. Changes were found before and during COVID-19.	The fraction of job postings mentioning climate change showed a statistically significant ($p < 0.0001$) increase over the last 16 years. 91.7% of employers believed there may be a need for PHGs with training in climate change.	Four specific recommendations for policy makers are suggested: improved workforce research, loan forgiveness for PHGs entering government, recruitment campaigns, and training and investment in the current public health workforce.

Source: Compiled by author.

- Advocate for policies which will fully fund the government public health workforce in the United States
- Advocate for policies that will reduce barriers to hiring public health graduates, especially into the core public health workforce, such as reforms of the hiring process in government agencies and new support for student loan forgiveness and repayment
- Advocate for funding to support research on the public health workforce and the employment outcomes of public health graduates

Through the author's role at Columbia University Mailman School of Public Health, and as a leader of professional associations such as the career services assembly of the Association of Schools and Programs of Public Health (ASPPH) and committee service with the National Association of Colleges and Employers, she has become involved with policy advocacy to advance the career development of public health graduates and better connect them with the workforce. This has included discussions with leaders of ASPPH, including its policy advocacy director, and broader discussions with a range of public health stakeholders, including many who will be involved with new hiring efforts related to the American Rescue Plan and Public Health AmeriCorps.¹

For example, the author was recently invited to be a closing plenary conference speaker at the Public Health Improvement Training conference, speaking alongside the Executive Director of the de Beaumont Foundation, a major public health philanthropy, and a senior leader of the Centers for Disease Control and Prevention, speaking to 250 public health workforce professionals from around the United States about how to better recruit new public health graduates into government. She also presented a blog article, written specifically for government public health agencies, about how to improve their recruitment efforts.²

Additionally, the author recently received an award from the Columbia University Provost's office to design a Massive Open Online Course to provide training to public health students in advocacy, specifically to increase their awareness of the underfunding of the public health workforce and to find political power to improve funding and support for the workforce. This training will also be open to current government public health workers, who are often unfamiliar or uncomfortable with navigating challenging political situations.

Finally, the author has been able to send an official letter, signed by the Deans of four leading public health schools, to the US Senate Committee on Health, Education, and Welfare, to attempt to influence the direction of the new investments in the public health workforce proposed by the Biden Administration.

Raising awareness of public health careers among the general public, to encourage more people to begin careers in the field

The author has co-authored, with Dr. Beth Seltzer, MD, MPH, a fully revised edition of a book for lay audiences, *101+ Careers in Public Health, 3rd Edition*.³ This book is approximately 190,000 words in length and includes 25 chapters, interviews with 53 public health professionals, and extensive, updated research on public health career pathways, with a specific emphasis on those which contribute to EPHOs/EPHS. It is the only book currently in print in the United States which focuses on public health careers; and we hope it will have a broad impact on the general population to enhance their understanding of career pathways in the field. The book also contains a unique, first-of-its kind career assessment tool which connects career interests based on a commonly-referenced vocational theory (the Holland Codes^{4,5}) with specific occupations, identified through research which was the basis of chapter 5 of the thesis⁶. The connection between public health occupations identified through taxonomies and current job postings with public health career choices, as the basis of a career guidance tool, is a new and likely unique contribution to the field of career guidance; and occupational information in the *101+ Careers in Public Health* book connects to occupation descriptions connected to Standard Occupational Classification codes as described in the O*Net Online⁷ and Occupational Outlook Handbook⁸, which is based on data from the US Department of Labor Statistics. The book also centers equity and inclusion, include career profile of individuals from diverse backgrounds, outlines public health careers which are available to people with educational backgrounds ranging from no postsecondary education through PhDs and MDs, and focuses on the impact of COVID-19 on public health careers.

101+ CAREERS IN PUBLIC HEALTH

BETH SELTZER | HEATHER KRASNA



Source: *101+ Careers in Public Health, 3rd Edition, Springer Publishing (draft cover).*³

The author also speaks frequently to the news media and has written numerous blog articles on topics related to public health careers, often on highly prominent websites like a blog article which was published by *The Muse*, one of the nation's leading career websites (considered in the top

100 career advice websites, and in the top 3,300 websites in the world and top 1,304th in the United States)⁹⁻¹¹. We are hopeful that these efforts will enhance the awareness of public health careers nationally and internationally.

New, National Career Guidance Website and Related Master's Thesis

The author is working on a national committee, funded by the US Centers for Disease Control and Prevention and implemented via the Kennedy Krieger Institute's Office for Health, Equity, Inclusion and Diversity, and Center for Diversity in Public Health Leadership Training, to design an evidence-based career guidance website to help the general public, and public health students in particular, to navigate the many diverse public health careers available to them.

