OCCUPATIONAL DISEASE IN NEW YORK STATE: AN UPDATE

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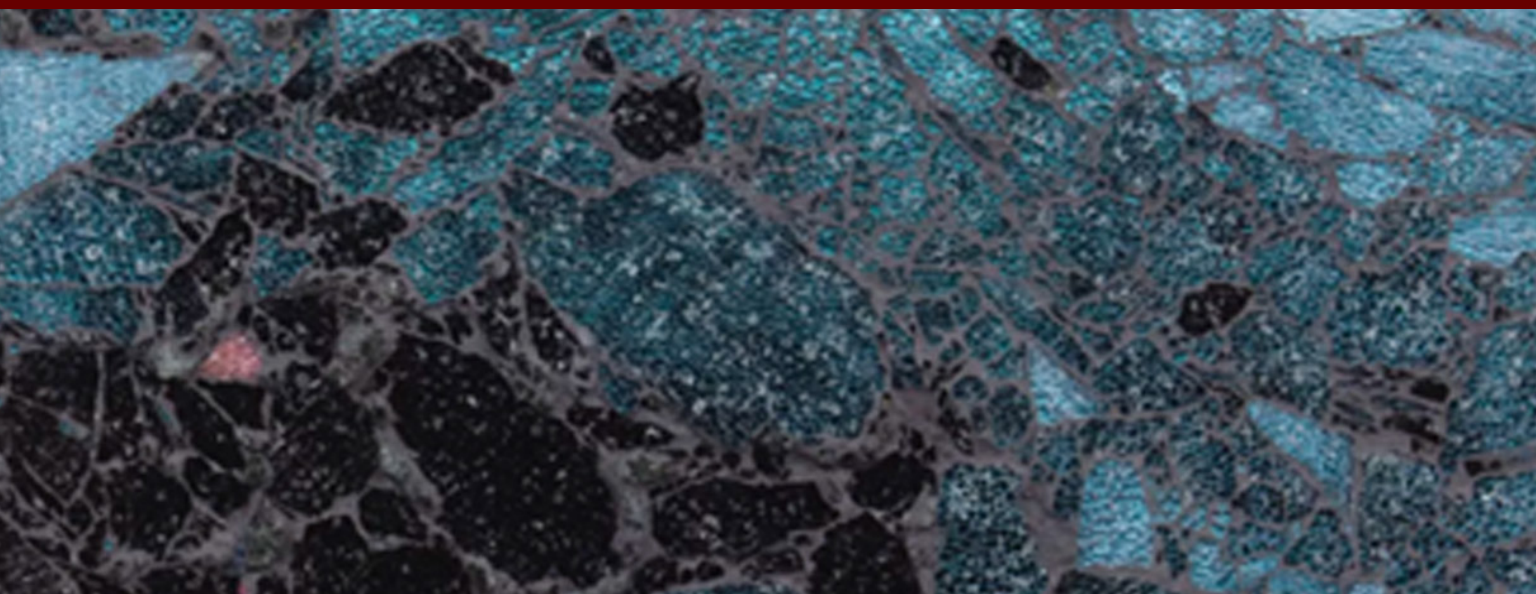

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PAINTERS AND ALLIED TRADES
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FORWARD

Its breadth and depth render occupational health endlessly fascinating. No sooner does one get an approximate handle on the great number of activities people do to earn a living then these activities evolve or are supplanted and require new examination. This breadth is matched by the equally challenging depth presented by workplace hazards and their attendant illnesses. I refer to the need to bring enormous areas of human knowledge, i.e., the lens of biomedical sciences, public health sciences, and social sciences, to develop a proper understanding of occupational health problems and their resolution. Consider, for example, what is required simply to identify and recruit an occupational population for a research study: toxicology to identify relevant toxins; medicine to target outcomes; epidemiology to structure and analyze the study population; and industrial relations to get your foot in the door.

It is little wonder then that most occupational health researchers adopt a narrow study approach. They follow the traditional scientific method of posing specific hypotheses, maximizing accuracy of exposure assessment, using accepted methods of characterizing illness or impairment, addressing confounders and interactions to the extent possible, and drawing conclusions that are qualified by caveats about study limitations. Adoption of this approach has been crucial to advancing our knowledge; supporting regulations to limit occupational exposures; and surviving the frequent challenges about the certainty of conclusions permitted by the knowledge gained by such research.

But, to their great credit, Drs. Lax and Zoeckler are after something else in this report: the big picture. They want to capture the breadth and, to the extent possible, the depth of occupational risks and illnesses in a large state with varied industry, New York. They raise important foundational issues, such as the nature of occupational diseases. They identify the hazards that we know most about – lead, silica, and ergonomic conditions, but also include key hazards not usually addressed in such studies, such as psychological stressors, substance abuse, asbestos in place, and COVID-19 infections. They include the problems of low wage workers with their characteristic racial, gender, and ethnic distribution, an issue that was not even on the radar of previous broad surveys of occupational diseases. They document the continued paucity of occupational health resources: just 37 occupational medicine physicians in the Workers' Compensation system in a state that has 20 million people and over 9 million workers! And they examine the utility of a unique resource – a network of state-supported occupational health clinical centers established over three decades ago in New York State.

Efforts such as this study inevitably have limitations and involve important assumptions. Data of all types – work-related hazards, illnesses, and costs – are of limited availability, quality, detail, and timeliness. The authors are transparent about these limitations, even if readers may not entirely agree on their importance and significance. And the report's recommendations may not engender consensus. But full agreement is not the point. The point is to provoke a discussion of where we are in occupational health and where we need to go. And, in this goal, Drs. Lax and Zoeckler have succeeded. Read on, and let the discussion begin.

Steven Markowitz MD, DrPH
City University of New York
November 13, 2021

EXECUTIVE SUMMARY

Occupational disease is an epidemic that is largely 'hidden in plain sight.' At the same time, work-related disease is preventable. Since these illnesses arise or are made worse by hazardous workplace conditions, elimination or reduction of those hazards eliminates or reduces disease.

More than 30 years ago, a report by Drs. Landrigan and Markowitz found that more than 5,000 NYS workers died from an occupational disease and at least 35,000 more developed a work-related illness each year. This new report shows that occupational disease remains a major public health problem in New York State, with little progress made since 1987.

Annually, over seven thousand New Yorkers lose their lives due to preventable exposure to workplace hazards, and at any given time, over two million New Yorkers suffer from a non-fatal work-related disease. Protecting workers from these hazards requires a multi-faceted approach, addressing disease recognition, treatment and prevention, and must involve both governmental agencies and non-governmental organizations and advocates.

Background

In 1987, Landrigan and Markowitz co-authored a report that showed:

1) At least 5,000-7,000 workers died from an occupational disease, and at least 35,000 workers developed a work-related illness each year
2) Nearly 10% of New York workers were employed in the fifty most hazardous industries and the Industrial use of toxic materials was extensive. Legally permissible levels of exposure were commonly exceeded.
3) The annual costs of occupational disease exceeded $600 million and much of the costs were borne by ill workers, their families, and taxpayers
4) Very few clinical resources existed to diagnose and prevent occupational disease

This new report builds on the framework created by Markowitz and Landrigan, but includes diseases and hazards that have emerged since that report, and takes into consideration additional ways that work plays a role in many chronic diseases, including cardiovascular disease, diabetes, and obesity.

Occupational Disease Mortality and Morbidity – New Findings

- Using the same methods as the 1987 study, this new report finds an estimated 3,085 to 4,430 workers die of an occupational disease annually in NYS. Though this number is slightly lower than in 1987, occupational diseases accounts for 3.3-4.7% of total deaths each year which is a higher percent than in 1987.
- When 'emergent' diseases are taken into account, an estimated 7,016 deaths annually were due to occupational disease, with 5,243 among men and 1,709 among women. Work related cancer and circulatory diseases comprised the majority of deaths for both genders.

- We estimated the annual prevalence of non-fatal occupational disease at 13.2% of total disease prevalence in the state, or over two million cases.
- 86% of the fatal diseases were cancers and circulatory, and 70% of the non-fatal diseases were musculoskeletal and respiratory.

Estimating the Extent of Hazardous Work

A very high proportion of workers in New York State continue to work under hazardous conditions that put them at risk of occupational disease. These hazards include:

Chemical Exposures	468,509 employees in 30,880 workplaces exposed to at least one of roughly 250 hazardous chemicals.
Lead	Over 300,000 workers were employed in industries with a risk of high lead exposure. An unknown additional number at risk of lower, yet still health threatening levels.
Silica	About 100,000 workers are exposed to silica at levels posing a risk of silicosis and other diseases. Over 90% of these exposures are in the construction industries.
Asbestos	Though asbestos use has declined precipitously since the mid-1970s, workers in the construction trades continue to be at high risk due to handling "asbestos in place."
Ergonomic Hazards	Ergonomic hazards are associated with a range of musculoskeletal conditions. Between 1 and 4 million workers reported significant exposure to ergonomic hazards .
Stressors	Psychosocial stress on the job is widespread, with as many as 6 million workers reporting significant exposure to stressful conditions at work.
COVID-19	A very high proportion of workers in NYS are employed in health care and other jobs deemed 'essential' and at high risk of acquiring COVID-19 infection, with a disproportionate burden of infection and mortality borne by Black and Latinx workers.

Occupational Health Inequities

Employer attitudes and practices, declining unionization, discrimination, and government policies all contribute to increasing numbers of 'vulnerable workers' at increased risk of occupational disease. 'Vulnerable workers' are concentrated in low-wage jobs that make up almost 40% of all jobs in the state. Workers in these jobs are disproportionately Black, Latinx, and women.

Estimating the Costs of Occupational Disease

The annual costs of occupational disease in NYS, an estimated $4.077 billion dollars, are tremendous. Employers are able to pass off most of those costs to others with injured workers, their families, and taxpayers paying over 70%.

Clinical Occupational Health Resources

Despite the creation of the publicly funded Occupational Health Clinic Network (OHCN), clinical occupational medicine resources remain scarce, particularly upstate. There are only 30 Board Certified Occupational Medicine specialists accepting patients with Workers' Compensation insurance in the entire state, almost one-third of whom are employed by the OHCN. A large gap remains between the magnitude of the problem of occupational disease and the clinical resources devoted to diagnosis, treatment, and prevention.

Recommendations

Recommendations to reduce the toll of occupational disease in New York State include:

1) Adequate Funding

- Increase funding for governmental and non-governmental occupational health programs commensurate with the need for services
- Develop mechanisms that make OHCN and OSHTEP funding sustainable and keep pace with increases in the cost of living

2) Building on the existing OSH infrastructure

- Systematically analyze existing data on occupational disease from the WCB, the OHCN, and state registries to target prevention efforts
- Develop other data sources to provide more comprehensive information on occupational disease workplace hazards
- Improve the Workers' Compensation process to provide an incentive for clinicians to participate
- Eliminate barriers to care for occupational disease by Workers' Compensation reforms that curb insurance carrier powers to deny and delay claims

3) Prevention of occupational disease

- Development of a statewide occupational disease prevention agenda that includes both governmental and non-governmental organizations in its crafting
- Incentivize employers to engage in occupational disease prevention efforts by reducing their ability to socialize the costs of occupational disease and by more assertive State intervention and regulation of workplace hazards

4) Integration and Collaboration

- Development of a statewide occupational disease prevention agenda that includes both governmental and non-governmental organizations in its crafting
- Continue the collaboration between these groups in the implementation of the agenda

5) Building worker capacity and expanding worker participation

- Build worker based occupational health capacity
- Include workers and worker advocacy organizations as central participants in collaborative occupational health efforts

Key words: occupational disease, occupational disease prevention, occupational disease surveillance, occupational epidemiology, occupational health, occupational medicine, occupational health services, work-related illness

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Chapter 1

OCCUPATIONAL DISEASE IN NEW YORK STATE

In 1987, Landrigan and Markowitz co-authored a report on occupational disease in New York State (NYS).[1,2] This pioneering effort estimated that:

1) At least 5,000-7,000O workers die from an occupational disease, and at least 35,000 workers develop a work-related illness each year
2) "(N)early 10% of New York workers were employed in the fifty most hazardous industries…Industrial use of toxic materials is extensive. Legally permissible levels of exposure are commonly exceeded."
3) The annual costs of occupational disease exceeded $600 million and that much of the costs are borne by ill workers, their families, and taxpayers

The report concluded that: occupational disease was common and often deadly; millions of workers labor under hazardous conditions that put them at risk of an occupational disease; and the costs of occupational disease were enormous. Given the magnitude of the problem, the authors emphasized that resources to diagnose, treat, and prevent occupational disease were wholly inadequate.

The report served to bolster an organizing effort led by the labor union movement, but including a broad range of occupational health professionals and activists, to establish a publicly funded network of occupational health clinical centers. The effort was successful in convincing state legislators and the governor to provide funding for the creation of a network.[3] Funding has been maintained for the more than thirty years since and the Occupational Health Clinic Network (OHCN) consists of eight clinics with a regional responsibility and one with a state wide mandate focused on agricultural safty and health.[4] OHCN clinics were envisioned as community based and advised centers that would employ multidisciplinary teams)including an Occupational Medicine physician, an Industrial Hygienist, and a Social Worker) to diagnose and prevent occupational disease.[5,6]

Just prior to the Landrigan/Markowitz report, the Occupational Safety and Health Training and Education Program (OSHTEP) was created to fund organizations to provide training and education to workers, heightening awareness about occupational health hazards and facilitating the development of the knowledge and skills necessary to reduce hazards by changing workplace conditions. OSHTEP funds were crucial to building both Committees on Safety and Health (COSH) and union health and safety staff. [7]

Both OSHTEP and the OHCN were funded through an assessment on Workers' Compensation Insurance premiums paid by employers. As a result of these pieces of legislation, public funding in New York has been crucial to building a relatively extensive, sustained and unique occupational health infrastructure. That infrastructure includes state-based programs in the Department of Labor (DOL) and the Department of Health (DOH) engaged in regulating,

educating, data collection and analysis, and technical assistance on occupational health issues. In addition, it includes the State's Workers' Compensation system that provides access to medical, wage replacement and vocational rehabilitation benefits to workers suffering from work related disease.

Thirty years later, it is time to re-assess the state of occupational disease in NYS. Over that period, aside from the development of the OHCN and OSHTEP, there have been significant economic, political, and scientific changes that have had important implications for occupational disease. Key issues include:

1) A dramatic shift in the economic base of the state away from manufacturing and toward service industries
2) A large growth of low-wage jobs that offer little in the way of security or benefits
3) A major increase in the participation of women and immigrants in the state's workforce
4) A significant decline in the size and power of the labor union movement
5) A sustained shift away from a liberal 'welfare state' to a neoliberal state emphasizing de-regulation, governmental downsizing, and shrinking both taxation (particularly business taxes) and government spending
6) Reform to the Workers' Compensation system inducing large numbers of physicians to exclude patients with work related injuries or illnesses from their practices.
7) A global viral pandemic (COVID-19) that dramatically reshaped virtually all aspects of life beginning in 2020. Work related infections and deaths brought the issue of occupational disease to widespread attention
8) Recognition of a high incidence musculoskeletal injuries due to long term work in ergonomically poorly designed jobs
9) An evolution in the way occupational disease is defined and conceptualized

As a whole, these changes are likely to substantially impact the results of an inquiry into all the areas covered in the original 1987 Landrigan/Markowitz report. The changing landscape of work alters the profile of hazards workers face on the job. Other political and economic changes combine to make it less likely that occupational disease will be recognized. Conversely, a re-definition of occupational disease that enlarges the concept and will improve the accuracy of what is recognized. The COVID-19 pandemic may generally raise awareness and sensitivity to other work-related diseases. Consequently, the approach to identifying, treating and preventing occupational disease will require modification to be effective under these changed circumstances.

This paper uses the Landrigan/Markowitz report as a model to re-assess occupational disease incidence, the extent of hazardous work that puts workers at risk of occupational disease, the costs of occupational disease, and occupational health resources available to identify and prevent occupational disease in New York State. Though the paper explores the same themes as Landrigan/Markowitz, it does so with a modified definition of occupational disease and the use of some different sources of data and methodology.

The intent of this report is to provide data that can both frame and inform efforts to reduce the toll of occupational disease in New York State.

The Incidence of Occupational Disease in New York State

What is an occupational disease?

The traditional definition of an occupational disease[8,9] has two key components that distinguish it from an occupational injury:

An exposure to a hazard that occurs over a period of time

1) An ill-defined onset that becomes evident over a period of time

In contrast an injury is conceived as a condition that:

1) Results from exposure to a hazard that produces immediate effects
2) Results in symptoms with a well-defined, often abrupt onset

There is a need to critically evaluate the definition of occupational disease in order to better determine what gets counted when assessing incidence, risk and costs, and consequently, the type and amount of resources that need to be devoted to the prevention, treatment, and compensation of these conditions.

Classic examples of occupational disease include asbestosis from years of asbestos exposure, lead poisoning from radiator repair work, and solvent related encephalopathy. "Emergent" occupational diseases that have become evident over the past several decades fall into several categories:

1) Musculoskeletal conditions caused by prolonged exposure to work-related risk factors
2) Airborne infectious disease (e.g. COVID-19)
3) Conditions that are multi-factorial and may include non-work-related causes (e.g. heart disease, chronic lung disease)
4) Conditions that are caused by workplace psycho-social factors (e.g. work-related stress, bullying, violence)
5) Conditions that are caused by organizational factors (e.g. shiftwork, short-staffing, long hours)
6) Mental health conditions that occur as a direct result of workplace conditions or as sequelae of a work-related physical condition
7) Work-related substance abuse
8) Less well-defined health conditions (e.g. loss of well-being) related to work
9) Non-musculoskeletal conditions that do not meet the prolonged exposure time and/or chronic onset aspects of the classic occupational disease definition

The possible pathways along which workplace exposures may interact with each other, and workplace exposures may interact with non-workplace exposures, to impact the expression of disease are many and potentially complex. The classic example is the interaction

between cigarette smoking and asbestos exposure that greatly increases the risk of lung cancer beyond that of either exposure alone.[10-12] 'Work aggravated' asthma is another example of this interaction.[13-15] The COVID-19 pandemic has also dramatically illustrated this interaction. Recognizing that the non-work and work worlds interact greatly complicates the concept of occupational disease. In addition, it may be quite difficult to parse out the contribution of the various exposures, and the occupational component may vary from minimal to predominant.[16]

One of the insights of this more complex model is that exposure to workplace hazards can interact with non-work exposures to contribute to the production of diseases typically not thought of as 'occupational' in origin. Characteristics of workplace stress that put workers at increased risk of cardiovascular disease including hypertension, myocardial infarction, and stroke have been elucidated over the past several decades.[17-21] Workplace hazards can play a role in aggravating, or perhaps in causing diabetes through a variety of mechanisms including: direct exposure to endocrine disrupting chemicals; limiting breaks necessary to access insulin and/or food; limited access to healthy food; or high stress levels. [22-30] Obesity can be encouraged through some of these same pathways, as well as by sedentary jobs that restrict movement throughout the work shift. [31-43]

At the time of the Landrigan/Markowitz report musculoskeletal conditions due to workplace conditions such as repetitive motion, forceful movements, and static posture were beginning to be recognized as an important part of the occupational disease landscape, but they were not included in the Landrigan/Markowitz assessment. In the ensuing decades, they have been established as a major source of work-related morbidity and disability and require inclusion in the discussion of occupational disease.[44-46]

The psycho-social and organizational characteristics of work have received considerable attention and recognition as contributors to illness. The characteristics of modern work have been explored including attributes of the work itself (e.g. high job demands with low control over work, machine paced work, shiftwork), social characteristics of the workplace (e.g. presence or absence of social support, lack of respect, bullying supervisor), and more macro level factors (e.g. lack of job security, unemployment). [17, 47-55] Cardiovascular and mental health were the main health impacts studied early on, but it has become evident that the potential health impacts of poor psycho-social work conditions are much broader. [56] For example, the epidemic of violence in health care workplaces exemplifies how systemic factors such as understaffing and underfunding lead to extreme stressors with complex multifactorial sources of job strain. [57-58] As already suggested above, work plays some role as a contributor to most, if not all, contemporary major health challenges including the obesity epidemic, diabetes, and substance abuse (not only opiates, but alcohol, tobacco, and other substances as well). [30, 34, 59-62] Undoubtedly, other health issues will continue to emerge. For example, the importance of sleep is increasingly recognized, and the way work is organized can have major impact on sleep, or lack of it. [63-68] Psycho-social and organizational characteristics of work play a major role in the production of these issues.

Mental health and its relationship to work is a specific area requiring attention. As already discussed, aspects of work generically grouped as 'stressful' have mental health consequences, commonly including depression and anxiety. Mental health impact is also manifest as a

consequence of suffering from an occupational disease and the resulting trauma of job loss, decline in physical capabilities, loss of friendships and social networks, financial stress, and the indignities of the Workers' Compensation process. [69-70]

Substance abuse is another contemporary public health challenge. While opiates have received most of the attention, tobacco and alcohol are the most commonly abused substances. Work may play a role in these addictions with their use as a way of coping with the various stresses of work. Tobacco may augment workers' ability to stay alert for long hours, and function as a substitute for food. Alcohol is used to unwind after a shift. And opiates help workers who are in pain to keep working, or to come back to work sooner after an injury.

Even an expanded definition of occupational disease does not adequately capture all aspects of health. Well-being can be stimulated or enhanced by work, but also the lack of well-being can be caused by or contributed to by work. The concept, as advanced by Schulte and colleagues, describes well-being as

> "flourishing and aspiring to… a good life that is characterized by happiness, life satisfaction, positive emotion and self-determination. It includes health, but goes beyond that …and has been linked to individual enterprise, national health care costs, reduced injury and illness and lower rates of absenteeism and presenteeism." [71]

The loss of a sense of "well-being" is important to the individual worker as it can negatively color all aspects of their lives, reducing their ability to engage and be present. Prolonged loss of "well-being" can have an impact on mental health and possibly on physical health as well.[71-72]

Finally, there are a number of conditions that intuitively seem like diseases that do not meet one or both criteria of prolonged exposure and ill-defined progressive onset. For example, asthma can occur, and become persistent, immediately following an initial heavy exposure to chlorine gas. In fact, asthma is an example of a disease that occurs along a full spectrum of both acute and chronic exposure and acute and chronic onset and progression. Contact dermatitis typically appears rapidly upon re-exposure to a substance to which an individual has been sensitized. It then recurs whenever the person is re-exposed to the allergen, and can become nonspecific, occurring with exposure to other substances as well. An argument that these conditions should be included among diseases and not injuries is based upon the cause: an exposure to an airborne, dermal, or, occasionally, ingested hazard.

An overall assessment of occupational disease requires investigation of both 'classic' and 'emergent' conditions.

Assessing the Incidence and Prevalence of Occupational Disease

Obtaining accurate and comprehensive data on occupational disease is notoriously difficult, as the United States and New York State have no systematic reporting systems in place that capture deaths and morbidity due to a workplace cause. [73] The NYS Workers' Compensation Board and Bureau of Labor Statistics are the most obvious potential sources of data, but they suffer from a narrow definition of occupational disease and multiple barriers to

reporting and recognition. [54, 74-83] Additionally, the NYS Workers' Compensation Board to date has offered only a superficial analysis of its data, and has not made its occupational disease data available in a meaningful way to allow further analysis. [84]

The NYS Department of Health maintains several registries (i.e. Heavy Metals Registry, Occupational Lung Disease Registry, Pesticide Registry). All suffer from limitations including difficulty accessing the data, and (except for the Heavy Metals Registry) non-comprehensive reporting which makes them of little use in estimating incidence or prevalence. The Occupational Health Clinic Network has amassed considerable data on patients with suspected work-related conditions evaluated over the last 32 years. This is a rich source of information that adds to the picture of occupational disease in the state, but is not comprehensive and also cannot be utilized to estimate incidence/prevalence.

In addition, the cumulative effect of the changes in the landscape of work that have occurred since the Landrigan/Markowitz report has been to reduce the visibility of occupational disease.

As a consequence of the dearth of data, alternative and less direct methods must be utilized to estimate occupational disease mortality and morbidity. The specific methodologies used will be discussed in the sections that follow.

Occupational Disease: Estimating Mortality and Morbidity

Methods for estimating occupational disease mortality and morbidity

Mortality

The Landrigan/Markowitz report used the idea of "attributable fraction" to estimate mortality in New York State. "Attributable fraction" is defined as the portion of overall deaths that can be attributed to occupational causes. For example, cancer can be caused by exposure to inhaled hazards at work or at home/in the community. The work-related attributable fraction, or the percentage caused by work exposures is estimated to be 8.4%. The attributable fractions are derived from review of relevant epidemiologic literature. The totals for specific causes of death in New York State are obtained from death certificates. In **Table 1**, we replicated the Landrigan/Markowitz mortality assessment using average annual mortality rates for 2010-2016 in New York State, and applying the same attributable fractions used by Landrigan/Markowitz.[1]

In addition, we estimated mortality using a different set of attributable fractions **(Table 2 and Table 3)**. Since the original Mount Sinai Report significant bodies of literature have accumulated that allow for an updating of the attributable fraction of occupational disease for many health conditions. In 2001, Nurminen and Karjalainen estimated the global burden of occupational disease based on significant improvements in the calculation of the attributable fractions.[85] Following on their methods, we have reformulated occupational disease mortality estimates for New York State. Nurminen and Karjalainen's work also allows for inclusion of

health conditions that may be work-related but were not included in the Mount Sinai calculation. This is consistent with the idea of a broadened conception of occupational disease.[86-90] Their work also allowed us to demonstrate how occupational disease fatalities vary by gender **(Table 4).** In addition, to accommodate known latency in chronic disease and the fact that workers are working longer, we specified age ranges to include additional years beyond the conventional time of workforce participation.

TABLE 1 Occupational Disease Mortality Estimates in New York State, 2010-2017

Cause of Death [a,b]	ICD10 Code(s)	Annual Mortality, New York State[c]									Occupational Fraction[d]		Occupational Disease Mortality	
		2010	2011	2012	2013	2014	2015	2016	2017	Average 2010-2017	lower range	upper range	lower range	upper range
Cancer (malignant neoplasms)	C00-C97	28817	28750	29110	28921	28455	28061	28428	28042	28573	8	10	2286	2857
Pneumoconioses[e]	J60-J70	379	416	398	395	454	545	502	512	450	100	100	450	450
Chronic lower respiratory disease	J40-J47	4642	4665	4699	4709	4488	4666	4582	4702	4644	1	3	46	139
Cardiovascular disease, Renal disease and Neurologic disorders														
circulatory system	I00-I99	30048	29582	28716	29168	28701	29339	29673	29571	29350	1	3	293	880
renal[e]	N00-N98	1931	1842	1916	1846	1844	1866	2043	1977	1908	1	3	19	57
neurological	G00-G98	2833	2791	2823	2881	2926	3267	3344	3509	3047	1	3	30	91
Other conditions		25648	27089	26889	27471	27989	28477	29626	29630	27852	0	0	0	0
Total occupational disease													3125	4476
Total all cause mortality		94298	95135	94551	95391	94857	96221	98198	97943	95824				
Percent of all deaths attributed to occupational disease													3.26%	4.67%

[a]Cause of Death computed from death certificates as recorded by New York State Vital Statistics.

[b]Centers for Disease Control and Prevention, National Center for Health Statistics. Multiple Cause of Death 1999-2015 on CDC WONDER Online Database, released December, 2016. Data are from the Multiple Cause of Death Files, 1999-2015, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed at http://wonder.cdc.gov/mcd-icd10.html April 22, 2019

[c]Age 15-84 economically active population, older ages accommodate disease latency

[d]Method derived from Landrigan & Markowitz, Occupational Disease in New York State, Proposal for a Statewide Network of Occupational Disease Diagnosis and Prevention Centers: Report to the New York State Legislature, February, 1987.

