

Working: The Role of Occupational Epidemiology

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Running head: Whatever happened to Occupational Epidemiology?

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Abstract

The COVID-19 pandemic redemonstrated the importance of work as a determinant of health. Extant disparities were accentuated, as the workforce was divided into the roughly 50% who could safely work from home and those who could not. With the spotlight on work, one might wonder where all the occupational epidemiologists have gone. To answer, we point to diminished research support and more limited workplace access that have led many to shift away from a focus on workers towards other vulnerable populations. We build on the renewed interest in work as a driver of health and inequality during the pandemic to highlight contributions of occupational epidemiology to public health. Consider: (1) *etiologic studies* of chronic disease based on employment records to define cohorts and reconstruct long-term exposure; (2) *studies of hypothetical interventions* particularly appropriate for evaluating potential regulations to reduce workplace exposures; and (3) *studies of disparities* that take advantage of work as a potential source of social stratification and economic opportunity. As we have learned during COVID-19, workplaces can become venues for public health messaging and delivering interventions to enumerated populations of adults. By starting with COVID-19 prevention policies, we have a chance to protect public health and rethink work.

Key words: occupational health, environmental health, health disparities, racial disparities, vulnerable populations, workplace, work as a social determinant of health

Abbreviations: NIOSH: National Institute for Occupational Safety and Health

The COVID-19 pandemic precipitated the swift and staggering loss of an estimated 22.1 million U.S. jobs between January and April 2020 alone.¹ In the intervening months, the importance of work as a determinant of health and well-being has been clearly demonstrated anew. For example, the pandemic accentuated extant disparities within the U.S. labor force by dividing the workforce into the roughly 50% who could safely work from home² – mostly well-educated workers in technology, education, and other professions – and those essential workers who could not. With the notable exception of physicians and nurses, most essential workers receive low wages and many are people of color. In Massachusetts, a study of COVID-19 fatalities across occupations reported that certain occupations, including healthcare support, transportation, and material moving, had mortality rates higher than that of working age adults overall. Hispanic and Black workers had age-adjusted rates more than four times higher than white workers overall and also higher rates than whites within occupational groups.³ In California, excess mortality rates were among the highest for Latino food and agriculture workers and among Black retail workers.⁴

Though occupation as a social determinant was recognized up to the mid 20th century,⁵ it largely disappeared from U.S. vital records as infectious disease became dominant in public health.⁶ Early in the pandemic, analogies with influenza initially led public health researchers to focus on risk of COVID-19 transmission in households and schools, as well as hospitals, but excess mortality due to COVID-19 was also found among essential workers in meat packing and poultry plants, as well as in agriculture and transportation. Public facing jobs, like cashiers in grocery stores and other retail outlets, were at increased risk of COVID, as were workers in elderly residential facilities. Risks borne by grocery store employees and other low wage essential

workers were not as widely acknowledged as frontline health workers but have contributed towards the recognition that exposures in the workplace can be a critical source of transmission and heightened risk of disease.

Given the prominence of the workplace as a risk factor for COVID, it is reasonable to wonder, as Jay Kaufman did in his plenary talk at the 2021 annual meeting of the Society of Epidemiologic Research (SER), why has the field of occupational epidemiology largely disappeared?

Despite its clear role as a determinant of health and a driver of inequality, few epidemiologists today are engaged in studying the health effects of work. This contraction of the field is reflected in fewer occupational studies published in our epidemiology journals or presented at our conferences. Yet traditional occupational exposures to dusts, gases and fumes, as well as ergonomic hazards, still exist in many sectors, such as manufacturing, construction, and mining. We see no reason to accept, as some have argued, that all important workplace health hazards have already been identified. As the labor market evolves in response to new and emerging technologies, unique workplace physical and chemical hazards are certain to emerge. Moreover, the definition of workplace exposures should be broadened to include socially toxic work environments such as gender, racial or cultural discrimination, as well as potentially hazardous work schedules.