This career website, like the *101+ Careers in Public Health* book, is grounded in the findings of the article, *Labour market competition for public health graduates in the United States: A comparison of workforce taxonomies with job postings before and during the COVID-19 pandemic*⁶. Related to this work is research conducted as part of a Master of Education at Teachers College, Columbia University, which the author received in Feb. 2021, focusing on the creation of a community of practice for individuals providing career guidance to public health students, as well as the design of a survey to assess the resources available for career counselors who advise these students. A brief excerpt of the Master's thesis is below:

“As the number of public health students has grown, some concerns have been raised regarding their employment outcomes¹². Tailored career guidance can improve career outcomes¹³, but this resource is not available to all public health students. A review of the websites of all 215 schools and programs accredited by the Council on Education in Public Health (CEPH) found fewer than half offered their own career services for graduate students, and while 76% of standalone graduate *schools* of public health offered their own career services, only 36% of graduate *programs* did. Additionally, there are 203 graduate programs that are not CEPH-accredited; and if even only a minority of accredited programs of public health offered career services, it seems even less likely that an unaccredited program might do so.

Publicly available guidance regarding public health careers is also difficult to find; a literature review found only four books about public health careers in the United States¹⁴⁻¹⁷, of which three are out of print. There were only four journal articles on public health career advising¹⁸⁻²¹ and while there are thousands of Google results for “public health careers,” 90% of results on the first page of results are commercial advertising sites, primarily for online degree programs; and of the first 100 results, 50 were links to university admissions pages, 38 were advertising sites, blog articles, or similar links, and only 12 were for government agencies or nonprofits. Well-researched sites like WhatIsPublicHealth.org or the American Public Health Association did not appear in the first 10

pages of Google results in August, 2020. A new, freely available career guidance resource might help bridge this gap.”²²

The new career guidance website will include career assessments similar to those described in the *101+ Careers in Public Health, 3rd Ed.*, book, career profiles of public health professionals, lists of professional associations, and additional informational materials to assist public health students and others with exploring and pursuing public health careers.

Consortium of Public Health Career Guidance Professionals

Finally, the author is serving as an advisor to a new, grassroots group of individuals providing guidance to public health students. Based on research conducted by Dr. Walter Zelman at California State University Los Angeles, we are building a community of practice for career guidance professionals who work with public health students. Our goal is to provide information-sharing and support as a community, but also to create a quick method for government agencies seeking to hire public health students to promote their career opportunities to public health students at the undergraduate and graduate levels nationally. No current association exists for this group, causing additional challenges for government agencies to hire public health students. This is especially relevant in light of the new \$7.4 billion set aside by the American Rescue Plan¹ to invest in the public health workforce, and the Biden Administration’s plan to create a Public Health AmeriCorps, since career advisors can be a key point of connection between government and new graduates.

Research Dissemination; Improving feedback loops between the workforce and academia

Another goal of the valorization for this dissertation includes providing feedback to academia by providing insights from employment outcomes and employer feedback, with the goal of improving curriculum design. This includes attempts to predict employment trends for public health graduates for the future, as well as efforts to raise awareness of research techniques which can be used for public health academic institutions internationally. For example, the article in chapter 6 of the thesis is currently being used to advocate to include topics related to climate change as a competency requirement for the newest iteration of the Council on Education in Public Health (CEPH).

In addition to the articles listed in this dissertation, the author has also contribute to another article as third author²³, focusing on the costs of a public health degree in comparison with earning potential, and contrasted the earnings of Master’s level public health graduates with those of other, similar disciplines such as social work, public administration, business, and nursing, demonstrating

that the financial returns on investment for the Master of Public Health may not be as high as some would hope, thus illustrating additional economic challenges with connecting public health graduates with employment in the government and nonprofit sectors and other fields which contribute to EPHOs. This additional research may be used to provide insights to academia on how to improve the relevance and even earning potential of public health graduates.

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Summary

Although educational institutions who prepare public health graduates (PHGs) are designed specifically to prepare their graduates for the public health workforce, especially the government public health workforce, little has previously been published about the employment outcomes of PHGs, nor about the demands of the employers who hire them. This thesis establishes the dearth of recent published information about employment outcomes of PHGs, presents the largest-scale data collection on the employment outcomes of PHGs in the United States in decades, and illustrates a trend toward increased hiring of PHGs by for-profit companies at one university in the United States; and then presents a revised occupational taxonomy reflecting the employer demands for PHGs based on an analysis of a large-scale data set of job postings, as well as an analysis of a specific subset of employers—those seeking candidates with a combination of training in public health and climate change. Finally, the thesis provides policy recommendations to address the potential mismatch between PHGs and the governmental public health workforce.

Acknowledgements

This dissertation is a culmination of more than 23 years' experience working directly with university students, as well as working as a recruiter and in other roles in the nonprofit/voluntary sector. My journey towards this project is both serendipitous and a product of my longstanding passion for an intersection of two concepts—public service, and career development.

