

Assessing the role of social determinants of health in health disparities: The need for data on work

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Abstract

Background: Work is a key social determinant of health. Without the collection of work-related information in public health data systems, the role of social determinants in creating and reinforcing health disparities cannot be fully assessed.

Methods: The Centers for Disease Control and Prevention (CDC) maintains or supports a number of public health surveillance and health monitoring systems, including surveys, case-based disease and exposure systems, vital status records, and administrative data systems. We evaluated a convenience sample of these systems for inclusion of information in three work-related domains: employment status, industry and occupation, and working conditions.

Results: While 12 of 39 data systems were identified as collecting work-related data, this information was often minimal (e.g., only employment status), restricted to a subset of respondents, or only gathered periodically. Information on working conditions was particularly sparse.

Conclusion: Historically, the limited and inconsistent collection of work-related information in public health data systems has hindered understanding of the role work plays in health disparities. Current CDC data modernization efforts present opportunities to enhance the identification and mitigation of health disparities by prioritizing inclusion of an expanded set of work-related data elements.

KEYWORDS

data, health disparities, social determinant of health, work

1 | INTRODUCTION

The World Health Organization (WHO) defines social determinants of health (SDOH) as “the nonmedical factors that influence health outcomes ... the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life.”¹ These socially constructed circumstances affect quality of life and a wide range of health risks and outcomes.

Work is a key social determinant, influencing and influenced by other social and structural determinants. Residential segregation provides an example of how structural racism affects the web of social determinants: segregation affects access to education, which in turn influences employment options.² Differential access to employment and specific types of jobs can lead to health disparities. Work affects health directly through a range of working conditions and experiences and can also create, reinforce, or mitigate health disparities as a

major determinant of access to income, social status, healthcare access, economic security, and more.^{2,3} Understanding the role of work in health disparities requires the collection of both robust demographic data and data on work.

The Centers for Disease Control and Prevention (CDC) and its state, local, territorial, and tribal partners collect data to characterize the public health impact of a wide variety of exposures, injuries, and diseases. Surveillance data are crucial to CDC's mission to inform policy, guide new program interventions, improve communications, and assess the impact of research, prevention, and intervention strategies.⁴ Previously, Rodriguez-Lainz et al. assessed the availability of several key demographic variables—race, ethnicity, language, and nativity—in CDC-supported public health surveillance and health monitoring data systems and found that each variable was absent from at least some of the systems.⁵ The authors concluded that more comprehensive collection of these demographic variables would enhance the utility of these systems for developing and assessing tailored interventions to address health disparities.

The role of work in health disparities is an underdeveloped aspect of health equity research,⁶ in part because current public health surveillance data systems do not consistently and comprehensively collect information about work.⁷ However, the fact and consequences of occupational segregation have been evident since the early days of occupational health, when information in company records about the jobs held by workers at coking plants and coal-tar production plants led to the recognition that all workers in the most hazardous positions, and those experiencing an elevated risk for lung cancer, were Black.⁸ Subsequent research has described the role of structural racism in disparate risks for adverse working conditions and health outcomes.^{9–13} Most recently, the COVID-19 pandemic foregrounded the overrepresentation of people of color among “essential workers” who incurred higher risks of infection with SARS-COV-2 and subsequent adverse health outcomes reflecting a pattern of occupational segregation of people of color into jobs which had lower pay, fewer benefits, and higher levels of precarity, as well as risk factors such as mandatory in-person work involving contact with the public or coworkers.^{14–17} Research gaps resulting from inadequate collection of data on work also hinder efforts to identify opportunities to use work as a potential site for interventions to decrease these disparities.⁶

Within CDC, the National Institute for Occupational Safety and Health (NIOSH) focuses on work as part of public health. Ideally, national public health surveillance data would provide a rich opportunity to assess associations between work, other SDOH, and the physical, mental, and social health of workers, their families, and their communities. However, work is a complex topic, and the information about work collected in many public health data systems is limited, due, in part to resource constraints. While prioritizing which work-related variables to include in a specific data system involves consideration of the workplace and worker population, outcomes of interest, and the overall purpose of the data system, employment status, industry (the type of business or category of economic activity [e.g., residential remodelers or ambulatory

healthcare]) and occupation (the job or profession [e.g., physical therapist or acrobat]), and working conditions are key for understanding how work functions as a SDOH.