The significance of the workplace extends beyond an opportunity to prevent disease and injury. Throughout labor markets both domestic and international workers are exposed to vastly different social and economic risks based on their job. In the United States specifically, declines

in manufacturing and unions, especially in the private sector, have coincided with a rise in wage inequality and disparities in access to health and retirement benefits along with the growth in precarious work and the gig economy. These new jobs entail a different set of health and safety concerns arising from high demand and low control over work, as well as fixed contracts, job insecurity, lack of worker rights and benefits, and reduced social standing. Together these trends in the labor market have eroded the middle class and increased economic and health disparities.⁷

Why have occupational epidemiologists largely disappeared?

In the 1970s and 80s, activist public health scientists interested in having an impact were motivated to protect workers' health and safety. In those years, labor unions provided strong advocacy for the creation and ongoing support of the National Institute for Occupational Safety and Health (NIOSH) within the Centers for Disease Control and Prevention as the premier research institute to support policies developed by Occupational Safety and Health Administration, newly created in the Department of Labor. Spearheaded by Tony Mazzochi of the Oil, Chemical and Atomic Workers Union, initiatives to align educated activists with the labor movement were supported by NIOSH training grants in public health schools across the country that attracted students to the field.

As public support for labor movements diminished, so too did support for NIOSH as an extramural funding agency. In response, the agency established a research-to-practice (r2p) initiative in 2004 designed to maximize the impact of a reduced budget.⁸ This policy shifted limited research funds (18% of their total budget in 2021) towards lower-cost studies at the expense of long-term cohort studies or new methods development. The dire funding situation for

academic occupational epidemiologists was exacerbated by an apparent NIH practice directing any grant proposal focused on workers to NIOSH. As examples, proposals on work-related risk factors for cancer were directed to NIOSH rather than National Cancer Institute and proposals about workplace exposure to fine particulate matter (PM_{2.5}) were directed to NIOSH rather than National Institute of Environmental Health Sciences. These practices created a real and profound disincentive for public health research to focus on working populations.

Research universities have become increasingly dependent on extramural funding to support faculty. As research funds dried up many trained occupational epidemiologists who had been drawn to the field as either public health scientists or activists shifted towards environmental health, and especially children's health. Public health students eager to have an impact were motivated to protect impoverished populations worldwide and gravitated to global environmental health. It may be, however, that the COVID-19 pandemic has altered perceptions of the role of work in defining vulnerable populations. As the workplace comes to be viewed once again as a significant determinant of health disparities, student interest in occupational epidemiology may grow.

Another longstanding obstacle to occupational epidemiology is restricted access to data required to study workplace exposures and their effects on health. In the past, unions were able to exert pressure on employers to release data necessary for health and safety studies.⁹ Collecting exposure data is not only expensive, but also requires the cooperation of the workplace in which the exposure occurs. Many occupational cohort studies in the U.S. were designed a quarter-century ago and include only mortality and basic demographic data.^{10,11} While mortality follow-

up can be extended using publicly available sources, exposure data cannot be. Occupational health research is often seen by employers as a potential threat to their company's reputation, leading to increased costs or new regulations. Increasing the presence and power of unions would improve the access to workplace data needed to do relevant research.

How might public health more broadly benefit from reinvigorated interest in work?

Beyond renewed interest in the importance of work as a driver of health and inequality during the COVID-19 pandemic, occupational epidemiology has the potential to play a renewed and essential role in public health. We consider three specific areas: (1) *etiologic studies* of chronic disease can rely on employment records to provide the basis for clearly defined cohorts and the reconstruction of long-term exposure; (2) *studies of hypothetical interventions* using g-methods to account for time-dependent confounders, are particularly appropriate for evaluating potential regulations to reduce workplace exposures; and (3) *studies of disparities* can take advantage of work as a potential source of social stratification and economic opportunity in a world of growing inequality.

Etiologic Studies: Both environmental and occupational epidemiology distinguish themselves from other areas of epidemiology in their reliance on rigorous, quantitative exposure assessment. One critical difference between the two fields is that the range of exposure concentrations is typically far wider in occupational settings than in the general environment, increasing the statistical power to detect modest associations. Moreover, occupational epidemiology often benefits from the availability of historical exposure measurements and individual work histories, which together facilitate the construction of cumulative exposure. By contrast, studies of

environmental exposures such as ambient air pollution typically assign long-term exposures on the basis of most recent address in the absence of full residential histories for cohort members—ignoring exposures experienced away from the home. Occupational studies can avoid this type of exposure misclassification. Due in part to these advantages, many of the most common environmental carcinogens – including asbestos, benzene, and radon – were initially identified in occupational cohorts.

