

Public Health Workforce Taxonomy

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Thoroughly characterizing and continuously monitoring the public health workforce is necessary for ensuring capacity to deliver public health services. A prerequisite for this is to develop a standardized methodology for classifying public health workers, permitting valid comparisons across agencies and over time, which does not exist for the public health workforce. An expert working group, all of whom are authors on this paper, was convened during 2012–2014 to develop a public health workforce taxonomy. The purpose of the taxonomy is to facilitate the systematic characterization of all public health workers while delineating a set of minimum data elements to be used in workforce surveys. The taxonomy will improve the comparability across surveys, assist with estimating duplicate counting of workers, provide a framework for describing the size and composition of the workforce, and address other challenges to workforce enumeration. The taxonomy consists of 12 axes, with each axis describing a key characteristic of public health workers. Within each axis are multiple categories, and sometimes subcategories, that further define that worker characteristic. The workforce taxonomy axes are occupation, workplace setting, employer, education, licensure, certification, job tasks, program area, public health specialization area, funding source, condition of employment, and demographics. The taxonomy is not intended to serve as a replacement for occupational classifications but rather is a tool for systematically categorizing worker characteristics. The taxonomy will continue to evolve as organizations implement it and recommend ways to improve this tool for more accurate workforce data collection. (Am J Prev Med 2014;47(5S3):S314–S323) © 2014 American Journal of Preventive Medicine. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Introduction

The public health workforce is a key component of our nation's public health infrastructure.^{1,2} Thoroughly characterizing and continuously monitoring the size and composition of the workforce is necessary for

ensuring sufficient capacity to deliver the essential services of public health.^{1–7} The federal government has instituted formal mechanisms for monitoring the size, composition, supply, and demand for the majority of health professions in the U.S.⁸ However, no systematic method for assessing characteristics of the governmental or non-governmental public health workforce exists. The importance of developing a better understanding of the public health workforce has moved to the forefront of the public health services and systems research (PHSSR) agenda, given the rapidly changing public health and healthcare delivery landscape in the U.S.^{5,9} The role of public health professionals and health departments in accountable care organizations—the intended vehicle for delivery of personal and population services in healthcare reform—has yet to be fully defined but will require an accurate characterization of both the health services and public health workforce to fully realize the promise of primary care–public health integration. Developing an accurate assessment of the number and type of workers, their training, certification or educational background, and work setting is essential for public health officials in adapting to the changes demanded by the transformation of our nation's health system while

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ensuring policies are in place for maintaining and strengthening healthcare delivery.

In its 2003 report, *The Future of the Public's Health in the 21st Century*, the IOM recommended that the federal government periodically assess the preparedness of the public health workforce to document the training necessary to meet basic competency expectations, and to advise on the funding necessary to provide such training.¹⁰ A prerequisite for this undertaking is to characterize the public health workforce as part of a larger effort to assess the U.S. health workforce overall, which requires developing a standardized methodology for classifying public health workers, permitting valid comparisons across agencies and over time.^{6,7} The many challenges inherent in conducting public health workforce research are well documented.^{2,4,6,7,11,12} Both categorizing and counting public health workers poses special challenges because of the breadth of the field, its multidisciplinary nature, the diverse settings for employment, the extreme variability in job tasks, and the lack of any standardized system for regularly and systematically collecting data regarding this segment of the health workforce.^{12–14}

To identify methods for monitoring the number and types of public health workers, CDC and the Health Resources and Services Administration (HRSA) funded two Centers of Excellence in public health workforce research at the University of Michigan and University of Kentucky in 2008–2009. The charge to the centers was multifaceted but had as a central focus the identification of barriers and challenges to enumerating the governmental public health workforce and the development of recommendations for improving workforce monitoring and assessment.⁶ For CDC and HRSA, understanding the size and composition of the public health workforce is crucial to determining whether adequate numbers and types of staff members are employed in positions that enable public health agencies to meet the mandate to protect the public's health.¹⁵ In order to support efforts to enumerate the public health workforce, these two federal agencies aligned their complementary roles toward achieving the Ten Essential Public Health Services, especially the eighth core service, which aims to ensure a competent public health and healthcare workforce.¹⁶

The two Centers of Excellence produced a joint report in February 2012, *Strategies for Enumerating the U.S. Governmental Public Health Workforce*.⁶ The report described a number of key challenges to public health workforce enumeration and identified among them the lack of applied standards for occupational definitions that, in turn, impedes any attempts to characterize workers precisely and consistently across agency types.⁶

Previous workforce enumeration efforts have demonstrated that workforce data sources in federal, state, tribal, and local governments differ substantially.^{17,18} This problem is further complicated in nongovernmental settings, where standardization of job categories, worker tasks, and data collection procedures have not been documented, rendering comparisons between nongovernmental and governmental public health workers difficult or impossible.