1.1 | Key categories of data on work

The most basic level of work-related information is employment status, classified by the Bureau of Labor Statistics as employed, unemployed, or not in the labor force.¹⁸ Employment is key for access to income and other resources that can affect health.^{19,20} This is particularly true in the United States, where the majority of working-age adults obtain healthcare coverage through paid employment.¹⁹ A recent study using data from the Behavioral Risk Factor Surveillance System (BRFSS) found that unemployment, in general, and longer unemployment specifically, are linked to higher prevalences of adverse health conditions such as hypertension, high cholesterol, obesity, depression, and diabetes.²¹ Reflecting a host of factors that restrict employment options ranging from employment discrimination to chronic health conditions, participation in the labor market was lower in socially marginalized groups. For example, non-Hispanic Black workers were more likely to report short-term unemployment, long-term unemployment, or being unable to work.²¹

Understanding the direct and indirect effects of specific types of work on health requires collecting detailed information about an individual's Industry and Occupation (I&O). Recent papers using BRFSS data found that groups of low-wage workers such as healthcare aides and janitors, many of whom are from socially marginalized groups, have poor access to healthcare and high prevalences of chronic conditions and injuries.^{22–24} Within the healthcare aide occupation, results differed by industry, with home health aides having worse health status.²³ This finding highlights the need to collect information that can be used to identify disproportionately affected worker populations and facilitate direction of workforce-appropriate resources and interventions.

Even workers who have the same occupation and work in the same industry may have different workplace experiences or exposures. These differences can be captured using questions about working conditions, which are defined as potentially modifiable risk factors that can affect the employment trajectory and health and well-being of workers. For example, access to paid sick leave, which varies among and within industries and occupations, is associated with a reduced incidence of nonfatal occupational injuries, particularly among workers in high-risk industry sectors and occupations.²⁵ This finding illustrates the importance of working conditions both for overall worker safety and health and as a means to reduce disparities among workers at high-risk of adverse health outcomes. Working conditions span many domains; some important broad categories include work arrangements, work schedule and hours, pay and benefits, workplace psychosocial conditions, and occupational exposure hazards.

To evaluate the current availability of key work-related variables (employment status; industry and occupation; and working

conditions) in public health data systems, we examined a sample of CDC-supported data systems, including surveys, disease and exposure case-based systems, vital statistics, and administrative data systems. We evaluated these systems to identify data gaps, as well as opportunities to better facilitate health disparities research through inclusion of more work-related information in public health data systems.

2 | METHODS

Using previously published methods,²⁶ we evaluated a convenience sample of CDC or CDC-supported (e.g., by sponsoring inclusion of questions) public health surveillance and health monitoring systems (henceforth, data systems) covering a range of health topics for the presence of work-related variables. We identified these data systems through a search of publicly available websites^{4,27,28} and developed and applied a set of inclusion criteria to determine which systems should be further assessed for the presence of work-related information. The data systems were required to (1) collect information in the United States, (2) on an on-going basis, and (3) for individual participants, so environmental studies or those limited to pooled lab specimens were excluded, for example. Systems meeting these criteria were then further restricted to those focusing on exposures or health conditions potentially relevant to work (including, for data systems focusing on children younger than working age, exposures of adult household members).

For each data system meeting these criteria, we assessed the presence of work-related information using websites, technical documentation, survey instruments (case report forms, questionnaires, and internet-based data-entry systems), publications, and discussions with program personnel. We extracted work-related survey items or variables into an annotated database categorizing systems into two groups: (1) those having basic work-related information—either through restriction to a specific workforce or by collecting employment status, as well as industry, occupation, or both; and (2) those with more than basic information, including augmented information on employment status, collecting information on work history, or collecting at least one variable from a set of working conditions: work arrangements; work schedule and hours; pay and benefits, workplace psychosocial conditions; and occupational exposure hazards (chemical, physical, and ergonomic). For each data system, we noted the presence of a pertinent data element, how frequently the data element was collected, and whether the element was collected for all individuals included in the system or only a subset.

3 | RESULTS

Our initial scan identified 98 CDC or CDC-supported data systems. Of these, we excluded 59 because they do not collect information from the United States on an ongoing basis or do not collect

information on individuals (e.g., contained environmental sampling data only). Of the remaining 39 data systems, 14 either include information related to work ($n = 12$) or collect information on exposures or health outcomes that may be related to work ($n = 2$). A brief description of each of these 14 data systems, along with website links and information about CDC's role with respect to these systems, is provided in Supporting Information S1: Appendix A.

Table 1 summarizes the extent of work-related information currently collected by each of the 14 data systems. The sources that focus on minors, the Childhood Blood-Lead Poisoning Surveillance System (CBLS) and the Youth Risk Behavior Surveillance System (YRBSS), collect no information on work, even though CBLS participants might be exposed through lead dust transported home by household adults, and YRBSS participants might have jobs. The remaining 12 systems have at least basic information, either by explicitly collecting industry ($n = 1$), occupation ($n = 1$), or both ($n = 7$), or by being restricted to specific working populations ($n = 3$, the Coal Workers' Health Surveillance Program [CWHSP]; the Commercial Fishing Incident Database [CFID]; and the National Agricultural Workers Survey [NAWS]). The two mortality data systems, the National Occupational Mortality System/National Vital Statistics System (NOMS/NVSS) and the National Violent Death Reporting System (NVDRS), which collect information from death certificates on usual (longest-held) I&O. NVDRS also captures current occupation from coroner/medical examiner or law enforcement reports, when available. The 10 other systems examined focus on current I&O.