[e]data surpressed for ages under 44 for some years due to confidentiality restraints (low numbers)

TABLE 2 Attributable Fraction[a] (%)

Cause of Death	Total	Women	Men
All causes (all codes)	6.7	2.1	10.2
Infectious diseases (all A and B)	8.8	32.5	4.8
Malignant neoplasms (all C)	8.4	2.2	13.8
Mental disorders (all F)	3.5	1.8	7.3
Diseases of the nervous system (all G and H)	3.1	1.7	5.1
Diseases of the circulatory system (all I)	12.4	6.7	14.4
Diseases of the respiratory system (all J)	4.1	1.1	6.8
Diseases of the digestive system (all K)	2.1	1.5	2.3
Diseases of the genitourinary system (all N)	1.3	0.4	3
Intentional self-harm and sequalae (X60 - X84, Y87.0)	0.4	0.3	0.4

[a]Nurminen and Karjalainen 2001

TABLE 3 Estimated work-related mortality in the United States and in New York State in 2016, by causes of death, age 15-84[a]

Cause of Death[b]	Attributable Fraction[c] (%)	Numbers of Deaths, US	Work-Related Mortality, US	% Work-Related Deaths, US	Numbers of Deaths, NYS	Work-Related Mortality, NYS	% Work-Related Deaths, NYS
Infectious diseases (all A and B)	8.8	52962	4661	3.8	3199	282	4.0
Malignant neoplasms (all C)	8.4	493324	41439	33.5	28428	2388	34.0
Mental disorders (all F)	3.5	50741	1776	1.4	2606	91	1.3
Diseases of the nervous system (all G and H)	3.1	96951	3005	2.4	3350	104	1.5
Diseases of the circulatory system (all I)	12.4	506027	62747	50.8	29673	3679	52.4
Diseases of the respiratory system (all J)	4.1	178742	7328	5.9	8758	359	5.1
Diseases of the digestive system (all K)	2.1	87119	1829	1.5	3815	80	1.1
Diseases of the genitourinary system (all N)[d]	1.3	44202	575	0.5	2043	27	0.4
Intentional self-harm and sequalae (X60 - X84, Y87.0)	0.4	43308	173	0.1	1620	6	0.1
Other causes		303564			14706		
Total occupational disease			123534			7016	
Total all-cause mortality		1856940			98198		
Percent of deaths attributable to occupational disease			**6.65%**			**7.14%**	

[a] (age 15-84), economically active population, older ages accommodate latency

[b] as recorded by New York State Vital Statistics, accessed via.CDC Wonder Detailed Mortality, Underlying Cause of Death (https://wonder.cdc.gov/ucd-icd10.html - abstracted April 2019)

[c] Nurminen and Karjalainen 2001

[d] some figures suppressed for 15-24 year olds

TABLE 4 Occupational Disease Mortality in New York State in 2016 by Gender, Age[a] and Cause[b] Estimated by Attributable Fractionc

Causes[b]		Infectious diseases (all A and B)	Malignant neoplasms (all C)	Mental disorders (all F)	Diseases of the nervous system (all G and H)	Diseases of the circulatory system (all I)	Diseases of the respiratory system (all J)	Diseases of the digestive system (all K)	Diseases of the genitourinary system (all N)	Self-harm and sequalae (X60-X84, Y87.0)	Other causes	Total occupational disease	Total all-cause mortality	Percent of deaths attributable to occupational disease
Deaths Women by Age	15-24	11	24	supressed	20	24	23	suppressed	suppressed	52	234		388	
	25-34	25	124	27	30	74	26	26	suppressed	62	484		878	
	35-44	60	384	28	30	184	39	48	18	63	466		1,320	
	45-54	153	1,322	39	80	677	180	189	40	91	714		3,485	
	55-64	286	3,118	75	184	1,662	605	323	127	69	886		7,335	
	65-74	390	4,541	188	379	3,234	1,288	441	261	38	1,071		11,831	
	75-84	490	4,661	861	953	6,261	2,039	580	507	25	1,438		17,815	
	Total	1,415	14,174	1,218	1,676	12,116	4.200	1,607	953	400	5,293		43,052	
Attributable Fraction Women[c]		32.5	2.2	1.8	1.7	6.7	1.1	1.5	0.4	0.3	0			
Deaths from Occupational Disease Women		460	312	22	28	812	46	24	4	1	0	1709	43,052	4.00%
Deaths Men by Age	15-24	13	58	10	28	24	29	suppressed	suppressed	151	743		1,056	
	25-34	43	105	44	37	166	36	43	10	184	1,337		2,005	
	35-44	77	295	87	42	447	66	114	15	204	1,033		2,380	
	45-54	201	1,163	166	106	1,582	193	327	63	240	1,384		5,425	
	55-64	481	3,456	221	216	3,614	737	585	172	241	1,649		11,372	
	65-74	486	5,030	253	430	5,112	1,500	595	315	122	1,379		15,222	
	75-84	483	4,711	603	810	6,612	1,997	531	509	78	1,352		17,686	
	Total	1,784	14,818	1,384	1,669	17,557	4,558	2,195	1,084	1,220	8,877		55,146	
Attributable Fraction Men[c]		4.8	13.8	7.3	5.1	13.8	7.3	5.1	13.8	7.3	5.1			
Deaths from Occupational Disease Men		86	2,045	101	85	2,045	101	85	2,045	101	85	5,243	55,146	9.50%
Total Work-Related Deaths		546	2,357	123	114	2,357	123	114	2,357	123	114	6,952	98,198	7.10%

[a] economically active population (age 15-64), also accommodates latency (age 65-84)
[b] as recorded by New York State Vital Statistics, accessed via CDC Wonder, Detailed Mortality, Underlying Cause of Death (https://wonder.cdc.gov/ucd-icd10.html - abstracted April 2019)
[c] Nurminen and Karjalainen 2001

Morbidity

The Landrigan/Markowitz used three data sources to estimate occupational disease morbidity:

1) New York State Workers' Compensation data
2) Bureau of Labor Statistics reports
3) Physicians' reports of occupational disease in California.

They acknowledged the severe limitations of each of these sources.

Numerous studies have emphasized the small proportion of individuals with an occupational disease who ever actually apply for and receive Workers' Compensation benefits.[75-83] These studies have examined well-established work-related conditions such as silicosis and asbestosis. Given the low recognition of even these diseases in Workers' Compensation, recognition of many of the conditions in the expanded definition of occupational disease would likely not be represented in this data. A further difficulty is that the New York State Workers' Compensation Board is not currently organizing its case data to even make an analysis of occupational disease possible.[84]

Bureau of Labor Statistics data are based on employer reports of occupational disease. These reports are mandated by the Occupational Safety and Health Administration (OSHA). A major limitation of this data is that it is restricted to a relatively few conditions which are almost entirely easily recognizable and acute.

In California physicians are required to submit reports of occupational disease to the State Department of Labor. Similar to the BLS data, the California Doctors' reports suffer from restriction to a limited set of primarily acute conditions. Physician and employer recognition and reporting of occupational disease suffer from significant limitations which also contribute to the lack of comprehensiveness of the BLS and California physicians' data.

Given the limitations of available data we chose to estimate occupational disease morbidity two ways. The first estimate uses BLS data. The second estimates attributable fractions using Nurminen and Karjalainen's 2001 work as a starting point and modifying their estimates based on newer data. Consequently, our estimates rest on the assumption that attributable fractions for mortality are also valid for estimating morbidity. Since occupationally-related cases for any given diagnosis are likely to have a similar probability of death as non-occupational cases, this assumption seems reasonable. Because most available data estimate prevalence rather than incidence, we chose to use prevalence rather than incidence rates. This was largely based on the practicalities of available data. In order to estimate the attributable fraction, the total number of people with the disease must be ascertained. Consequently, the morbidity estimates provide a useful picture of the overall occupational disease burden, but do not reveal how many cases occur each year, and are not directly comparable with the Landrigan/Markowitz morbidity estimates.

Results: Mortality and Morbidity

Mortality

The Mount Sinai study estimated between 4,686 and 6,592 New Yorkers died each year from an Occupational Disease. **Table 1** provides our estimate of occupational disease mortality. Using an average annual mortality for 2010-2016 in New York, and applying the same attributable fractions used by Landrigan/Markowitz, current estimates of occupational disease fatalities range from 3,085 to 4,430. Overall number of deaths have decreased in 2010-2016 compared to the 1979-1982 period described in the Mount Sinai report, with 95,824 and 132,139 annually in the respective time periods.88-89 Consequently despite the decline in the number of deaths, occupational disease accounts for an increased proportion of deaths in 2016 compared with 1987, with the estimate ranging from 3.3-4.7% in 2016 and 2.8-3.7% in 1987.

Using Nurminen and Karjalainen's attributable fractions (**Table 2 and Table 3**), a total of 7016 deaths (7.14%) were due to occupational disease in NYS. **Table 4** stratifies mortality by gender and age and relies on gender-based attributable fractions. Deaths attributable to occupational disease in men numbered 5,243 or 9.5% of deaths from all causes among men. Deaths attributable to occupational disease in women numbered 1,709 or 4.0% of deaths from all causes among women. Among the men, cancer and circulatory causes made up 87% of the occupationally related deaths, and among the women 93% were comprised of cancer, circulatory conditions and infectious diseases.

Morbidity: Non-fatal occupational illnesses

According to BLS data abstracted for NYS, there are an estimated 9,300 people diagnosed with a non-fatal occupational illness in NYS each year. In 2016, the incidence rate was 13 per 10,000 full time workers (**Table 5**). It should be noted that these are mostly acute or subacute conditions, with chronic conditions largely unrecognized. Two-thirds of the illness are occurring in the private sector with the remaining one-third in state and local government. In the private sector, utilities, manufacturing, health care and social assistance and transportation and warehousing have higher than average incidence rates. Hearing loss drives the figures for utilities and manufacturing while the category named "all other illnesses" drives the figures for health care and social assistance significantly. Among public sector workers, the "all other illnesses" category also drives the reported rates. Examples of "all other illnesses include: Heatstroke, heat exhaustion, and heat stress; freezing and frostbite; decompression sickness; effects of ionizing radiation (isotopes, x-rays, radium); effects of nonionizing radiation (welding flash, ultra-violet rays, lasers); anthrax; bloodborne pathogenic diseases such as AIDS, HIV, hepatitis B or hepatitis C; brucellosis; malignant or benign tumors; histoplasmosis; coccidioidomycosis.

TABLE 5 Incidence rates[1] and numbers of nonfatal occupational illnesses by industry sector and category of illness, New York, 2016

Industry sector[2]	Total cases	Skin disorders	Respiratory conditions	Poisonings	Hearing loss	All other illnesses	Total cases	Skin disorders	Respiratory conditions	Poisonings	Hearing loss	All other illnesses[6]
	Incidence rates per 10,000 full-time workers[1]						Numbers of illnesses in thousands					
All industries including state and local government[3]	13.0	1.3	1.1	0.2	2.0	8.4	9.3	0.9	0.8	0.1	1.5	6.0
Private industry[3]	9.9	0.8	0.6	0.1	2.1	6.2	6.1	0.5	0.4	0.1	1.3	3.8
Goods-producing[3]	19.7	1.3	0.6	--	8.9	9.0	1.6	0.1	*	*	0.7	0.7
Natural resources and mining[3,4]	--	--	--	--	--	--	--	--	*	*	*	--
Agriculture, forestry, fishing and hunting[3]	--	--	--	--	--	--	--	--	*	*	*	--
Mining, quarrying, and oil and gas extraction[4]	--	--	--	--	--	--	*	*	*	*	*	*
Construction	2.5	--	0.5	--	--	1.7	0.1	*	*	*	--	0.1
Manufacturing	26.0	1.4	0.7	--	15.7	8.2	1.1	0.1	*	*	0.7	0.4
Service-providing	8.4	0.8	0.6	0.1	1.1	5.8	4.5	0.4	0.3	0.1	0.6	3.1
Trade, transportation, and utilities[5]	8.1	0.4	0.6	--	1.7	5.2	1.0	*	0.1	--	0.2	0.7
Wholesale trade	1.6	--	--	--	--	1.3	0.1	*	*	*	*	*
Retail trade	7.5	0.5	0.6	--	--	5.6	0.5	*	*	--	--	0.4
Transportation and warehousing[5]	15.1	--	1.2	--	3.4	10.1	0.3	*	*	*	0.1	0.2
Utilities	34.7	--	--	--	32.0	--	0.1	*	*	*	0.1	*
Information	5.2	0.9	--	--	--	3.5	0.1	*	--	*	*	0.1
Finance, insurance, and real estate	--	--	--	--	--	1.2	--	--	--	*	--	0.1
Finance and insurance	0.7	--	--	--	--	0.6	*	*	*	*	*	*
Real estate and rental and leasing	--	--	--	--	--	--	--	--	--	*	--	--
Professional and business services	3.3	--	0.3	--	--	2.2	0.4	--	*	*	*	0.2
Professional, scientific, and technical services	1.9	--	--	--	--	--	0.1	*	*	*	--	--
Management of companies and enterprises	--	--	--	--	--	--	*	*	*	*	*	*
Administrative and support and waste management and remediation services	6.3	--	0.4	--	--	3.9	0.2	--	*	*	--	0.1
Educational and health services	15.6	1.1	0.9	0.1	--	13.3	2.0	0.1	0.1	*	*	1.7
Educational services	9.4	--	0.9	--	--	8.0	0.2	*	*	*	*	0.2
Health care and social assistance	16.9	1.3	1.0	0.2	--	14.5	1.8	0.1	0.1	*	*	1.6
Leisure, entertainment, and hospitality	5.8	0.9	0.6	--	--	4.0	0.3	0.1	*	*	--	0.2
Arts, entertainment, and recreation	9.0	--	--	--	--	7.0	0.1	--	*	*	--	0.1
Accommodation and food services	5.3	0.9	0.7	--	--	3.5	0.3	*	*	*	*	0.2
Other services (except public administration)	6.1	1.1	--	--	--	3.1	0.2	*	--	*	*	0.1
Other services (except public administration)	6.1	1.1	--	--	--	3.1	0.2	*	--	*	*	0.1
State and local government[3]	33.3	4.0	4.4	0.5	1.7	22.8	3.2	0.4	0.4	*	0.2	2.2
State government[3]	25.8	2.2	3.3	1.0	1.2	18.1	0.5	*	0.1	*	*	0.4
Local government[3]	35.4	4.5	4.7	0.3	1.9	24.1	2.7	0.3	0.4	*	0.1	1.8

[1] Incidence rates represent the number of illnesses per 10,000 full-time workers and were calculated as: (N/EH) x 20,000,000 where: N= number of illnesses; EH= total hours worked by all employees during the calendar year; 20,000,000 = base for 10,000 equivalent full-time workers (working 40 hours per week, 50 weeks per year).

[2] *North American Industry Classification System* -- United States, 2012.

[3] Excludes farms with fewer than 11 employees.

[4] Data for mining (Sector 21 in the North American Industry Classification System Manual, 2012 edition) include establishments not governed by the Mine Safety and Health Administration (MSHA) rules and reporting, such as those in oil and gas extraction and related support activities. Data for mining operators in coal, metal, and nonmetal mining are provided to BLS by the Mine Safety and Health Administration, U.S. Department of Labor. Independent mining contractors are excluded from the coal, metal, and nonmetal mining industries. These data do not reflect the changes OSHA made to its recordkeeping requirements effective January 1, 2002; therefore, estimates for these industries are not comparable to estimates in other industries.

[5] Data for employers in railroad transportation are provided to BLS by the Federal Railroad Administration, U.S. Department of Transportation.

[6] Examples: Heatstroke, sunstroke, heat exhaustion, heat stress and other effects of environmental heat; freezing, frostbite, and other effects of exposure to low temperatures; decompression sickness; effects of ionizing radiation (isotopes, x-rays, radium); effects of nonionizing radiation (welding flash, ultra-violet rays, lasers); anthrax; bloodborne pathogenic diseases such as AIDS, HIV, hepatitis B or hepatitis C; brucellosis; malignant or benign tumors; histoplasmosis; coccidioidomycosis.

NOTE: Because of rounding, components may not add to totals. Dash indicates data do not meet publication guidelines. Asterisk indicates data too small to be displayed.

SOURCE: U.S. Bureau of Labor Statistics, U.S. Department of Labor, Survey of Occupational Injuries and Illnesses in cooperation with participating state agencies, November 09, 2017

Nurminen and Karjalainen's attributable fraction approach estimates that occupational disease comprises 13.2% of total disease prevalence in the state. In contrast to mortality, musculoskeletal, respiratory and nervous disorders make up nearly 80% of the total occupational disease burden. Diseases of the skin, circulatory system and cancer account for an additional 17% of the total. Occupationally related mental illness is an estimated 4.5%. These results, applying Nurminen and Karjalainen's attributable fraction values, are shown in **Table 6.** In total, there were an estimated 2,218,426 cases of occupational disease prevalent in 2016.

Prevalence estimates for several selected diseases and conditions representing current major health and public health challenges are demonstrated in **Table 7**. The prevalence of all of these conditions (except opioid misuse) is quite high in the general population, and the health consequences of all are serious, and potentially lethal. Through different mechanisms work can contribute to all of these conditions. Attributable fractions demonstrating the occupational contribution to these specific conditions have not been developed. However, even a relatively small attributable fraction would represent thousands of cases and a significant burden of disease contributed to by workplace conditions.

Definitions for Analysis of Occupational Disease Burden[a] for Table 6		
Illnesses[c]	Definition and Individual Population Attributable Fraction (when applicable)	Population Attributable Fractiona (%)
Infectious diseases (A and B) [g]	all reportable (except STDs and congenital)	8.8
Cancer (C and D 0-99)[h]	all sites	8.4
Mental disorders (F, X60-84,Y87)[i]	"any mental illness" (AMI) 3.5 intentional self-harm and sequelae 0.4	3.5, 0.4
Diseases of the nervous system (G and H)[j]	Parkinsons 9.2 Alzheimers 2.3 hearing loss 7.2	6.7
Diseases of the circulatory system (I)[k]	cardiovascular diseases (CHD, HF, stroke)	12.4
Diseases of the respiratory system (J)[l]	COPD 11.7 asthma 18.2 pneumoconiosis 100 idiopathic pulmonary fibrosis 15.4	11.7, 18.2, 100, 15.4
Diseases of the digestive system (K)[m]	gastric and duodenal ulcers 5.7, liver disease 1.9	2.1
Diseases of the genitourinary system (N)[n]	chronic kidney disease	1.3
Diseases of the skin (L)[o]	NHIS definition, ICD-10 L except infection and cancer	10.2
Diseases of the musculoskeletal system(M)[p]	low back pain, carpal tunnel syndrome, arthritis	3.68

TABLE 6 Excess Occupational Disease Burdena in the United States and in New York State in 2016[b]

Illnessesc	Population Attributable Fractiona (%)	Prevalence Rates, USD	U.S. Population Age 18-84[e]	Numbers of Illnesses, US[e]	Excess Occupational Disease Burden, US	% Work-Related Illnesses, US	Prevalence Rates[d], NYS	NYS Population Adults 18-84[f]	Numbers of Illnesses, NYS	Excess Occupational Disease Burden, NYS	% Work-Related Illnesses, NYS
Infectious diseases (A and B) [g]	8.8	0.1	238,918,622	328,119	28,874	0.08	0.01	15,029,160	20,233	1,781	0.08
Cancer (C and D 0-99)[h]	8.4	4.24	238,918,622	10,130,150	850,933	2.38	7	15,029,160	981,084	82,411	3.71
Mental disorders (F, X60-84,Y87)[i]	3.5, 0.4	18.9	238,918,622	45,466,214	1,581,689	4.42	18.9	15,029,160	2,860,049	99,496	4.48
Diseases of the nervous system (G and H)[j]	6.7	0.57, 2.3, 16	238,918,622	45,988,041	3,081,199	8.61	2.5, 2.6, 12.9	15,029,160	2,436,637	163,255	7.36
Diseases of the circulatory system (I)[k]	12.4	9	238,918,622	24,300,000	3,013,200	8.42	7.4	15,029,160	1,112,158	137,908	6.22
Diseases of the respiratory system (J)[l]	11.7, 18.2, 100, 15.4	6.2, 8.3, .06	238,918,622	168,138,002	5,399,156	15.08	4.0, 9.5, .0006	15,029,160	2,038,614	335,359	15.12
Diseases of the digestive system (K)[m]	2.1	5.7 1.9	238,918,622	18,157,815	381,314	1.07	5.7 1.9	15,029,160	1,142,216	23,987	1.08
Diseases of the genitourinary system (N)[n]	1.3	2.7	238,918,622	6,450,803	83,860	0.23	2	15,029,160	330,642	4,298	0.19
Diseases of the skin (L)[o]	10.2	10.1	238,918,622	24,130,731	2,461,340	6.88	10.1	15,029,160	1,517,945	154,830	6.98
Diseases of the musculoskeletal system(M)[p]	3.68	5.68,1.68,15.1	238,918,622	70,003,156	18,912,034	52.84	5.68 /1.68 /19.7	15,029,160	4,403,544	1,215,102	54.77
Total disease and occupational disease				**413,093,080**	**35,793,599**				**16,843,121**	**2,218,426**	
Percent of illnesses attributable to occupational disease					**8.66%**		**100**			**13.17%**	**100**

[a] Nurminen and Karjalainen 2001, except for MSDs and skin disease, across all occupational diseases 6.7%
[b] age 18-84, economically active population, older ages accommodate latency, analysis focused on 2016 with some exceptions due to availability of data
[c] selected illnesses organized by ICD-10 code scheme
[d] prevalence (period rates expressed as % of population)
[e] based on 2016 US population age 18-84, US Census
[f] based on 2016 NYS population age 18-84, US Census
[g] Karjalianen et al 1998, National Public Health Institute Finland 1998, Nuorti et al 2000
[h] CDC, SEER, 24-year limited duration prevalence counts for 2016 divided by the population for the US in 2016= 13,725,579/323,400,000
[i](AMI) as recognized by NIMH
[j] Sawitz et al 1998, Gorrell et al 1998, Checkoway & Nelson 1999, Sobel et al. 1995
[k] Tenkanen et al 1997, Kawachi et al 1995, 1997, Olsten & Kristenesen 1991, Stern 1988, Virtanen & Notkola 2001, Bonita et al 1999
[l] sources: Coggon et al 1994, Isoaho et al 1994, Hunting & Welch 1993, Euler et al 1987, Karjalainen et al 1998, 2000, Kogevinas et al 1999, Toren et al 1999, Leino et al 1997, Flodin et al 1995, Hubbard et al 1996,
[m] Tuchsen et al 1994, Numunen and Karjalianen 2001
[n] U.S. Renal Data System chronic kidney disease in the us. NHANES participants equal to or over 20 14.8% in 2011 to 2014.
[o] NHIS 1988 figure of 1.7% prevalence self-reported occupational dermatitis was used, contact dermatitis, photoreactive dermatitis, folliculitis & acne, contact urticaria, nail discoloration and dystrophy, acro-osteolysis
[p] NHIS unadjusted prevalence among all employed adults 2013-2015, not including upper extremity MSDs (complaints of arm, neck and/or shoulder), knees, cumulative trauma disorders, https://wwwn.cdc.gov/Niosh-whc/chart/nhis-sd/illness?OU=ARTH1&T=GE&V=R

TABLE 7 Adults with health conditions expected to contribute to future occupational disease diagnosis[a]						
Illnesses	**Prevalence Rate, US[b]**	**U.S. Population Age 18-84[c]**	**Numbers of Illnesses, US[d]**	**Prevalence Rate, NYS[b]**	**NYS Population[e]**	**Numbers of Illnesses, NYS**
Diabetes	10.5	238,918,622	25,086,455	10.5	15,029,160	1,578,062
Hypertension	31.4	238,918,622	75,020,447	31.7	15,029,160	4,764,244
Obesity	30.1	238,918,622	71,914,505	25.5	15,029,160	3,832,436
Binge drinking in the past month	16.9	238,918,622	40,377,247	17.5	15,029,160	2,630,103
Currently smoking	17	238,918,622	40,616,166	14.2	15,029,160	2,134,141
Opioid misusee	4.6	238,918,622	10,933,000	3.7	15,029,160	553,073

[a] BRFSS, Prevalence Rates, 2016 CDC Division of Population Health: Chronic Disease Indicators: Explore by Location: Crude Prevalence (%), Adults greater than or equal to 18

[b] prevalence (period rates expressed as % of population)

[c] based on 2016 US population age 18-84, US Census

[d] based on 2016 NYS population age 18-84, US Census

[e] SAMSHA, misuse opioids (heroin or prescription pain relievers) in the past year age 18 and over, 2016

Conclusions

Mortality and Morbidity

Occupational disease remains a significant cause of death and illness in NYS. Our estimates demonstrate that the percentage of all death in NYS attributable to occupational illness ranges from 3.3-4.7%, with men experiencing more than twice the deaths as women. Also, over two million working people are experiencing work-related illness (13.2% of the total disease prevalence). Finally, an expanded definition of occupational disease should include highly prevalent conditions that contribute to workers' lack of health, especially because the connections between work and health for these conditions are well-documented.

Using the Landrigan/Markowitz methodology, the proportion of annual deaths attributable to occupational causes is actually higher than the proportion they found in the 1980's. Not surprisingly, using an expanded definition of occupational disease based on Nurminen and Karjalainen's work yields an estimate of occupational disease-related deaths 57% higher than the estimate using Landrigan/Markowitz methods.

Non-fatal occupational diseases are also quite prevalent in New York State. Roughly half of the cases are musculoskeletal conditions due to chronic exposure to work characterized by some combination of repetition, forceful movements, awkward postures, and vibration. Only a relative few of the total types of musculoskeletal diagnoses were included due to limitations in available data. Consequently, despite the high prevalence, the estimate is likely to be a substantial under-estimate. This underscores the importance of these types of conditions in the current landscape of work.

More than three quarters of the illnesses originate in the musculoskeletal, respiratory, and nervous systems. Respiratory conditions included asthma, pneumoconiosis, chronic obstructive lung disease (COPD) and interstitial lung disease, all of which have well known connections to various workplace exposures. The prominence of nervous system conditions is driven by the high prevalence of hearing loss.

The actual prevalence of work-related mental health conditions is likely severely underestimated by this data. Clinical experience evaluating individuals with work-related illness over a period of many years demonstrates the widespread occurrence of mental health issues.[91] These can occur as a direct result of the nature of the work itself, or as a consequence of being diagnosed with another occupational disease and all of the implications (social, financial, job and career) that entails.[67] These effects are important in terms of their impact on the individual, but may not conform to the diagnostic criteria of a 'mental illness', or may not be formally recognized and diagnosed by the treating clinician.[93-116]

A broadened definition of occupational disease allows for an exploration of how work may contribute to the major health challenges faced by modern society. For example, hypertension is a major risk factor for heart attack and stroke and is highly prevalent, especially among men, Black men in particular, with age-adjusted rates for White and Black men reaching 26.5% and 30.3% respectively.[114] Stressful psychosocial conditions of work have been identified as important contributors to the development of high blood pressure.[115,116] Many causes have been hypothesized for the rapidly increasing prevalence of obesity and diabetes.[22-30] Working conditions have appeared in the mix of factors considered, operating through several different potential mechanisms. Likewise, multiple mechanisms originating at work contribute to epidemic of substance abuse, including alcohol, tobacco, and opiates.[55-62]

The extent of the role work plays in these conditions is debated and only relatively recently receiving research attention. Further exploration may reveal a significantly more important role for work in some, or all of these conditions. **Tables 6** and **7** illustrate the large numbers of people potentially affected. From a public health perspective, an important conclusion of this report is that the contribution of work should be considered and investigated for all of the major modern health issues.

Chapter 2

ESTIMATING THE EXTENT OF HAZARDOUS WORK

What is an occupational hazard?