Studies of hypothetical interventions: Because work can be modified by plausible interventions, the study of work as an environmental or social determinant of health presents an opportunity to identify possible strategies for reducing adverse outcomes. Occupational studies of chronic disease, however, are plagued by potential bias due to the healthy worker survivor effect. Healthy worker survivor effect arises because workers in poorer health tend to accrue less exposure, whether by reducing the amount of time that they work, switching to lower exposed jobs, or leaving work entirely. The workers who tend to survive in the active workforce and to accrue the most exposure, conversely, are the ones at lowest risk of adverse outcomes. Without addressing this bias, estimates of exposure-response associations can be misleading. By unpacking cumulative exposure into a series of successive exposures over time, healthy worker survivor effect can be understood as health status acting as a time-varying confounder on the causal pathway: it both contains a portion of the effect of past exposure and acts as a confounder of the future exposure-response relationship. Estimation of unbiased causal effects of exposure when data structures include these pathways requires the use of a class of modern statistical estimation approaches known collectively as g-methods.¹² G-methods were initially developed by J Robins, who had been trained in occupational medicine, to address the structural bias

created by healthy worker survivor effect and provide answers to causal questions.¹³ Though the implementation of G-methods is technically challenging, the motivation can be easily understood by all epidemiologists and the results can be described more intuitively than results of standard methods, eg hazard ratios. We have seen many epidemiology students drawn to studies of worker populations precisely because they provide an opportunity to apply these new analytical methods to correct for this particular form of selection and confounding bias.

G-methods in a counterfactual framework lend themselves to evaluating the impacts of hypothetical interventions on exposure. Consider two possible interventions where all workers experience the same fixed level of exposure: in the first, exposure is always high, and in the second, exposure is always low. If these two interventions were implemented, workers in poorer health would not reduce their exposure by leaving work and so health status would not act as a time-varying confounder in the resulting data. Although this intervention would not be feasible, G-methods contrasting the outcomes under these two interventions would estimate the etiologic effect of exposure. Alternatively, consider a more *realistic* intervention of the nature “if at work then exposure is set at or below the exposure limit.” This dynamic intervention depends on a subject’s employment status, in contrast to static “always at work and always exposed” interventions. Using G-methods, outcomes under no intervention can be compared to estimates of outcomes under such interventions allowing workers to leave work and be unexposed if not at work, as would be expected in a real-world setting.¹⁴ Policy changes will affect work in plausibly exogenous ways making the implementation of quasi-experimental methods a compelling approach to studying the causal effects of work on health.

Studies of health and economic disparity: Finally, an understanding of work is essential to promoting and improving public health because of its potential to impact both health and health disparities. Allied disciplines including sociology, economics, and organizational psychology have long focused on work as a key axis of social stratification. Although occupational epidemiologists have historically focused on the implications of physical and chemical exposures, there exist myriad questions at the nexus of occupational and social epidemiology. Consider the power of longitudinal studies of active workers such as the seminal Whitehall Studies that demonstrated an inverse association between social class and mortality among British Civil Servants,⁵ or the American Manufacturing Cohort (AMC) studies of aluminum manufacturing workers¹⁵ that linked gender composition with treatment for depression¹⁶ and layoffs with the mental healthcare utilization of remaining workers¹⁷.

Both U.S. and global labor markets have evolved in recent years to rely increasingly on shift work and flexible scheduling practices. The concurrence of union decline, weakening of institutional protections for workers, and the rise of the gig economy have normalized contract, temporary, and contingent jobs that rarely provide benefits. Even full-time U.S. jobs with regular employment contracts show marked disparities in access to health insurance or paid sick and parental leave. It does not have to be this way. Good jobs, with decent compensation and opportunities for worker voice, have the potential to promote health and well-being and to provide a sense of purpose and identity.¹⁸ Work also has the potential to provide upward social mobility and improved economic opportunity. And as we have learned during COVID--19, workplaces can become valuable venues in which public health messaging and interventions can

be delivered to clearly defined populations of adults. By starting with COVID-19 prevention policies, we may have a chance to simultaneously protect public health and rethink work.

ORIGINAL UNEDITED MANUSCRIPT

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