Given the significance of data quality for conducting any assessment of the public health workforce, developing strategies to improve and standardize data collection is imperative. These strategies can be focused at the organizational level in the way the agency collects data regarding its workers, or the focus might be on recategorizing organizational data into a systematic, consistent format to allow for better data integration. Developing a public health workforce taxonomy, which was one of the chief recommendations of the aforementioned report (i.e., development of a common public health workforce taxonomy⁶), provides a foundation for standardizing workforce categories to improve data collection and use.

Taxonomy is the practice of classifying concepts within hierarchic categories that help organize it in meaningful ways. Many PHSSR researchers are familiar with Bloom's Taxonomy,¹⁹ which is a multi-tiered framework for classification of thoughts according to cognitive levels and is often discussed in the context of public health workforce development. Comprehensive schemas for organizing and categorizing terminology exist in the field of medicine to provide a consistent and comparable method for classifying diagnoses, tasks, and worker characteristics.²⁰ By contrast, public health lacks both a standardized terminology and a method for organizing worker characteristics. In this paper, we present a new public health workforce taxonomy and the process by which it was developed.

Methods

In July 2012, the University of Michigan Center of Excellence in Public Health Workforce Studies (UM CEPHS), supported by CDC and HRSA funding, convened a group of ten content experts to serve on its Public Health Enumeration Working Group (the Working Group) to develop a public health workforce taxonomy. After reviewing existing public health workforce surveys and data sources, along with examples of taxonomies and ontologies developed in medicine, health information, and information systems,^{20–31} the Working Group determined that a public health workforce taxonomy should use a standardized language with subclass–superclass hierarchies for classifying workers and employ a multi-axial framework, which would encompass multiple taxonomies for key worker characteristics. The multi-axial framework

allows organizations to choose the axes of most relevance to them when collecting and using workforce data; it is structured so that all axes can be used together, or alternatively, a subset of axes, or even an individual axis, might be used separately to best meet the needs of the organization conducting the survey.

The Working Group agreed to produce two outcomes: a standardized multi-axial taxonomy to facilitate the systematic characterization of every public health worker, and a set of minimum data elements to be incorporated into future public health workforce surveys. The taxonomy is designed to improve the comparability among public health surveys collecting workforce data and assist with difficult enumeration problems (e.g., estimating the extent to which duplicate counting of workers occurs), although identity resolution is not a specific feature of this taxonomy. Collectively, the taxonomic axes permit a description of the size and composition of the public health workforce. Importantly, the public health workforce taxonomy is not an attempt to develop a new set of standard occupational classifications for public health; rather, it serves as a tool for post-coordination of public health worker characteristics (i.e., previously designated characteristics such as titles, occupations, employers, and settings rather than development of new ones) regardless of the differences in the occupational classifications applied.

The Working Group spent approximately 18 months engaged in developing the 12 unique axes that comprise the public health workforce taxonomy. Teleconference meetings occurred, on average, every 4–8 weeks with group members reviewing and submitting recommendations for changes to the taxonomic axes between meetings. UM CEPHS served as the convener of the meetings and coordinated taxonomy development. To the extent possible, the taxonomy categories were derived from existing governmental public health workforce data sources, which are more complete and collected more frequently on a national level than data collected regarding nongovernmental workers.^{22–26} When possible, the taxonomic axes and categories or subcategories therein were tested with existing workforce data and revised.³² The Working Group used an iterative and consensus approach for making changes to the taxonomy; these changes occurred frequently throughout the project. This project was reviewed by CDC for human subjects protection and deemed to be nonresearch.

Public Health Workforce Taxonomy

The axes for the public health workforce taxonomy are detailed in the following section. Each of the 12 axes has a unique designation (e.g., Axis 4: education), and within each axis, multiple categories more precisely define the characteristics for that type of worker that are also numbered according to the axis designation (e.g., Axis 4: education/4.1: graduate degree). The majority, but not all, of the axes' subcategories under a given category further refine a given type of worker characteristic that, again, is numbered according to both the axis and category number (e.g., Axis 4: education/4.1: graduate degree/4.1.1: Doctor of Medicine or Doctor of Osteopathy [MD/DO] or 4.1.2: Doctor of Veterinary Medicine or Veterinary Medical Doctor [DVM/VMD]) (Tables 1

Table 1. Public health workforce taxonomy axes

1. Occupation
2. Setting
3. Employer
4. Education
5. Licensure
6. Certification
7. Job tasks
8. Program area
9. Public health specialization area/expertise
10. Funding source
11. Condition of employment
12. Demographics

and 2). The taxonomy is purposefully intended to be flexible in terms of how the axes are used to characterize public health workers based on the needs and intent of the researcher or organization using this tool.

Depending on the level of precision and specificity desired, a single category or subcategory can be selected under each axis; alternatively, a researcher might allow multiple categories or subcategories to be used under each axis with the notable exception of the last axis, demographic, which is mutually exclusive for the categories of age, sex, and race/ethnicity. For example, a researcher desiring a high degree of specificity regarding education might therefore instruct survey participants to select the single best category (and subcategory) under that axis, which would likely be the highest degree attained. In contrast, an organization might want to have high levels of precision in fully describing worker characteristics and therefore ask respondents to select all categories and subcategories that apply under the education axis to capture all pertinent degrees and other education that workers possess.