After a beginning a career in grant writing, I found a first position in career services in 1998. After 10 years of working with undergraduate students, I was lucky to find an opportunity, through networking, to become director of career services at the University of Washington's Evans School of Public Affairs, where I spent four years helping graduate students find careers in government and nonprofit organizations. When I later became Assistant Dean of Career Services at Columbia University's Mailman School of Public Health, I had the privilege of visiting the Ecole des Hautes Etudes de Sante Publique in 2014, where, by chance, I had a dinner of crepes with another visiting faculty member, Dr. Kasia Czabanowska. Years went by, and I began studies towards a Master of Education, with the goal of eventually earning a Doctorate in Education in Adult Learning and Leadership at Teachers College Columbia University. I also ventured to use my observations regarding the gradual changes I observed about the employment outcomes of Columbia students to write an article on a trend for public health graduates towards employment in for-profit corporations. Through my studies at Teachers College, I became fascinated by the topic of emotional intelligence and conducted a literature review of emotional intelligence in the training of public health graduate students. I identified only a small handful of articles, many of which were written by Dr. Katarzyna

Czabanowska. Then, again by chance, I met Dr. Czabanowska at the ASPPH conference in March of 2019, where I enthusiastically approached her and told her how much I had admired all of her articles on emotional intelligence and public health education, and how I hoped to write my EdD dissertation on this topic. I was astonished when she invited me to become her student at Maastricht University on the spot, in a culmination of good luck and planned happenstance. I enrolled at Maastricht University CAPHRI in September 2019. Little did we know then, that COVID-19 would make research on the public health workforce even more urgent. I am hopeful that the research in this dissertation will illuminate an element of public health workforce development and serve as a call to action to better connect academic institutions and the core public health workforce.

I would like to deeply thank Dr. Czabanowska for her incredible support, as well as my co-supervisor, friend, and mentor Dr. Linda Cushman, who unfailingly encouraged me to pursue a doctoral degree, and the brilliant Dr. JP Leider who always has a quick answer to everything. Dr. Julie Kornfeld and Dean Linda Fried, as well as Dr. Michael Joseph also provided great support, and I have been lucky to have the collaboration of public health workforce researchers including Angela Beck, Beth Resnick and Valerie Yeager. I deeply thank all of my co-authors and collaborators, including Jeffrey Shaman, Dana March Palmer, Shan Jiang, Shuyue Ni, Pantelis Antoniou, Karina Myers, Simran Khadka and Haruka Morita at Columbia University; Christine Plepys, Emily Burke, Craig Blakeley, and Laura Magana at ASPPH; my classmate Olga Gershuni; Kristy Sherrer at UCLA; and my book co-author Beth Seltzer. I also thank other stakeholders who contributed to the research or provided insights in various ways, including Maria O'Brien and Ross Frommer at Columbia University; Harolyn Belcher at Kennedy Krieger Institute; Kathleen Amos at Public Health Foundation; Edwin Koc at the National Association of Colleges and Employers; Samantha Cinnick at de Beaumont Foundation; Gloria Wilson at Columbia University Library, who provided guidance with the scoping review; Daniel Russ at the NIH, who created the SOCCer system and answered all of my emails with courtesy and speed; the employers who responded to the climate change survey; all of the Association of Schools and Programs of Public Health member schools and programs of public health that contributed data to this study; and the small but mighty community of career services professionals who support the career development of public health graduates. Most of all, I thank the public health students who shared their employment outcomes data with their various universities, and for the current and future contributions these students will make to public health in all of its diverse aspects.

And I would like to thank my extremely patient family, including my husband and daughter, for their ongoing support through many long nights at the computer, and for my mother for her constant encouragement and willingness to read my articles.

I hope you enjoy reading this work. –Heather Krasna

Curriculum Vitae

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EDUCATION:

PhD candidate, Public Health/Care and Public Health Research Institute/Department of International Health, Maastricht University, Care and Public Health Research Institute, Maastricht, The Netherlands.

- Dissertation: *Public Health Graduates in the United States: Employment Outcomes and Employer Demand*; Defense expected Fall 2021
- Advisor: Dr. Katarzyna Czabanowska, PhD, past president, ASPHER; co-promoters: Dr. Linda Cushman, PhD, Columbia University Mailman School of Public Health; Dr. Jonathon P. Leider, PhD, University of Minnesota

Master of Education (EdM), Adult Learning and Leadership

Columbia University Teachers College, New York, NY, Graduated 12/2020

- *Courses Included:* Online Teaching & Learning; Emotional Intelligence; Social Intelligence; Facilitating Adult Learning; How Adults Learn; Teaching Race in White Spaces; Developing Critical Thinkers; Discussion as a Way of Learning; Cognition and Handheld Devices; Healing and Reconciling Relationships in Conflict; Applied Regression Analysis; Probability & Statistical Inference

Master of Science (MS), Non-Profit Management and Certificate in Organizational Development

The New School, Milano School of Policy, Management and Environment, New York, NY, 6/97

- Thesis: *Program Evaluation for Support Center for Nonprofit Management*

Hunter College, 19 credits towards Master of Education in Counselor Education degree 2004-2005

Bachelor of Arts (BA) in Cultural Anthropology, University of Michigan at Ann Arbor, 6/95

- Graduated with High Honors, Phi Beta Kappa. Honors Thesis: Culture of an Israeli Kibbutz.