All of the systems that explicitly collect I&O either receive this information as detailed, standardized codes from the states (ABLES and SENSOR-Pesticides) or elicit the information as free text. In many cases, however, the detailed I&O information is not included in publicly available data sets and requires special access arrangements to protect respondent confidentiality.

Even when included, I&O information is not always collected consistently and nationally. For example, the Adult Blood Lead Epidemiology and Surveillance program (ABLES) collects industry only if the exposure is thought to be work-related; the same is true for collection of work-related information by Sentinel Event Notification System for Occupational Risk (SENSOR)—Pesticides. BRFSS does not collect I&O for all participants, as I&O is elicited in an optional module. The National Health Interview Survey (NHIS) now collects I&O two out of three successive years. The National Health and Nutrition Examination Survey (NHANES) stopped collecting industry after 2014, although occupation is still collected.

Table 2 provides the details of work-related information captured by each of the 12 systems identified as collecting some data about employment status, I&O and work history, and selected working conditions. The table indicates where variables are not collected for all participants or every time the survey is administered. Beyond employment status, I&O is most frequently collected, along with three items related to pay and benefits: household income, health insurance, and source of health insurance. However, income is usually collected at the household level, as is health insurance information in some surveys, so access to these forms of pay and

TABLE 1 Selected Centers for Disease Control and Prevention public health data systems reviewed for work-related information^a.

Name	Includes basic information (employment status, industry and/or occupation; or restricted to specific worker group) ^b	More than basic (basic variables and at least one working condition) ^c
Adult Blood Lead Epidemiology & Surveillance (ABLES)	Subset	No
Behavioral Risk Factor Surveillance System (BRFSS)	Subset	Yes
Childhood Blood-Lead Poisoning Surveillance System (CBLS)	No	–
Commercial Fishing Incident Database (CFID)	Restricted to worker group	Yes
Coal Workers Health Surveillance Program (CWHSP)	Restricted to worker group	Yes
National Agricultural Workers Survey (NAWS)	Restricted to worker group	Yes
National Health and Nutrition Examination Survey (NHANES)	Yes	Yes
National Health Interview Survey (NHIS)	Yes	Yes
National Occupational Mortality Surveillance System (NOMS)/National Vital Statistics System—Mortality	Yes	No
National Violent Death Reporting System (NVDRS)	Yes	No
Pregnancy Risk Assessment Monitoring System (PRAMS)	Subset	Yes
Quality of Worklife Survey (QWL)—Supplement to General Social Survey (GSS)	Yes (GSS)	Yes
Sentinel Event Notification System for Occupational Risks – Pesticides (SENSOR-Pesticides)	Subset	Yes
Youth Risk Behavior Surveillance System (YRBSS)	No	--

Note: Subset = information ascertained for subset of individuals in data set.

^aCDC or CDC-supported public health data systems.

^bData sets restricted to specific groups of workers are marked “Yes.”

^cData sources only including veteran's status in addition to employment status and I&O are coded “No.”

benefits may not be directly attributable to the respondent's employment in a particular industry or occupation. Three data systems focusing on specific types of workers (CWHSP, CFID, and NAWS) also collect work history information on other jobs held in that industry, along with pertinent exposure data.

Some surveys only elicit information on working conditions periodically or do not ask related questions of all respondents. In addition to the I&O module that states and territories can opt to administer annually, the BRFSS has historically collected additional work-related information from a subset of employed respondents as part of the Asthma Call-back Survey (<https://www.cdc.gov/asthma/acbs.htm>), which is also an optional module. Of all data systems examined, the NHIS and the Quality of Worklife (QWL) module, which NIOSH sponsors periodically as part of the General Social Survey (GSS), include the most extensive sets of questions on working conditions, but neither supplement/module is administered annually.

Information collected by these instruments covers a wide range of topics, with the scope including employment status; detailed work arrangement categories; workplace psychosocial conditions; and occupational exposure hazards (such as chemical, physical, and

ergonomic). For NHIS, this information has been gathered through a set of NIOSH-sponsored occupational health supplements (OHS) administered in 2010, 2015, and 2021, with questions differing by supplement year (see <https://www.cdc.gov/niosh/topics/nhis/default.html> for questions from 2010 and 2015). NIOSH was also able to sponsor questions on NHIS related to potential for workplace exposures to SARS-CoV-2 in 2020 and 2021. The information on the QWL has been gathered periodically; while the core GSS elicits current employment status, whether the respondent ever worked for at least a year, and current industry and occupation annually, the QWL has gathered additional work-related information every 4 years since 2002 from GSS respondents who are employed adults.