Importantly, employing the same approach to each axis is not necessary when using the taxonomy. That is, a researcher might ask respondents to select only the single best category and subcategory under each of the 12 axes that best describes a given worker's characteristics, or the researcher might instruct participants to select the single best choice under particular axes, but use an all-that-apply choice for other axes. Alternatively, the respondents might be asked to indicate all that apply under all axes. It seems probable that certain axes would lend themselves more to an all-that-apply approach (e.g., job tasks) because the majority of public health workers perform an array of job tasks as part of their daily duties; again, this is something that would be decided by the researcher or organization using the taxonomy. Conversely, other axes (e.g., occupation) might be more likely to be used as single best-fit choices because worker surveys typically classify worker occupation under one category. Even here the taxonomy can be used flexibly; for example, a health officer who is

Table 2. Public health workforce taxonomy

Axis 1: Occupation
1.1. Management and leadership
1.1.1. Public health agency director
1.1.2. Health officer
1.1.3. Department or bureau director (subagency level)
1.1.4. Deputy director
1.1.5. Program director
1.1.6. Public health manager or program manager
1.1.7. Other management and leadership
1.1.7.1. Coordinators
1.1.7.2. Administrators
1.2. Professional and scientific
1.2.1. Behavioral health professional
1.2.1.1. Behavioral counselor
1.2.2. Emergency preparedness worker
1.2.3. Environmentalist
1.2.3.1. Sanitarian or inspector
1.2.3.2. Engineer
1.2.3.3. Technician
1.2.4. Epidemiologist
1.2.5. Health educator
1.2.6. Information systems manager
1.2.6.1. Public health informatics specialist
1.2.6.2. Other informatics specialist
1.2.6.3. Information technology specialist
1.2.7. Laboratory worker
1.2.7.1. Aide or assistant
1.2.7.2. Technician
1.2.7.3. Scientist or medical technologist
1.2.8. Nurse
1.2.8.1. Registered nurse unspecified
1.2.8.1.1. Public health or community health nurse
1.2.8.1.2. Other registered nurse (clinical services)
1.2.8.2. Licensed practical or vocational nurse
1.2.9. Nutritionist or dietitian
1.2.10. Oral health professional
1.2.10.1. Public health dentist
1.2.10.2. Other oral health professional
1.2.11. Physician
1.2.11.1. Public health or preventive medicine physician
1.2.11.2. Other physician
1.2.12. Medical examiner
1.2.13. Physician assistant
1.2.14. Public information specialist
1.2.15. Social worker
1.2.15.1. Social services counselor
1.2.16. Statistician
1.2.17. Veterinarian
1.2.17.1. Public health veterinarian
1.2.17.2. Other veterinarian
1.2.18. Other professional and scientific
1.2.19. Student professional and scientific
1.3. Technical and outreach
1.3.1. Animal control worker
1.3.2. Community health worker
1.3.3. Home health worker
1.3.4. Other technical and outreach
1.4. Support services
1.4.1. Clerical personnel
1.4.1.1. Administrative assistant

(continued)

Table 2. (continued)

1.4.1.2. Secretary
1.4.2. Business support
1.4.2.1. Accountant or fiscal
1.4.2.2. Facilities or operations
1.4.2.2.1. Custodian
1.4.2.2.2. Other facilities or operations worker
1.4.2.3. Grants or contracts specialist
1.4.2.4. Human resources personnel
1.4.2.5. Attorney or legal counsel
1.4.3. Other business support services
1.5. Other
Axis 2: Setting
2.1. Local setting
2.1.1. County health agency
2.1.2. City or town health agency
2.1.3. Multicity health agency
2.1.4. Multicounty health agency
2.1.5. Hospital or primary care clinic
2.1.6. Other public health local agency
2.1.7. School
2.1.8. Other local health setting
2.1.9. Other local setting, not health
2.2. State setting
2.2.1. State health agency—central office
2.2.2. State health agency—local or regional office
2.2.3. Inpatient or outpatient clinical setting
2.2.4. Other state agency, not health
2.3. Territorial health agency
2.4. Federal health agency
2.5. Tribal health agency
2.6. Educational institution
2.7. Private nonprofit organization
2.8. Private foundation
2.9. Personal health services industry
2.10. Other private industry
Axis 3: Employer
3.1. Local government
3.2. Tribal government
3.3. State government
3.4. Federal government
3.5. Nongovernment
Axis 4: Education
4.1. Graduate degree
4.1.1. Doctor of Medicine (MD) or Doctor of Osteopathy (DO) (or international equivalent)
4.1.2. Doctor of Veterinary Medicine (DVM) or Veterinary Medical Doctor (VMD)
4.1.3. Doctor of Dental Surgery (DDS) or Doctor of Dental Medicine (DMD)
4.1.4. Doctor of Nursing Practice (DNP)
4.1.5. Doctor of Public Health (DrPH), Doctor of Philosophy (PhD), Doctor of Science (ScD), or other public health doctorate
4.1.6. PhD, ScD, or other non–public health doctorate
4.1.7. Doctor of Pharmacy (PharmD)
4.1.8. Juris Doctor or Doctor of Jurisprudence (JD)
4.1.9. Master of Public Health (MPH)