The traditional idea of a workplace hazard is closely coupled with the traditional definition of an occupational disease. A straightforward causal relationship between exposure to a hazard and a specific disease is envisioned. Hazardous exposures may include:

Chemicals
Metals
Dusts: inorganic, organic
Physical: ergonomics, noise, radiation
Infectious/Biological
Psychosocial (i.e. stress)

The extent and patterns of various hazardous exposures has changed dramatically in the United States. These changes reflect shifts in the broad outlines of the US economy as sectors traditionally identified as hazardous (e.g. manufacturing, agriculture) have faded in importance or make up a relatively small slice of the workforce (e.g. construction). In contrast, service jobs including education, health care, and food service, have increased.[1-4] As a result, hazards such as poor ergonomics, indoor air contaminants, infections, and stress have become much more prevalent. Chemical exposures have not disappeared in these settings but are often intermittent and include cleaners, renovation or construction materials, pesticides, and exposures from adjoining offices or external sources.[5-7]

It should not be inferred, however that 'traditional' hazards have ceased to exist. Hazardous sectors have shrunk but have not disappeared. Chemicals continue to be widely used, and new chemicals continue to be introduced into workplaces.[8] For example the reporting of a number of bronchiolitis obliterans ('popcorn lung') cases in the mid 1990's pulled the curtain back on the use of diacetyl and other potentially hazardous chemicals in a wide spectrum of workplaces including flavoring manufacturing, food production, and coffee roasting.[9-11]

The example of coal dust and a recent resurgence in the occurrence of coal workers' pneumoconiosis (CWP) is a reminder that 'traditional' exposures in 'traditional' settings should not be ignored. The incidence of CWP dropped as regulatory pressure reduced exposures and the shrinkage of the industry reduced the workforce. However, the coal seams remaining in unworked mining areas are thinner and require drilling and removal of more silica containing rock to get to. As a result, many are of the opinion that the increased exposure to silica is a key factor responsible for the spike in CWP. The lesson for other settings is that exposure is not necessarily static, and that hazards thought to be controlled in one context can change dramatically if the context changes.[12-15]

In addition, 'traditional' hazards continue to be found in 'new' contexts. Silica exposure can be quite significant among workers fabricating and installing natural and artificial stone countertops, an increasingly popular product in both residential and commercial settings.[16-20] Workers are exposed to isocyanates applying spray foam insulation in homes and other buildings.[21-25] Many workers are employed in industries that clean up hazards that are no longer used or have been dumped indiscriminately such as asbestos[26-31] or mercury.[32-35] As these examples suggest, these exposure contexts are often small employers working in diffuse settings, in contrast to traditional manufacturing in a large centralized work setting.

Over the past 30 years, the psychosocial environment and workplace organization have received increased attention as sources of workplace hazards.[36-37] In fact, stress and stressors often dominate discussions with workers in the large and fast-growing low-wage service sectors.[38] The concept of 'stress' has been increasingly better defined, at least as far as identifying a variety of specific stressors. The imbalance between high psychological demands and low control over the work, and between effort expended on the job and rewards received are two of the dominant models of workplace stress.[36-37] However, a range of other stressors not captured by these models have been identified including employment quality,[39-43] discrimination,[44-45] and degrading and disrespectful behavior by supervisors.[46-47]

'Precarity' has also come to the fore as an important stressor.[48] The idea of a lifelong job with wages and benefits high enough to support a middle-class lifestyle and build a nest egg for retirement has gone by the wayside. Job insecurity is now the norm and a growing portion of the workforce is employed without guarantee or even the likelihood of long term employment, decent or any benefits, full time work, or regular schedules.[49-51] The growing number of temporary workers, day laborers, and many now included among the 'self-employed' are on the extreme end of the precarity spectrum.[52] The heightened and chronic insecurity inherent in these job arrangements is suspected, and increasingly connected as a contributor to a range of health problems.[48, 53-57]

Connected to the idea that occupational disease is often multifactorial in origin, is the interaction of non-work and work hazards. As noted earlier, work and non-work life are not always neatly separable, and the worker who is stressed at work often takes that stress home, and the worker stressed at home brings that stress to work.[57-59] The result in either case is stress that is reciprocally amplified. Adding to this complexity is the unknown way mixtures of hazards interact to affect risk and health, and how the accumulation of mixed exposures over a lifetime impact risk.

In this chapter we provide estimates for workers at risk of occupational disease in NYS from selected major hazards. By necessity, the methods used to make the estimates were quite disparate for each category of hazard, reflecting the disparate nature of available data. In addition, the list of hazards considered is partial and should not be construed as composing a comprehensive picture of hazard and risk.

Exposure to Hazardous Materials

Chemicals

A wide array of chemicals are used in New York's workplaces, some with known toxicity, others benign, and many with incomplete or completely lacking toxicity profiles. Unfortunately, there are no systems in place in New York to track workplace chemical usage. However, Massachusetts has legislated the mandatory reporting of a portion of hazardous chemicals used in workplaces in the state. Their reports were used as a method of estimating usage of similar chemicals in New York State and the number of workers potentially exposed to these hazardous substances.

In 1989, Legislation in Massachusetts was passed "to promote safer and cleaner production that enhances the economic viability of Massachusetts firms". In practice the Toxic Use Reduction Act (TURA) required employers who manufacture, process, or use hazardous chemicals to report that use to the state. Over 1400 chemicals are subject to reporting. A business is required to report if it manufactures or processes more than 25,000 pounds, or 'otherwise uses' 10,000 pounds of a chemical annually.[1-3] Since reporting began businesses in Massachusetts have reported using roughly 250 chemicals on the list.[4] In May 2020, a list of 1536 chemicals was released.[5]

Methods

Data from the Toxics Use Reduction Institute (TURI) in Massachusetts was obtained for 2013 (the most recent year available) detailing the numbers and types of industries reporting chemical usage.[6] The Standardized Industrial codes for the reporting businesses were re-coded into North American Industrial Classification (NAICS) codes.[7-8] County Business Pattern (CBP) data was used to estimate the number of workers employed in those businesses in New York State.[9-10]

Results

In New York, we estimated that 468,509 employees (about 5% of the total NYS workforce), work in 30,880 establishments with potential exposure to one or more of the hazardous chemicals reported to TURI. These results are further detailed in **Table 8.**

As expected, manufacturing accounts for 44% of potentially exposed workplaces and together with administrative and support and waste management and remediation services comprise over 60%. No other sector contributes more than 7% to the total with information, professional scientific and technical services, and utilities all hovering around that level.

Conclusions

The limitations of the data include factors that can lead to both under and over-estimates of exposure. The data assumes that all workers employed in the reporting industries are potentially exposed to the hazard which is highly unlikely. The proportion of workers exposed will vary from industry to industry and even from individual workplace to individual workplace. While this will result in an over-estimate of exposure there are a number of factors contributing to under-estimation.

TABLE 8 Numbers of Establishments, Number of Paid Employees and Payroll in Industries using Toxic Chemicals[a], 2013, NYS			
NAICS Sector	**Description**	**Number of establishments[b]**	**Number of paid employees[b]**
21	Mining, Quarrying, and Oil and Gas Extraction	25	370
22	Utilities	511	34,231
31-33	Manufacturing	7,403	206,065
42	Wholesale Trade	4,356	26,944
48-49	Transportation and Warehousing	386	9,128
51	Information	1,260	32,736
52	Finance and Insurance	493	n/a
54	Professional, Scientific, and Technical Services	4,870	31,789
56	Administrative and Support and Waste Management and Remediation Services	6,245	82,634
71	Arts, Entertainment, and Recreation	1,663	23901
81	Other Services (except Public Administration)	3,668	20,711
	TOTALS	**30,880**	**468,509**

[a] As compared with Massachusetts industrial data (Toxics Use Reduction Institute, UMass Lowell)
[b] County Business Patterns (U.S. Census)

Exemptions for businesses with less than ten employees, trade secrets, and some sectors altogether (i.e. workers employed by the state, in education, and in construction) obscure potential hazards for a significant number of workers. In addition, there are undoubtedly businesses that use hazardous chemicals, but in an amount less than necessary to mandate reporting. This does not lessen the hazard for workers exposed in those industries, but does hide them from being counted. Another factor is that only 250 of 1400 hazardous chemicals on the TURI list were reportedly used in Massachusetts. As a result, there are no data on another 1150 chemicals potentially used in New York State. Finally, there are many more than 1400 chemicals being used in US workplaces, with new ones being introduced continuously.[10-11] Toxicity data of any kind is lacking for many of these substances, while for others is too scanty to draw conclusions. There is no doubt that some proportion of these substances are hazardous to human health.[12-14] Until there is laboratory or epidemiologic data, however, these substances will remain off the hazards list, leaving workers exposed to potentially harmful chemicals and uncounted.

The Landrigan/Markowitz report used two hazard index models to estimate the number of workers exposed in the most hazardous industries in the state. Neither of these models could be utilized to estimate current numbers of workers exposed to hazardous conditions as the data serving as the basis for the estimates has not been updated since the Landrigan/Markowitz report. Their estimates were 158,804 and 746,806 workers employed in the 50 most hazardous industries for the respective models. In contrast to our estimate, the Landrigan/Markowitz estimates include hazards of various types while ours includes only chemicals. Consequently, it is not possible to directly compare the numbers.

Despite the limitations of the data, however, the estimates indicate that hazardous exposures to chemicals and risk of occupational disease continues for a large number of workers in New York despite the changing landscape of work.

Lead

Lead has been known for centuries as a threat to human health.[1,2] The nature of the threat has been refined over the last several decades with the understanding that adverse health effects are evident at much lower exposure levels than those previously deemed 'safe'. [3,4] The potential health impacts are myriad and include damage to the central and peripheral nervous systems, kidneys, cardiovascular system, reproduction, and increased cancer risk.[5,6] Lead continues to be used in a variety of applications.[7-15] Direct medical costs for occupational exposure to lead have been estimated to be $141 million annually in the U.S. [16]

Methods

In NYS, blood lead levels (BLLs) are reported to a central Heavy Metals Registry which in turn, reports to the national Adult Blood Lead Epidemiology and Surveillance (ABLES) program administered by the National Institute for Occupational Safety and Health (NIOSH).[17] Elevated BLLs in New York, defined as levels greater than or equal to 10 micrograms per deciliter (μg/dl) were identified from this database, as was a subset of workers with BLLs greater than or equal to 25 μg/dl.[18]

Historically, adult BLL thresholds requiring a public health response were much higher. Until 2008, an adult BLL wasn't considered "elevated" unless it was higher than 25 μg/dL. By 2010, it was generally accepted that adult BLLs ≥ 10 μg/dL were hazardous to human health. In 2015, NIOSH designated adult BLLs ≥ 5 μg/dL as the reference point, however NIOSH statistics report only on BLLs ≥ 10 μg/dL and ≥ 25 μg/dL.

NIOSH also creates a National Occupational Research Agenda (NORA) which has developed a list of industries in which workers are likely to be at high risk of occupational lead exposure.[19] Using county business patterns data we estimated the number of workers employed in these industries in NYS.[20] The industries were grouped using NIOSH's National Occupational Research Agenda's (NORA) categories. County Business Patterns from 2014 were used to determine the number of establishments and their employees for the identified industries.

In addition, the ABLES program collects exposure source information on reported cases. The ABLES and NORA data were combined to estimate the prevalence of workers with BLLs greater than or equal to 25 μg/dl from the high-risk industries.

Results

Prevalence rates express the number of cases with elevated BLLs ≥ 10 μg/dL per 100,000 employed adults. In the United States, prevalence rates for BLLs ≥ 10 μg/dL have declined each year starting at 26.6 in 2010 and declining to 19.1 in 2014. As shown in **Table 9**, in 2014, the prevalence rate for elevated adult BLLs in NYS was 19.5 per 100,000 employed adults, just above the national average.

In the United States, prevalence rates for BLLs ≥ 25 μg/dL have declined each year starting at 7.0 in 2010 and declining to 4.5 in 2014. As shown in **Table 10**, in 2014, there were 246 cases of adult BLLs ≥25 μg/dL in NYS. The prevalence rate for adult BLLs was 2.5 per 100,000 employed adults, lower than the national average (4.5 per 100,000).

For the U.S., 76.4% of BLLs ≥ 25 μg/dL in adults were cases of occupational exposure, but a lower percentage, 70.3% of occupational cases were reported in NYS. (**Table 10**)

Individuals with BLLs ≥ 25 μg/dL were employed in a variety of settings as shown in **Table 11**. The number of workers at risk of lead overexposure in NYS is also illustrated in the table. Just under half of the elevated lead levels occurred in manufacturing industries including battery manufacturing, foundries, and metal products. Another quarter were employed in various construction trades. Services and mining industries were the source of just under another quarter of the reported cased. Over 300,000 workers are employed in these industries in NYS, just under half in construction and only about 7% percent in manufacturing.

TABLE 9 Reported numbers of cases and prevalence rates of adults* with blood lead levels (BLL) ≥10 µg/dL and blood lead levels ≥25 µg/dL§, in New York State (State Adult Blood Lead Epidemiology and Surveillance (ABLES) programs), 2014

Division/State	Number of employed state-resident adults	BLL ≥10 µg/dL, all cases¶, number	BLL ≥10 µg/dL, all cases, rate	BLL ≥25 µg/dL, all cases, number	BLL ≥25 µg/dL, all cases, rate
Total U.S.†	99,806,197	18,453	19.1	4,461	4.5
New York	8,989,429	1,754	19.5	246	2.7

* An employed person aged ≥16 years at the time of blood collection. When an adult had multiple blood lead tests in a given year, only the highest blood lead level for that adult in that year was counted. Rate per 100,000 employed adults. Data from the Adult Blood Epidemiology and Surveillance (ABLES) Program, National Institute for Occupational Safety and Health (NIOSH/CDC). Denominators for 2014 extracted from 2015 U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics (LAUS) program (http://www.bls.gov/lau/staadata.txt).

§ The numbers and rates of adults with BLLs ≥25 µg/dL are subsets of the numbers and rates of adults with BLLs ≥10 µg/dL.

¶ All cases reported by a state. These include cases among adult residents in the reporting state plus cases identified by the reporting state but who reside in another state.

** Adults residing in the reporting state.

TABLE 10 Reported numbers of adults* with blood lead levels ≥25 µg/dL, by exposure, in New York State (State Adult Blood Lead Epidemiology and Surveillance (ABLES) programs), 2014

Division/ State	Occupational§, number	Occupational, percentage	Nonoccupational, number	Nonoccupational, percentage	Unknown, number	Unknown, percentage	Total, number
Total U.S.†	3,408	76.4	207	4.6	846	19.0	4,461
New York	173	70.3	55	22.4	18	7.3	246

* An employed person aged ≥16 years at the time of blood collection. When an adult had multiple blood lead tests in a given year, only the highest blood lead level for that adult in that year was counted.

§ Includes 26 cases coded with both occupational and nonoccupational exposure source. State Adult Blood Epidemiology and Surveillance (ABLES) programs follow-up with laboratories, health care providers, employers, or workers to ensure completeness of information (e.g., the industry in which the adult is employed and whether the exposure source is occupational, nonoccupational, or both).

¶ Data not available.

†Prevalence Rate per 100,000 employed adults aged ≥16 years. State-resident prevalence rate might be lower for some states. Data from the Adult Blood Epidemiology and Surveillance (ABLES) Program, National Institute for Occupational Safety and Health (NIOSH/CDC). Denominators for 2014 extracted from 2015 U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics program (http://www.bls.gov/lau/staadata.txt).

TABLE 11 Estimated Number of Lead Exposed Adult Workers[a] in NY and US from County Business Patterns, by Selected Industries,[b] 2014

Number of Workers with Elevated Lead Levels by Industry Sector					Estimated Number of Workers Potentially Exposed			
					New York		United States	
National Occupational Research Agenda (NORA) Sector	North American Industry Classification System (NAICS) Description	NAICS code	Numbers of Workers with BLL > 25 µg /dL	Percent of workers with BLLs >25 µg /dL in all NORA sectors	Number of establishments	Paid employees	Number of establishments	Paid employees
All NORA sectors	Grand total		1801	100.0	45,676	308,520	643,345	5,178,793
Manufacturing								
	Storage battery manufacturing	33591	340	38.9	9	1880	207	25102
	Nonferrous metal (except copper and aluminum) rolling, drawing, extruding, and alloying	33149	196	22.5	39	1861	559	27969
	Alumina and aluminum production and processing	33131	102	11.7	19	¶	544	56964
	Nonferrous metal foundries	33152	56	6.4	32	925	1060	57463
	Other basic inorganic chemical manufacturing	32518	40	4.6	33	2087	642	38131
	All other fabricated metal product manufacturing	33299	33	3.8	211	6719	5345	171133
	Other manufacturing industries	33999	106	12.1	328	7428	5035	108594
	Total, manufacturing industries		**873**	**48.5**	**671**	**20,900**	**13,392**	**485,356**
Construction								
	Highway, street, and bridge construction	23731	131	29.1	465	8899	9920	259667
	Painting and wall covering contractors	23832	97	21.6	2393	9937	31607	173590
	Residential building construction	23611	65	14.4	13960	46826	159792	598399
	Plumbing, heating, and air-conditioning contractors	23822	55	12.2	6718	55990	95201	882906
	All other specialty trade contractors	23899	25	5.6	1858	7814	31044	213131
	Site preparation contractors	23891	20	4.4	1638	11746	33816	301119
	Other heavy and civil engineering construction	23799	17	3.8	183	5647	4308	81674
	All other specialty trade contractors	23899	40	8.9	1858	7814	31044	213131
	Total, construction industries		**450**	**25.0**	**29,073**	**154,673**	**396,732**	**2,723,617**
Services (except Public Safety)								
	All other amusement and recreation industries	71399	61	46.6	1097	7802	16820	114975
	Automotive mechanical and electrical repair and maintenance	81111	14	10.7	5987	20573	90615	375426
	Remediation services	56291	11	8.4	289	5898	4220	75726
	Other services (except public safety industries)	71394	45	34.4	2320	56479	31715	637182
	Total, services (except public safety) industries		**131**	**7.3**	**9,693**	**90,752**	**143,370**	**1,203,309**
Mining (except Oil & Gas Extraction)								
	Copper, nickel, lead, and zinc mining	21223	61	96.8	1	¶	68	15797
	Support activities for mining	21311	2	3.2	48	733	15114	423259
	Total, mining industries		**63**	**3.5**	**49**	**733**	**15,182**	**439,056**
Other/missing	**Total, other/missing industry information**		**284**	**15.8**	**6,239**	**42,195**	**89,851**	**766,511**

[a] An employed person aged ≥16 years at the time of blood collection. When an adult had multiple blood lead tests in a given year, only the highest blood lead level for that adult in that year was counted.

[b] Selected industries were the National Occupational Research Agenda (NORA) sectors with high with blood lead levels ≥25 µg/dL coded with North American Industry Classification System (NAICS) industry - State Adult Blood Lead Epidemiology and Surveillance (ABLES) programs, United States, 2014. NORA sectors consist of ten industry sectors based on major areas of the U.S. economy (https://www.cdc.gov/niosh/nora/sectorapproach.html).

¶ Data not available.

Limitations

In 2014, elevated BLLs were defined as >10 μg/dL, but NORA was defining high risk industries (and workers) as those with BLLs > 25 μg/dL, where workers with BLLs between 10 and 25 μg/dL were employed is unknown. If the distribution of lead overexposure is different than those with BLLs > 25 μg/dL, then our results would be an underestimate.

Conclusions

A substantial number of workers in NYS continue to be potentially exposed to lead at levels high enough to pose a health risk. The greatest number of the potentially lead exposed employees work in construction, particularly bridge work, and painting. "Traditional" lead exposed occupations in manufacturing industries are relatively lower in number but are disproportionately exposed to higher levels of lead.

Silica

Silica (silicon dioxide) is a mineral widely distributed and found in rocks, soil, and sand. It occurs in crystalline and non-crystalline forms. Quartz is by far the most common crystalline form. Crystalline forms of silica have been known for centuries to cause a scarring lung disease (silicosis).[1-3] More recent research has implicated silicosis as a cause of lung cancer, kidney disease, autoimmune diseases like rheumatoid arthritis and scleroderma, and an increased risk of pulmonary tuberculosis.[4-13]

Historically, exposure to silica at work has been widespread, both as a contaminant and as a material used in production.[14] Mining, milling, and construction work are well known sources of silica exposure.[15-18] Abrasive blasting with sand on construction sites and in manufacturing is a particularly important exposure source.[19-22] Silica exposure can also be found in specialized trades like cutting grave stones,[23] jewelry manufacturing,[24] and dental laboratories.[25] Important sources of emerging exposures include hydraulic fracturing for natural gas,[26-27] and the fabrication of artificial stone kitchen and bathroom counter tops.[28-30]

OSHA recently promulgated a Silica Standard reducing allowable exposure levels as significant numbers of workers continue to be exposed to hazardous levels of silica.[31-32] As part of its justification for the Standard OSHA carried out a detailed assessment of the likely exposed workforce on a national level.[33-35] Estimates for New York State were obtained utilizing a similar approach.

Methods

In the Preamble to the Silica Standard, OSHA presents silica exposure profiles for at-risk workers by sector and job category. Summary data are also provided for the number of workers in each affected industry who are currently exposed above the proposed silica PEL of 50 $\mu g/m^3$, as well as above an alternative PEL of 100 $\mu g/m^3$ for economic analysis purposes.[33-35]

OSHA's analysis was applied to NYS employment data, from 2014, obtained through County Business Patterns to determine the number of affected employees at silica air levels: $\mu g/m^3$ >=0, >=25, >=50, >=100, and >=250 within each occupation.

Results

Overall, we estimate that almost 100,000 workers are exposed to silica at work in New York State. Over 90% work in a construction industry, while the rest are in general industry. The distribution of silica exposure among specific industries is illustrated in **Tables 12 and 13.**

In terms of the number of workers exposed, State and Local government workers were far and away the largest category making up 36% of the total number of construction workers. Building construction including residential, non-residential, finishing, foundation/structure/exterior, and other specialties comprised another 46% of the construction sector.

The General Industry workers were scattered over a much larger list of types of workplaces, though more than half were employed in jewelry and silverware manufacturing, dental laboratories, or ready mixed concrete manufacturing. Foundry work, a well-known source of silica exposure, employs a relatively small number of workers in the state (though numbers were not available for iron and steel foundries).

With regard to severity of exposure, a significant proportion of exposures are above OSHA's Action Level of 25 $\mu g/m^3$ and at high risk of disease. Forty percent of workers in the Construction sectors are exposed above the Action Level with nine percent exposed to levels more than ten times the Action Level. In General Industry half the workers are exposed above the Action Level with 14% exposed at the highest level.

Among the Construction industries, Foundation, Structure and Building Exterior Contractors stood out with 71% of workers exposed above the Action level and 24% exposed at the highest level. Workers in this category made up 17% of the total number of workers in the Construction sector but 31% of workers exposed above the Action Level and 48% of workers exposed at the highest level.

Of the seven industry types with the most silica exposed workers in General Industry, Ready mixed concrete manufacturing employed 11%, but was responsible for 56% of the highest-level exposures. It should be noted that Aluminum and Nonferrous metal foundries employ a relatively few numbers of workers, but the percent exposed above the Action Level (92% and 76% respectively) and at the highest level of exposure (23% and 10%) are disproportionately high. These results indicate that foundry work remains a significant source of exposure for workers employed in these settings.

Conclusions

Almost 100,000 workers in New York continue to be exposed to silica and are at risk of developing silicosis and other silica-related diseases, according to our analyses. As anticipated, construction work of various types is the most important setting for silica exposure. Foundry work, while employing a relatively small number of workers, carries a high risk of disease due to high exposure levels. The emergent artificial stone countertop fabrications and installation industry is a growing source of concern with regard to silica exposure.

TABLE 12 Estimated Numbers of Workers Exposed to Silica in the United States and in New York State, by Affected Industry and Exposure Level,($\mu g/m^3$),[a,b] 2014[c]

Industry	Number of Establishments[b]	Number of Employees[b]	Percent of Total Employees Affected[c]	Number of Affected Employees	>=0	>=25	>=50	>=100	>=250
	Number Exposed in U.S.								
Construction	667,099	20,032,076	0.076	2,827,321	1,526,647	310,201	347,883	312,329	330,261
General Industry and Maritime	234,467	3,983,834	0.023	214,964	91,394	38,150	29,399	22,632	33,389
Totals	901,566	24,015,910	0.067	3,042,285	1,618,041	348,351	377,282	334,961	363,650
	Number exposed in N.Y.S.								
Construction	46,446	1,388,571	0.038	88,435	53,427	9,037	10,054	8,184	7,734
General Industry and Maritime	13,843	133,223	0.032	8,312	4,207	1,216	926	836	1,127
Totals	60,289	1,521,794	0.038	96,747	57,633	10,252	10,981	9,020	8,861

a Source: U.S. Dept. of Labor, Occupational Safety and Health Administration, Directorate of Standards and Guidance, Office of Regulatory Analysis, Federal Register. Vol. 78, No. 177. Thursday, September 12, 2013, Proposed Rules

b Source: 2014 Annual Survey of Public Employment & Payroll, Census EP1400A4

c Source: Table III–5 and the technological feasibility analysis presented in Chapter IV of the Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis, Supporting document for the Notice of Proposed Rulemaking for Occupational Exposure to Crystalline Silica, 2013

TABLE 13 Estimated Numbers of Workers Exposed to Silica in New York State (by Affected Industry and Exposure Level (µg/m³))[a,b], 2014[c]									
NAICS 2012	**Industry**	**% > 25 within industry[c]**	**# >25**	**% >25 of total >25**	**%>250 within industry[c]**	**# >250**	**% >250 of total >250**	**# of employees**	**% total affected**
Construction		**27%**	**8,519**	**24%**	**3%**	**959**	**12%**	**31,602**	**36%**
999000	State and local governments	71%	10,942	31%	24%	3,707	48%	15,443	17%
238100	Foundation, Structure and Building Exterior Contractors	32%	3,061	9%	5%	481	6%	9,626	11%
238900	Other Specialty Trade Contractors	48%	3,831	11%	12%	946	12%	8,029	9%
236200	Nonresidential Building Construction	35%	2,127	6%	4%	271	4%	6,023	7%
237100	Utility System Construction	29%	1,600	5%	4%	204	3%	5,607	6%
237300	Highway, Street, and Bridge Construction	41%	2,141	6%	12%	642	8%	5,223	6%
238300	Building Finishing Contractors	28%	809	2%	3%	86	1%	2,932	3%
237900	Other Heavy and Civil Engineering Construction	58%	1,565	4%	14%	364	5%	2,682	3%
236100	Residential Building Construction	33%	393	1%	6%	71	1%	1,187	1%
238200	Building Equipment Contractors	27%	22	0%	2%	2	0.03%	82	0%
237200	Land Subdivision		35,009	100%		7,734	100%	88,435	100%
	Total								
General Industry and Maritime									
339910	Jewelry and Silverware Manufacturing	63%	1,073	29%	13%	214	20%	1,712	22%
339116	Dental Laboratories	16%	270	7%	0%	0	0%	1,674	22%
327320	Ready mixed Concrete manufacturing	75%	697	19%	67%	629	59%	935	12%
327390	Other Concrete Product Manufacturing	50%	281	8%	8%	47	4%	560	7%
327991	Cut stone and stone product manufacturing	85%	413	11%	10%	50	5%	484	6%
327110	Pottery, ceramics, and plumbing fixture manufacturing	76%	282	8%	8%	30	3%	370	5%
327120	Clay building material and refractories manufacturing	58%	207	6%	6%	20	2%	356	5%
	Miscellaneous Other General Industry and Maritime	38%	498	13%	6%	69	7%	1,559	20%
	Total		**3,721**	**100%**		**1,059**	**100%**	**7,650**	**100%**
331511	Iron foundries	n/a							
331513	Steel foundries	n/a							
331524	Aluminum foundries	92	67	17%	23%	17	25%	73	11%
331529	Other nonferrous metal foundries	76	95	25%	10%	14	21%	143	22%
327999	All other miscellaneous nonmetallic mineral product mfg	50	97	25%	8%	16	24%	194	29%
	Miscellaneous other foundry	50	125	33%	8%	21	31%	252	38%
	Total		**384**	**100%**		**68**	**100%**	**662**	**100%**
	Grand Total		**39,114**			**8,861**		**96,747**	

Source: U.S. Dept. of Labor, Occupational Safety and Health Administration, Directorate of Standards and Guidance, Office of Regulatory Analysis, Federal Register. Vol. 78, No. 177. Thursday, September 12, 2013, Proposed Rules