EXPERIENCE:

ACADEMIC APPOINTMENTS:

6/13-present **Assistant Dean and Director, Career Services, Columbia University Mailman School of Public Health, New York, NY**

6/18-present **Associate Faculty, Health Policy & Management, Columbia University Mailman School of Public Health, New York, NY**

5/08-5/12 **Director, Career Services/Course Instructor, Evans School of Public Affairs, University of Washington, Seattle, WA**

10/01-5/08 **Assistant Director / Internship Coordinator, Baruch College / CUNY, New York, NY**

11/98-10/01 **Internship Program Developer, Brooklyn College / CUNY, Brooklyn, NY**

8/97-11/98 **Associate Director of Development, National Council of Jewish Women, New York, NY**

1/96-5/96 **Teaching Assistant, Economics, New School for Social Research, New York, NY**

NON-ACADEMIC EXPERIENCE

11/10-11/2019 **Director, Candidate Services, Nonprofit Professionals Advisory Group, Boston, MA**

2/2013-6/2013 **Talent Acquisition Specialist, American Civil Liberties Union (ACLU), New York, NY**

2001-present **Founder/Sole Proprietor, Jobs that Matter**, New York, NY

AWARDS & HONORS

Columbia University Mailman School of Public Health Dean's Award for Excellence in Administrative Leadership, given to only one senior leader in the school each year (2017).

Honorary Member, Phi Eta Sigma, Baruch College honor society (2006).

New School University, Nonprofit Management Award for top three students in Program (1997).

University of Michigan, Phi Beta Kappa; John B. Angell Scholar for 3 semesters of all A grades (1995).

MEMBERSHIPS (CURRENT)

American Public Health Association (APHA)

European Public Health Association (EUPHA)

Graduate Career Consortium (GCC)

Career Directors International

National Association of Colleges and Employers (NACE)

National Career Development Association (NCDA)

PUBLICATIONS

PEER-REVIEWED/REFEREED JOURNAL ARTICLES:

Krasna H, Fried L. Generation Public Health: Fixing the Broken Bridge Between Public Health Education and the Governmental Workforce. *Am J Public Health*. 2021;111(8):1413-1417. doi:10.2105/AJPH.2021.306317

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Plepys CM, **Krasna H***, Leider JP, Burke EM, Blakely CH, Magaña L. First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment. *Am J Public Health*. 2021;111(3):475-484. doi:10.2105/AJPH.2020.306038

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Krasna H, Czabanowska K, Jiang S, Khadka S, Morita H, Kornfeld J and Shaman J, The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us? *Int. J. Environ. Res. Public Health* 2020, 17, 1310; doi:10.3390/ijerph17041310

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Krasna H. Employment Trends Among Public Health Doctoral Graduates. *Am J Public Health*. 2019;109(4):e9. doi:10.2105/AJPH.2019.304966

Krasna H, March D, Kornfeld J, Cushman L, Antoniou P, The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students, *Journal of Public Health Management and Practice*. 00 2019 • Volume 00, Number 00, DOI: 10.1097/PHH.0000000000000976

JOURNAL SPECIAL ISSUE CO-EDITOR:

International Journal of Environmental Research and Public Health, special issue on public health workforce (forthcoming)

JOURNAL PEER REVIEWER:

Invited Peer Reviewer, Journal of Public Health Management and Practice

BOOKS:

Selzer B, and Krasna H, *101+ Careers in Public Health, 3rd Edition*, Springer Publishing Company

- Expected date of publication August 2021

Krasna H, *Jobs That Matter: Find a Stable, Fulfilling Career in Public Service*, JIST Publishers 6/10

- Wrote 300-page book in 4 months; book has been positively mentioned in *USA Today*, *The New York Times Syndicate*, Careerbuilder.com, Idealist.org, NPR; in top 10 career books on Amazon.com.

Krasna H, *Job Search 2.0: How the Job Market has Changed and What you Can Do About It*, Amazon KDP, 1/2013.