(continued on next page)

Table 2. Public health workforce taxonomy (continued)

4.1.10.	Master of Health Services Administration (MHSA)
4.1.11.	Master of Social Work (MSW)
4.1.12.	Master of Science in Nursing (MSN)
4.1.13.	Master of Public Administration (MPA)
4.1.14.	Master of Arts (MA) or Master of Science (MS)
4.1.15.	Master of Business Administration (MBA)
4.1.16.	Other master's degree
4.2.	Baccalaureate degree
4.2.1.	Bachelor of Science (BS) or Bachelor of Arts (BA)
4.2.2.	Bachelor of Science in Nursing (BSN)
4.2.3.	Other baccalaureate degree
4.3.	Associate's degree
4.3.1.	Associate Degree in Nursing (ADN)
4.3.2.	Other associate degree
4.4.	Other education
4.4.1.	High school or equivalent diploma
Axis 5: Licensure	
5.1.	MD or DO License
5.2.	DDS or DMD License
5.3.	DVM License
5.4.	Registered Nurse (RN) License
5.5.	Licensed Practical Nurse or Licensed Vocational Nurse
5.6.	Licensed Clinical Social Worker or Licensed Master Social Worker
5.7.	Registered Sanitarian or Registered Environmental Health Specialist
5.8.	Licensed Registered Dietitian
5.9.	State licensure to practice laboratory science
5.10.	Other license
5.11.	Not currently licensed
Axis 6: Certification	
6.1.	Physician certification
6.1.1.	Preventive Medicine Physician
1.1.1.1.	Public Health and General Preventive Medicine
1.1.1.2.	Specialty: Occupational Medicine
1.1.1.3.	Aerospace Medicine
6.1.2.	Other board-certified physician
6.2.	Nurse certification
6.2.1.	Certification: Advanced Public Health Nurse—Board-Certified
6.2.2.	Certification: Public or Community Health Clinical Nurse Specialist—Board-Certified
6.2.3.	Certification: Nurse Executive, RN—Board-Certified
6.2.4.	Certification: Nurse Executive, Advanced—Board-Certified
6.2.5.	Certification: Nurse Practitioner
6.2.6.	Certification: Clinical Nurse Specialist
6.2.7.	Certification: Registered Nurse Anesthetist
6.2.8.	Certification: Other
6.3.	Physician Assistant—Certified
6.4.	Certified in Public Health
6.5.	Certified Health Education Specialist (CHES or Master CHES)
6.6.	Laboratory certification
6.6.1.	National generalist certification
6.6.2.	National specialist certification
6.7.	Infection control certification
6.8.	Other certification
6.9.	Not formally certified
<i>(continued)</i>	

Table 2. (continued)

Axis 7: Job tasks	
7.1.	Monitor health status to identify and solve community health problems
7.1.1.	Conduct community assessments
7.1.2.	Develop surveillance procedures
7.1.3.	Report data to the county or state
7.2.	Diagnose and investigate health problems and health hazards in the community
7.2.1.	Investigate health problems, including environmental health
7.2.2.	Obtain information, specimens, or samples
7.3.	Inform, educate, and empower people about health concerns
7.3.1.	Provide education to the public
7.3.2.	Interact with local or regional media
7.3.3.	Phone communication with the public
7.3.4.	Process requests from the public (for services, information, or appointments)
7.4.	Mobilize community partnerships and action to identify and solve health problems
7.4.1.	Develop community partnerships
7.4.2.	Represent the department at community meetings
7.5.	Serve on committees, boards, or task forces
7.5.1.	Develop policies and plans that support individual and community health efforts
7.5.2.	Develop public policy or regulations
7.5.3.	Plan public health programs
7.5.4.	Plan for emergencies
7.5.5.	Respond to emergencies
7.6.	Enforce laws and regulations that protect health and ensure safety
7.6.1.	Enforce regulations
7.6.2.	Vector control
7.6.3.	Schedule services and inspections
7.6.4.	Conduct site visits, home visits, or inspections
7.6.5.	Issue permits
7.7.	Link clients to needed personal health services and ensure the provision of health care when otherwise unavailable
7.7.1.	Register and enroll clients
7.7.2.	Deliver direct health services to clients
7.7.3.	Meet with clients for purposes other than delivering direct health services
7.7.4.	Review medical records
7.7.5.	Perform health or environmental screenings
7.8.	Ensure competent public and personal health care workforce
7.8.1.	Develop information and training materials
7.8.2.	Post or publish information for staff use
7.9.	Evaluate effectiveness, accessibility, and quality of personal and population-based health services
7.9.1.	Evaluate program performance
7.10.	Research for new insights and innovative solutions to health problems
7.10.1.	Take part in public health research
7.11.	Organizational management and administration
7.11.1.	Manage files, prepare reports, or correspondence
7.11.2.	Manage inventory
7.11.3.	Manage personnel (e.g., recruit, schedule, train, or evaluate staff)
7.11.4.	Manage public health programs
7.11.5.	Supervise, plan, or distribute work to others
7.11.6.	Process billing, fees, and payments
<i>(continued on next page)</i>	