Four systems (NAWS, NHANES, NHIS, and PRAMS) collect information on work hours and scheduling, and only NHIS and PRAMS collect information about leave (whether paid or unpaid). NHIS OHS (2015). NAWS collect data on safety climate, and the CWHSP collects information about the use of respirators at work. Coverage of emerging working conditions is sparse; for example, no data system collects information on electronic surveillance of workers (e.g., whether worker productivity is captured electronically).

TABLE 2 Work-related variables captured in 2021¹ in select Centers for Disease Control and Prevention public health data systems.

Domains and variables	ABLES	BRFSS	CWHSP	CFID	NAWS	NHANES	NHIS	NOMS/ NVSS	NVDRS ^a	PRAMS	QWL	SENSOR— Pesticides	Not collected in sample systems
EMPLOYMENT STATUS													
Employment status details													
Employment status (minimally employed, unemployed, or out of the labor market; can also include self-employed, unable to work, retired, student, homemaker)	○	●	⊗	⊗	⊗	●	●		○		GSS	○ ⊗	
Number of jobs currently held										●			
Duration unemployed						●					GSS		
Reasons unemployed		○			●	●					GSS		
Change in employment status or hours						●			○				
INDUSTRY AND OCCUPATION													
Employer, industry and occupation													
Employer name/address			●		●								
Current industry	○ NAICS codes from states	○ Free text	⊗	⊗	⊗	○	○ Free text		○	○ Free text	GSS	● Census code or NAICS from states	
Usual/longest held industry						2010/2015 Free text		● Free text	●				
Current occupation	○ Free text	○ Free text	●	●	●	○	○ Free text		○	○ Free text	GSS	● Census occupation from states	
Usual/longest held occupation						2010/2015 Free text		● Free text	●				
Main work activity or duties						●							
Current military service						●			○				
Work history													
Years at present job/job dates		●			●								
Years at all jobs/job dates													

(Continues)

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TABLE 2 (Continued)

Domains and variables	ABLES	BRFSS	CWHSP	CFID	NAWS	NHANES	NHIS	NOMS/ NVSS	NVDRS ^a	PRAMS	QWL	SENSOR— Pesticides	Not collected in sample systems
Partial employment history			•		•								
Complete employment history			•	Mining and other dusty jobs only	•								X
Veteran status		•				•	•				GSS		
WORKING CONDITIONS													
Work arrangement													
Temporary or not expecting job to last							2010/2021				○		
Standard arrangement							2010/2015				○		
Independent contractor							2010/2015				○		
Temporary help agency workers							2010				○		
Worker provided by contract firms					•		2010				○		
On-call workers							2010				○		
Other							2010				○		
Combined temporary help agency and workers provided by contract firms							2015						
Combined on-call and other							2015						
Employer deducts taxes from pay							2021						
Work schedule and hours													
Work hours (including part-time work, long shifts)					•	•	•				○		
Total hours worked at all jobs													○
Number of days per week worked													○
Work shift (e.g., day, evening, night, rotating, split)					•		2010/2015/2021						○
Schedule control, predictability, or flexibility (choice of days off, hours off, work schedule)							2021						○
Overtime (any, voluntary vs. mandatory)													○

TABLE 2 (Continued)

Domains and variables	ABLES	BRFSS	CWHSP	CFID	NAWS	NHANES	NHIS	NOMS/ NVSS	NVDRS ^a	PRAMS	QWL	SENSOR— Pesticides	Not collected in sample systems
Work location (work at home, reason working at home)											○		
Work/nonwork balance							2010/2015				○		
Pay and benefits													
Pay status (salaried, hourly, piecework)					●						○		
Salary/wage income					●						GSS		
Household income		●			●	●	●		●		GSS		
Income stability/variability of earning (predictable, or varying with hours or business)							2021						
Income adequacy and equity											○		
Health insurance		●			●	●	●		●		GSS		
Health insurance cost							●		●				
Source/type of health insurance		○			●	●	●		●		GSS		X
Retirement benefits													
Paid sick leave							●						
Other paid time off										○			
Unpaid leave available									b				
Workers' compensation					●		2010						
Workplace psychosocial conditions													
Job security (i.e., pertaining to labor agreement: permanent, open-ended, or limited in terms of time; or concern about becoming unemployed)							2010/2015/2021				○		
Quantitative workload (vigilance, mental demands)							2015				○		
Job control (skill discretion and decision latitude)							2015				○		
Opportunity for advancement/skills development											○		
Safety Climate		●			●		2015				○		

(Continues)

TABLE 2 (Continued)