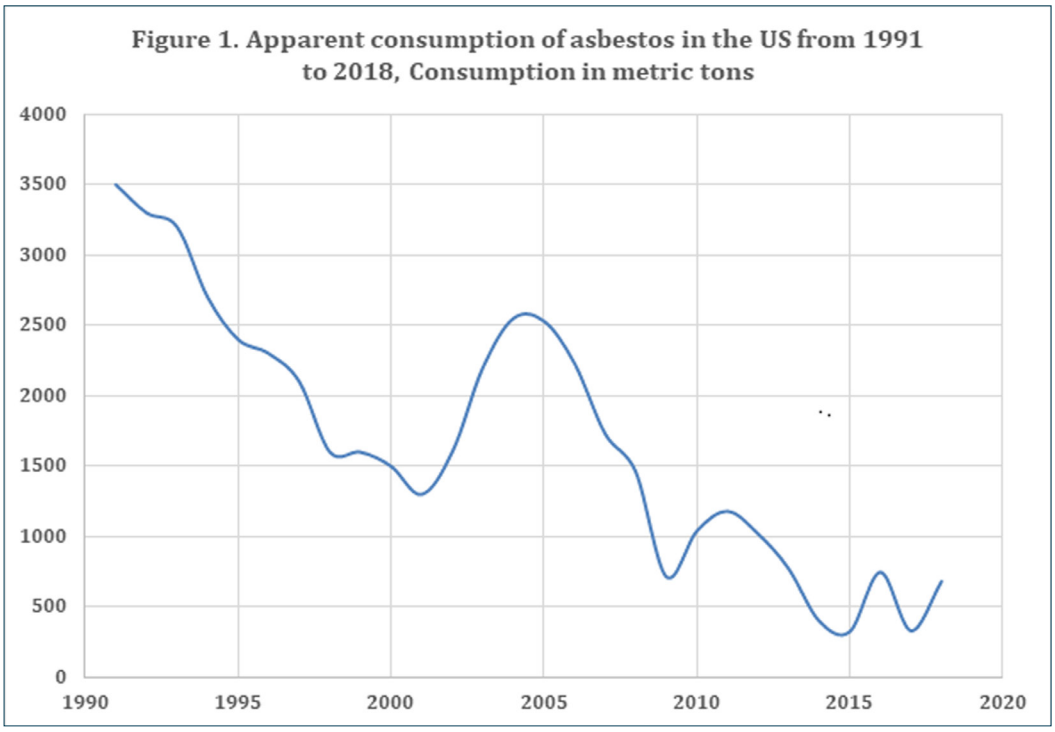
Source: 2014 Annual Survey of Public Employment & Payroll, Census EP1400A4

Asbestos

Asbestos is the name given to a group of naturally occurring minerals including chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite. They are valued for their heat and corrosion resistant properties and, since the late 19th century have been used in thousands of products across the globe.[1,2] Though the health risks of asbestos exposure were known within the industry and scientific community for decades,[3-9] the work of Selikoff and associates in the 1960s brought these risks to much wider public attention.[10-13] These risks include asbestosis, lung cancer, mesothelioma, and other cancers.[14-21]

Asbestos manufacturing and use declined precipitously in the United States beginning in the mid-1970s (**Figure 1**), though asbestos mining, manufacturing and use continues in many parts of the world, particularly in the Global South. Observers have described waves of asbestos exposure in the United States:[22]

1) Asbestos mining and milling, manufacture into products
2) Use of asbestos containing products (e.g. pipe insulation, gaskets, brake shoes)[23-24]
3) Disturbance of asbestos in place[25-27]



Source: U.S. Geological Survey, https://www.usgs.gov/centers/nmic/asbestos-statistics-and-information

For several decades, the disturbance of asbestos in place has been the primary source of exposure to asbestos for workers in NYS. Asbestos abatement has become an important business where workers engaged in this work are routinely handling asbestos. Others, such as building maintenance workers, HVAC installers and repair people, bridge workers, auto mechanics, and phone company installers, encounter asbestos irregularly.[28-30] Their job activities require them to work in proximity to asbestos, or to disturb and remove the asbestos in order for them to access their work. The collapse of the World Trade Center in New York City following the terrorist attack of 9/11/2001 is a vivid example of how workers (and nearby residents and bystanders) can be exposed to a release of asbestos in place.[31-32]

To date in the U.S., asbestos has not been fully banned, but significant regulatory activity has curtailed its manufacture, import, processing and distribution.[33-36] Consumption has significantly reduced from about 3,500 metric tons per year to about 700 in 2018.[37] Until 2007, Canada provided nearly all imported asbestos, but since then Brazilian imports have replaced Canadian, with Zimbabwe, Russia and other countries supplying small amounts. [36-39]

Occupations at risk of asbestos exposure were identified by Nicholson, Perkel, and Selikoff (1982).[40] They divided the industries into groups including:

1) Asbestos mining and milling
2) Asbestos primary manufacturing
3) Asbestos secondary manufacturing
4) Shipbuilding and repair
5) Construction
6) Electric, gas and combination utility services
7) Other occupational groups

Nicholson and colleagues' estimates were based on 1970s exposures, when asbestos was still actively used in large amounts. Since those estimates and their associated jobs are no longer accurate for current exposures, new estimates would be required to pursue a realistic estimate in today's conditions. The asbestos mining, milling, and manufacturing industries have essentially disappeared, and exposure in shipbuilding and repair would not be expected to be of significance.

As already noted, since the 1980s, exposure to asbestos has shifted to the disturbance of asbestos in place. This includes asbestos abatement workers, as well as a number of occupational groups not considered exposed in 1982 including building maintenance workers in schools and offices, communications workers disturbing asbestos as they install and service lines in buildings, and firefighters. In addition, some workers are exposed to relatively brief, accidental exposures such as those responding in various ways to the collapse of the World Trade Center towers following the attack of 9/11/01 or to various natural disasters. [31-32] Exposure to asbestos in place continues among the construction trades, but it is quite variable and intermittent, depending on the trade and the specific job.

Other occupational groups with potential exposure to asbestos have been identified more recently including: lab workers, instrument technicians, sound recording technicians, ceramic industry workers, jewelry and silverware manufacturers, and electronic and precision equipment repairers.[41-42]

Conclusions

Lack of more specific exposure information, and the extreme variability of exposure, both within, and between occupational groups severely constrains any attempt to quantitatively estimate asbestos exposure for workers in NYS. Qualitatively, a substantial number of workers continue to potentially be exposed in NYS. Asbestos was used so widely in a myriad of applications that it remains present in many industrial, commercial, and residential buildings. Construction workers (including asbestos abatement) are the largest group that potentially encounters asbestos on the job. Other workers tasked with installing, repairing, and maintaining boilers, pipes, communications equipment and other building -related materials and machinery are also at risk of exposure. Those responding to disasters like the World Trade Center attack, and workers in several relatively recently identified occupations make up another segment of the working population that should be included as potentially exposed.

Ergonomic Hazards

The incidence of musculoskeletal injuries involving the hands, arms, shoulder, neck, and back related to chronic overuse and other workplace factors increased dramatically in the United States in the 1980s and 1990s. These injuries occurred across a wide spectrum of occupations and injuries in all sectors of the economy. Specific job characteristics including repetitive motion, awkward postures, forceful movements, repetitive lifting, static postures, vibration, and work in cold temperatures have been associated with these types of injuries.[1-12] Due to the pervasive nature of these hazards and the widespread prevalence of injury, health and safety advocates called for an OSHA ergonomics standard to better control the hazard. Though a standard was promulgated during the last days of the Clinton administration, it was immediately rescinded by Congress after the election of George W. Bush. One of the results was an end to the reporting of musculoskeletal disorders due to chronic use by employers to OSHA, removing one of the only sources reporting and tracking these types of conditions.[13-14]

Clearly, work-related musculoskeletal conditions due to chronic use remain important causes of disability and estimation of workers at risk is an important piece of the overall hazard picture for the state and compensable claims in the workers' compensation systems in the country continue to be driven by MSDs.[15]

Methods

The O*NET Database 24.0 was utilized to estimate ergonomic exposures among NYS workers.[16] This database obtains information from workers in a survey covering a broad range of issues related to working conditions. The questions include seven pertaining to ergonomic conditions. Answers are divided into low, medium, and high exposure categories. Each exposure category is rated on a 0-100 scale and the average for each occupational code is calculated. The data was last updated in August, 2019.[17-18]

Estimates were produced using only the high hazard exposure category. The total number of workers at risk was calculated by multiplying the percentage of high exposure workers in each occupational category by the total number of workers in that occupation as identified in NYS County Business patterns data.[19,20] The individual occupation totals were then summed to produce a grand total for each of the seven ergonomics-related survey questions. Definitions are provided for our analysis in **Table 14**.

Results

Results of our data exploration are detailed in **Table 15.** More than 40% of survey respondents reported frequent (more than half the time) activities requiring repetitive motion. Static postures were reported frequently with 36% sitting and 25% standing more than half the time. Significant percentages of respondents reported 'bending or twisting the body' (21%), and 'kneeling, crouching, stooping, crawling' (10%). The numbers of workers reporting at least one of these hazards were large, ranging from just over one million to over four million. Fourteen percent of respondents reported exposure to 'cramped work space, awkward positions' at a lower level of exposure (once a week or more).

Limitations

The following limitations in the data should be noted.

1. A limited number of ergonomic factors were investigated.
2. The data was self-reported and not supplemented with any direct observations of the work.
3. Low and medium level hazards were excluded, even though they could pose a health risk.
4. The data did not allow for determinations of patterns of exposure among groups of workers as each risk factor was calculated individually. It is likely that many workers reported exposure to more than one ergonomic hazard.

5. In addition, musculoskeletal injuries related to ergonomic hazards include the hands, arms, shoulders, back, neck, and sometimes the legs. Different risk factors may be operational for different parts of the body, but there is also significant overlap. Most of the risk factors asked by O*NET pertain more to the back and neck than the upper extremities. Sitting, kneeling/crouching/stooping/crawling, and bending/twisting are all more back and possibly neck-related hazards. Standing for prolonged periods may also strain the back, neck and in addition, the legs. Repetitive motion is often associated with hand and arm use, though it may also refer to jobs requiring repetitive lifting. It is also unknown whether respondents distinguished between the repetitive motion question and those asking about bending/twisting, kneeling/crouching/stooping/crawling. Those are repetitive activities as well and those reporting repetitive motion may have been referring once again to the activities asked about in other questions.
6. Missing data is attributed to coding differences (11.6%) and data suppression per regional, state and federal analysts (5.1%).[17]

The impact of individual limitations including the limited number of ergonomic factors investigated, and the exclusion of low and medium level hazards, contributes to an underestimate of incidence. The data should be interpreted as providing a partial picture.

Conclusions

The use of the O*NET data indicates a large number of workers in NYS are exposed to ergonomic hazards and at risk of musculoskeletal injury. A significant proportion are at risk of back and neck injury. Estimating the number of workers at risk of upper extremity injury is hampered by the lack of specific questions in the O*NET survey.

TABLE 14 Exposure Definitions and Thresholds			
Category/Hazard	**Exposure**	**Definition**	**Threshold**
Ergonomic	Spend time bending or twisting the body	Bending or twisting the body	More than half the time
	Cramped work space, awkward positions	Working in cramped spaces that require getting into awkward positions	Once a week or more
	Spend time kneeling, crouching, stooping, or crawling	Kneeling, crouching, stooping, or crawling	More than half the time
	Spend time making repetitive motions	Makes repetitive motions	More than half the time
	Spend time sitting	Time spent sitting	More than half the time
	Spend time standing	Time spent standing	More than half the time
	Exposed to whole body vibration	Exposure to whole body vibration (such as operating a jackhammer)	Once a week or more

TABLE 15 Number and percent of workforce with ergonomic exposures[a] in New York State[b], 2016			
Ergonomic Exposures	Frequency	Total Workforce	Percent Total Workforce
		10,201,820	
Cramped work space, awkward positions	once a week or more	1,405,694	14
Exposed to whole body vibration	once a week or more	341,983	3
Bending or twisting the body	more than half the time	2,118,286	21
Kneeling, crouching, stooping, crawling	more than half the time	1,004,493	10
Make repetitive motions	more than half the time	4,199,291	41
Sitting	more than half the time	3,696,184	36
Standing	more than half the time	2,582,123	25

[a] SOC-O*NET Codes

[b] Statewide Long-term Occupational Projections for New York State, number employed reported in thousands, https://www.labor.ny.gov/stats/lsproj.shtm

TABLE 16 Exposure Definitions and Thresholds			
Category/Hazard	**Exposure**	**Definition**	**Threshold**
Psychosocial	Level of competition	Presence of competing on the job or aware of competitive pressures	High (4 or 5 on a 5-point scale)
	Frequency of conflict situations	Frequency of conflict situations worker has to face in the job	Once a week or more
	Frequency of decision making	Frequency of decisions affecting other people, financial resources, and/or reputation of the organization	Once a week or more
	Freedom to make decisions	Degree of decision making freedom in the job without supervision	Some freedom
	Deal with physically aggressive people	Deal with physical aggression of violent individuals	Once a week or more
	Highly structured work	Degree to which job is structured for worker versus allowing worker to determine tasks, priorities, goals	Some freedom
	Time pressure	Need to meet strict deadlines	Once a week or more
	Atypical work schedule	Regularity of work schedule for the job	Irregular or seasonal
	Duration of typical work week	Number of hours typically worked in one week	Less than or more than 40 hours

TABLE 17 Number and percent of workforce with psychosocial exposures[a] in New York State[b], 2016			
Ergonomic Exposures	Frequency	Total Workforce	Percent Total Workforce
		10,201,820	
Irregular Work Schedule		1,993,898	20
Deal with physically aggressive people	once a week or more	893,740	9
Work more or less than 40 hours/week		5,685,533	56
Limited freedom to make decisions		2,605,112	26
Frequent Conflict Situations	once a week or more	3,780,731	37
Required to make decisions	once a week or more	2,728,777	27
Highly structured work		2,503,968	25
Highly competitive workplace		3,350,225	33
Under time pressure		6,020,802	59

[a] SOC-O*NET Codes

[b] Statewide Long-term Occupational Projections for New York State, number employed reported in thousands, https://www.labor.ny.gov/stats/lsproj.shtm

Psychosocial Hazards: Exposure to Work-related Stress

Over the past several decades psychosocial stressors at work have received increased attention as hazards associated with disease and illness, both physical and mental. During that time the definition of stress has been better delineated, though no single definition has been universally accepted.[1-3] However, widespread agreement continues to develop about some of the specific characteristics that make a workplace stressful including:

- Work that is highly psychologically demanding[1]
- Lack of control over decision-making[1]
- Inadequate social supports[2]
- Effort-reward imbalance[3]
- Hostile environments- bullying, disrespect by supervisors[4]
- Relations with clients and customers[4]
- Precarious employment arrangements[5]
- Discrimination[6]

There have also been attempts to synthesize these individual elements into a more holistic model that puts the individual worker in their institutional and macro context.[7-9]

Not surprisingly, there is little data to tap for use in estimating workers laboring under stressful conditions. The O*Net database 24.0, was used to estimate psychosocial stressors.[10-11]

Methods

The O*NET Database 24.0 obtains information from workers in a survey covering a broad range of issues related to working conditions. The questions include nine pertaining to psychosocial stressors. Answers are divided into low, medium, and high exposure categories. Each exposure category is rated on a 0-100 scale and the average for each occupational code is calculated. The data was last updated in August, 2019.

Our estimates were produced using only the high hazard exposure category. The total number of workers at risk was calculated by multiplying the percentage of high exposure workers in each occupational category by the total number of workers in that occupation as identified in NYS County Business Patterns data.[12] The individual occupation totals were then summed to produce a grand total for each of the nine psychosocial-related survey questions.10-11 Definitions are provided in **Table 16**.

Results

Responses to the nine O*NET survey questions we analyzed are shown in **Table 17.** Work schedules of more or less than the standard 40-hour week considered full time are reported by more than half the workforce (5,685,533 workers). Irregular work schedules (20%), limited freedom to make decisions (26%), highly structured work (25%), highly competitive workplace (33%) and under time pressure (59%) may all reflect a lack of control over workplace activities and conditions, and each was reported by a significant segment of the workforce. A large proportion of workers reported frequent conflict situations (37%), and a smaller proportion

reported having to deal with physically aggressive people (9%). These percentages translate into large numbers of workers (excluding those reporting dealing with physically aggressive people) ranging from over 1.9 million to over 6 million.

Limitations

Some of the same limitations of the O*NET data noted for the ergonomics exposures apply to the psychosocial variables. These include:

1) A limited set of psychosocial stressors
2) An inability to assess how the stressors interact or occur in patterns on specific jobs
3) A limiting of workers at risk to those reporting on the highest exposure frequency.
4) One of the stressors (Deal with physically aggressive people) is limited to only a portion of the spectrum of workplace violence.
5) Missing data is attributed coding differences (11.6%) and data suppression per regional, state and federal analysts (5.1%).[17]

The limitations, overall, suggest that we have underestimated the number of people working under stressful conditions.

Conclusions

Even the partial picture provided by the O*NET data suggests that a large proportion of the workforce labors under stressful working conditions that could have an adverse impact on their physical and mental health. An accurate count might find that well over a majority of New York's workers are at risk from this category of hazard.

COVID-19 and Infectious Disease in the Workplace

While infectious diseases that are airborne (e.g. tuberculosis), blood borne (e.g. Hepatitis B and C, HIV), and fecal orally transmitted (e.g. Hepatitis A, Clostridium Dificile) have long been recognized as workplace risks, the COVID-19 pandemic has brought the risk of workplace exposure and infection to universal attention.[1-3]

The major route of exposure to the COVID-19 virus is through inhalation of virus particles, though hand to nose or mouth exposure via direct contact with virus contaminated surfaces may play a relatively minor role. Accumulating evidence points to the role of both large droplet and smaller aerosolized particles in causing infection.[4]

In the workplace there are several pathways for the virus to spread:

1) Workers may be directly infected by patients or clients they serve
2) Workers may spread the infection to each other
3) Workers may spread the infection to the patients or clients they serve.[5,6]

In addition, the nature of the infection and its transmission blurs the lines between work and community/home environments. Workers may be infected at home and then bring it to work infecting co-workers and patient/clients. Conversely, workers may be infected at work and bring the infection home to their families and community, who may, in turn spread it to their co-workers.[7-12]

There are other ways work can contribute to risk of COVID-19 infection. Low wages and lack of paid sick time make it impossible for workers to miss work when sick, or when exposed and needing to quarantine.[13-19] Large outbreaks have been documented among migrant farm workers whose working conditions may be less hazardous then their employer provided housing which puts them in very close proximity to each other in cramped quarters.[20-23] In this situation, working conditions dictate housing/living conditions that put workers at risk.

Somewhat less directly, a high percentage of workers in NYS are employed in low-wage settings, many with routine direct contact with patients/clients, and often without adequate employer provision of protective measures, but with a mandate to keep working throughout the pandemic because their work has been deemed 'essential'.[13-18] Low wages also contribute to higher density living conditions with less ability to social distance and control the potential of infection being brought in and spread through the household.[7-12]

As noted in the following section, low-wage jobs are disproportionately held by people of color and the COVID-19 pandemic has struck these communities disproportionately hard. It is likely that work has contributed to these inequities. There was little or no monitoring of the workplace during the early months of the crisis. Lack of personal protective equipment was a constant issue among lower paid staff, especially in health care settings.[24-36]

Estimating workers at risk of COVID-19 infection at the workplace

Attempts to estimate the number of workers at increased risk of COVID-19 suffer from a variety of difficulties, of which two are key. The first is that COVID-19 is a novel infectious agent and a priori assumptions about who is at risk have yet to be extensively tested through experience. A logical and widely used assumption is that the frequency a worker comes into contact with potentially infected people, and the closer the job requires them to work to the potentially infected person is a reasonable indication of risk. Initial studies have suggested the validity of this assumption and its usefulness as a predictor. However, the studies also suggest that there are clearly additional factors at play determining risk.

The second is that information about a COVID-19 patient's occupation is rarely collected. This is a huge handicap for attempts to assess risk. Researchers are forced to rely on the records from the rare state that does collect occupational information, or to limit themselves to looking at death certificates for individuals who have died of COVID-19, both of which provide only a partial picture. Researchers could attempt to retrospectively obtain occupational information from COVID-19 patients through direct contact but this would require significant funding, personnel, and time.[37]

As a consequence of these difficulties, to date there are only a handful of studies that have attempted to identify and quantify workers at increased risk of occupational COVID-19 infection.[5,6] Despite non-uniform definitions and study designs, there is significant consistency in the studies' findings that allows some conclusions to be drawn.

As might be expected, health care workers are at increased risk. The risk is not equal, however for all categories of health care workers. **Table 18** predicts prevalence for categories of health care workers at higher risk of COVID-19 infection.[38-39]

Beyond health care, a wide swath of workers are employed in occupations that put them at increased risk of COVID-19 infection**. Table 19** lists the broad categories identified in one study and estimates mortality.[39] This list overlaps with the list of 'essential' workers as defined by NYS.[40] Many of these workers continued to work throughout the pandemic at their usual worksites.

Conclusions

At the end of March 2021, NYS had sustained 1.82 million confirmed cases with 49,305 deaths from COVID-19.[41] Even though NYS's vaccination rate is nearly 70%, by September 1st, the total of confirmed cases was 2.3 million with over 54,300 deaths.[41] The pandemic continues with significant morbidity and mortality, primarily due to the strength of the Delta Variant. Premature returns to social 'normalcy' and vaccine hesitancy also factors in the current resurgence of disease. Workers experiencing "long-Covid" are an increasing concern.[42]

A very high proportion of workers in NYS are employed in jobs deemed 'essential' and at high risk of COVID-19 infection. In addition, it is important to note the disproportionate burden of COVID-19 infection and mortality borne by Black and Latinx communities, to which work is contributing.

Finally, a unique feature of a highly infectious disease spread primarily through exposure through inhalation of virus, is the risk of carrying a workplace infection home and vice versa. Consequently, the population at risk is comprised not only of workers directly present in the workplace, but also their families, friends and other contacts in the community.

TABLE 18 Estimated individual health care occupations at highest risk for COVID-19, NYS, 2019

						Expected COVID-19 cases		
SOC Code	Occupation	Predicted Prevalence Ratio[a]	95% Confidence Interval		Employed in NYSb	Predicted cases	Low range	High range
29-1292.00	Dental hygienists	2.71	1.28	4.13	11620	315	149	480
29-1022.00	Oral and maxillofacial surgeons	2.67	1.26	4.07	360	10	5	15
31-9091.00	Dental assistants	2.64	1.24	4.05	19,520	515	242	791
29-1021.00	Dentists, general	2.62	1.23	4.02	8,780	230	108	353
31-1132.00	Orderlies	2.61	1.22	4	3,070	80	37	123
29-1124.00	Radiation therapists	2.6	1.22	3.98	1,170	30	14	47
29-1218.00	Obstetricians and gynecologists	2.57	1.19	3.94	1,580	41	19	62
29-1126.00	Respiratory therapists	2.54	1.16	3.93	5,860	149	68	230
29-1062.00	Family and general practitioners	2.53	1.13	3.93	17852	452	202	702
29-1141.00	Registered nurses	2.61	1.16	4.14	178,320	4,654	2,069	7,382
29-1024.00	Prosthodontists and other specialty dentists	2.51	1.15	3.88	280	7	3	11
29-2034.00	Radiologic Technologists	2.52	1.16	3.88	12,620	318	146	490
29-1161.00	Nurse midwives	2.51	1.15	3.86	480	12	6	19
29-2040.00	Emergency medical technician and paramedics	2.51	1.15	3.88	18,610	467	214	722
29-1122.00	Occupational therapists	2.51	1.15	3.87	12,460	313	143	482
	Totals				**292,582**	**7,593**	**3,424**	**11,907**

Estimated individual nonhealthcare occupations at highest risk for COVID-19, NYS, 2019

						Expected COVID-19 cases		
SOC Code	Occupation	Predicted Prevalence Ratio[a]	95% Confidence Interval		Employed in NYSb	Predicted cases	Low range	High range
53-2031.00	Flight attendant	2.34	1.02	3.68	10,820	253	110	398
33-2011.01	Firefighters	2.21	0.94	3.5	14,050	311	132	492
53-3011.00	Ambulance drivers, attendants	2.17	0.90	3.6	990	21	9	36
39-5011.00	Barbers	2.1	0.76	3.7	1,790	38	14	66
25-2012.00	Kindergarten teachers, except special education	2.04	0.81	3.8	6,450	132	52	245
33-3012.00	Correctional officers and jailers	2	0.76	3.9	35,420	708	269	1381
33-1011.00	First-line supervisor of corrections officers	1.96	0.56	3.1	3,890	76	22	121
39-4031.00	Morticians, undertakers, and funeral directors	1.91	0.57	3.11	1,420	27	8	44
33-9093.00	Transportation security screeners	1.88	0.66	3.13	3,720	70	25	116
25-2051.00	Special education teachers, preschool	1.86	0.62	3.14	5,930	110	37	186
47-4071.00	Septic tank servicers and sewer pipe cleaners	1.83	0.63	3.15	1,570	29	10	49
39-4011.00	Embalmers	1.8	0.32	3.16	1,450	26	5	46
25-2053.00	Special education teachers, middle school	1.79	0.60	3.17	10,960	196	66	347
21-1093.00	Social and human service assistants	1.79	0.60	3.18	39,810	713	239	1266
	Totals				**138,270**	**2,710**	**997**	**4,794**

[a]Sources: Zhang 2021; [b]NYS Bureau of Labor

TABLE 19 Occupational groups at higher risk of COVID-19 infection, New York State, 2019[a]			
SOC Occupation Group	**Number of Workers[b]**	**Mortality rate, per 100,000[a]**	**Estimated deaths**
Transportation and materials moving	631,580	61	385
Food preparation and serving	768,040	30	230
Building and Grounds cleaning and maintenance	311,150	42	131
Production	328,630	45	148
Construction and Extraction	358,350	45	161
Installation maintenance and repair	318,830	21	67
Protective services	314,490	14	44
Personal care and services	262,220	14	37
Arts, design, entertainment, sports, and media	221,800	16	35
Community and social services	198,410	12	24
TOTAL	**3,713,500**		**1,262**

Sources: [a]Hawkins, Davis, Kriebel 2020; [b]NYS Bureau of Labor

Chapter 3

WORK AND INEQUALITIES OF HEALTH: UNEQUAL RISK OF OCCUPATIONAL DISEASE

Not all workers are at equal risk of injury or illness caused or contributed to by exposure to workplace hazards.[1-13] As described above, some jobs are more hazardous than others, creating unequal risk of an injury or illness. Risk varies, however, even among jobs with relatively similar hazard profiles. Employers differ in the attention they give to health and safety, the extent to which they provide effective control measures, the rapidity with which they respond to suspected or identified safety and health issues, the training they provide employees on hazards and controls, and the way they deal with workers who are injured or ill.