Table 2. Public health workforce taxonomy (continued)

7.11.7.	Financial management (including managing budgets)
7.11.8.	Prepare applications for external funding
7.11.9.	Manage contracts or service agreements
7.11.10.	Review facility operational plans
7.11.11.	Establish fees for public health services
Axis 8: Program area	
8.1.	Communicable disease
8.1.1.	HIV
8.1.2.	Sexually transmitted diseases (STD)
8.1.3.	Tuberculosis (TB)
8.1.4.	Other communicable disease
8.2.	Noncommunicable disease
8.3.	Injury
8.4.	Environmental health
8.5.	Maternal and child health
8.5.1.	Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)
8.6.	Clinical services (excluding TB, STD, and family planning)
8.6.1.	Immunizations
8.7.	Oral health or clinical dental services
8.8.	Administration or administrative support
8.9.	Mental health
8.10.	Substance abuse (includes tobacco control programs)
8.11.	Public health genetics
8.12.	Vital records
8.13.	Medical examiner
8.14.	Animal control
8.15.	Cross-cutting areas
8.15.1.	Emergency preparedness
8.15.2.	Epidemiology surveillance
8.15.3.	Program evaluation
8.15.4.	Health education
8.15.5.	Health promotion or wellness
8.15.6.	Community health assessment or planning
8.15.7.	Training or workforce development
8.15.8.	Global health
8.16.	Other program area
Axis 9: Public health specialization area or expertise	
9.1.	Generalist
9.2.	Biostatistics
9.3.	Environmental health sciences
9.4.	Epidemiology
9.5.	Health management and policy
9.6.	Health behavior and health education
9.7.	Maternal and child health
9.8.	Emergency preparedness
9.9.	Informatics
9.10.	Global health
9.11.	Other
Axis 10: Funding source	
10.1.	Local government
10.2.	Tribal government
10.3.	State government
10.4.	Federal government (not including Medicare or Medicaid)
10.5.	Fee for service
10.5.1.	Medicare or Medicaid payments for service
<i>(continued)</i>	

Table 2. (continued)

10.5.2.	Other clinical revenue (private insurers, fees from patients)
10.5.3.	Other fee for service or fines
10.6.	Private foundation
10.7.	Other sources
10.8.	Unpaid or no funding source
Axis 11: Condition of employment	
11.1.	Full-time equivalent status
11.1.1.	Full-time
11.1.2.	Part-time
11.2.	Category of employment
11.2.1.	Regular employee
11.2.2.	Contracted employee
11.3.	Exemption status
11.3.1.	Exempt employee
11.3.2.	Nonexempt employee
11.4.	Temporality
11.4.1.	Permanent employee
11.4.2.	Temporary employee
11.5.	Other employment considerations
11.5.1.	Bargaining unit employee
11.5.2.	Postdegree fellow or fellowship
11.5.3.	Student or trainee
11.5.4.	Volunteer
Axis 12: Demographics	
12.1.	Age
12.2.	Sex
12.3.	Race/ethnicity

also a physician might be categorized only under the occupation axis in the management and leadership category and health officer subcategory (i.e., 1.1.2), or s/he might be classified under the physician category and public health physician subcategory (1.2.11.1).

The 12 axes of the workforce taxonomy are occupation, workplace setting, employer, education, licensure, certification, job tasks, program area, public health specialization, funding source, condition of employment, and demographics. Each category is described in the following sections.

Occupation

The first axis, Occupation, includes a listing of occupations or job titles that fall under five main categories. These categories are based on the U.S. Office of Personnel Management (OPM) Occupational Categories of professional, administrative, technical, clerical, and other, which were part of the classification scheme used in the *Public Health Workforce: Enumeration 2000* study.^{18,21}

The Management and Leadership category includes a series of possible job titles (e.g., Public Health Agency Director, Health Officer, Department or Bureau Director, Program Director, Public Health or Program Manager, or Other Management and Leadership). The Professional and Scientific category is intended to capture the bulk of

professional public health workers. This category includes the job titles most commonly used in public health, including those collected in the Association of State and Territorial Health Officials (ASTHO) and the National Association of County and City Health Officials (NACCHO) profile surveys.^{25,26} Selected areas have further subcategories providing additional detail (Table 2).

The Technical and Outreach category includes Animal Control Workers, Community Health Workers, Home Health Workers, and other similar positions. The Support Services category includes Clerical Personnel, the largest subcategory of governmental public health workers in previous ASTHO and NACCHO profile surveys.^{16,17} Business Support (e.g., Accountants, Facilities or Operations Personnel, Grants and Contracts Specialists, and other workers who provide support services) is also included within Support Services. Public health workers whose jobs are not identified by any of the listed subcategories are classified as Other. Categories in this axis can be mapped to the Standard Occupational Classification system³⁰ used by federal statistical agencies to classify workers, although a detailed crosswalk has not yet been developed.