REFEREED CONFERENCE ABSTRACTS & PRESENTATIONS:

Middleton, J, Czabanowska, K, **Krasna, H**, Preparing the climate and health workforce in Europe, 14TH EUROPEAN PUBLIC HEALTH CONFERENCE, 10 – 12 NOVEMBER 2021

Krasna H, Czabanowska K, Beck A, Cushman LF, Leider JP. Labor market competition for public health graduates: Implications for governmental public health agencies, American Public Health Association Conference, Oct. 2021 (accepted)

Czabanowska K, and **Krasna H**, Support4Global Health and SDGs in health workforce education: advocacy and action: Public health competencies in global health education and demand of the global health labour market. Co-author, oral presentation. 16th World Congress on Public Health 2020, Rome, Italy, Oct. 15, 2020

Krasna H, Czabanowska K, Jiang S, Khadka S, Morita H, Kornfeld H and Shaman J, The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us? Co-author, oral presentation, American Public Health Association Conference, Oct. 2020

Krasna H, Evaluating Career Services Programs: Using a Logic Model Approach and National Data Sources, Conference panelist, Association of Schools and Programs of Public Health, March 21, 2019

Krasna H: “Hiring the global health workforce: Whose needs are (and are not) being met?” (Session 3373.0), Invited panelist, American Public Health Association national conference, Nov. 12, 2018

Krasna H, Invited speaker, Association of Schools and Programs of Public Health national conference, “Using Employment Outcomes and Program Evaluations to Inform Career Services Strategy,” March 8, 2018

Krasna H, March D, The New Public Health Workforce: Changing Employment Outcomes of Public Health Graduate Students, Presenter/Panelist, Session 4088.0, American Public Health Association Conference, November 07, 2017

Krasna H, Health Policy & Management Skills Required for MPH graduates, Invited Panelist, Association of Schools and Programs of Public Health (ASPPH) National Conference, 3/2016

Krasna H, Employment Data of Graduates of Schools and Programs of Public Health, Presenter, Association of Schools and Programs of Public Health (ASPPH) National Conference, 3/2015

ACADEMIC CONFERENCES: POSTER PRESENTATIONS

Krasna H, Leider J, Plepys C, Burke E, Magaña M, Blakely C, Employment outcomes of public health graduates: 4 years of national data collection, Poster Presentation, American Public Health Association Conference, Oct. 26 2020

Krasna H, Plepys C, Burke E, What do Public Health Graduates Do After Graduation? Postgraduate outcomes of public health graduates, Poster presentation, Association of Schools and Programs of Public Health, March 2020

Krasna H, Plepys C, Burke E, What do Public Health Graduates Do After Graduation--And What Does it Mean for the Public Health Workforce? American Public Health Association Conference, Nov. 2019

Krasna H, Cushman L, March D, Kornfeld J, “The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students” Poster presentation, Association of Schools and Programs of Public Health, March 2019

Krasna H, Employment Outcomes of Global Health MPH Graduates: Association of Schools & Programs of Public Health (ASPPH), and Five Years of Trends at Columbia University Mailman School of Public Health, Poster presentation, Consortium of Universities for Global Health, March 2019

ACADEMIC COURSES:

Public Health Field Practice (PUBH 8086), Columbia University Mailman School of Public Health, 2016-present

(Co-Instructor, Fall 2016; Instructor, Spring 2017: 1.5 credits; Instructor, 2018-present, 0.5 credits)

- Redesigned syllabus based on student input and achieved approval from Columbia Mailman School curriculum committee.
- Designed instructional program, led discussions, and mentored up to 13 international students per semester in a course focused on experiential, field-based learning. Spearheaded initial course concept to provide an additional off-campus internship opportunity for international students which was previously unavailable.
- Received a mean 4.33/5.0 and median 5.0 evaluation from students, above the school-wide average of 4.07 and median of 4.0. Student quotes included: “This course has been amazing - I could share my own experiences in my internship and also hear the insights from others.” “Heather is an incredible resource and offers great advice and feedback, and it was fun to learn from the other students in the class as well.”

Interprofessional Education Seminar (IPE), Columbia University Medical Center, Fall 2019-present

- Co-taught online one-week seminar for students from schools of Nursing, Medicine, Public Health, Dentistry, Physical Therapy, Occupational Therapy, Social Work.

Substitute Instructor, Leadership Course, Columbia University Mailman School of Public Health, Spring 2019

- Co-taught 1.5 credit, graduate level leadership course for public health graduate students.

Instructor, Navigating the Public Administration Job Search, University of Washington Evans School of Public Affairs, 2009-2012 (1 credit)

- Taught a career and professional development course focusing on communication skills to 30-40 graduate public administration/policy students per year.
- Redesigned syllabus and taught course, focusing on all phases of public service career exploration and job search. Received highest-level student evaluations.

Instructor, Eugene Lang College: The New School for Liberal Arts, New York, NY, 9/02-6/03 (6 credits)

- Taught Academic Internship Program course for undergraduate students performing internships in nonprofit organizations. Created curriculum which was adopted by future instructors.