The flip side of the coin is the influence and knowledge workers are able to marshal on their own behalf. A union provides at least the potential of collective power in the workplace, giving workers the ability to bargain and struggle in other ways for better working conditions.[14-18] Even non-union workers who are trained to identify workplace hazards and know their rights and resources, are in a better position to achieve improvements in their working conditions compared to others without a similar level of knowledge.[19] The support of worker oriented health and safety organizations in the community including Councils on Occupational Safety and Health (COSHs),[20] occupational health clinics,[21-22] and Workers' Centers[23-24] also can play an important role strengthening workers' abilities to pursue health and safety goals.[25-27]

The larger political economic context plays a key role in determining how employers and workers 'negotiate' working conditions. The shift away from manufacturing has cost the country a large number of jobs, a high proportion of which were unionized.[28-33] The threat of companies moving off shore or outsourcing work becomes an even more potent means of silencing worker demands in this context. Over the past several decades the balance of power has swung decidedly in employers' favor.[34-36] Low-wage jobs grow while middle income employment has disappeared. Unions have lost thousands of members and their ability to defend workers has weakened considerably.[37]

The larger context also powerfully structures who is able to access available jobs. Part of the legacy of discrimination of various types, including racial, gender, age, class, and sexual orientation has been to sort people into certain jobs and industries.[38-46] Unsurprisingly low-wage, high risk jobs are disproportionately filled by Latinx and African-Americans.[39-41] Women have historically been slotted into jobs that involve domestic work, care work, the education of children, customer service, social service or work that requires repetitive and tedious handiwork based on their inappropriately presumed superior abilities to tolerate and perform these types of activities.[41-43]

Government policy and regulation is another important determinant of actual workplace conditions. Health and safety policy includes research on hazards and controls, funding for training professionals and community members, and setting and enforcing standards.[25-27, 47-48] All presidential administrations since the late 1970s have paid homage to the idea of smaller

government, reduced government spending and deregulation. As a result, from a health and safety standpoint, over time the threat of inspection and enforcement has decreased, funding to sustain and continue building the government and non-government safety and health infrastructure has shrunk, standard setting moves at a glacial rate, and Workers' Compensation is increasingly inadequate as a remedy for workers with occupational disease.[49-59]

Consequently, another way to look at who is at increased risk of occupational disease in New York State is to identify individuals and groups most impacted by the processes outlined above. Low-wage work provides an accessible vantage point for capturing the bulk of these 'marginalized' or 'vulnerable' workers.[60-89]

Low-Wage Work as High Risk for Occupational Disease

Counting low-wage workers is a useful way of getting a picture of the bulk of 'marginalized' workers. Low-wage work is overwhelmingly non-union and conforms to the other criteria of work that produces vulnerability. IPUMS data, from the Institute for Social Research and Data Innovation, integrates and harmonizes data across time and location. (Note: IPUMS originally stood for Integrated Public Use Microdata Series, but is currently not used as an acronym). Using IPUMS USA Version 10.0, we stratified the distribution of historically marginalized groups (people of color, women, immigrants) into various low-wage occupations. This allows an estimate of both the size of this population, and the job hazards they are likely to face.[93-94]

In non-union workplaces, workers are maintained on the job "at will", meaning the employer can discipline and fire them at any time and without even needing a reason. Likewise, employers in non-union workplaces have undisputed control over which workers are placed in which jobs, how the work is done, hours and shifts worked, safety and health measures and training, and how to respond to hazards. Though nominally protected from discrimination and retaliation for raising health and safety concerns, in practice those rights mean very little to workers in a non-union "at will" workplace.[89-92] What has come to be called 'precarious' work is increasingly the norm, with such work being characterized by insecurity, which in practice includes: lack of fixed hours, shifts and consequent wages; fear that one can be easily replaced due to the low skills required to do the job and the knowledge that there are many potential replacement workers; fear of retaliation for speaking up or making waves about working conditions.

Policies and Practices

In many low-wage workplaces, where employers spend little on wages, they also spend little on health and safety. Lack of resources, lack of attention, and lack of management commitment all amplify the risk of the actual hazards themselves. Workers in precarious jobs are reluctant to step forward and demand improvements. In an employment "at will" setting, it is relatively easy for the employer to fire any worker perceived as a troublemaker for raising health and safety issues. Since many low-wage occupations involve work that is relatively unskilled, it is not that difficult for an employer to find a replacement for a terminated worker. Government

regulation including workplace inspection by OSHA and whistleblower protection is weak and few low-wage employers seem deterred by the possibility of regulatory sanction.

The impact of racism, sexism and other forms of discrimination must also be considered as a factor impacting low-wage worker health and safety. Discrimination plays a role in how workers are sorted into specific types of work, with people of color often disproportionately represented in dirtier, more hazardous jobs. Aside from selective job placement, racist and sexist attitudes and practices adversely impact how people of color and women are treated on the job by employers and co-workers, by regulatory agencies, and by physicians and other occupational health resources.

Access to Occupational Health Resources

Workers in most low-wage workplaces are not unionized and consequently, have no institutional resource to readily turn to if they want to address workplace hazards or have suffered a possible workplace illness. These workers are typically unaware of their workplace rights or how to effectively exercise those rights. In addition, if they are experiencing symptoms they suspect may be work-related, they may lack access to medical resources to help diagnose the condition and advocate for them in the workplace. Commonly they are unaware of Workers' Compensation or of the legal and medical resources necessary to help them navigate this very difficult system. Conversely, they may know of others who have filed Workers' Compensation claims and suffered adverse consequences from the employer and/or experienced the victim blaming, drawn out struggle to obtain any benefits from Workers' Compensation. Observing the experience of others may act as a deterrent to accessing appropriate care and other benefits.

NYS Occupational Employment Statistics were used to select all low-wage jobs (below $15 per hour/$31,200 per year). Linking these occupations to IPUMS National Data Set, we observed some details about historical trends, race/ethnicity and gender (**Tables 21, 22, 23 and 24 and Figure 2**). Some related occupational groups were combined.[93,94]

Low-Wage work in New York State: Total

The top 28 low-wage categories in NYS in 2018 are illustrated in **Table 20**, with 2,915,172 workers or 31% of the workforce. Of the total number of low-wage workers, the top 10 categories employ 79%. The top three categories alone comprise 42% and include retail salespersons and cashiers; nursing assistants, home health aides and personal care aides; and restaurant workers. The other largest categories of low-wage workers include construction trades; pre-school and kindergarten teachers and assistants; restaurant workers including cooks, servers, and bar staff; truck and delivery drivers; and bookkeeping, accounting, and related clerical jobs.

When considering all low-wage work since 1990 (rather than the top 28 low-wage categories as in the analysis above), low-wage work has increased from 32% to 40% as a proportion of the total employed. **Table 21** demonstrates trends from 1950-2019. Nine of the top ten job categories in 1990 were the same as those in 2018, though the order of their ranking after the top three was different. The most striking growth was observed in early education

and childcare occupations with the number of teachers and aides more than quadrupling, and childcare jobs increasing two and a half times. Health and nurses' aides also jumped significantly, more than doubling in numbers. Construction laborers, masons, tilers and carpet installers likewise more than doubled. Restaurant work including servers, bartenders, and cooks expanded dramatically, with the number of jobs increasing over 80%.

Low-Wage Work: Women

Over the last 90 years, the proportion of women who have entered the workforce has increased dramatically, but economic and social equality has been elusive. As **Figure 2** and **Table 22** show, less than one third of women worked outside of the home in 1930 compared to 71% in 2018. Over three quarters of the increase occurred between 1950 and 1990, with the most dramatic increase (half the total) between 1970 and 1990. As **Table 23** details, by 2018 women numbered 5,982,333 and composed 50.8% of the total labor force in NYS.

Early education, childcare and health aide jobs all increased tremendously in the last 30 years and the vast majority of the increase was fueled by women, further contributing to a persistent gender wage gap across the U.S.[1-13] and in NYS.[14]

Among low-wage workers overall, women are mildly over-represented. However, among certain low-wage jobs women predominate. The occupational categories most dominated by women are illustrated below. Sixty percent of women in low-wage jobs work in one of these six occupational categories.

Low-wage occupational categories with the highest percentage of women

Occupational Category	Number	Percent
Hairdressers and Cosmetologists	82,847	90
Childcare	132,891	88
Health Aides, Nursing Aides, Personal Services	402,170	86
Housekeepers, Maids, Butlers, Stewards	99,145	84
Secretaries, Customer Service Representatives	528,908	79
Kindergarten and Earlier Teachers	208,469	78

Gender-related occupational health disparities have multiple mechanisms, both direct and indirect.[15-22] Occupational segregation, wage gaps, role strain, unfair time use patterns and limited opportunity for advancement persist and contribute to workplace inequity.[23-27]

TABLE 20 Low-Wage Occupations (collapsed into 28 occupational groups), New York State, 2018			
SOC Codesa	**Occupational Titles***	**Number of Workers below $31,200**	**Percent low-wage workers**
41-2031, 41-2021, 41-2011	Retail Salespersons, Counter and Rental Clerks, Cashiers	519,660	17.8%
39-9021, 39-9099, 31-1014, 31-1011	Personal Care Aides, Home Health Aides, Nursing Assistants*	422,984	14.5%
35-3031, 35-9011, 35-3011, 35-9031	Waiters and Waitresses, Bartenders, Helpers, Hosts and Hostesses,	267,870	9.2%
35-3021, 35-3022, 35-3041, 35-9099, 35-1012	Combined Food Preparation and Serving Workers, Including Fast Food, Counter Attendants, Cafeteria, Food Concession, and Coffee Shop, First-Line Supervisors of Food Preparation and Serving Workers*	242,427	8.3%
43-5081, 43-9061, 43-3031	Stock Clerks and Order Fillers, Office Clerks, General*,Bookkeeping, Accounting, and Auditing Clerks*	208,847	7.2%
53-7062, 53-7064	Laborers and Freight, Stock, and Material Movers, Hand, Packers and Packagers, Hand	154,070	5.3%
25-9041, 25-3098, 25-2011	Teacher Assistants, Substitute teachers*, Preschool Teachers, Except Special Education*	146,454	5.0%
43-6014, 43-4051, 43-4171	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive*, Customer Service Representatives*, Receptionists and Information Clerks*	144,409	5.0%
35-1011, 35-2011, 35-2012, 35-2014, 35-2015	Chefs and Head Cooks,* and all cooks (restaurants, fast food, institutions, cafeteria and short order)	102,729	3.5%
35-2021, 35-9021	Food Preparation Workers, Dishwashers	94,540	3.2%
39-9032, 39-3091, 39-3031, 39-2021	Recreation Workers, Amusement and Recreation Attendants, Ushers, Lobby Attendants, and Ticket Takers, Nonfarm Animal Caretakers	71,080	2.4%
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners*	63,527	2.2%
33-9032, 33-9099	Security Guards* and Protective Service Workers	63,283	2.2%
51-2098, 51-9111	Assemblers and fabricators, all other, Packaging and Filling Machine Operators and Tenders	55,880	1.9%
37-2012	Maids and Housekeeping Cleaners	48,460	1.7%
39-9011	Childcare Workers	47,260	1.6%
53-3031, 53-3033	Driver/Sales Workers, Light Truck or Delivery Services Drivers*	36,762	1.3%
49-9071	Maintenance and Repair Workers, General*	36,013	1.2%
47-2061, 47-2141, 47-3012, 47-3013, 47-3014, 47-3015, 47-3019, 47-2081, 47-4090, 47-2131, 47-4031, 47-4071	Construction Laborers*, Painters, Construction and Maintenance*, Helpers--Carpenters, Electricians, Painters, Paperhangers, Plasterers, Stucco Masons, Pipelayers, Plumbers, Pipefitters, Steamfitters, Construction Trades, Drywall and Ceiling Tile Installers*Miscellaneous Construction and Related Workers*	33,407	1.1%
39-5092	Manicurists and Pedicurists	24,190	0.8%
39-5012	Hairdressers, Hairstylists, and Cosmetologists	23,650	0.8%
53-7061	Cleaners of Vehicles and Equipment	19,520	0.7%
53-3041	Taxi Drivers and Chauffeurs	16,650	0.6%
53-6021	Parking Lot Attendants	16,220	0.6%
51-6011	Laundry and Dry-Cleaning Workers	15,980	0.5%
37-3011	Landscaping and Groundskeeping Workers*	14,855	0.5%
21-1093	Social and Human Service Assistants*	12,445	0.4%
51-3011	Bakers	12,000	0.4%
	Total, Low-Wage Occupations	**2,915,172**	
	Total, All Occupations	**9,385,620**	

*Occupations making low wages only at the "entry wage" or the mean of the bottom third of wages in the occupation.

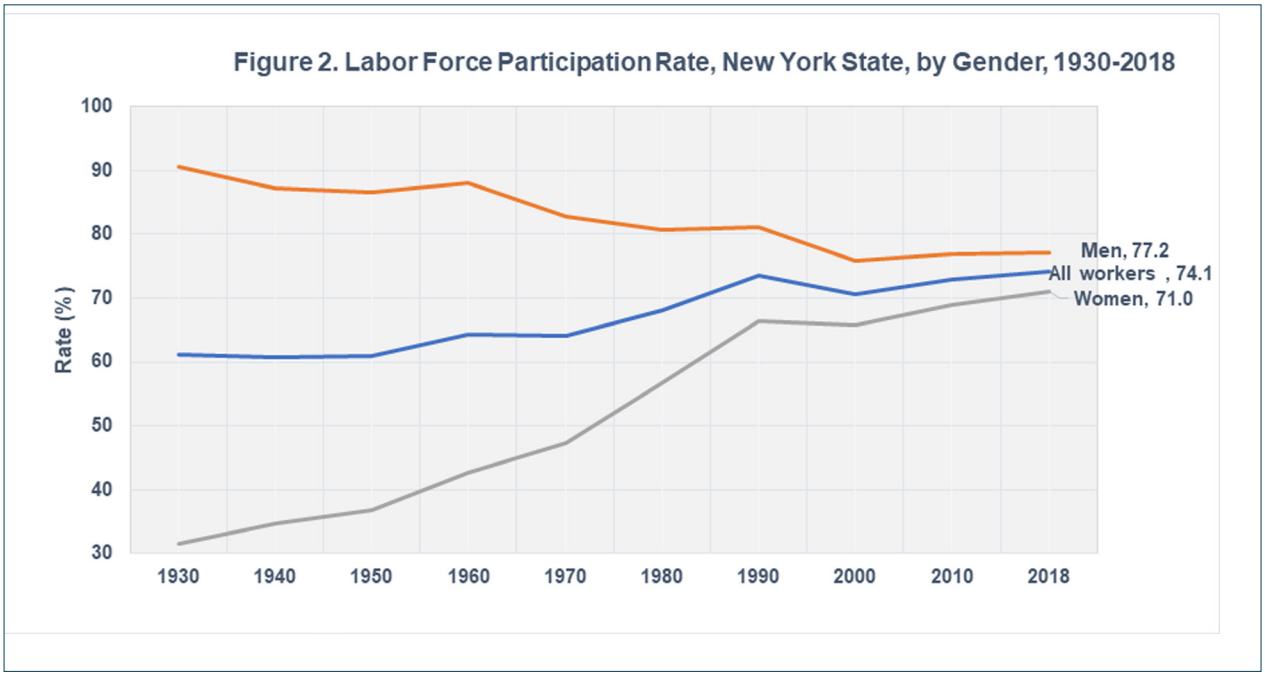
[a]Standard Occupational Codes, NYS Occupational Employment Statistics, 2018

TABLE 21 Workers Employed in Low-Wage Jobs, 1950 - 2019, NYS, Age 16-64									
IPUMS CODE(S)	**IPUMS CODE TITLES**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**	**2019**
274, 275*, 276	Cashiers, salespersons, retail sales	426971	441929	470700	441900	398840	497593	536001	503956
446, 447, 469	Health aides, Nursing aides, personal service	164083	193380	169000	166500	228074	256159	356610	433845
435, 443*, 434	Waiters/waitresses, waiters' assistants, bartenders	101477	88657	93300	137600	124264	154593	185120	178832
439	Kitchen workers	68555	29193	42000	6800	12908	16056	23553	36308
365*, 337	Stock and inventory clerks, bookkeeping, accounting and auditing clerks	89970	133690	185300	178000	168812	164377	149512	131258
883*, 888*, 876	Freight, stock, and materials handlers, packers and packagers by hand	18158	20537	46200	77500	47222	19793	23667	27659
155, 159	Kindergarten and earlier teachers, teachers n.e.c.	.		25400	36700	51884	153191	195363	236327
313, 376*, 319*, 389*, 379	Secretaries, Customer service reps, investigators and adjusters, except insurance, receptionists, administrative support jobs, general office clerks	695501	581156	579300	566300	580188	613055	568035	525343
436	Cooks	47088	46521	51000	92300	123088	144179	167095	180433
444, 439	Food prep workers	68555	29193	42000	47900	60256	60503	88721	117283
175,462, 487, 459	Recreation, ushers, animal caretakers not on farms, recreation facility attendants	9350	8166	13100	14100	15862	38872	44433	73869
453	Janitors	25138	30282	83300	132500	159264	133640	189289	180016
426,427	Guards, watchmen, doorkeepers	27805	29687	32600	53300	73318	72576	96270	101311
874		.	.	.	8400	3262	3827	4773	4772
405	Housekeepers, maids, butlers, stewards, and lodging quarters cleaners	48255	64738	73900	63500	47936	73755	100663	84141
468	childcare	.	8273	18900	42800	42182	86083	119906	107097
804	Truck, delivery, and tractor drivers	161690	139200	142800	142800	159866	160712	139133	155603
549	Mechanics and repairers, n.e.c.	104038	113680	87500	31800	37072	38532	35505	33688
869, 563, 865, 889	Construction laborers, masons, tilers, carpet installers, construction workers,	233814	203591	101000	100700	138194	162899	228996	231592
458	Hairdressers and cosmetologists	44702	28569	28800	35100	43050	45569	68404	75440
887	Vehicle washers and equipment cleaners	6101	4383	7900	6200	9058	16642	13581	14511
809	Taxi cab drivers and chauffeurs	46056	38152	32900	32100	45528	51655	65944	93226
813	Parking lot attendants	.		2700	3300	3514	4670	10060	9084
748	Laundry workers	41893	36359	34600	11600	9296	13872	12660	11009
486,	Gardeners and groundskeeper	15665	12256	18300	20400	28210	36340	51216	50662
465	Welfare service aides	.	1600	14600	6034	21666	21666	23614	31463
687, 688	bakers and batch food makers	18526	17922	13000	12400	15946	17361	16235	16722
TOTAL Low-Wage Occupations		**.**	**.**	**.**	**2470514**	**2650750**	**3060170**	**3516369**	**3647469**
	Total All Occupations	**5901204**	**6256205**	**6358400**	**7122700**	**8052982**	**8109921**	**8525453**	**9042783**

SOURCE IPUMS, National Data Set

*Totals include additional "experienced workers" (as noted with asterisks) who may make slightly higher wages. IPUMS data does not refine by wage rates. Occupations were selected first using OES data defining low-wages as less than $15 per hour or less than $31,200 per year.

TABLE 22 Labor Force Participation Rate, New York State, by Gender, 1930-2018										
	1930	1940	1950	1960	1970	1980	1990	2000	2010	2018
All workers	61.2	60.8	60.9	64.3	64.1	68.2	73.6	70.7	72.9	74.1
Men	90.6	87.3	86.6	88.0	82.9	80.7	81.1	75.9	76.9	77.2
Women	31.5	34.7	36.8	42.7	47.3	56.7	66.5	65.7	69.0	71.0



Source: IPUMS data, National Data Set in same font as other charts

TABLE 23 Workforce Engagement[a] in the United States and in New York State, 2018								
	Labor Force Total		Labor Force Participation Rate		Employment / Population Ratio		Unemployment Rate	
	United States	New York	United States	New York	United States	New York	United States	New York
GENDER/SEX[b]	192,453,695	11,754,335	77.8	77.8	73.8	74	4.5	4.7
Male	95,709,923	5,772,002	82.4	81.6	77.8	77.3	4.6	5
Female	96,743,772	5,982,333	73.2	74	69.8	70.8	4.5	4.4

[a] ACDST1Y2018.S2301 data with overlays
[b] Population 20 to 64 years

Table 24 Low-Wage Occupations (collapsed into 28 occupational groups)[a] by Race, New York State, 2018

IPUMS CODE(S)[a]	IPUMS CODE TITLES	White (non hispanic)	%	African American or Black	%	Latino	%	Asian, Pacific Islander	%	Native American	%	Mixed / Other	%	Total Valid Cases
274, 275, 276	Cashiers, salespersons, retail sales	340,927	53	94,847	15	131,731	20	63,208	10	771	0	15,875	2	647,359
446, 447, 469	Health aides, Nursing aides, personal service	144,874	31	145,072	31	117,314	25	50,675	11	650	0	11,099	2	469,684
435, 443, 434	Waiters/waitresses, waiters' assistants, bartenders	126,827	54	19,538	8	54,419	23	27,164	12	330	0	5,241	2	233,519
439	Kitchen workers	27,718	54	4,749	9	13,067	25	4,547	9	0	0	1,384	3	51,465
365, 337	Stock and inventory clerks, bookkeeping, accounting and auditing clerks	92,414	55	26,504	16	31,064	19	12,398	7	376	0	4,156	2	166,912
883, 888,	Freight, stock, and materials handlers, packers and packagers by hand	9,306	28	8,605	26	10,996	33	3,666	11	13	0	530	2	33,116
155, 159	Kindergarten and earlier teachers, teachers n.e.c.	154,872	58	39,607	15	43,852	16	20,883	8	1,199	0	5,571	2	265,984
313, 376, 319, 389, 379	Secretaries, Customer service reps, investigators and adjusters, etc.	384,238	58	98,692	15	117,569	18	47,487	7	1,247	0	16,595	2	665,828
436	Cooks	89,624	40	31,161	14	70,147	31	25,877	12	115	0	5,770	3	222,694
444	Food prep workers	47,309	42	12,714	11	37,460	34	11,300	10	179	0	2,798	3	111,760
175,462, 487, 459,	Recreation, ushers, animal caretakers not on farms, recreation facility attendants	71,489	68	8,761	8	16,148	15	4,676	4	667	1	4,101	4	105,842
453	Janitors	92,073	37	53,236	21	88,639	36	9,290	4	913	0	4,483	2	248,634
426,427	Guards, watchmen, doorkeepers	53,050	40	43,681	33	25,653	20	5,518	4	744	1	2,647	2	131,293
874	Production helpers	1,518	47	738	23	717	22	246	8	0	0	43	1	3,262
405	Housekeepers, maids, butlers, stewards, and lodging quarters cleaners	26,176	22	22,306	19	56,972	48	8,934	8	194	0	3,602	3	118,184
468	Childcare	62,192	41	27,351	18	50,665	33	8,470	6	24	0	2,917	2	151,619
804	Truck, delivery, and tractor drivers	103,146	52	27,763	14	50,666	25	12,902	6	1,346	1	3,501	2	199,324
549	Mechanics and repairers, n.e.c.	27,289	63	5,829	13	7,825	18	1,451	3	360	1	621	1	43,375
869, 563, 865, 889	Construction laborers, masons, tilers, carpet installers, construction workers	144,324	48	41,625	14	93,566	31	16,438	5	672	0	7,156	2	303,781
458	Hairdressers and cosmetologists	36,235	44	9,225	11	18,846	23	17,264	21	0	0	1,277	2	82,847
887	Vehicle washers and equipment cleaners	8,753	42	5,356	26	5,222	25	226	1	113	1	1,119	5	20,789
809	Taxi cab drivers and chauffeurs	16,639	15	23,951	21	31,339	28	38,266	34	10	0	2,984	3	113,189
813	Parking lot attendants	2,853	35	1,688	21	3,268	40	236	3	0	0	93	1	8,138
748	Laundry workers	3,558	27	1,091	8	5,366	41	2,896	22	63	0	0	0	12,974
486,	Gardeners and groundskeeper	36,833	58	5,173	8	19,761	31	350	1	264	0	1,483	2	63,864
465	Welfare service aides	15,367	50	8,853	29	5,136	17	1,124	4	0	0	460	1	30,940
687, 688	Bakers and batch food makers	10,183	52	1,859	10	5,929	30	1,352	7	153	1	47	0	19,523
	TOTAL	**2,129,787**	**47**	**769,975**	**17**	**1,113,337**	**25**	**396,844**	**9**	**10,403**	**0**	**105,553**	**2**	**4,525,899**

Source: [a]IPUMS, National Data Set, 2018

Low-Wage Work in NYS: Race/Ethnicity

Race/ethnicity is a well-recognized and fundamental determinant of health disparity.[28-38] Work is an important contributor to the unequal distribution of disease among different racial/ethnic groups. [39-58] Estimates of select low-wage occupations by race/ethnicity are shown in **Table 24**.

As illustrated in the table below the total working population of NYS in 2018 was 57% White, 14% Black, 18% Latinx, and 9% Asian/Pacific Islander. In the low-wage population both Blacks and Latinx workers were disproportionately over-represented by 21% and 44% respectively. Whites were disproportionately under-represented by 18%. Asian/pacific islanders in the low-wage workforce were proportionate to their number in the overall working population.

Race/Ethnicity	Percent total workforce	Percent low-wage workforce
White	57	46.9
Black	14	17
Latinx	18	24.9
Asian/PI	9	9

The top three low-wage categories (secretaries/customer service, cashiers/sales/retail, health aides/nurses' aides/personal care) were in the top 5 categories for all ethnic groups. The following table illustrates differences in the other job categories rounding out the top five for each ethnic group. Among each group between 50-58% of low-wage workers worked in one of these job categories.

Race / Ethnicity	Other job categories in the top five	Overall category rank
White	Kindergarten and earlier teachers/aides	5
	Construction laborers, masons, tilers	4
Black	Janitors	6
	Guards, watchmen, doorkeepers	12
Latinx	Construction laborers, masons, tilers	4
	Janitors	6
Asian/PI	Taxi cab drivers, chauffeurs	14
	Restaurant servers, assistants, bartenders	7

Another way to look at where different ethnic groups cluster in low-wage jobs is by each group's percentage in a category. The table below demonstrates the top five job categories for each group in this way.

The distinctness of each ethnic group's top five categories demonstrates the sorting or segregation of specific groups into specific job categories.

Top 5 Occupational Groups by Race/Ethnicity and the Percent of Low-Wage Occupations				
Race / Ethnicity	**Occupation**	**Total Low-Wage**	**Percent**	**Number of Workers**
White		2,129,787	32	674,721
	Recreation, ushers, animal care		68	71,489
	Mechanics and repairers		63	27,289
	Gardeners, groundskeepers		58	36,833
	Kindergarten, pre-school and childcare		58	154,872
	Customer Service, investigators		58	384,238
Black		769,975	27	211,567
	Guards, watchmen, doorkeeper		33	43,681
	Health aides, nurse aides, personal service		31	145,072
	Welfare service aides		29	8,853
	Freight, stock, material handling		26	8,605
	Vehicle wash, equipment cleaning		26	5,356
Latinx		1,113,337	17	191,705
	Housekeeping, maid, butler		48	56,972
	Laundry worker		41	5,366
	Parking lot attendant		40	3,268
	Janitors		36	88,639
	Food preparation		34	37,460
Asian/PI		396,884	28	111,467
	Taxi driver, chauffer		34	38,266
	Laundry worker		22	2,896
	Hairdresser, cosmetologist		21	17,264
	Cook		12	25,877
	Waiters/waitress, bartender		12	27,164

Sources: IPUMS, National Data Set, 2018

Health Risks of Low-Wage Work

As noted above, the health risks of low-wage work result from the interplay of several factors including:

1) The nature of the hazards encountered at the workplace
2) The ways in which social, political, and workplace policies and practices amplify or mitigate hazards
3) Access to occupational health resources once a hazard is encountered or an illness is incurred

Consequently, the hazard profile for specific jobs will vary. However, there are some hazards that are widespread and common to many low-wage jobs, and these are described below.

Major Hazards of low-wage work

Ergonomics and musculoskeletal injuries

Ergonomic hazards including repetitive work, awkward postures, forceful movements, lifting and moving heavy weights are widespread in many categories of low-wage work. For women in aide roles in hospitals, nursing homes, and home care, musculoskeletal injuries from lifting and transferring patients are epidemic. Office and clerical jobs dominated by women are also sources of ergonomic hazards, often as a consequence of highly repetitive work in poorly designed work spaces. Hairdressers, 90% of whom are women suffer the consequences of working long hours in constrained postures with repetitive hand and arm tasks. Construction work, restaurant occupations (both serving and cooking), and materials lifting and moving in stock and driving/delivery jobs are other examples of categories of low-wage work where workers are at increased risk of musculoskeletal disorders. Overall, workers in low-wage jobs with ergonomics hazards number in the millions.

Chemical, metal, dust exposures

Exposure to hazardous materials is an important issue on many low-wage jobs. Over 300,000 people work in low-wage construction jobs where an array of hazards is potentially present ranging from asbestos, lead, and silica, to solvents and other chemicals. Hairdressing and cosmetology jobs employ almost 200,000 people with potential exposure to a variety of chemicals including formaldehyde containing hair straighteners, hair dyes, and skin and respiratory sensitizing chemicals used in hair and nail care. Cleaners and disinfectants are major exposures for workers using them directly (e.g. janitors, restaurant workers) and those exposed as bystanders. During the COVID-19 pandemic, this has taken on increased importance as the indiscriminate use of cleaning and disinfecting products containing quaternary ammonium salt and other chemicals has become rampant.