Setting

The second axis, Setting, refers to the location in which the public health worker performs his or her work, regardless of the organization or agency paying the employee's salary. For example, a worker funded by a state health agency to work in a local setting is counted as *local*; the worker's employer is captured in the third axis. Ten public health settings are identified in the taxonomy.

Employer

The third axis, Employer, specifically refers to the agency or organization employing the worker (i.e., the worker's payroll source). The taxonomy categorizes employers as local government, state government, federal government, or nongovernment.

Education

The Education axis collects information on degrees earned by the worker. This axis does not capture information related to the degree(s) required for the worker's job. Main categories for this axis include graduate degrees (i.e., professional or master's- or doctoral-level degrees); baccalaureate degrees; associate's degrees; and other education (e.g., high school or equivalent diploma) and permit differentiation of degrees in public health and non-public health areas (e.g. public health doctorate versus non-public health doctorate).

Licensure

This axis refers to the type of license(s) held by the worker, including medical, nursing, social work, and sanitarian licenses, among others. Similar to the Education axis, this information pertains to any license the worker has earned, rather than licensure requirements associated with the worker's job.

Certification

Certification information is collected for physicians, nurses, and physician assistants in this axis. In addition, workers certified in public health or health education, those holding generalist or specialist laboratory certification or infection control certification are captured under the Certification axis.

Job Tasks

The Job Tasks axis arguably has the most potential for further refinement and modification in the future. This axis uses an assemblage of 41 tasks identified by local public health workers in a 2009 study²² using the Ten Essential Public Health Services as a framework.¹⁶ In addition, a cross-cutting category of Organizational Management and Administration is included in this axis. The authors anticipate that this axis will be expanded with more specific and diverse job tasks of public health workers.

Program Area

This axis collects information regarding 14 major programmatic categories in which public health workers might devote their effort (e.g., communicable disease or maternal and child health). Additionally, eight cross-cutting program areas are subsumed in this axis (e.g., emergency preparedness, epidemiology, surveillance, and health education).

Public Health Specialization Area or Expertise

The axis is intended to collect information about areas of expertise held by the worker that might not be reflected by his or her program area of current work, occupational category, or job tasks. This information can be useful for resource and training allocation because workers might have substantial content expertise outside their program area assignment or their current occupational category. Ten areas have been identified for the Public Health Specialization Area or Expertise axis. For example, someone trained in epidemiology but working in a maternal and child health program area can select maternal and child health in the Program Area axis and identify his or her specialized area of expertise (i.e., epidemiology) in this axis. Alternatively, a worker both trained and employed as an epidemiologist would likely

indicate epidemiologist as their Program Area, epidemiologist as their Occupational category, and epidemiology as their public health specialization area.

Funding Source

The source of a worker's funding, whether local government, tribal government, state government, federal government, fee for service, private foundation, or nonprofit organization, is identified in this axis. This distinction is important for workers whose setting or employer differs from their funding source (e.g., state health department employees funded by a federal grant).

Condition of Employment

The Condition of Employment axis allows workers to designate their full-time equivalent status (i.e., full-time versus part-time); category of employment (regular versus contracted); exemption status; temporality; and other employment considerations (e.g., bargaining unit employee, postdegree or fellowship worker, student or trainee, or volunteer). More than one category in this axis will be applicable to the majority of workers.

Demographics

The Demographics axis includes subcategories of age, sex, and race/ethnicity. The U.S. Office of Management and Budget standard for data regarding race and ethnicity was used to develop race/ethnicity categories.³³

Discussion

The major changes under way in healthcare delivery in the U.S. have dramatic implications for the role of public health and its workforce in promoting and ensuring the nation's health and underscore the importance of improving the public health workforce.^{9,34} A longstanding need has existed for developing a standardized system for classifying public health workers as part of a larger effort to characterize the public health workforce periodically to ensure it is robust and skilled enough to deliver essential services to the population. Routine data collection is required for monitoring the impact on investment and advocate for additional resources; assess gaps in the workforce pipeline; guide recruitment, retention, and competency compliance and credentialing efforts; permit better alignment of academic resources and workforce needs; and allow for a clearer comprehension of the association between workforce infrastructure and actual health outcomes.

This public health workforce taxonomy provides a mechanism for standardizing public health workforce research and permitting more valid comparisons across studies. Ideally, governmental and nongovernmental agencies will refer to the taxonomy and axes contained

therein when collecting workforce data to ensure consistency throughout the field. However, the authors anticipate that this tool (at least initially) will more likely be used by PHSSR researchers in the development of survey tools and in analyses of secondary workforce data. Presently, the taxonomy provides a framework for constructing survey questions about the public health workforce, with the main categories and subcategories under each axis of the taxonomy constituting potential survey responses. Organizations can select the axes of greatest relevance to their project as they develop a survey and need not feel obliged to use them all in a given survey (e.g., a survey specifically related to worker education, certification, licensure, and area of specialization might not use any of the other axes).