Domains and variables	ABLES	BRFSS	CWHSP	CFID	NAWS	NHANES	NHIS	NOMS/ NVSS	NVDRS ^a	PRAMS	QWL	SENSOR— Pesticides	Not collected in sample systems
Supervisory support							2015				○		
Supervisory responsibilities							2015				○		
Social hazards (discrimination; harassment; bullying)							2010/2015				○		
Occupational exposure hazards													
Work-relatedness of exposure	○											○	
Specific chemicals (e.g., lead, asbestos, specific pesticides)	●	●										●	
Contaminants: vapors, dust, gases, fumes (collected as a grouped exposure)		○					2010					●	
Route of exposure													
Secondhand Smoke							2010/2015						X
Vibration, radiation, temperature stress													
Outdoor work				⊗			2010						
Exposure risk factors ^c for adverse outcome (injury/fatality/poisoning)				●								●	
Ergonomic stressors (e.g., repetitive motion, forceful exertion, lifting)							2015				○		
Work in close proximity to others							2021						

Note: For NHIS, occupational health supplements (OHS) were administered in 2010, 2015, and 2021. Variables collected in the NHIS core are labeled as described above. Variables collected in the OHS are labeled with the year(s) collected. The QWL has been administered as part of the GSS in 2002, 2006, 2010, 2014, 2018, and 2022. Additional questions have been added since 2010. For GSS/QWL, variables collected by the core GSS are labeled "GSS" and those collected by the QWL use the open circle because the QWL is administered periodically. Please see Supporting Information S1: Appendix B for explanation of the conceptual organization of work arrangements and selected other working conditions, particularly those elicited by NHIS-OHS.

Abbreviations: ABLES, Adult Blood Lead Epidemiology & Surveillance; BRFSS, Behavioral Risk Factor Surveillance System; CWHSP, Coal Workers Health Surveillance Program; CFID, Commercial Fishing Incident Database; FACE, Fatality Assessment and Control Evaluation; GSS, General Social Survey; NATS, National Adult Tobacco Survey; NAWS, National Agricultural Workers Survey; NHANES, National Health and Nutrition Examination Survey; NHIS, National Health Interview Survey; NHSN, National Healthcare Safety Network; NOMS/NVSS, National Occupational Mortality Surveillance/National Vital Statistics System; NVDRS, National Violent Death Reporting System; OHS, Occupational Health Supplement of NHIS; PRAMS, Pregnancy Risk Assessment Monitoring System; SENSOR, Sentinel Event Notification System for Occupational Risks—Pesticides; QWL, Quality of Worklife Questionnaire;

●, collection on a regular basis (i.e., annually) from all participants.

○, periodic or optional collection (because questions are optionally added by states or only administered to a sample or specific subset of participants, and so forth).

⊗, implied variables collected (e.g., employment status and outdoor work for CFID and NAWS, because the data systems focus on specific groups of workers).

^aTable reflects variables captured in 2021, except as noted.

^bNVDRS has a separate Public Safety Officer Suicide module that gives the opportunity to provide more occupation-specific information for these decedents.

^cElicits whether unpaid leave was taken, not whether it was available.

^dExamples of exposure risk factors include working alone (CFID) and whether a leak/spill occurred (SENSOR-Pesticides).

4 | DISCUSSION

A research agenda designed to explore relationships between work, health, and health disparities requires robust data on both work and health,⁷ yet no public health data system we reviewed captures nationally-representative information about a wide range of work domains annually. The resulting data gaps hinder efforts to understand how work functions as a social determinant that can potentially produce, reinforce, or mitigate health disparities.

The most complete information could be obtained by national, routine administration of a comprehensive survey of current and former workers, including their work histories (including industry, occupation, and dates for all jobs and gaps in employment) and past and current information about a wide range of working conditions and health and well-being outcomes. Developing and conducting such a population-based survey would involve consideration of resources this effort would entail.

In the absence of such a survey, examining health disparities and inequities among US workers requires cobbling together multiple health surveys and other data sources not created for that purpose. As the 2018 National Academies Consensus Study Report points out, this piecemeal approach is limiting: important demographic variables may be omitted; the surveys focusing on work may not include health-related items; and surveys focusing on health often fail to capture an adequate set of work-related items.⁷ In the interim, improvements in the collection of employment status, I&O, and work characteristics can increase the utility of existing data systems.

4.1 | Suggested approaches for collecting employment status, I&O, and working conditions

4.1.1 | Employment status

Basic collection of employment status uses the BLS categories employed, unemployed, and not in the labor market. However, more granular information about unemployment duration facilitates examination of the relationships between employment, demographics, and health. Potential cutpoints include 6 months (BLS definition of short-term unemployment); 12 months (currently used in BRFSS and other studies); 18 or 24 months (to demarcate eligibility to purchase continuation of employer-sponsored health coverage); and 60 months (for very long-term unemployment). The type of work arrangement (employed by a business or company; employed by a temporary employment agency; employed by a contract firm, other than a temporary employment agency; an independent contractor; self-employed, not an independent contractor, or other) may be related to benefits (availability of health insurance or employer retirement contributions), work-life balance, and other SDOH. In addition, understanding why respondents are not working (e.g., full-time students, voluntarily out of labor market, unable to find work, unable to work due to disability, permanently retired) is important for distinguishing voluntary from involuntary employment and how

employment status is related to health equity, but this information is not fully captured in many data systems. This more comprehensive information on employment status might be best collected using multiple questions.