GUEST LECTURES: ACADEMIC COURSES:

Guest Lecturer, Maastricht University, NL, Dec. 2020—Professional Development Lecture

Guest Lecturer, Columbia University Mailman School of Public Health 2013-present (Selected list)

- Columbia University Patient Oriented Research Certificate, Biostatistics P8103 - Patient Oriented Research Career Development Colloquium; Topics: Salary Negotiation, Networking (multiple dates)
- Seminar in Research and Professional Development, Sociomedical Sciences P8798
- Professional Development in Global Health seminar, Epidemiology P8880 (multiple dates)
- Seminar in Health Communication, Sociomedical Sciences P8901 (annually, 2017-present)
- Health Policy & Management Dept. Professional Development Program program—Presentation on Social Media for the Job Search, 10/24/16; Behavioral Interviewing 11/28/16; Salary Negotiation 2/6/17
- Initiative for Maximizing Student Development (IMSD) Seminar—Negotiation 11/17/16

Facilitator, Self, Social & Global Awareness (SSGA), Columbia University Mailman School of Public Health 2013-present

- Facilitated groups of 20-30 incoming students in a highly experiential workshop to raise self-awareness and understanding of equity, diversity, inclusion, power and privilege.

NON-REFERREED/INVITED TALKS: OTHER EVENTS, KEYNOTES (Partial List)

- National Coordinating Center for Public Health Training; National Network of Public Health Institutes, Closing Plenary Panelist, June. 9, 2021
- National Association of Colleges and Employers—meet the authors talk at national conference, June 7, 2021
- ASPPH Data Section Retreat—speaker and facilitator for “Employer & Alumni Surveys,” “Workforce Development Assessment,” June 16, 2021
- Health Career Connect, LinkedIn webinar, 9/2020, 11/7/19
- LinkedIn for Alumni, Columbia University School of Public Health, Oct. 2019
- Eastern Association of Colleges & Employers, Advanced Boolean Search & Employer Research Tricks for Career Counselors, 8/20/19
- Columbia University Postdoctoral Affairs Office, Invited speaker, Summer 2018
- ICAP Minority Health and Health Disparities International Research Training (MHIRT) Invited speaker, program 2017-18
- ASPPH Fellowship Program job search workshop webinar, Invited speaker, 8/8/18
- Association of Schools and Programs of Public Health Career Services Task Force meeting at the American Public Health Association national conference, Invited panelist, “How to Get Published,” Nov. 11, 2018
- Columbia University Mailman School of Public Health Leadership Course Series, General Public Health MPH program (Self Assessment; Resume Writing, Personal Pitch), 10/17/16, 10/27/16, 11/29/16
- Columbia University Mailman School of Public Health, Environmental Health Department “Casual Conversations” presentations (multiple dates)
- Columbia University Mailman School of Public Health Advanced Epidemiology Certificate Program presentation 2/23/17
- National Association of Colleges and Employers webinar on Applicant Tracking Systems, “Applicant Tracking Systems: What Career Advisors Need to Know LIVE Webinar,” presented to 200+ university career services professionals nationally, 12/6/2016
- Columbia-wide Training program on How to Advise Formerly Incarcerated Students, Organizer, 2016
- Association of Schools & Programs of Public Health, Webinar Presentation on Employment Outcomes Statistics Gathering Methods, “ASPPH Presents: Collecting and Utilizing Graduate Outcome Data” 10/18/2016
- Graduation Keynote Speaker, New York Public Library Office Readiness Series, Sept. and Dec. 2016, 5/4/17
- NY Bio Conference, presentation Leveraging University Partnerships for Recruiting, 5/10/17
- *I Have a Dream Foundation* workshop, 6/2/17
- American Public Health Association webinar on Salary Negotiation (6/2016) (100+ participants)
- Nonprofit Job Search Webinar: 10 Strategies for Making the Leap from For-Profit to Non-Profit , Idealist.org, 1/14/15
- Ecole des Hautes Etudes en Sante Publique, Career Days speaker, Rennes, France, 7/2014
- Advanced LinkedIn for University Career Centers Webinar, Internbridge.com, 5/2014
- Keynote Speaker, American Library Association national conference, Library Leadership & Management Association President’s Program, 6/23/2012.
- Keynote Speaker, Medical Library Association national conference, “Managing and Revitalizing Your Career as a Medical Librarian,” 5/19/2012
- Planning for a Career in Nonprofits, Chronicle of Philanthropy live chat 8/2/2011
- Advanced LinkedIn for College Career Centers webinar for University career centers through InternBridge.com’s Career Services Online Conference, 8/9-12/2011
- Seattle Nonprofit Social Media Summit presentation on Twitter for Nonprofits, 7/26/2011
- National Association of Colleges & Employers webinar on “Government and Nonprofit Job Search Secrets,” 3/9/2011
- Workshop for Seattle Society for Human Resources Management on building an excellent internship program, 8/10/2010
- KUOW Radio appearance, The Conversation with Ross Reynolds Tues. 9/21/2010
- Net Impact National Conference in Ann Arbor, MI, 2020: Vision for a Sustainable Decade, 10/30/2010