Stress

Stress is ubiquitous in low-wage work across virtually all occupations. Typical low-wage work offers very little control to the individual worker over their working conditions. Employers often treat workers as if they are interchangeable parts, able to fill any employment hole at any time and are expendable. As a consequence, work schedules are frequently variable and not easily predictable and employment is "at will" and insecure. The threat of violence, as defined by a spectrum from verbal abuse to bullying to outright physical violence is another common source of stress in low-wage jobs. Reports of workplace violence in healthcare especially has been increasing and some states have passed legislation to require workplace violence prevention programs. This violence may originate with supervisors and employers, or from clients. Workplace stress is often linked with home stress in a relationship where either can amplify the other.

Infectious Disease

The COVID-19 pandemic has proven the importance of infectious disease as a workplace hazard. Throughout the pandemic many low-wage workers continued to work in jobs deemed 'essential' or in industries that were closed down for a period and then reopened, remaining open as the pandemic surged again in the fall and winter of 2020-21. For health care, nursing home, and home health workers, the risk comes through the job itself which requires them to directly take care of individuals infected with COVID-19 or at risk of infection. Many other jobs carry an increased risk because of contact with the general public in settings that vary widely in terms of ventilation and other factors that impact the level of exposure. Even in jobs without much contact with the public there may still be an increased risk of COVID-19 infection depending on how many co-workers are present and the kind of space they are configured into while working. Exposure on the job also carries the risk of conveying the infection into the home environment.

Summary

Low-wage work carries a high risk of occupational disease. This increased risk results from the nature of the hazards faced on the job, the way work is organized, managed and regulated, discriminatory treatment, and lack of access to occupational health resources. According to NYS government data, over 2.5M jobs in NYS (27%) pay less than $15 per hour. We've estimated 2.9M workers, or 31% of New York's workers occupy 28 low-wage occupations, constituting an immense at-risk group.

Chapter 4

EXPANDING THE DEFINITION OF OCCUPATIONAL DISEASE

The ways in which work impacts health are further illustrated in this chapter with the examples of stress, substance use and obesity, all important contemporary health problems. While often conceived as problems caused by individual choices, and remedied through personal responsibility and behavior modification, the recognition of the contribution of work requires a different solution. As with more 'traditional' workplace hazards, the prevention of work-related illness depends upon changing workplace conditions to reduce or eliminate the hazard. A similar approach could be used for other major health and public health challenges.

Significance of Workplace Stress and Illness

Job stress is a central preoccupation of workers across the spectrum of industries and occupations. There is a sense that work has become increasingly stressful in the last few decades. A variety of maladies have been linked to stress, some with more evidence than others.[1-2] Impacts on mental health encompassing both specific diagnostic conditions such as depression and anxiety, and conditions like 'distress' and 'burnout' that are not easily placed in a formal diagnostic category are widely described.[3-8] Cardiovascular disease including hypertension, heart attack, and stroke has also been given significant attention.[9-13] Researchers connect musculoskeletal problems to stressful work.[14-16] The gastrointestinal system may also be a target for stress related conditions including gastritis, gastroesophageal reflux, ulcers, irritable bowel syndrome, and symptoms such as abdominal pain and bloating.[2,17] Other symptoms caused or exacerbated by stress include headaches, disrupted sleep, and fatigue.[18-20] Some evidence points to stress having detrimental effects on the immune system, and there is speculation that stress might increase the risk of certain cancers.[21-22] Stress may also contribute to behaviors such as tobacco smoking, substance use, and dietary intake that increase the risk for other diseases.[23]

Work over the last several decades has done much to move stress from a vague to a relatively well-defined concept. In general, stress can be seen as a "form of stimulus that causes bodily or psychological reaction."[24] This definition doesn't specify whether the reactions are positive or negative. But most work on stress is focused on how it produces distress and illness.[1] The workplace has long been recognized as a source of stress, and researchers have done much to illuminate the specific characteristics of a job that generate stress. Work produced by Karasek, and others following his lead, has emerged as the dominant paradigm describing stress as a work hazard. His demand-control model suggests that jobs that subject workers to high psychological demands and deny them the ability to exert significant control over their work carry the highest risk for mental health, cardiovascular, and other conditions. [9, 25-27]

Critique of the Karasek model has included the argument that it is incomplete and fails to capture other aspects of work that play a significant role in producing stress. Chief among these is the idea that job-related support can buffer the negative impact of high demands or low control. In this augmentation of Karasek's model, support is specifically defined as a helping function, occurring in the form of either material provision of information or emotional support from colleagues or managers. Higher levels of support can mitigate some of the impact of stress and workers lacking social support suffer more of the adverse impacts. [28-32]

While Karasek's model has dominated the literature, others have advanced significant models. Siegrist, for example, asserts that an imbalance between effort on the job and reward leads to poor health outcomes.[33-34] Various sociological paradigms describe stress processes wherein stressors either produce poor outcomes, or the lack of stressors leads to the accumulation of advantages including better health.[35-40] Occupational health psychology research often emphasizes psychosomatic connections between factors based on individual experiences and health, such as stress perception or coping mechanisms.[41-43] Others assert that contributing stressors include: workplace violence, bullying, harassment, perceived job insecurity, and times when work interferes with life outside of work and/or the reverse.[44-48]

Still others have recognized the value of Karasek's model, but have posited that it describes just one link in a causal chain between work, stress, and disease. Tausig and Fenwick, for example, argue that it is important to understand the forces that encourage the creation of high demand- low control work which are to be found in the larger context within which an individual workplace resides. They argue that macro level economic and political policies ultimately shape conditions at the workplace, or micro level.[49-51] These policies are mediated by work organizations and the labor market (the meso level). They describe a process beginning in the mid-1970's where the political economy has shifted from a 'Fordist' economy premised on the idea that workers should be paid enough to be able to afford the products being manufactured. That demand would keep the economy stimulated. Accordingly, the characteristics of Fordism included relatively decent wages and benefits, a strong union presence, job security and a substantial safety net.

With 'post-Fordism' (what others would call neoliberalism) came a re-shaping of the American political economy with the disappearance of manufacturing jobs and their relatively high wages and benefits.[52] The labor market increasingly split into higher wage (professionals, managers) and lower wage segments, with the middle 'hollowed out'. Along with this split came lower wages, reduced benefits, and much decreased job security.[53] Companies strove for maximum 'flexibility' to meet the demands of global competition, and a key feature of that flexibility is the ability to hire, fire, and move workers around as the employer deems necessary. In their view, impediments to this mobility in the form of regulations and law must be removed. In this context, there is minimal state oversight, so employers control the work environment. Working conditions often deteriorate as employers pay less attention to matters like health and safety that get in the way of production, and workers are much more reluctant to speak out about conditions, being concerned mainly with just holding onto their jobs.[54-62]

The importance of understanding the larger context within which stressful working conditions are produced is twofold. It suggests that interventions limited to job re-design to increase worker control and reduce demands at the individual workplace are unlikely to be effective as they do not address the underlying pressures to create these types of jobs. It follows that effective interventions to reduce workplace stress must address it on multiple levels.

The work cited in the preceding paragraphs strongly suggests the importance of stress related conditions in the consideration of occupational illness. This has been underscored by work the OHCC has undertaken over the last several years with low-wage workers in the Syracuse area. In discussions with 1,924 low-wage workers, workplace stress and related symptoms were a central feature of every discussion.[63] Our consideration of the extent of occupational illness requires inclusion of stress related illnesses since these are quite widespread and linked to work conditions. We expect further expansion of traditional models to recognize closely-related phenomenon such as resilience, overwork, work-non-work interference, job insecurity/precarity/low-wages, workplace incivility, workplace harassment as part of the workplace stress picture.[64-71] Given the inherent complexity, currently existing data is frequently inadequate to allow for a full and accurate assessment of the incidence and prevalence of work-related stress and the disorders/diseases associated with it.

Substance Use and Work

As the deaths from opioid overdose become epidemic, 47,600 in 2017 alone, the issue has forced itself beyond the medical and public health spheres into the public and political eye.[1] Prevalence of drug use in adults is high, indicating pervasive substance use and misuse (**Table 25**). Occupational health professionals and advocates have begun exploring the relationship between opioid use and work.[2-3]A recent study from Massachusetts found opioid overdoses were associated more commonly with certain kinds of work and also varied by gender, with 77.3% (3,324) among men and 22.7% (978) among women.[4] The data and findings from other research suggest some underlying reasons for this disproportionate use.[4-12]

The scenario described in the Massachusetts report, however, is just one of the ways that work and opioid use are related, and opioids are just one of the addictive/psychoactive substances that should be considered in trying to draw a more comprehensive picture of the role of work in substance use.[13-18] Other major substances to consider are tobacco,[19-22,28] alcohol,[23-26,28] stimulants [13-18,27] and perhaps marijuana.[13-18,28]

TABLE 25 Prevalence of Drug Use in Adults, United States and New York State, 2018 and 2019*				
	US Estimate %	**Confidence Interval**	**NYS Estimate %**	**Confidence Interval**
Illicit Drug Use in the Past Month	12.73	12.42 - 13.05	12.81	11.74 - 13.97
Marijuana Use in the Past Year	17.1	16.72 - 17.47	17.7	16.50 - 18.98
Marijuana Use in the Past Month	11.17	10.88 - 11.47	11.36	10.37 - 12.44
Cocaine Use in the Past Year	2.16	2.05 - 2.28	2.71	2.26 - 3.26
Heroin Use in the Past Year	0.31	0.26 - 0.37	0.32	0.17 - 0.60
Methamphetamine Use in the Past Year	0.76	0.69 - 0.83	0.25	0.13 - 0.48
Pain Reliever Misuse in the Past Year	3.69	3.53 - 3.85	3.05	2.59 - 3.59
Alcohol Use in the Past Month	55.09	54.53 - 55.64	54.57	52.70 - 56.42
Binge Alcohol Use in the Past Month	26.15	25.75 - 26.55	24.88	23.41 - 26.40
Tobacco Product Use in the Past Month	23.01	22.61 - 23.41	19.25	17.95 - 20.61
Cigarette Use in the Past Month	18.35	17.98 - 18.72	15.63	14.47 - 16.87
Illicit Drug Use Disorder in the Past Year	2.97	2.83 - 3.11	3.01	2.56 - 3.55
Pain Reliever Use Disorder in the Past Year	0.57	0.51 - 0.64	0.42	0.27 - 0.64
Alcohol Use Disorder in the Past Year	5.71	5.53 - 5.90	5.48	4.81 - 6.23
Substance Use Disorder in the Past Year	7.74	7.52 - 7.96	7.43	6.65 - 8.30

*adults over 18; percentages based on annual averages National Survey of Drug Use and Health; SAMHSA definitions and statistical method
Source: https://www.samhsa.gov/data/sites/default/files/reports/

A useful framework for exploring the relationship between substances and work contains several elements, with an understanding that each element may not be equally relevant for each substance.

1) Substances as workplace hazards

   In the past few years, heroin has been increasingly cut with fentanyl. This increases the potency and also reduces the volume of product smugglers have to transport across borders. Since fentanyl can be absorbed through the skin, this raises the possibility of medical responders and law enforcement being exposed. In fact, NIOSH has already investigated a number of these types of exposures.[29-30] Second hand smoke is another example of how workers may be exposed directly to a substance at work.

2) Use of substances to perform the job

   Some jobs require long hours, night shifts, and the maintenance of vigilance. Examples include long distance truckers, and military personnel. To keep awake and alert stimulants like amphetamines may be used. Tobacco may serve a similar function.[31-36]

3) Use of substances to cope with the job

For many, substance use is a way of coping with difficult life circumstances. Job 'stress,' as described elsewhere in this report, is an important source of difficulty for many workers. Precarious insecure work, an unfair boss, demanding work with no ability to exert control, irritated clients, unsafe conditions, poor wages and benefits, no opportunities for advancement or change, and discrimination are among the factors that can make work life extremely hard to tolerate.[37-43] Under these circumstances, it is not surprising that some workers turn to substances to make it through the shift and the day.[44-49] Few programs or supports are in place to prevent or reduce stress on the job.

The line between job stress and life stress is often not clear, with interaction between the two working in both directions to exacerbate both.

For example, the single parent making low-wages struggles to manage all aspects of family life under conditions of rotating schedules and fluctuating hours. Juggling to keep quality childcare consistent, accomplish all of the household chores and errands, and manage finances often presents mounting unsolvable predicaments. When asked to work more, the network of support so carefully constructed can be strained to the breaking point. If informed that hours are reduced, paying rent and/or putting food on the table may create an immediate crisis. Often finding themselves "putting out fires," it should not be surprising that some turn to stimulants to give energy, or alcohol/drugs for relief from the unrelenting demands of life.[28,50-56]

4) Use of substances after a work injury

This aspect of the substance issue has received the most attention to date, specifically in relation to opioid use. Workers injured on the job may be prescribed opioids for pain control and then become addicted. With physicians over prescribing and providing easy access, workers in industries and occupations with higher injury rates (e.g. construction) are consequently, at higher risk of opioid use and abuse. But in addition to the inherent riskiness of the job, other factors come into play exacerbating the problem. If the workplace has no light duty policy, workers may feel pressured to take pain relievers to enable them to return to full duty prematurely and to keep working despite pain and a less than fully healed injury.[57-59] In jobs with little or no sick leave, and precarious jobs generally, a similar dynamic is at play, with injured workers using opioids to get them back on the job quicker and keep them on the job to avoid losing pay they cannot afford to go without.[37-43] In seasonal jobs like construction or agriculture the pressure to return to work and stay at work injured is heightened by the compressed time period workers have to earn the income necessary for the off season as well.[60-62]

5) Impact of substance use on work

In many instances work may not be a cause or contributor to substance use, but may be adversely impacted by such use. Intoxicated workers can pose a safety risk to themselves and others.[63] Pilots, bus drivers, and firefighters are examples of workers among whom on the job impairment by substances could be disastrous for themselves, their co-workers, and those to whom they are providing a service.[64-65] On a more mundane, day to day level, substance use can affect any user's ability to be productive at work.

6) Accessibility and use of medical treatment resources

In 2018, 18.9 million people in the U.S. (7.18%) needed specialty substance use treatment, but did not receive it. In New York State, in 2018, among adults over 18 who needed, but did not receive treatment numbered 1,073,903 (6.94%) for substance use, 795,369 (5.14%) for alcohol use, and 442,559 (2.86%) for illicit drug use.[14-15]

Common reasons given in NYS for not receiving substance use treatment were:

- not being ready to stop using (38.4 %)
- having no health care coverage, not able to afford the cost of treatment (32.5%)
- not knowing where to go to get treatment (21%)
- felt that getting treatment would have a negative effect on their job (17%)
- felt that getting treatment would cause their neighbors or community to have a negative opinion of them (15%).[14-15]

Once a worker develops an addiction to a substance, work can play an important role in determining the outcome of the addiction. Ideally employers would treat substance abuse as a health, rather than a moral or criminal problem.[67] This would mean encouraging workers with substance abuse issues to seek treatment without punitive consequences (e.g. termination), and facilitating access to treatment resources. Under these circumstances workers will be more likely to come forward and take advantage of the opportunity.[68-75] With a punitive policy and no easy access to effective treatment, workers will be apt to do the opposite: keep using and hide the problem.

Attempting to quantify the impact of work on substance use in terms of disease incidence is impossible, yet we know that drug use is highly prevalent, and that work deserves attention as a contributor to substance use and abuse, and as a contributor to the immense overall disease burden, resource use, and costs imposed by this problem.[13,76-77]

Work and the Incidence of Overweight and Obesity

Many discussions of obesity conceptualize it simply as a technical issue: too many calories ingested and not enough used up. Causes and solutions are primarily seen as individual: eat less and increase activity. Individuals who are obese are frequently viewed in judgmental or moralistic terms as weak, lacking self-control, and lazy. Obesity in this framework is a personal failing.

This is not to say that obesity has not been analyzed in its economic, political, and social context, just to note that this is not the mainstream approach.[1-9] The dominant paradigm from this perspective sees the increasing incidence of obesity as a result of a shift in the type of foods eaten to more calorie dense offerings, increased caloric intake, and an increasingly sedentary lifestyle.

The American diet has changed dramatically since the Second World War. Corporations marketed processed foods to an increasingly urbanized population. Those foods became relatively cheap to produce and buy and were typically laden with sugars. They are also convenient, requiring little or no preparation. Some commentators have dubbed this the 'neoliberal' diet as a result of its connection to the production and marketing practices of large corporations in a setting of decreased government regulation.[10-12]

Obesity- why is it a health problem?

Americans also have found convenience buying and eating prepared food in places other than the home. Over time restaurants increased the size of the portions served, as a lure to diners seeking increased value for their dollars. This has translated into larger portions at home also, as a new norm for the size of meals has been established. As a result, each American adult ingests on average 800 more calories per day than they did just 50 years ago.[13]

Changes in levels of daily physical activities have also shifted dramatically among Americans. Jobs have become more sedentary, with more people spending time at work sitting or moving minimally, often in front of a computer screen. Urban sprawl and suburbanization, along with notoriously lacking public transportation systems have made car use practically mandatory for most Americans. There is very little walking to get to the grocery store, the pharmacy or the bar. Screens of various types (computer, television, phone) dominate leisure time, starting at a very young age.[14]

As some critics have pointed out, the 'dominant paradigm' is limited and does not describe all of the causes of the obesity increase.[15-16] It is acknowledged that the causes of obesity are complex and multifactorial and the description above is simplified. However, even a schematic outline describes some of the major underlying developments, and is useful for turning our gaze from the individual to the social when trying to explain and understand the explosion of obesity.[17]

The risk of obesity is not shared equally by all Americans, in much the same way as most other health problems. There is a social gradient for obesity which has been noted for both income and race. Simply put, the lower the income the higher the risk of obesity. Likewise, non-whites have a higher incidence than whites.[18]

Work and Obesity

At first glance work may not seem to have obvious connection to the increased incidence of obesity. An emerging literature, however, particularly the work of Schulte and collaborators from NIOSH has illuminated a number of potential pathways, albeit some better established than others. Obesity can be both an outcome of working under conditions that promote obesity, and a risk factor for the development of disease through an interaction with other workplace and health conditions.[19-24]

Examples of ways in which workplace conditions may contribute to the development of obesity include:

1) Sitting/sedentary work

As noted in the description of the 'dominant paradigm' to explain the increase in obesity, the increase in sedentary lifestyles is seen as an important development. Presumably, the reduction in physical activity results in less calorie expenditure. If the dietary caloric intake does not change then the imbalance between intake and expenditure is augmented, and if sustained, will result in ongoing weight gain.

Work has not been immune to the increase in sedentary activity. More and more jobs require less physical exertion and more sitting. [25-29] In this way work is contributing to the generalized reduction in physical activity, and clearly should be considered a contributor to the obesity epidemic through this mechanism.

2) Job stress

Various health outcomes, most prominently cardiovascular and mental health issues, have been clearly linked to stressful working conditions.[30-38]

Workplace stress may increase the risk of obesity in several ways. In response to stress, workers may seek more 'comfort foods', typically high calorie and energy dense. After a long stressful shift, workers may be too tired to cook and will look for processed foods that are easy to prepare or can be conveniently purchased. Likewise, there may not be time or energy before a shift to prepare a healthy meal or snacks to be taken to work. On demanding jobs, workers may have very little time to sit for a regular meal, and instead may rely on quickly ingested, high calorie snack foods or caffeinated drinks as an alternative. Stress can also reduce a worker's ability to exercise, reducing calorie use. Daily hassles related to work can interfere with home life and generate role strain, especially for parents or caregivers.

3) Shift work

Shift work has also been associated with the increased risk of obesity.[39-43] Presumably some of the same mechanisms as described for work stress generally would be operative with shift work. In addition, shift work disrupts normal circadian and hormonal cycles potentially altering metabolism and how the body utilizes calories.

4) Chemical exposure

Obesity can be a direct result of chemical exposure.[44-47] Substances with endocrine or lipid metabolism disrupting properties, such as Bisphenol A and phthalates, cause weight gain through a variety of mechanisms. Some of these occur in utero, but others alter hormones that regulate appetite and satiety, alter basic metabolic rate, insulin sensitivity and lipid metabolism. Exposures to obesogenic endocrine disruptors over the life span, for some, may have appetite altering qualities in terms of both quantity and types of food eaten. Exposure to these chemicals can be widespread. For example, phthalates are found in many consumer products including adhesives, paints, packaging, children's toys, electronics, flooring, medical equipment, personal care products, air fresheners, food products, pharmaceuticals and textiles.[47]

Obesity can also be a risk factor contributing to the development or increased seriousness of other health conditions. Examples include:

1) Musculoskeletal disorders[48]
2) Osteoarthritis[49-50]
3) Asthma [51-56]
4) Mental health/substance abuse[57-60]
5) Diabetes[60-63]

Quantifying the Work/Obesity Connection

The development of obesity reflects a complex multifactorial process. Work clearly has the potential to contribute to the development of obesity, and to interact with obesity to produce ill health. The full extent of these interactions is unknown as research into these issues remains relatively undeveloped. In the current context there is no way to accurately quantify how much obesity can be attributed to workplace conditions. The precise role obesity plays interacting with other workplace and health conditions to produce ill health is even more difficult to ascertain. However, as the examples described above indicate, the connection between work and obesity has already been shown to be substantial, and is very likely to grow stronger as our knowledge base develops.

Chapter 5

COSTS OF OCCUPATIONAL DISEASE

Estimating Overall Costs

The Landrigan/Markowitz report estimated the costs of occupational disease in New York State. They used a variety of data sources to produce an estimate for occupational cancer, heart disease and stroke, end stage renal disease, chronic respiratory disease and pneumoconiosis. As they note, this is only a partial list of occupational diseases, and the costs they were able to estimate for these diseases were not comprehensive, resulting in an underestimate of overall costs. Despite these limitations the economic burden of occupational disease was striking, $685 million per year, equivalent to about $1.4 billion in 2019 dollars.

Since Landrigan/Markowitz, J. Paul Leigh has produced a body of work that can be used to update occupational disease estimates.[1-16] Leigh's work utilizes an increased number and types of data sources, and has produced a uniform approach for all diseases and injuries. The basic approach he uses is similar to Landrigan/Markowitz:

1) Determine the incidence of various injuries and illnesses
2) Determine the proportion of overall incidence that is occupational in origin
3) Estimate the costs for a case of each type of injury and illness with costs divided into:
    a. Direct costs defined as "spending on hospitals, physicians, pharmaceuticals, and nursing homes"
    b. Indirect costs defined as "current and future lost earnings, fringe benefits, and home production (e.g. making home repairs, cooking, cleaning, and rearing children)"

Leigh estimated the costs of occupational disease in the US, both fatal and non-fatal cases, to be $57.81 billion based on 2007 figures for both fatal and non-fatal disease rates and currency value.[1] **Table 26** updates figures for New York State. Waehrer provided state-by-state figures. The total costs of $57.81 billion were multiplied by Waehrer's NYS factor (5.69%), resulting in an estimate for NYS costs at $3.289 billion.[6-8] Adjusting cumulative inflation rates from 2007 to 2016 for both medical inflation (32.118%) and wage inflation (15.734%) brought the figure up to $4.077 billion.[17]

The Distribution of the Costs of Occupational Disease

The overall economic costs of occupational diseases and injuries were estimated by Leigh to be $249.6 billion. Workers' Compensation, the state-based system established to pay for the direct and indirect costs of work-related injuries and diseases covered only $55.4 billion (22%) of the total. As Leigh notes, Workers' Compensation payments for restitution of lost wages "rarely, if ever" exceed 70% of the actual wages lost. Most of the time they cover far less. In addition, Workers' Compensation benefits do not cover lost fringe benefits or home production.

As many as 95% of those with an occupational disease receive no payment at all from Workers' Compensation. Consequently, Leigh's estimate that Workers' Compensation pays for 22% of the costs of occupational diseases and injuries combined, is certainly substantially lower for occupational diseases.[2]

TABLE 26 Estimated Occupational Disease Costs in NYS (based on contribution to US costs)

US costs for fatal and non-fatal occupational disease cases[a]	NYS costs for fatal and non-fatal occupational disease cases[b]	NYS costs for fatal and non-fatal occupational disease cases adjusted for medical and wage inflation, 2007-2016 [c,d]
$57,810,000,000	$3,289,938,085	$4,077,088,158

[a] Leigh 2011
[b] Waehrer et al.2004 (5.69%)
[c] Leigh, conversation 2016,[formula: 1/2 x (medical inflation + wage inflation)]
[d] Halfhill 2018

TABLE 27 Distribution of Costs of Occupational Disease in NYS

	Total estimated costs	
Employers	$1,182,355,566	29%
Sick workers and their families; taxpayers	$2,894,732,592	71%
Total, estimated costs	$4,077,088,158	

Source: Leigh 2011, 2012

Costs are distributed among employers, ill workers and their families, and taxpayers. Employers pay for Workers' Compensation insurance. Some employers also contribute to payment for employees' health insurance which is utilized when occupational disease is not paid for by Workers' Compensation. **Table 27** estimates the proportion of the costs of occupational disease borne by employers. Leigh estimated the total cost of occupational disease to be $57.8 billion with $20.83 billion (36%) in direct costs and $36.97 billion (64%) in indirect costs. If it is assumed that employers pay for 22% of the direct costs and the lost earnings portion of the indirect costs through Workers' Compensation and 50% of other direct costs (i.e. medical costs paid for by private health insurance), their share of the total costs would be $16.90 billion or 29% of the total. In New York employers would pay about $1.18 billion a year. The employer share is actually likely to be significantly less for occupational disease as the assumptions used for the estimates are generous.

The other 71% of the costs are paid by ill workers and their families, and taxpayers. In New York this amounts to about $2.89 billion annually. These costs include co-pays, deductibles, contributions to insurance premiums and other out-of-pocket medical expenses. Sick workers pay for a portion of these costs and taxpayers contribute to publicly funded health care under Medicare and Medicaid. Indirect costs are likewise covered by publicly funded benefits including Social Security Disability Insurance.

Hidden Costs

Costs not captured by the methods employed by Leigh are important additions to the overall burden of occupational disease. [18-20] 'Pain and suffering' is a shorthand way of describing some of these costs, which encompass a variety of impacts. For an injured worker it may literally describe the day to day reality of living with a chronic illness that may be progressive or even eventually fatal. 'Pain and suffering' also describes the anguish of lost abilities and the frustration of not being able to participate in social and recreational activities that were once sources of pleasure. It describes the impact of losing a job that was a major source of identity, pride, and social standing as well as social contact. 'Pain and suffering' extends to partners, children and close family members of ill workers. Taking care of an ill or disabled partner exacts a tremendous toll over time. As Leigh comments: "pain and suffering can be terrible for a child" when a parent dies from an occupational disease. These effects are extremely difficult to quantify, but are no doubt substantial. Some estimate these costs to be greater than those of occupational disease and injury combined. They are borne entirely by ill workers and their families.

Also uncounted are costs to employers for absences, decreased productivity, and recruiting and training replacement workers. When workers miss work due to illness their absence clearly decreases productivity. 'Presenteeism', when ill workers come to work, but are unable to perform at a high level, also reduces productivity, but may be less obvious.[21-25] When ill workers can no longer work, employers are faced with the task of finding and training replacements. The difficulty of this task depends on a number of factors and costs increase along with the difficulty.[26]

Conclusions

Using updated methods, we estimated the costs of occupational disease in New York State to be over $4 billion a year, about 3.25 times greater than those estimated by Landrigan/ Markowitz. The cost burden is tremendous. Injured workers and their families bear the major brunt of the costs. Taxpayers also contribute a substantial amount to the costs of occupational disease. Given that, under the Occupational Safety and Health Act, employers have the responsibility of creating and maintaining a safe and healthy workplace, their contribution of less than 30% to the costs of occupational disease is strikingly low.