4.1.2 | I&O

I&O are collected to assess, both directly and indirectly, how differences in types of work, such as exposures,²⁹ affect health. Collection and analysis of both I&O is optimal for assessing these differences; currently, some systems only collect one of the two data elements.

Optimizing collection of I&O information is key to examining associations between work and health. In the absence of a work history, current or usual I&O has often been used to examine these associations. Whether current or usual I&O is most salient depends on the research questions under study, with usual I&O collected in cancer registries and death records to account for disease latency and work longevity and current I&O collected in systems designed to capture traumatic injuries or infectious diseases. As many population surveys cover multiple health outcomes, the collection of both current and usual I&O is optimal if resources allow. In addition, some people hold multiple jobs simultaneously; while surveys may opt to collect I&O for the main job (i.e., most hours), information about all jobs is necessary to truly understand a worker's experience and information on potential workplace exposures.

Standardized, detailed I&O data are key to maximizing the utility of this information for health equity research. However, currently, as illustrated by our review of CDC Surveillance systems, the information is elicited using different questions and is collected in some systems as free-text narratives and in others, via selection from a menu of choices by respondents or interviewers. In some surveys, the name of the worker's business is captured along with or in place of industry, and primary job tasks may be captured to augment occupation. Free text I&O data provide greater specificity than a drop-down menu or limited set of options; pre-selected options are often limited to broader I&O categories to minimize participant response time, yielding I&O data that may be too broad to permit identification of previously unrecognized relationships between specific jobs and outcomes of interest (e.g., collection of only "healthcare worker" and "non-healthcare worker" rather than the exact job held by the participant in COVID-19 surveys). The lack of free-text I&O data on all working age COVID-19 cases may have delayed or prevented identification of the disparate impacts of COVID-19 on different worker populations, including work-related risk of infectious disease and the intersection of social marginalization of demographic groups and increased work-related infection risks.

NIOSH has developed tools to facilitate the universal collecting and coding of free text I&O information in health data systems.³⁰ For analytic use, I&O free text can be transformed into standardized, numeric I&O codes such as the North American Industry

Classification System (NAICS) and Standardized Occupational Classification (SOC) codes or the US Census Industry and Occupation codes.³⁰ Recently developed high-throughput, publicly available automated coding systems have greatly reduced the burden of coding free-text I&O, which was previously a deterrent to gathering I&O as free text. NIOSH developed the NIOSH Industry and Occupation Computerized Coding System (NIOCCS) to transform free-text I&O into standard codes established by the Bureau of Census, the Department of Commerce, and the Department of Labor.³¹ NIOSH has used this program to code I&O from many sources, including US death certificates (used for the National Vital Statistics Reports and NVDRS); BRFSS; and NHANES. The program has also been used to meet the needs of other of CDC and external partners. Academic researchers, and others have used the public facing version of NIOCCS to code records individually or in batch mode.

4.1.3 | Working conditions

One of the seven NIOSH Strategic Goals is to “Promote safe and healthy work design and well-being.”³² There is no consensus on how to prioritize the collection of information on working conditions, even though this information is necessary to fully evaluate associations between work and health equity. In addition, related concepts that include different sets of working conditions, such as safety climate, work arrangements, and flexibility, are not consistently defined within and among data systems. The objectives of the data system, as well as the specific populations included, can guide the determination of which potential variables are critical to collect.

Some key categories of working conditions include work arrangements^{33,34}; work schedule (e.g., full- vs. part-time status, shift start time, scheduling flexibility and predictability)³⁵⁻³⁷; pay and benefits, including leave^{38,39}; and workplace psychosocial conditions (e.g., job control and demand, and work precariousness—including components of temporariness, disempowerment, vulnerability, and satisfaction with wages, benefits, and career advancement).^{37,40} Examples of other working conditions related to health and well-being as well as health equity include training, skill development, and advancement opportunities; workplace safety and safety climate; workload and work-nonwork balance; and physical, chemical, and ergonomic exposures. Aspects of job content (variety, predictability, engagement) and work pace control are also important working conditions that were included on the QWL but no other survey. Tasks associated with an individual's job are also crucial for understanding job hazards and for ascertaining whether workers of color are more likely to be assigned to more hazardous tasks within an industry/occupation combination.