- “Crafting an Excellent Internship Program,” a workshop for employers, presented at the 2009 Washington State Nonprofit Leadership Conference and for Global Washington
- Dale Carnegie Training—graduated from “Strictly Business” 3-day immersion training, New York City; graduated from Product Endorsement and Training of the Trainer 3-day training; as a tandem trainer, trained a group of 19 students in a modified version of the 12-week course. Received numerous awards for excellent public speaking, including best inspirational speech.
- Internships 101: How to Best Utilize Interns, at Support Center for Nonprofit Management and Baruch College, 2004-2008; trained over 100 organizations on building an excellent internship program
- City University of New York Student Development & Enrollment Management Conferences: topics included Career Counseling for Creative Students; Utilizing Technology in the Career Center; and in 4/2008, “Interactive Technologies, Friend or Foe, How Social Networking is Transforming Colleges.”
- Résumé Writing and Managing Your Career Success: Volunteer Trainer for Inroads, a nationally-recognized program that helps under-represented minorities launch their careers in business

WORKSHOPS TAUGHT (Partial List):

- **For Job Seekers:** Résumé Writing; Job Search Correspondence; Social Media for the Job Search; Secrets of the Government & Nonprofit Job Search; Negotiating Your Salary; Interview Tips; Networking 101; Job Search for PhDs; Jobs Search for Biostatisticians; Job Search for Global Health Professionals; Making the Most of Your Internship
- **For Professionals:** Leading at All Levels—Managing Your Career While Mentoring Others; Beating Burnout
- **For Employers:** Designing an Excellent Internship Program
- **For Career Centers:** Advanced LinkedIn for University Career Centers; Applicant Tracking Systems—What Career Counselors Need to Know

INVITED NATIONAL AND LOCAL COMMITTEE SERVICE:

- My IDP Public Health Task force, Funded by CDC/Kennedy Krieger Institute, 9/2020-present
 - Invited to plan first-ever, evidence-based career development/assessment/planning website for public health students
- De Beaumont Foundation, National Consortium for Public Health Workforce Planning Committee. 9/2019-present
 - Invited to be part of a national panel of experts to provide input into workforce planning efforts.
- National Association of Colleges and Employers (NACE), First Destinations Task Force invited member, 2017-2019
- Association of Schools and Programs of Public Health, Data Committee, 2014-present
- Association of Schools and Programs of Public Health, Career Services Forum Leadership Committee, 2014-2017; National Public Health Career Fair Organizing Committee, Spring 2020
- Columbia University Career Consortium, President, 2019-present
- Columbia University Mailman School of Public Health Office of Education Leadership Team, 2015-Present
- Columbia University Mailman School of Public Health CEPH Accreditation Committee, 2017-18
- People’s Music Network, Board of Directors, 1997-8
- WBAI Radio, Board of Directors, 1996-7
- Intercooperative Council, University of Michigan, Board member, 1994-5

GRANTS:

- Columbia University Provost’s Massive Open Online Course Grant, \$15,000 award to create the Columbia Public Health Activist Academy, 2021
- Partnership for Public Service Call To Serve Grant, University of Washington, to support university-wide collaborations regarding federal government hiring, 2010, \$3000
- Baruch College Workforce Development Grant to support Financial Leadership Development Program, \$25,000
- Starr Foundation Grant, Brooklyn College, to support funding for unpaid internships, 2001, \$300,000
- Brooklyn College CUNY Career Development Grant for Career Development of Students with Disabilities, 2000, \$20,000

- Kauffman Foundation for Entrepreneurship Grant, Brooklyn College, to fund awards to students working in start-up companies, 1999, \$150,000
- Support Center for Nonprofit Management, support from various foundations, 1997, \$70,000
- Puffin Foundation Grant for Peoples Music Network, 2002, \$2,000
- Puffin Foundation Grant for music organization, 2000, \$750

PROFESSIONAL TRAINING, CERTIFICATIONS, AND AFFILIATIONS:

- **Advanced Literature Searching in the Health Sciences**, University of Michigan EdX, *Fall 2019*
- **Myers Briggs Type Indicator Certified Practitioner**, *6/2018*
- **Certified Employment Interview Consultant**, Career Directors International, *9/2016*
- **Certified Workforce Development Professional**, National Association of Workforce Development Professionals
- **Certified Social Sourcing Recruiter, Certified Diversity Recruiter, Professional Recruiter Certification**, AIRS, *1/12*
- **Dale Carnegie Training**, New York, NY, *1/08*; tandem-taught 12-week course for 18 students.
- **Certificate in Adult Career Planning and Development**, **New York University**, *8/00*
- IRB/Human Subjects Research Certification
- HIPAA Certification

TECHNICAL SKILLS:

General: MS Word, Excel (including V-Lookups/Pivot Tables), PowerPoint; MS Access

Research software: SPSS, Qualtrics, some experience with NVivo.