Chapter 6

CLINICAL OCCUPATIONAL HEALTH RESOURCES

The Landrigan/Markowitz report identified a serious lack of occupational health clinical resources focused on the identification and prevention of occupational disease in New York State.[1] The deficiencies they recognized are largely still in place in the private health care sector, and have actually worsened since their report came out in 1987. However, as the report recommended, a publicly funded Occupational Health Clinic Network (OHCN) was established in 1987 and has contributed to addressing these needs.[2-6]

Occupational Health in the Private Health Care Sector

While there is no central database to identify or quantify private sector doctors and clinics that provide occupational medicine services, experience suggests the number of providers has increased since Landrigan/Markowitz. With the decline in manufacturing and the loss of large plants, there are fewer employers that maintain an on-site occupational medicine service or an occupational medicine specialist. The trend has been for employers to contract out these services to providers in the community. These industrial clinics may be free standing or a service of a parent institution, usually a hospital.

The characteristics of these services are similar to those described by Landrigan/Markowitz:

1) A focus on the treatment of acute injuries, pre-employment examinations, examinations to comply with specific regulations (e.g. Department of Transportation requirements for truck drivers), and periodic examinations not specific for occupational hazards
2) Financial dependency on employers creating a potential conflict of interest
3) Lack of involvement in occupational disease prevention without integration with industrial hygiene and training and education staff or resources

In addition, these services:

1) Are often not staffed by Board-Certified Occupational Medicine specialists despite being advertised as 'Occupational Medicine' services.
2) Even when staffed by a Board-Certified Occupational Medicine specialist, they are not accessible to the individual injured or ill worker unless referred by an employer with a contract with that provider/clinic.
3) Often include 'Independent Medical Examinations', (i.e. examinations provided to Workers' Compensation insurance carriers and/or employers), usually in cases where the insurer and/or employer is disputing or denying a claim.

The Landrigan/Markowitz report envisioned community-based physicians as continuing to take the leading role in the diagnosis and treatment of occupational injuries and the ongoing treatment of occupational disease after it had been diagnosed by an OHCN clinician. Physicians in the community have traditionally provided care to patients injured or made ill on the job. For the most part, this has meant care for patients with acute musculoskeletal injuries. Much occupational disease went undetected by evaluations in the community due to lack of physician training in occupational which has not improved in the intervening years since Landrigan/Markowitz[7-8].

In addition, OHCN clinicians discovered immediately that physicians in the community were not generally interested in taking patients back for treatment after being diagnosed with an occupational disease at an OHCN center. Consequently, the OHCN clinics took on this task, which required the patient be seen at least once every 3 months. Because many patients had complicated Workers' Compensation trajectories, it often takes years for the issues of the case to be settled. Even then, the OHCN clinics are often called on to continue care indefinitely as no physician in the community (including the patient's own primary care provider) is willing to take on that role.

This problem has been dramatically compounded in the years since the 1987 report as increasing numbers of physicians in the community have declined to see patients with Workers' Compensation insurance. This trend has accelerated since the last major round of legislated Workers' Compensation reform in 2007 and, according to our most recent survey, of 310 medical practices conducted in eight counties, has included virtually every medical specialty except orthopedics, neurosurgery and pain management. Only 20% of dermatologists, 17% of ENTs, about 40% of psychiatrists/psychologists and 50% of pulmonologists were accepting new Workers' Compensation patients as listed in **Table 28.**[9-12] Since then, the number have gotten worse. Physicians already feeling burdened by increased demands by health insurers, have found the Workers' Compensation paper work and process to be simply intolerable. In many parts of the state this lack of providers has reached crisis proportions with patients forced to travel long distances to seek care.

It should also be noted that some of the practitioners that continue to accept Workers' Compensation are unable and/or unwilling to fill out the necessary paper work and to meet the other needs of the Workers' Compensation process. Their patients suffer as the Workers' Compensation benefits they receive are below what they are entitled to, and are sometimes cut altogether.[9,10] This is another reason that some patients might seek care from other resources.

TABLE 28 Medical Practices Accepting New Patients compared with New Workers' Compensation Patients in Cayuga, Cortland, Fulton, Hamilton, Herkimer, Madison, Oneida, and Onondaga Counties, 2013 (n=310)

Specialty	Number of Practices	Accepting New Patients	Accepting New Workers' Compensation Patients
Allergy	5	100%	20%
Dermatology	5	100%	20%
ENT	6	100%	17%
Family	104	59%	37%
Internal	68	72%	23%
Neuro Surgery	6	100%	100%
Neurology	18	100%	61%
Ortho Surgery	26	96%	96%
Physical Medicine/Pain Management	12	100%	100%
Psychiatry	13	69%	38%
Psychology	34	58%	41%
Pulmonology	8	88%	50%
Rheumatology	5	80%	40%
Total	310	76%	46%

Source: Occupational Health Clinical Center, SUNY Upstate Medical University, internal data

Occupational Medicine Specialists: Number and Geographic Distribution

Physicians trained in occupational medicine are key to the diagnosis and prevention of occupational disease. Board Certification is an important indicator of training and suggests a certain level of competency.[13] The Landrigan/Markowitz report demonstrated a shortage of Board-Certified Occupational Medicine specialists in the state. For our report, the current number of Occupational Medicine specialists in the state was assessed.

Methods

Occupational Medicine specialists are residency trained and must pass an exam to become Board Certified. Their training focuses on the identification, treatment and prevention of work-related diseases and injuries. However, residencies in the specialty are few in number and small in size, limiting the number of practitioners with this training and expertise. All Board-Certified Occupational Medicine specialists in New York were identified at the American Board of Preventive Medicine (ABPM) website. The ABPM is the organization responsible for certifying Occupational Medicine specialists and maintains a list of all current Board-Certified physicians.[14]

Beyond enumerating the number of occupational medicine specialists, it is important to determine if they practice clinically and if their services are realistically available to individual worker/patients. In order to treat patients with work related illnesses and injuries and to bill

Workers' Compensation in New York state, physicians must apply for a rating from the Workers' Compensation Board (WCB).[15] Physicians coded by the WCB are able to evaluate patients with possible work-related conditions and bill Workers' Compensation insurance. All physicians coded as Occupational Medicine specialists by the New York State Workers' Compensation Board were identified from the New York State Workers' Compensation Board's website.[16] The practice location and whether the practitioner is accepting new patients was ascertained. Each practitioner was then searched via Google to attempt to determine the setting within which they practice.

Results

Landrigan/Markowitz identified 73 occupational medicine specialists in the state out of a total of about 26,000 physicians. According to the ABPM there are currently 153 Board Certified occupational medicine specialists out of a total of 73,299 physicians in New York State. The number of occupational medicine specialists per 1000 physicians was 2.8/1000 and 2.08/1000 in 1987 and 2020 respectively. While the absolute number of occupational medicine specialists has increased, their presence as a proportion of all physicians has diminished by almost a quarter.

According to the New York State WCB there are 44 Occupational Medicine specialists who have been coded, 7 of whom are not listed as Board Certified by the ABPM. Of the 37 Board Certified Occupational Medicine specialists coded to accept Workers' Compensation as payment only 30 are accepting new patients.

The 30 Board Certified Occupational Medicine specialists are distributed around the state as follows:

City/Region	Number of Occupational Medicine Physicians on Staff
New York City	6
Long Island	5
Lower Hudson Valley	1
Albany	6
Eastern New York	2
Syracuse	1
Central New York/Southern Tier	3
Rochester	4
Finger Lakes	0
Buffalo	1
Western New York	1

Forty percent of the occupational medicine specialists accepting new patients are located in the New York City/Long Island/Lower Hudson valley area. Another 27% are located in the Albany and Eastern New York area. Despite the similarity in size to Albany and heavier concentration of industry, Syracuse and Rochester have only 3% and 13% of the total respectively. Buffalo, a larger city with an historically heavier concentration of industry only has 1 Occupational Medicine specialist. In contrast, the Southern tier, which is relatively sparsely populated has 3 specialists.

Nine of the 30 specialists (30%) practice in the OHCN. Of the remaining 21, twelve practice as part of a hospital based ambulatory care system, 8 in private practices, and 1 as part of a large multi-specialty group. Just under half (10) practice in settings advertising services primarily to employers. The practices of the remaining 11 could not be further characterized from their internet presence.

Occupational Health Clinic Network

To address the scarcity of occupational health services focused on occupational disease, the Landrigan/Markowitz report recommended the establishment of a publicly funded Occupational Health Clinic Network (OHCN). The envisioned network, which came to fruition in 1987, was to be regionally based and focused on the diagnosis and prevention of occupational disease. The unique features of the OHCN included:

- Public funding to promote independence from employers
- A multidisciplinary team to provide services including an Occupational Medicine Specialist, Industrial Hygienist, Social Worker, and Outreach/Education specialist [17-19]
- Universal accessibility for patients desiring evaluation
- A community based Advisory Board, the majority of whom are, or represent workers directly affected by unhealthy working conditions. A key function of the Advisory Board was to help guide the centers in targeting services to high risk workers and workplaces.

The central activity of the OHCN clinics has been the clinical evaluation of individual patients with suspected work-related health conditions. Since its inception over 30 years ago, OHCN clinics have evaluated 105,664 patients in 324,397 visits or group screenings **(Table 29)**, advocated for workplace changes to allow for safe stay or return to work, and have helped patients obtain benefits from the state's very difficult Workers' Compensation system.[20-22] Currently funded at about $9.6 million dollars, the OHCN is comprised of eight regional centers and an additional center with an agricultural health focus and a statewide mandate. [23]

TABLE 29 New York State Department of Health, Occupational Health Clinical Network Individual and Group Patients Seen 01/01/1987 through 03/23/2021			
	Individual Patients	**Group Patients**	**Total**
Visits	211,769	112,628	324,397
New Patients	47,023	58,641	105,664

Limitations

The number of Board-Certified Occupational Medicine physicians able to evaluate patients in New York state would seem to be relatively accurately ascertainable from the sources accessed, however, the WCB list suffers from shortcomings that could impact the results. The WCB list of specialists accepting new patients has been notoriously inaccurate, with many doctors listed not actually accepting new patients, or even actively practicing. Consequently, the number of Occupational Medicine specialists accepting new patients and accessible to workers may be over-estimated.

Conclusions

The number of Board-Certified Occupational Medicine specialists in New York state remains minuscule. While the number of specialists in the state has more than doubled since the Landrigan/Markowitz report, the number actually available to evaluate workers with injuries or illnesses is only 30 for the entire state. Wide swaths of the state are without any specialists and the historically industrial population centers of Syracuse and Buffalo have only one per city. While a plurality of specialists practice in the NYC/Long Island area, given the very large population to be served, the specialty remains under-represented. The development of the OHCN has made a significant contribution to the number of practicing specialists, making up almost a third of the total and being the only specialist in the population centers of Syracuse and Buffalo.

In addition, physicians who are employed either directly by corporations, or under contract in a hospital–based or free-standing clinic generally see patients referred by employers and are not necessarily accessible to individual patients. Even if they nominally accept self-referred individuals, many patients might be reluctant to seek care from facilities they know depend on contracts with employers. Nearly half of the non-OHCN specialists' practice in settings explicitly offering these kinds of services. The remaining 11 work in settings that are typically employer oriented, but their internet descriptions did not offer enough information to make a certain determination.

In summary, despite the creation of the OHCN, workers in New York State seeking an employer-independent Occupational Medicine specialist to evaluate a potential occupational disease remain grossly under-served.

Chapter 7

CONCLUSIONS AND RECOMMENDATIONS

Despite a significant governmental and non-governmental occupational health infrastructure, and innovations including the OHCN and OSHTEP, occupational disease remains a major public health problem in New York State.

- ***Over 7 thousand workers die from an occupational disease each year, and at any given time over 2 million workers are suffering from an occupational disease***
- ***Work related musculoskeletal disorders, stress related illness, and infectious diseases (COVID-19) are increasingly recognized***
- ***Millions of workers in NYS are exposed to a wide array of hazards and working conditions that put them at risk of occupational disease.***
- ***The costs of occupational disease are tremendous, estimated to be over $4 billion a year, of which injured workers, their families, and taxpayers pay the vast majority***
- ***Despite the creation of the OHCN clinical occupational health resources remain scarce and inadequate***

Effectively recognizing, treating, compensating and preventing occupational disease will require a broad-based effort involving both governmental and non-governmental safety and health organizations working in collaboration with labor unions, Worker Centers' and other advocacy groups to stimulate development of both a road map for change and action to effectuate it. In the final section of this report we offer some recommendations that flow from our findings to frame this effort.

Recommendations

Adequate Funding

- ***Increase funding for governmental and non-governmental occupational health programs commensurate with the need for services***
- ***Develop mechanisms that make OHCN and OSHTEP funding sustainable and keep pace with increases in the cost of living***

New York State funds both state government and non-state organizations to carry out specific occupational disease related functions. These include programs in the Department of Labor, Department of Health, the Occupational Health Clinic Network (OHCN), and the Occupational Safety and Health Training and Education Program (OSHTEP). The State also provides funding for academic occupational health programs at Hunter and Queens College.

While the State agencies have suffered from general austerity and low prioritization, the OHCN and OSHTEP have additionally faced insecure funding and flat allocations that endure for many years, in effect resulting in yearly budget cuts and program reductions.

To fund some of these programs the State instituted a funding mechanism that requires employers to pay a small surcharge on their annual Workers' Compensation premiums. While the amount the State collects through this mechanism is shrouded in mystery, the scant information available suggests that considerably more is collected than what is used to fund the programs for which it was intended.

Consequently, the State could increase funding for occupational disease related activities by simply using more of what is already collected for that purpose, for that purpose, instead of diverting the funds to other use. If increased revenue is necessary, however, the surcharge could be increased. Businesses who are legally responsible for creating and sustaining a healthy workplace are in actuality socializing much of the costs of their failure to do so. Paying their fair share either through this or other mechanisms would be a morally just way of increasing funding for programs aimed at reducing the burden of occupational disease.

In addition, mechanisms that would keep the OHCN and the OSHTEP on more secure footing should also be developed. An indexing mechanism would help these programs at least keep pace with inflation without the need for an annual legislative lobbying campaign that, more often than not, proves fruitless. Currently the OHCN has been flat funded for 13 years and counting, with OSHTEP faring even worse.

Building on the existing OSH infrastructure

- ***Systematically analyze existing data on occupational disease from the WCB, the OHCN, and state registries to target prevention efforts***
- ***Develop other data sources to provide more comprehensive information on occupational disease workplace hazards***
- ***Improve the Workers' Compensation process to provide an incentive for clinicians to participate***
- ***Eliminate barriers to care for occupational disease by Workers' Compensation reforms that curb insurance carrier powers to deny and delay claims***

The already existing OSH infrastructure in New York State includes both governmental and non-governmental agencies and organizations and provides a strong basis on which to build augmented efforts on occupational disease.

The identification of occupational disease suffers from a lack of data. Existing data sources including Workers' Compensation (WC), the OHCN patient database, Occupational lung, pesticide, and heavy metals registries, and Bureau of Labor statistics should all be systematically and regularly analyzed and reported in a form that is accessible to all who are interested. Efforts to include occupation in medical records would also increase identification of occupational disease.

As detailed in this report, all of these data sources suffer from serious shortcomings and will need to be complemented by developing new sources of relevant data. The experiences of workplace and community-based organizations involved in occupational safety and health including unions, COSH groups, and Workers' Centers should be included as potentially rich sources of data on occupational disease.

The clinical diagnosis and treatment of occupational disease could be strengthened by supporting the OHCN, which remains the only statewide clinical resource focused on occupational disease and staffed with a multidisciplinary team experienced in addressing all facets of patients' clinical needs.

Community based resources including specialist and primary care clinicians (MDs, NPs, and PAs) are an essential component of the health care system providing care to workers with occupational disease. Their participation in this endeavor, however, has been declining. To encourage more clinicians to participate, the Workers' Compensation Board needs to more decisively act to make navigating the WC system at least as easy as the private health insurance system. In addition, the OHCN could be used as a resource for other clinicians offering training and consultation without necessarily taking over the care of the patients.

A key reform in attempting to improve the clinical care of patients with occupational disease would be the elimination of barriers to care and to disability benefits imposed by the current way work related illnesses are handled. Disease claims are routinely challenged by WC insurance carriers resulting in patients losing access to diagnostic and treatment resources, often for long periods of time. This can have detrimental effects on the patient's course, delaying or blocking recovery, or worse, leading to irreversible consequences. Fundamental reform is necessary to end the problem of patients suffering as insurance carriers fight liability.

Prevention of occupational disease

- ***Development of a statewide occupational disease prevention agenda that includes both governmental and non-governmental organizations in its crafting***
- ***Incentivize employers to engage in occupational disease prevention efforts by reducing their ability to socialize the costs of occupational disease and by more assertive State intervention and regulation of workplace hazards***

The prevention of occupational disease depends on data that identifies workers at high risk, and strategies that translate the data into effective action. New York State has largely accepted the idea that prevention, in the private sector at least, is a federal responsibility and consists mainly of OSHA standards and inspections. The State has, however, on occasion stepped in to address problems where OSHA has proven lacking. Recent examples include hazards in nail salons, safe patient handling, and airborne infectious disease in the workplace. A shift from a reluctant, only in dire circumstances stance to a more active and assertive approach is a necessary first step toward more effective prevention.

The State could develop a Statewide prevention agenda which could unify the efforts of the disparate participants in the OSH infrastructure, and could amplify the impact of limited resources. It would be crucial to tap the expertise and experience of non-governmental organizations including unions, the OHCN, COSHs, and Worker Centers in the construction and implementation of this agenda. These organizations often have more direct and intimate relations with workers at high risk. They also have experience with varying approaches to outreach, training, and education that can be profitably utilized.

Along with the carrot of increased resources for training and education, the State could also wield the stick of increased costs to incentivize employer prevention efforts. Those costs could originate in enforcement efforts with teeth as part of legislation like Safe Patient Handling and the new Airborne Infectious disease regulation. Existing regulations that require employers with poor safety records to obtain safety consultations could be broadened and strengthened to include occupational disease more effectively. As noted above, the WC insurance surcharge could be increased to fund preventive activities. And employers could be required to pay for workers to be trained to become safety and health advocates in their own workplaces. Elimination of barriers to participation on workplace health and safety committees, including paid time off for training and participation could also be mandated.

Integration and Collaboration

- ***Development of a statewide occupational disease prevention agenda that includes both governmental and non-governmental organizations in its crafting***
- ***Continue the collaboration between these groups in the implementation of the agenda***

One of the major characteristics and failings of the State's current prevention efforts is the lack of communication and collaboration between OSH related agencies and between State and non-State based OSH resources. Each agency and organization focuses on its specific aspect, with some collecting data, others engaged in clinical work, still others doing training and education, all rarely, if ever, coming together to discuss how the various pieces of their work fit together.

The result is a piecemeal approach that minimizes potential effectiveness. With collaboration the identification, treatment, and prevention of occupational disease could be planned, coordinated, implemented and evaluated. For example, Workers' Compensation data could be shared, analyzed and used for targeting high risk occupations and workers. Workers' Compensation, DOL, and OHCN data could be used to aid and focus enforcement efforts. Agencies and organizations could freely consult each other when their additional expertise and skills are needed in a specific situation.

Toward this end the State could convene a group focused on occupational disease that brings all of the relevant agencies and organizations together to implement a joint statewide occupational disease agenda.

Building worker capacity and expanding worker participation

- ***Build worker based occupational health capacity***
- ***Include workers and worker advocacy organizations as central participants in collaborative occupational health efforts***

There are at least three major reasons why workers and organizations that advocate for workers should be included as a central participant in prevention efforts. First, from a justice standpoint, since workers are the ones taking the risk and paying the price with their health, they should have a say in what the prevention of occupational disease should consist of. Second, workers have valuable experience and expertise about their jobs and workplaces that should be tapped in developing and implementing preventive efforts. And third, even with expanded resources there is no way for the State to be able to address the problems of every workplace in the state. Trained workers who know their rights and are empowered to participate would be an invaluable resource in efforts to bring effective prevention of occupational disease to every workplace.

For these reasons the building of worker OSH capacity should be a major focus of the State's efforts, and adequate resources should be devoted toward this end.

In 1987 the Landrigan/Markowitz report documented the massive toll occupational disease took on ill workers, their families, and society as whole. More than thirty years later thousands of workers die and many thousands more fall ill as a consequence of exposure to hazardous working conditions. Millions continue to work under conditions that put them at risk of occupational disease. The resources available to identify, treat and prevent occupational disease remain appallingly limited in the face of such a large-scale problem. Landrigan/Markowitz helped pave the way for the creation of a publicly funded occupational health clinic network. What is needed now is a comprehensive approach that builds on New York State's safety and health infrastructure and addresses the changed landscape of work.

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LIST OF TABLES AND FIGURES

**Technical Notes giving details, methods, and additional sources are available upon request.*

REFERENCES

Chapter 1

Occupational Disease in New York State

1. Landrigan PJ, Markowitz SB. *Proposal for a Statewide Network of Occupational Disease Diagnosis and Prevention Centers. Report to the New York State Legislature*. New York, NY: Environmental and Occupational Medicine, Department of Community Medicine. Mount Sinai School of Medicine of the City University of New York; 1987.
2. Tuminaro D. Organizing for a statewide network of occupational disease diagnostic centers. *New Solut*.1991;1:18-19.
3. New York State Workers' Compensation Law. Section 151. https://www.nysenate.gov/legislation/laws/WKC/151. Accessed Jan 19, 2020.
4. New York State Department of Health. Occupational Health Clinic Network – Prevention and Protection for the NYS Workforce. https://www.health.ny.gov/environmental/workplace/clinic.htm. Published October 2018. Accessed January 19, 2021.
5. Lax, MB. The Occupational Health Clinical Center in New York State: Achievements, prospects, and constraints. In Levenstein C, Wooding J. eds. Work, Health and Environment. New York: Guilford Press;1997:363-384.
6. Lax MB. Occupational health in Central New York: A publicly funded occupational health clinical center after 25 years. *Revista Brasiliera de Saúde Ocupacional.* 2013;38(127):149-161.
7. Lax, MB. New York State's COSH movement: A brief history. *New Solut*. 2018;28(2):202-226. doi:10.1177/1048291117752462.
8. Guidotti, T. Chapter 18. Occupational Diseases. In: *Handbook of Occupational and Environmental Medicine: Principles, Practice, Populations, and Problem-Solving.* 2nd ed. Santa Barbara, CA: Praeger; 2020:745-746.
9. Oppliger A, Seixas NS. What Makes a Disease 'Occupational'? *Ann Work Expo Health*. 2017;61(2):135-136. doi: 10.1093/annweh/wxw029.
10. Liddell FD. The interaction of asbestos and smoking in lung cancer. *Ann Occup Hyg*. 2001;45:341–56.
11. Berry G, Liddell FK. The interaction of asbestos and smoking in lung cancer: a modified measure of effect. *Ann Occup Hyg*. 2004;48:459–62.
12. Boffetta P. Epidemiology of environmental and occupational cancer. *Oncogene*. 2004;23:6392–6403.
13. Vlanovich KP, Sood A. A 2019 update on occupational lung diseases: A narrative review. *Pulm Ther* Online ahead of print. 2020 doi:10.1007/s41030-020-00143-4.
14. Vandenplas O, Godet J, Hurdubaea L, Rifflart C, Suojalehto H, Walusiak-Skorupa J, et al. Severe occupational asthma: insights from a multicenter European cohort. *J Allergy Clin Immunol Pract.* 2019;7(7):2309–18.
15. Logar-Henderson C, MacLeod JS, Arrandale VH, Holness DL, McLeod CB, Peter A, et al. Adult asthma among workers in Ontario. Results from the occupational disease surveillance system. *Ann Am Thorac Soc*. 2019;16(5):563–71.
16. Beach J, Chen Y, Cherry N. How physicians allocate causation: a scenario study with factorial design. *Occup Med*. 2012; 62: 07 – 412.
17. Karasek R, Theorell T. *Healthy Work: Stress, Productivity, and the Reconstruction of Working Life*. New York: Basic Books; 1990.
18. Siegrist J. Adverse health effects of high-effort/low-reward conditions. *J Occup Health Psychol*. 1996;1(1):27-41. doi:10.1037//1076-8998.1.1.27.
19. Schnall PL, Pieper C, Schwartz JE, Karasek RA, Schlussel Y, Devereux RB, et al. The relationship between 'job strain,' workplace diastolic blood pressure, and left ventricular mass index: Results of a case-control study. *JAMA*. 1990;11;263(14):1929-35.

20. Landsbergis PA, Schnall PL, Warren K, Pickering TG, Schwartz JE. Association between ambulatory blood pressure and alternative formulations of job strain. *Scand J Work Environ Health*. 1994;20(5):349-63. doi: 10.5271/sjweh.1386.
21. Kivimäki M, Nyberg ST, Batty GD, Fransson EI, Heikkilä K, Alfredsson L. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. *Lancet*. 2012; 380:1491–97. doi:10.1016/ S0140-6736(12)60994-5.
22. Li, J, Jarczok MN, Loerbroks A, Schollgen I, Seigrist J, Bosch JA, et al. Work stress is associated with diabetes and prediabetes: Cross-sectional results from the MIPH industrial cohort studies. *Int.J Behav Med.* 2013;20:495–503. doi:10.1007/s12529-012-9255-0.
23. Li AK, Nowrouzi-Kia B. Impact of diabetes mellitus on occupational health outcomes in Canada. *Int J Occup Environ Med*. 2017;8(2):96-108.
24. Kivimaki M, Virtanen M, Kawachi I, Nyberg ST, Alfredsson L, Batty GD, et al. Long working hours, socioeconomic status, and the risk of incident type 2 diabetes: a meta-analysis of published and unpublished data from 222 120 individuals. *Lancet Diabetes Endocrinol.* 2015;3:27–34.
25. Poulsen K, Cleal B, Clausen T, Andersen LL. Work, Diabetes and obesity: A seven-year follow-up study among Danish health care workers. *PloS One*. 2014;9(7): e103425.
26. Vanni R, Bussuan RM, Rombaldi RL, Arbex AK. Endocrine disruptors and the induction of insulin resistance. *Curr Diabetes Rev.* 2020; 2020 Oct 22. Epub ahead of print. doi:10.2174/1573399816666201022121254.
27. Lian Y, Sun Q, Guan S, Ge H, Tao N, Jiang Y, et al. Effect of changing work stressors and coping resources on the risk of type 2 Diabetes: The OHSPIW cohort study. *Diabetes Care*. 2018;41:453–460. doi:10.2337/dc17-0749
28. Mutambudzi M, Javed Z. Job strain as a risk factor for incident diabetes mellitus in middle and older age U.S. Workers. *J Gerontol B Psychol Sci Soc Sci*. 2016;71(6):1089-1096. doi:10.1093/geronb/gbw091.
29. Mutambudzi M, Siegrist J, Meyer J, Li J. Association between effort-reward imbalance and self-reported diabetes mellitus in older U.S. workers. *J Psychosom Res*. 2018;104:61-64.
30. Nyberg ST, Fransson EI, Heikkil¨K, Ahola K, Alfredsson L, Bjorner JB, et al. Job strain as a risk factor for type 2 Diabetes: A pooled analysis of 124,808 men and women. Diabetes Care. 2014;37:2268–2275. doi:10.2337/dc13-2936.
31. Schulte PA, Wagner GR, Ostry A, Blanciforti LA, Cutlip RG, Krajnak KM, et al. Work, obesity, and occupational safety and health. *Am J Public Health*. 2007;97(3):428.
32. Roos E, Lallukka T, Rahkonen O, Lahelma E, Laaksonen M. Working conditions and major weight gain: A prospective cohort study. *Arch Environ Occup Health*. 2013;68(3):166-172. doi:10.1080/19338244.2012.686931.
33. Pandalai SP, Schulte PA, Miller DB. Conceptual heuristic models of the interrelationships between obesity and the occupational environment. *Scand J Work Environ Health.* 2013;39(3): 221–232. doi:10.5271/sjweh.3363.
34. Nyberg ST, Heikkila K, Fransson EI, Alfredsson L. DeBacquer D, Bjorner JB, et al. Job strain in relation to body mass index: pooled analysis of 160,000 adults from 13 cohort studies. *J Intern Med*. 2012;272(1):65-73. doi:10.1111/j.1365-2796.2011.02482.x.
35. Choi B, Schnall PL, Yang H, Dobson M, Landsbergis P, Israel L, et al. Sedentary work, low physical job demand, and obesity in US workers. *Amer J of Ind Med*. 2010;53:1088-1101. doi:10.1002/ajim.20886.
36. Nobrega S, Champagne N, Abreu M. Goldstein-Gelb M, Montano M, Isabel Lopez I, et al. Obesity/Overweight and the role of working conditions: A qualitative, participatory investigation. *Health Promot Pract. 2016;17(1):127-36. doi:10.1177/1524839915602439.*
37. Magee CA, Caputi P, Stefanic N, Iverson DC. Occupational factors associated with 4-year weight gain in Australian adults. *J Occup Environ Med*. 2010;52:977–81.
38. Iversen LB, Strandberg-Larsen K, Prescott E, Schnohr P, Rod NH. Psychosocial risk factors, weight changes and risk of obesity: the Copenhagen City Heart Study. *Eur J Epidemiol.* 2012;27:119–30.