Work flexibility is yet another term with no standardized definition, but common work-flexibility types include being able to work at home, take time off when needed, and change one's work schedule. The COVID-19 pandemic has highlighted how the ability to work at home is key both economically and in lowering

risk of infection with SARS-CoV-2, with higher infection rates observed among frontline/essential workers who could not work remotely.⁴¹ Those who could not work from home are disproportionately members of minoritized races and ethnicities,¹⁷ highlighting the association between this working condition and health disparities.

4.2 | Strengthening collection of work-related information

4.2.1 | CDC surveys and CDC-sponsored modules

Despite some improvement in the inclusion of work-related variables in data systems, sizable gaps in the information needed to evaluate the role of work in health disparities remain. Some key enhancements to existing CDC surveys could markedly increase their utility for evaluating work as a SDOH and for examining occupational and other health disparities. Collecting work-related information (employment status, I&O, and working conditions) in surveys focusing on minors, such as YRBSS, is increasingly important as some state-level restrictions on child labor are eliminated^{42,43}; collecting work-related information for parents in data sets such as CLBS where take-home exposures potentially affecting children may be relevant. Studies that collect only industry or occupation could be enhanced by collection of the other variable, to account for differences in work environments within industry by occupation and the converse. Four CDC surveys, BRFSS, NHIS, NHANES, and PRAMS, could be enhanced by annual collection of I&O data from all employed or recently employed participants (Supporting Information S1: Table 1). This enhancement could facilitate analytic approaches such as estimation of national prevalences and evaluation of temporal trends. Comprehensive data on I&O, coupled with biological data (such as in NHANES) or with data on working conditions, could be used to assess where, within I&O groups, workplace hazards fall disproportionately on employees from minoritized groups. Comprehensive collection of I&O in these systems could allow future efforts to prioritize collection of key data on working conditions. The QWL has been administered six times since 2002 with approximately 2000 respondents per administration; this relatively small set of respondents limits the ability to analyze working conditions by detailed occupation. Administration of the QWL annually would yield a more robust data set for assessing relations between I&O and an extensive list of working conditions, and selected health conditions.

More frequent administration of existing work-related questions, more comprehensive administration of these questions (i.e., to all employed participants), and addition of new items, are hindered by the limited space available on the instruments and by requirements to limit participant burden. In response, some systems have responded by reducing the frequency of ascertainment of some items, such as I&O. This “rotating survey core” strategy does save space and reduce burden but can limit the ability of researchers to analyze items that

are rarely ascertained in the same year or to evaluate short-term temporal changes in those variables. Consideration of the role of different variables in SDOH and the scope of content captured in the variables may be helpful for prioritization and scheduling of question administration.

Employment status is intertwined with all other SDOH; collection of this information from all participants of working age at every survey administration is key. Because I&O are so varied, accumulation of multiple years of data is often required for reportability, particularly for analyses involving less common I&O or examining I&O combinations (e.g., patient care aides in the home health industry compared to those in the nursing home industry). With less than annual ascertainment of I&O, or ascertainment from only some participants (i.e., in the context of optional modules), timely identification of groups of workers most impacted by health disparities is hindered. Therefore, annual ascertainment of I&O from all currently- or recently-employed participants is a high priority. Data on working conditions are also key for understanding how work functions as a SDOH; however, the set of variables within this umbrella is so large that either judicious selection of items for frequent collection or less frequent collection of a larger set of these variables may be necessary, although less than ideal, given rapid changes in the world of work.

4.2.2 | Nonsurvey data systems (case reports)

CDC also has a role in promoting the collection of work-related information in other types of data systems. The COVID-19 pandemic illustrated the critical importance of collecting I&O for infectious disease cases; for example, this information was used to identify jobs and workplaces with high infection rates or infection clusters and to prioritize those for interventions. The National Notifiable Disease Surveillance System (NNDSS) collects national notifiable disease data on 120 diseases, bioterrorism agents, and noninfectious conditions from public health departments. Data collection for some conditions already include I&O for all reports, while others only ascertain whether a report involved someone working in a particular occupation (e.g., “childcare worker” or “healthcare worker”). Inclusion of employment status and free-text I&O for more of these diseases could yield valuable information about disease risks and help prioritize worker populations for surveillance, prevention, and treatment efforts. An example of progress in including I&O in mortality data systems is shown in Box 1.

Cancer registry data can be used to evaluate relations between employment in certain industries and occupations (and attendant exposures) and development of malignancies. The 1992 Cancer Registries Improvement Act (Cancer Registries Amendment Act, 3372 [Public Law 102–515]) included industrial and occupational history among data items to be collected, when available, for incident cancer cases. However, there are large gaps in the availability of I&O data in registries,^{45,46} particularly for malignancies commonly reported by entities such as laboratories. Laboratories also collect

BOX 1 Progress in Inclusion of I&O—National Occupational Mortality Surveillance (NOMS)/Vital Statistics System Mortality Files

A collaboration between NIOSH and the National Center for Health Statistics (NCHS) resulted in inclusion of industry and occupation for all deaths of those aged 15 and older in the National Vital Statistics System public use data available through NCHS's website (https://www.cdc.gov/nchs/nvss/mortality_public_use_data.htm). As of 2022, the data set includes free text I&O for all vital statistics jurisdictions (50 states and two cities). Usual I&O can be analyzed by cause of death, with ability to standardize for a set of demographic variables (race, ethnicity, sex, education level, manner of death, and others).