Of note, worker information required among the different axes might be more difficult or costly to obtain for certain workers, whereas other axes might be beyond the knowledge of the employee or the organization for which they work. It is also important to acknowledge the almost complete lack of past experience with systematically collecting workforce data on public health workers in non-health or nongovernmental agencies (e.g., voluntary agencies, community-based organizations). Although the taxonomy was primarily developed with governmental public health workers in mind, it could be used in the nongovernmental setting while recognizing that more experience will be required to fully test its utility in that setting. Despite these challenges, the Working Group, comprising workforce expertise from the principal national public health professional groups, all levels of governmental public health, and multiple academic institutions, felt it is feasible to collect the requested data for all axes on the basis of past experience. Several of the axes contain information that has been traditionally included in public health professional group surveys (e.g., Education, Licensure, Program Area, Condition of Employment); has been successfully collected by academic researchers (e.g., Occupation, Setting, Specialization, Funding Sources); is possible to collect although is done infrequently (e.g., employee demographics); or has been the focus of research to delineate a methodology for establishing a framework for doing so (e.g., Job Tasks). The Working Group concedes that no public health workforce survey has ever attempted to collect information in all of these axes using a single instrument, which may reveal unanticipated issues that could be discerned with its use.

To aid in its use in survey research, the decision rules for adopting the taxonomy have been purposefully designed to be highly flexible to meet diverse needs. For example, multiple axes might be used in different ways in different surveys. As previously noted, the Occupation axis can be used to collect information

regarding the worker's best-fit category, or it can employ a check-all-that-apply choice because determining the occupation of a worker can be difficult (i.e., public health workers often perform multiple tasks during the course of their daily job). The development of this taxonomy is intended to help identify primary occupational classifications, meaning the category in which workers focus the majority of their efforts, but it might also capture secondary classifications subject to how it was used. In addition to the Occupation axis, the Setting, Employer, Program Area, and Public Health Specialization Area or Expertise axes might be more likely to be used to collect the single best answer from respondents, although this remains the determination of the researcher or organization. Other axes more naturally lend themselves to capturing the highly variable information that characterizes axes (e.g., Education, Licensure, Certification, Job Tasks, Funding Source), which would use a check-all-that-apply approach. The Condition of Employment and Demographics axes contain subcategories requiring a separate response. For example, if incorporating Condition of Employment into a survey tool, the taxonomy will support separate questions regarding full-time equivalent status, category of employment, exemption status, temporality, and other employment considerations. The majority of the subcategories for these areas are mutually exclusive.

This taxonomy has certain limitations. The axes are intended to capture the major categories and subcategories relevant to the public health workforce; however, the taxonomy does not include certain occupations, employer types, or other worker characteristics that might be important to public health workforce characterization and will need to be validated against real data. All axes include a category designated as Other; the authors strongly encourage researchers to collect metadata to describe the concepts that fall into the excluded categories. In addition, matching job titles provided by governmental and nongovernmental organizations to occupational classifications can be difficult as the taxonomy is initially being implemented. Additional resources (e.g., crosswalks, toolkits) to aid workers or their employers when responding to workforce surveys can help with data collection. Finally, limiting survey respondents to one category, particularly in the Occupation, Program Area, and Specialization or Expertise axes, will be challenging. Public health workers frequently have multifaceted jobs with diverse tasks. The goal of this taxonomy is to find an applicable primary category for all workers and still capture supplemental information by using discrete, non-overlapping axes that, in aggregate, capture all the key features needed to fully characterize a public health worker.

This taxonomy also has numerous strengths, including its development by a Working Group with members drawn from the large public health professional groups and governmental agencies involved in workforce studies and surveys: ASTHO, NACCHO, CDC, HRSA, the Bureau of Labor Statistics, and an academic workforce center that has worked extensively with the Council of State and Territorial Epidemiologists, Association of Public Health Laboratories, and the Quad Council of Public Health Nursing Organizations on national worker enumerations. All of these organizations develop workforce surveys using different methodologies with variable worker classifications, and they collect often dissimilar information on each worker. The usage of a single, agreed upon, public health workforce taxonomy can substantially increase the ease and value of comparisons across surveys that target different types of workers and are conducted by different public health organizations to better and more accurately describe the size and composition of the national public health workforce.

The taxonomy presented in this paper is the result of intense discussion, thoughtful debate, and internal consensus-based vetting by an expert Working Group. The taxonomy will continue to evolve as organizations implement sections of it into their surveys and find ways to modify and improve the tool for more accurate and efficient workforce data collection. The many challenges inherent in public health workforce enumeration have been long recognized. This taxonomy is intended to bring greater standardization and precision to characterizing those workers, as has been done with other health professions, as a necessary step in continuously monitoring the size and composition of the workforce to ensure sufficient capacity to deliver the essential public health services.