Learning Management Systems/Educational Technologies: Canvas, Blackboard, Schoology, RISE 360, Zoom, GoToWebinar, Flipgrid, Trello

Communications/Web Design: Mailchimp; Wordpress; Prezi; Adobe Spark; Animoto; Some knowledge of web design, SEO, HTML, some experience with Drupal.

Social Media: Expert knowledge of LinkedIn.com; strong knowledge Facebook, Twitter, Instagram.

Career Management Software, Databases: Symplicity/NACELink, GradLeaders, Graduway, Insight.ly CRM, some experience with Salesforce, Filemaker Pro, Applicant Tracking Systems.

Career Assessments: Myers Briggs Type Indicator, Strong Interest Inventory, Campbell Interests & Skills Survey, Some experience with StrengthsFinder

Other: Boolean Search, Prospect Research, Federal government and civil service hiring methods

About the Author

Heather Krasna, MS, EdM, has served as Assistant Dean of Career Services at Columbia University Mailman School of Public Health since 2013. In this role, she spearheads efforts to ensure that students and alumni of the school obtain meaningful careers in public health by developing career education programs and building connections with employers. Throughout her 22 years as a career services professional, she has served as Director of Career Services at the University of Washington's Evans School of Public Affairs as well as Internship Program Coordinator at Baruch College, CUNY.

She is currently pursuing her PhD in Public Health at the Care and Public Health Research Institute of Maastricht University in the Netherlands with a focus on public health workforce research, and she holds a Master of Education in Adult Learning and Leadership from Teachers College Columbia University and a Master of Science in Nonprofit Management from New School University, as well as a bachelor of arts in anthropology from the University of Michigan. She has published several articles in leading academic journals on the public health workforce, including the first national study of employment outcomes of public health graduates published since 1992 as well as a unique analysis of more than 38,500 public health job postings. In addition to co-authoring the book *101+ Careers in Public Health (3rd Ed.)*, she is the author of *Jobs That Matter: Find a Stable, Fulfilling Career in Public Service* (2010) as well as more than 100 blog articles.

Publications

Krasna H, Fried, L. Generation Public Health: Fixing the Broken Bridge Between Public Health Education and the Governmental Workforce, *Am J Public Health.*, Forthcoming, July 2021

Krasna H, Czabanowska K, Beck A, Cushman LF, Leider JP. Labour market competition for public health graduates in the United States: A comparison of workforce taxonomies with job postings before and during the COVID-19 pandemic. *The International Journal of Health Planning and Management*. n/a(n/a). doi:<https://doi.org/10.1002/hpm.3128>

Krasna H, Gershuni O, Sherrer K, Czabanowska K. Postgraduate Employment Outcomes of Undergraduate and Graduate Public Health Students: A Scoping Review. *Public Health Rep*. Published online March 5, 2021:0033354920976565. doi:10.1177/0033354920976565

Plepys CM, **Krasna H***, Leider JP, Burke EM, Blakely CH, Magaña L. First-Destination Outcomes for 2015–2018 Public Health Graduates: Focus on Employment. *Am J Public Health*. 2021;111(3):475-484. doi:10.2105/AJPH.2020.306038

* *co-first author*

Krasna H, Czabanowska K, Jiang S, Khadka S, Morita H, Kornfeld J and Shaman J, The Future of Careers at the Intersection of Climate Change and Public Health: What Can Job Postings and an Employer Survey Tell Us? *Int. J. Environ. Res. Public Health* 2020, 17, 1310; doi:10.3390/ijerph17041310

Beck AJ, Leider JP, **Krasna H**, Resnick BA. Monetary and Nonmonetary Costs and Benefits of a Public Health Master's Degree in the 21st Century. *Am J Public Health*. 2020;110(7):978-985. doi:10.2105/AJPH.2020.305648

Krasna H. Employment Trends Among Public Health Doctoral Graduates. *Am J Public Health*. 2019;109(4):e9. doi:10.2105/AJPH.2019.304966

Krasna H, March D, Kornfeld J, Cushman L, Antoniou P, The New Public Health Workforce: Employment Outcomes of Public Health Graduate Students, *Journal of Public Health Management and Practice*. 00 2019 • Volume 00, Number 00, DOI: 10.1097/PHH.0000000000000976