The resulting data facilitate monitoring of changes in causes of death by usual industry and occupation over time, as well as research on occupational health disparities, such as recognition that people of color are overrepresented in two of the three occupation groups with the highest 2020 COVID-19 death rates: food preparation and serving related, and construction and extraction.⁴⁴

information on infectious disease cases and exposures (e.g., lead and pesticides) that may be work-related. However, gaps in the flow of demographic data (including I&O) between providers, labs, and data recipients, resulting from human factors and from antiquated or incompatible data systems, hinder use of the data to identify populations at greatest risk, as well as the level of excess occupational disease burden experienced by these populations.

Key work information, particularly I&O, is not currently systematically included in electronic health records (EHRs). NIOSH developed Occupational Data for Health (ODH), a structured framework for capturing self-reported patient work information to provide EHR vendors with methods for including I&O and other work-related variables in EHRs. The model also includes collection of information on employed household contacts for data systems focusing on minors.⁴⁷ When patient record systems will be upgraded to include work-related information and become fully integrated into hospital patient records is unclear.

Our study has several limitations. We used a convenience sample of CDC-supported systems and may have missed other CDC-supported systems that collect or would benefit from collection of information on work. Non-CDC data systems (both governmental and nongovernmental) were outside the scope of this project but include many longitudinal systems that do collect extensive data on work. We included many of the working conditions that are currently captured by the systems we reviewed, but other information about working conditions is important for understanding associations between work and health. Examples include the quality of the

relationship with coworkers, the quality of relationship with customers and clients, and the opportunity to learn and use one's skills. We focused on the availability of information on multiple aspects of work; information on health and well-being also varies by data system but was beyond the scope of the current project.

Despite these limitations, our findings reveal patterns of data gaps that, if addressed, would yield more robust information for identifying health disparities with a level of specificity that would be informative for prevention and intervention efforts. Collecting employment status and labor market participation from all teens and adults, eliciting I&O from all employed or recently employed participants, and routinely collecting data about working conditions would strengthen the data systems evaluated here, along with many others.

5 | CONCLUSION

Currently, the lack of robust data spanning work and health in nationally representative public health data sets hinders the ability of occupational and public health researchers to assess relationships between work and other social determinants and to understand and address the role of work in health disparities. If work is not consistently included in surveys, case reports, registries, and other public health and clinical data collections, efforts to fully understand what drives and reinforces health disparities will be missing key information.⁷ Once collected, evaluating work-related data in the context of the structural and systemic drivers of work equity (e.g., residential segregation affecting educational, and then employment, options); hiring and employment discrimination; occupational segregation; pay inequalities affecting access to childcare and transportation) is key to effectively addressing work-related health inequities. Furthermore, because working conditions and job characteristics are modifiable through policies and practices at the organizational and societal levels, work can serve as a locus for interventions to decrease disparities in and beyond the workplace.

Routine and robust collection of work-related data in CDC and other data systems is critical to informative assessments of the role of work as a SDOH. More robust collection of employment status, industry, and occupation, along with key work characteristics, in CDC data systems could facilitate immediate progress toward this goal. In addition, data modernization efforts that promote inclusion of work data across systems, as resources allow, can provide the long-term foundation for research needed to identify and address health disparities.

AUTHOR CONTRIBUTIONS

Michael A. Flynn originated the project. Michael A. Flynn, Rene Pana-Cryan, Marie H. Sweeney, Sharon R. Silver, and Andrea L. Steege contributed substantially to the project design. Wayne Sanderson, Tania Carreon, Brian Quay, Sharon R. Silver, Andrea L. Steege, and Marie H. Sweeney collected the data. Wayne Sanderson, Tania Carreon, and Sharon R. Silver developed the data tables. Rene

Pana-Cryan and Brian Quay provided economic perspectives on working conditions, and Rene Pana-Cryan developed supplemental material on this topic. Michael A. Flynn, Sharon R. Silver, Rene Pana-Cryan, Marie H. Sweeney, Brian Quay, Andrea L. Steege, and Wayne Sanderson wrote sections of the manuscript. Sharon R. Silver finalized the manuscript, reflecting comments and revisions provided by all of the authors and reviewers. All authors have approved this version of the manuscript for submission to AJIM and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

John D. Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no data sets were generated or analyzed during the current study.

DISCLAIMER

The findings and conclusions presented in this article are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health/Centers for Disease Control and Prevention.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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