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References

- Gebbie KM. The public health workforce: key to public health infrastructure. *Am J Public Health* 1999;89(5):660–1.
- Lichtveld MY, Cioffi JP. Public health workforce development: progress, challenges, and opportunities. *J Public Health Manag Pract* 2003;9(6):443–50.
- Cioffi JP, Lichtveld MY, Tilson H. A research agenda for public health workforce development. *J Public Health Manag Pract* 2004;10(3):186–92.
- Beck AJ, Boulton ML. Building an effective workforce: a systematic review of public health workforce literature. *Am J Prev Med* 2012;42(1S):S6–S16.
- Consortium from Altarum Institute, CDC, Robert Wood Johnson Foundation, National Coordinating Center for Public Health Services and Systems Research. A national research agenda for public health services and systems. *Am J Prev Med* 2012;42(1S):S72–S78.
- University of Michigan Center of Excellence in Public Health Workforce Studies and University of Kentucky Center of Excellence in Public Health Workforce Research and Policy. Strategies for enumerating the U.S. governmental public health workforce. Washington DC: Public Health Foundation, 2012.
- Sumaya C. Enumeration and composition of the public health workforce: challenges and strategies. *Am J Public Health* 2012;102(3):469–74.
- Health Resources and Services Administration. National Center for Health Workforce Analysis. bhpr.hrsa.gov/healthworkforce/.
- American Public Health Association. The Affordable Care Act's public health workforce provisions: opportunities and challenges. Washington DC: American Public Health Association, 2011.
- IOM. The future of the public's health in the 21st century. Washington DC: National Academies Press, 2003.
- Gebbie K, Merrill J, Sanders L, Gebbie EN, Chen DW. Public health workforce enumeration: beware the "quick fix." *J Public Health Manag Pract* 2007;13(1):72–9.
- Gebbie K, Merrill J, Tilson HH. The public health workforce. *Health Aff* 2002;21(6):57–67.
- Gebbie KM, Raziano A, Elliott S. Public health workforce enumeration. *Am J Public Health* 2009;99(5):786–7.
- Tilson H, Gebbie KM. The public health workforce. *Annu Rev Public Health* 2004;25:341–56.
- Coronado F, Polite M, Glynn MK, Massoudi MS, Sohani MM, Koo D. Characterization of the federal workforce at the CDC. *J Public Health Manag Pract* 2014;20(4):432–41.
- CDC. 10 essential public health services. National Public Health Performance Standards Program. cdc.gov/nphpsp/essentialServices.html.
- University of Michigan Center of Excellence in Public Health Workforce Studies. Public health enumeration, 2012. Ann Arbor MI: University of Michigan, 2013.
- Health Resources and Services Administration. The public health workforce: enumeration 2000. Washington DC: USDHHS, 2000.
- Krathwohl DR. A revision of Bloom's taxonomy: an overview. *Theor Pract* 2002;41(4):212–8.
- U.S. National Library of Medicine. Unified Medical Language System. SNOMED Clinical Terms. nlm.nih.gov/research/umls/Snomed/sno_med_main.html.
- Gebbie KM, Merrill J. Enumeration of the public health workforce: developing a system. *J Public Health Manag Pract* 2001;7(4):8–16.
- Merrill J, Keeling J, Gebbie KM. Toward standardized, comparable public health systems data: a taxonomic description of essential public health work. *Health Serv Res* 2009;44(Pt II):1818–41.
- University of Michigan Center of Excellence in Public Health Workforce Studies and Association of Public Health Laboratories. National laboratory capacity assessment, 2011. Ann Arbor MI: University of Michigan, 2012.
- University of Michigan Center of Excellence in Public Health Workforce Studies. Enumeration and characterization of the public health nurse workforce: findings of the 2012 public health nurse workforce surveys. Ann Arbor MI: University of Michigan, 2013.
- Association of State and Territorial Health Officials. Profile of state public health, Vol. 2. Arlington VA: Association of State and Territorial Health Officials, 2011.
- National Association of County and City Health Officials. 2010 national profile of local health departments. Washington DC: National Association of County and City Health Officials, 2011.
- Noy NF, McGuinness DL. Ontology development 101: a guide to creating your first ontology. Stanford CA: Stanford University, 2001.
- Kuziemyk CE, Lau F. A four stage approach for ontology-based health information system design. *Artif Intell Med* 2010;50(3):133–48.
- Jurisica I, Mylopoulos J, Yu E. Ontologies for knowledge management: an information systems perspective. *Knowl Inf Syst* 2004;6:380–401.
- U.S. Department of Labor, Bureau of Labor Statistics. Standard Occupational Classification. www.bls.gov/soc/.
- U.S. Office of Personnel Management. FedScope Federal Human Resources Data. www.fedscope.opm.gov.
- Keeling JW, Merrill J. Understanding the local public health workforce: labels versus substance. *Am J Prev Med* 2014:In press.
- USDHHS, Office of Minority Health. OMB Standards for Data on Race and Ethnicity. minorityhealth.hhs.gov/templates/browse.aspx?lvl=2&lvlID=172.
- IOM. Primary care and public health: exploring integration to improve population health. Washington DC: National Academies Press, 2012.