39. Marchand A, Beauregard N, Blanc M-E. Work and non-work stressors, psychological distress and obesity: evidence from a 14-year study on Canadian workers. *BMJ Open* 2015;5(3):e006285. doi:10.1136/bmjopen-2014006285.
40. Solovieva S, Lallukka T, Virtanen M, Viikari-Juntura E Psychosocial factors at work, long work hours, and obesity: a systematic review. *Scand J Work Environ Health*. 2013;39(3):241-258. doi:10.5271/sjweh.3364.
41. Brunner EJ, Chandola T, Marmot MG. Prospective effect of job strain on general and central obesity in the Whitehall II study. *Am J Epidemiol.* 2007;165(7):828-837. doi:10.1093/aje/kwk058.
42. Shrestha N, Pedisic Z, Neil-Sztramko S, Kukkonen-Harjula KT, Hermans V. The impact of obesity in the workplace: A review of contributing factors, consequences and potential solutions. *Curr Obes Rep.* 2016;5:344–360. doi:10.1007/s13679-016-0227-6.
43. Shulte PA, Wagner A, Downes A, Miller DB. A framework for the concurrent consideration of occupational hazards and obesity. *Ann Occup Hyg.* 2008;52(7):555–566. doi:10.1093/annhyg/men055.
44. National Research Council (US) and Institute of Medicine (US) Panel on Musculoskeletal Disorders and the Workplace. Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities. Washington (DC): National Academies Press (US); 2001.
45. Hulshof CTJ, Pega F, Neupane S, van der Molen HF, Colosio C, Daams JG, et al. The prevalence of occupational exposure to ergonomic risk factors: A systematic review and meta-analysis from the WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury. *Environ Int*. 2021;146:106157. Epub 2020 Dec 14. doi:10.1016/j.envint.2020.106157.
46. Foley M, Silverstein B. The long-term burden of work-related carpal tunnel syndrome relative to upper-extremity fractures and dermatitis in Washington State. *Amer J Ind Med*. 2015;58:1255-1269.
47. Siegrist J. Effort-reward imbalance at work and cardiovascular diseases. *Int J Occup Med Environ Health*. 2010;8:1-7.
48. Tsutsumi A, Kayaba K, Ishikawa S. Impact of occupational stress on stroke across occupational classes and genders. *Soc Sci Med*. 2011;72(10):1652-8. doi:10.1016/j.socscimed.2011.03.026.
49. Szerencsi K, van Amelsvoort LG, Viechtbauer W, Mohren DC, Prins MH, Kant I. The association between study characteristics and outcome in the relation between job stress and cardiovascular disease - a multilevel meta-regression analysis. *Scand J Work Environ Health*. 2012;38(6):489-502. doi:10.5271/sjweh.3283.
50. Kalleberg AL. Precarious work, insecure workers: Employment relations in transition. *Am Sociol Rev*. 2009;74(1):1-22.
51. Lewchuk WMC, Wolff A. *Working Without Commitments: The Health Effects of Precarious Employment.* Montreal: McGill-Queen's University Press. 2011.
52. Doussard M. *Degraded Work: The Struggle at the Bottom of the Market.* Minneapolis University of Minnesota Press. 2013.
53. Weil D. *The Fissured Workplace: Why work became so bad for so many and what can be done to improve it*. Cambridge, MA Harvard University Press. 2014.
54. Bernhardt A, Milkman R, Theodore N, Heckathorn D, Auer M, DeFilippis J, Spiller M. Broken Laws, Unprotected Workers: Violations of Employment and Laws in America's Cities. 2009. https://www.nelp.org/publication/broken-laws-unprotected-workers-violations-of-employment-and-labor-laws-in-americas-cities/. Accessed January 20, 2021.
55. Muntaner C, Solar O, Vanroelen C, Martínez JM, Vergara M, Santana V, et al. Unemployment, informal work, precarious employment, child labor, slavery, and health inequalities: pathways and mechanisms. *Int J Health Serv*. 2010;40(2):281-95. doi:10.2190/HS.40.2h.
56. Brophy J, Keith M, Hurley M. Breaking Point: Violence Against Long-Term Care Staff. *New Solut*. 2019;29(1):10-35. doi:10.1177/1048291118824872
57. Brophy JT, Keith MM, Hurley M. Assaulted and Unheard: Violence Against Healthcare Staff. *New Solut*. 2018;27(4):581-606. doi:10.1177/1048291117732301

58. Tausig M, Fenwick R. *Work and Mental Health in Social Context*. New York Springer. 2011.
59. Marchand A, Blanc ME. Occupation, work organization conditions and alcohol misuse in Canada: an 8-year longitudinal study. *Subst Use Misuse*. 2011;46:1003-14.
60. Kowalski-McGraw M, Green-McKenzie J, Pandalai SP, Schulte PA. Characterizing the interrelationships of prescription opioid and benzodiazepine drugs with worker health and workplace hazards. *J Occup Environ Med*. 2017;59(11):1114–1126.
61. Choi B. Opioid use disorder, job strain, and high physical job demands in US workers. *Int Arch Occup Environ Health*. 2020; epub ahead of print January 9, 2020.
62. Shaw WS, Roelofs C, Punnett L. Work Environment Factors and Prevention of Opioid-Related Deaths. *Am J Public Health*. 2020 Aug;110(8):1235-1241. doi:10.2105/AJPH.2020.305716. Epub 2020 Jun 18.
63. de Lange AH, Kompier MA, Taris TW, Geurts SA, Beckers DG, Houtman IL, Bongers PM A hard day's night: a longitudinal study on the relationships among job demands and job control, sleep quality and fatigue. *J Sleep Res*. 2009;18(3):374-83. doi: 10.1111/j.1365-2869.2009.00735.x.
64. Wang XS, Armstrong ME, Cairns BJ, Key TJ, Travis RC. Shift work and chronic disease: the epidemiological evidence. *Occup Med*. 2011;61: 78–89.
65. Gumenyuk V, Roth T, Drake CL. Circadian phase, sleepiness, and light exposure assessment in night workers with and without shift work disorder. *Chronobiol Int.* 2012;29:928–936.
66. Zhao I, Bogossian F, Turner C. The effects of shift work and interaction between shift work and overweight/obesity on low back pain in nurses: results from a longitudinal study. *J Occup Environ Med*. 2012;54(7):820-5. doi:10.1097/JOM.0b013e3182572e6a.
67. Burgard SA, Ailshire JA. Putting work to bed: stressful experiences on the job and sleep quality. *J Health Soc Behav*. 2009;50(4):476-92. doi:10.1177/002214650905000407.
68. Knudsen HK, Ducharme LJ, Roman PM. Job stress and poor sleep quality: Data from an American sample of full-time workers. *Soc Sci Med*. 2007;64(10):1997-2007. doi:10.1016/j.socscimed.2007.02.020.
69. Lax MB, Klein R. More than meets the eye: Social, economic and emotional impacts of work-related injury and illness. *New Solut*. 2008;18(3):343-360.
70. LaMontagne AD, Keegel T, Louie AM, Ostry A. Job stress as a preventable upstream determinant of common mental disorders: a review for practitioners and policy-makers. *Adv Ment Health*. 2014;9(1):17–35.
71. Schulte PA, Pana-Cryan R, Schnorr T, Schill AL, Guerin R, Felknor S, Wagner GR. An approach to assess the burden of work-related injury, disease, and distress. *Am J Public Health.* 2017;107(7):1051-1057. doi:10.2105/AJPH.2017.303765.
72. Schulte PA, Guerin RJ, Schill AL, Bhattacharya A, Cunningham TR, Pandalai SP, et al. Considerations for incorporating "well-being" in public policy for workers and workplaces. *Am J Public Health*. 2015;105(8):e31-e44. doi:10.2105/AJPH.2015.302616.
73. National Academies of Sciences, Engineering, and Medicine. *A Smarter National Surveillance System for Occupational Safety and Health in the 21st Century.* Washington, DC: The National Academies Press; 2018. doi:10.17226/24835.
74. Rosenman KD, Kalush A, Reilly MJ, Gardiner JC, Reeves M, Luo Z. How much work-related injury and illness is missed by the current national surveillance system? *J Occup Environ Med* 2006;48(4):357-365.
75. Galizzi M, Miesmaa P, Punnett L, Slatin C. Injured workers' underreporting in the health care industry: An analysis using quantitative, qualitative, and observational data. *Ind Relat.* 2010;49(1):22-43. doi: 10.1111/j.1468-232X.2009.00585.x.
76. Grey RE, *Workers' Compensation in New York State: State of the System.* Grey & Grey. 2016.
77. Rand Corporation. Dworsky M, Broten N. *How can workers' compensation systems promote occupational safety and health? Stakeholders views on policy and research priorities.* 2018.Santa Monica, CA. www.rand.org/t/RR2566 . Accessed May 25, 2021.

78. Morantz A. *Workers' Compensation at a Crossroads: Back to the Future or Back to the Drawing Board?* in Pound Institute/Rutgers/Northeastern Symposium, The Demise of the Grand Bargain: Compensation for Injured Workers in the 21st Century, 2016. http://poundinstitute.org/content/2016-symposium-papers. Accessed May 25, 2021.
79. Morantz A, Bodson J, Levine SM, Palsson MV. Economic incentives in workers' compensation: A holistic, international perspective. *Rutgers University Law Review*. 2016;69:1015–1080.
80. McLaren CF, Baldwin ML. National Academy of Social Insurance. Workers' Compensation: Benefits, coverage, and costs (2015 data). Washington, D.C. 2017.
81. Spieler EA, Wagner GR. Counting matters: Implications of undercounting in the BLS survey of occupational injuries and illnesses. *Amer J Ind Med.* 2014;57: 1077-1084.
82. Leigh JP, Marcin JP. Workers' Compensation benefits and shifting costs for occupational injury and illness. *J Occup Environ Med* 2012;54(4):445–450.
83. Leigh JP, Robbins JA. Occupational disease and workers' compensation: coverage, costs, and consequences. *Milbank Q*. 2004;82(4):689-721. doi:10.1111/j.0887-378X.2004.00328.x.
84. Executive correspondence with NYS Workers' Compensation Board, Schenectady, NY 12305, September 28, 2018.

Occupational Disease: Estimating Mortality and Morbidity

85. Numinen M, Karjalainen A. Epidemiologic estimate of the proportion of fatalities related to occupational factors in Finland. *Scand J Work Environ Health*. 2001;27(3):161-213.
86. Steenland K, Armstrong B. An Overview of methods for calculating the burden of disease due to specific risk factors. *Epidemiology.* 2006;17(5):512- 519.
87. Steenland K, Burnett C, Lalich N, Ward E, Hurrell J. Dying for work: the magnitude of US mortality from selected causes of death associated with occupation. *Amer J Ind Med*. 2003;4(3):461-482.
88. Driscoll T, Takala J, Steenland K, Corvalan C, Fingerhut M. Review of estimates of the global burden of injury and illness due to occupational exposures. *Am J Ind Med*. 2005;48(6):491-502. doi: 10.1002/ajim.20194. PMID: 16299705.
89. Takala J, Hämäläinen P, Saarela KL, Yun LY, Manickam K, Jin TW, et al. Global estimates of the burden of injury and illness at work in 2012. *J Occup Environ Hyg*. 2014;11(5):326-37. doi: 10.1080/15459624.2013.863131.
90. Hämäläinen P, Takala J, Saarele KL. Global estimates of fatal work-related diseases. *Amer J Ind Med*. 2007;50:28-41.
91. United States Department of Health and Human Services (US DHHS). Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). Compressed Mortality File. https://wonder.cdc.gov/wonder/help/cmf.html (accessed May 9 2021)
92. United States Department of Health and Human Services (US DHHS). Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS), Mortality Statistics Branch, Division of Vital Statistics. Underlying Cause of Death
93. Belkic K, Savic C. *Job Stressors and Mental Health: A Proactive Clinical Perspective*. World Scientific Publishing Co. Pte. Ltd. Hackensack, NJ. 2013.
94. Marchand A, Durand P. 2011. Psychological distress, depression, and burnout: Similar contribution of the job demand-control and job demand-control-support models. *JOEM*. 2011;53(2):185-189. doi:10.1097/JOM.0b013e318206f0e9.
95. Asfaw A, Boden LI. Impact of workplace injury on opioid dependence, abuse, illicit use and overdose: a 36-month retrospective study of insurance claims. *Occup Environ Med*. 2020;77(9):648-653.
96. López Gómez MA, Williams JAR, Boden L, Sorensen G, Hopcia K, Hashimoto D, Sabbath E. The relationship of occupational injury and use of mental health care. *J Safety Res*. 2020;9(74):227-232.
97. López Gómez MA, Sabbath E, Boden L, Williams JAR, Hopcia K, Hashimoto D, et al. Organizational and psychosocial working conditions and their relationship with mental health outcomes in patient-care workers. *J Occup Environ Med*. 2019;61(12):e480-e485.

98. Sabbath EL, Williams JAR, Boden LI, Tempesti T, Wagner GR, Hopcia K, et al. Mental health expenditures: Association with workplace incivility and bullying among hospital patient care workers. *J Occup Environ Med.* 2018;60(8):737-742.
99. Bültmann U, Kant IJ, Van den Brandt PA, Kasl SV. Psychosocial work characteristics as risk factors for the onset of fatigue and psychological distress: Prospective results from the Maastricht Cohort Study. *Psychol Med*. 2002;32(2):333-45. doi: 10.1017/s0033291701005098.
100. Nieuwenhuijsen K, Bruinvels D, Frings-Dresen M. Psychosocial work environment and stress-related disorders, a systematic review. *Occup Med*. 2010;60(4):277-86. doi:10.1093/occmed/kqq081.
101. Harvey SB, Modini M, Joyce S, Milligan-Saville JS, Tan L, Mykletun A, et al. Can work make you mentally ill? A systematic meta-review of work-related risk factors for common mental health problems. *Occup Environ Med*. 2017;74(4):301-310. doi: 10.1136/oemed-2016-104015.
102. Milner A, Witt K, LaMontagne AD, Niedhammer I. Psychosocial job stressors and suicidality: a meta-analysis and systematic review. *Occup Environ Med*. 2018;75(4):245-253. doi:10.1136/oemed-2017-104531.
103. Watanabe K, Imamura K, Kawakami N. Working hours and the onset of depressive disorder: a systematic review and meta-analysis. *Occup Environ Med*. 2016;73(12):877-884. doi: 10.1136/oemed-2016-103845.
104. Laine H, Saastamoinen P, Lahti J, Rahkonen O, Lahelma E. The associations between psychosocial working conditions and changes in common mental disorders: a follow-up study. *BMC Public Health.* 2014;11(14):588. doi: 10.1186/1471-2458-14-588.
105. Taniguchi T, Takaki J, Hirokawa K, Fujii Y, Harano K. Associations of workplace bullying and harassment with stress reactions: a two-year follow-up study. *Ind Health*. 2016;54(2):131-8. doi: 10.2486/indhealth.2014-0206.
106. Rugulies R, Aust B, Madsen IE. Effort-reward imbalance at work and risk of depressive disorders. A systematic review and meta-analysis of prospective cohort studies. *Scand J Work Environ Health*. 2017;43(4):294-306. doi: 10.5271/sjweh.3632.
107. Theorell T, Hammarström A, Aronsson G, Träskman Bendz L, Grape T, Hogstedt C, et al. A systematic review including meta-analysis of work environment and depressive symptoms. *BMC Public Health.* 2015;15:738. doi: 10.1186/s12889-015-1954-4.
108. Fan JK, Mustard C, Smith PM. Psychosocial work conditions and mental health: Examining differences across mental illness and well-being outcomes. *Ann Work Expo Health*. 2019;21;63(5):546-559. doi:10.1093/annweh/wxz028.
109. Duchaine CS, Aubé K, Gilbert-Ouimet M, Bruno Pena Gralle AP, Vezina M, Ndjaboue R, et al. Effect of psychosocial work factors on the risk of depression: a protocol of a systematic review and meta-analysis of prospective studies. *BMJ Open*. 2019;9(11):e033093. doi: 10.1136/bmjopen-2019-033093.
110. Duchaine CS, Aubé K, Gilbert-Ouimet M, Vézina M, Ndjaboué R, Massamba V, et al. Psychosocial stressors at work and the risk of sickness absence due to a diagnosed mental disorder: A systematic review and meta-analysis. *JAMA Psychiatry*. 2020;77(8):842-851. doi:10.1001/jamapsychiatry.2020.0322.
111. Sirviö A, Ek E, Jokelainen J, Koiranen M, Järvikoski T and Taanila A. Precariousness and discontinuous work history in association with health. *Scand J Public Health* 2012;40(4):360-367.
112. Ervasti J, Vahtera J, Virtanen P, Pentti J, Oksanen T, Ahola K, et al. Is temporary employment a risk factor for work disability due to depressive disorders and delayed return to work? The Finnish Public Sector Study. *Scand J Work Environ Health* 2014;40(4):343-352.
113. László KD, Pikhart H, Kopp MS, Bobak M, Pajak A, Malyutina S, et al. Job insecurity and health: A study of 16 European countries. *Soc Sci Med* 2010;70(6):867-874.
114. Villarroel MA, Blackwell DL, Jen A. National Center for Health Statistics. National Health Interview Survey. Tables of Summary Health Statistics for U.S. Adults: 2018. 2019. http://www.cdc.gov/nchs/nhis/SHS/tables.htm. Accessed May 21, 2021.

115. Karasek R, Baker D, Marxer F, Ahlbom A, Theorell T. Job decision latitude, job demands, and cardiovascular disease: A prospective study of Swedish men. *Amer J Public Health* 1981;71(7):694-705. doi: 10.2105/ajph.71.7.694.
116. Siegrist J. Adverse health effects of high effort - low reward conditions at work. *J of Occ Health Psych*, 1996;1:27–43.

Chapter 2

ESTIMATING THE EXTENT OF HAZARDOUS WORK

1. Mishel L, Bivens J, Gould E, Shierholz H. Jobs: A function of demand, In: *The State of Working America. 12th ed*. Ithaca, NY: Cornell University Press; 2012;321-375.
2. Pew Research Center. *The State of American Jobs.*2016;20-40.
3. Wallace M, Kwak J. Bad jobs in a troubled economy: The impact of the great recession in America's major metropolitan areas. In: Kalleberg AL, Vallas SP, eds. *Precarious Work: Causes, Characteristics, and Consequences. Research in the Sociology of Work.* Bingley UK: Emerald. 2018;31:125–156.
4. Mouw T. Kalleberg AL. Occupations and the structure of wage inequality in the United States, 1980s to 2000s. *Amer Soc Rev.* 2010;75(3):402–31. doi:10.1177/0003122410363564.
5. Leigh JP, Leigh WA, Du J. Minimum wages and public health: a literature review. *Prev Med.* 2019;118:122–134.
6. van der Noordt M, IJzelenberg H, Droomers M, Proper KI. Health effects of employment: a systematic review of prospective studies. *Occup Environ Med*. 2014;71(10):730–736. doi: 10.1136/oemed-2013-101891.
7. Burgard SA, Lin KY. Bad Jobs, Bad Health? How Work and Working Conditions Contribute to Health Disparities. *Am Behav Sci*. 2013;57(8):10.1177/0002764213487347. doi:10.1177/0002764213487347.
8. Gochfeld M, Laumbach R. Chemical Hazards. In: Levy BS, Wegman DH, Baron SL, Sokas RK, eds. *Occupational and Environmental Health: Recognizing and Preventing Disease and Injury. 6th ed*. Oxford: Oxford University Press, Inc.; 2011:192-226.
9. Hubbs AF, Kreiss K, Cummings KJ, Fluharty KL, O'Connell R, Cole A, et al. Flavorings-related lung disease: A brief review and new mechanistic data. *Toxicol Pathol.* 2019;47(8):1012-1026. doi:10.1177/0192623319879906.
10. McCoy MJ, Hoppe Parr KA, Anderson KE, Cornish J, Haapala M, Greivell J. Diacetyl and 2,3-pentanedione in breathing zone and area air during large-scale commercial coffee roasting, blending and grinding processes. *Toxicol Rep*. 2017;4:113-122. doi:10.1016/j.toxrep.2017.01.004.
11. Kreiss K. Recognizing occupational effects of diacetyl: What can we learn from this history? *Toxicology*. 2017;388:48-54. doi:10.1016/j.tox.2016.06.009.
12. Suarthana E, Laney AS, Storey E, Hale JM, Attfield MD. Coal workers' pneumoconiosis in the United States: regional differences 40 years after implementation of the 1969 Federal Coal Mine Health and Safety Act. *Occup Environ Med*. 2011;68(12):908-913. doi:10.1136/oem.2010.063594.
13. Perret JL, Plush B, Lachapelle P, Hinks TSC, Walter C, Clarke P, et al. Coal mine dust lung disease in the modern era. *Respirology*. 2017;22(4):662-670. doi:10.1111/resp.13034.
14. Blackley DJ, Halldin CN, Laney AS. Continued increase in prevalence of coal workers' pneumoconiosis in the United States, 1970-2017. *Am J Public Health*. 2018;108(9):1220-1222. doi:10.2105/AJPH.2018.304517.
15. Hall NB, Blackley DJ, Halldin CN, Laney AS. Current review of pneumoconiosis among US coal miners. *Curr Environ Health Rep*. 2019;6(3):137-147. doi:10.1007/s40572-019-00237-5
16. Johnson DL, Phillips ML, Qi C, Van AT, Hawley DA. Experimental evaluation of respirable dust and crystalline silica controls during simulated performance of stone countertop fabrication tasks with powered hand tools. *Ann Work Expo Health*. 2017;61(6):711-723. doi:10.1093/annweh/wxx040.

17. Leso V, Fontana L, Romano R, Gervetti P, Iavicoli I. Artificial stone associated silicosis: A systematic review. *Int J Environ Res Public Health*. 2019;16(4):568. doi:10.3390/ijerph16040568.
18. Rose C, Heinzerling A, Patel K, Sack C, Wolff J, Zell-Baran L, et al. Severe silicosis in engineered stone fabrication workers - California, Colorado, Texas, and Washington, 2017-2019. *MMWR Morb Mortal Wkly Rep*. 2019;68(38):813-818. doi:10.15585/mmwr.mm6838a1
19. Guarnieri G, Salasnich M, Lucernoni P, Sbaraglia M, Grazia Putzu M, Zuliani P, et al. Silicosis in finishing workers in quartz conglomerates processing. *Med Lav*. 2020;111(2):99-106. doi:10.23749/mdl.v111i2.9115.
20. Carrieri M, Guzzardo C, Farcas D, Cena LG. Characterization of silica exposure during manufacturing of artificial stone countertops. *Int J Environ Res Public Health*. 2020;17(12):4489. doi:10.3390/ijerph17124489.
21. Huang YC, Tsuang W. Health effects associated with faulty application of spray polyurethane foam in residential homes. *Environ Res*. 2014;134:295–300. doi: 10.1016/j.envres.2014.07.015.
22. Lockey JE, Redlich CA, Streicher R, Pfahles-Hutchens A, Hakkinen PBJ, Ellison GL, et al. Isocyanates and human health: multistakeholder information needs and research priorities. *J Occup Environ Med.* 2015;57(1):44-51. doi:10.1097/JOM.0000000000000278.
23. Malo JL, Chan-Yeung M. Agents causing occupational asthma. *J Allergy Clin Immunol.* 2009;123(3):545-550. doi:10.1016/j.jaci.2008.09.010.
24. Bello A, Xue Y, Gore R, Woskie S, Bello D. Assessment and control of exposures to polymeric methylene diphenyl diisocyanate (pMDI) in spray polyurethane foam applicators. *Int J Hyg Environ Health*. 2019;222(5):804-815. doi:10.1016/j.ijheh.2019.04.014.
25. Verschoor L, Verschoor AH. Nonoccupational and occupational exposure to isocyanates. *Curr Opin Pulm Med*. 2014;20(2):199-204. doi:10.1097/MCP.0000000000000029.
26. Lemen RA, Landrigan PJ. Toward an asbestos ban in the United States. *Int J Environ Res Public Health.* 2017;14(11):1302. doi:10.3390/ijerph14111302.
27. Lemen RA. Mesothelioma from asbestos exposures: Epidemiologic patterns and impact in the United States. *J Toxicol Environ Health.* 2016;19:250–265.
28. Lemen RA, Dodson RF. Asbestos-Chapter 83. In: Bingham E, Cohrsen B, eds. *Patty's Toxicology. 6th ed. Volume 5.* New York, NY:John Wiley & Sons, Inc.; 2012:211–256.
29. Castleman BI. *Asbestos Medical and Legal Aspects*. 5th ed. Gainthersburg, MD: Aspen Publishers; 2005.
30. Rosner D. Deregulating safety: The case of the effort to ban asbestos. *Milbank Q*. 2017;95:257–260. doi: 10.1111/1468-0009.12260.
31. Barlow CA, Sahmel J, Paustenbach DJ, Henshaw JL. History of knowledge and evolution of occupational health and regulatory aspects of asbestos exposure science: 1900-1975. *Crit Rev Toxicol*. 2017;47(4):286-316. doi:10.1080/10408444.2016.1258391.
32. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.1999.
33. Wilson E, Lafferty JS, Thiboldeaux R, Tomasallo C, Grajewski B, Wozniak R, et. al. Occupational mercury exposure at a fluorescent lamp recycling facility - Wisconsin, 2017. *MMWR Morb Mortal Wkly Rep*. 2018;67(27):763-766. doi:10.15585/mmwr.mm6727a3.
34. Ewers L, Page E, Mortimer V. Hazards associated with the manufacture and repair of neon lights. *Appl Occup Environ Hyg*. 2003;18(1):1-9. doi:10.1080/10473220301388.
35. Makos K, Burroughs G. Managing occupational exposure to mercury vapor from museum collections. American Industrial Hygiene Conference and Exposition, June 1-6, 2002, San Diego, California. Fairfax, VA: American Industrial Hygiene Association, 2002:31.
36. Karasek R, Theorell T. *Healthy Work: Stress, Productivity, and the Reconstruction of Working Life.* New York: Basic Books; 1990.
37. Siegrist J. Adverse health effects of high-effort/low-reward conditions. *J Occup Health Psychol.* 1996;1(1):27-41. doi:10.1037//1076-8998.1.1.27.

38. Zoeckler J. Occupational Stress Among Home Healthcare Workers: Integrating Worker and Agency-Level Factors. *New Solut*. 2018;27(4):524-542. doi:10.1177/1048291117742678.
39. Eisenberg-Guyot J, Peckham T, Andrea SB, Oddo V, Seixas N, Hajat A. Life-course trajectories of employment quality and health in the U.S.: A multichannel sequence analysis. *Soc Sci Med*. 2020;(264):12. doi:10.1016/j.socscimed.2020.113327.
40. Peckham T, Fujishiro K, Hajat A, Flaherty BP, Seixas N. Evaluating employment quality as a determinant of health in a changing labor market. *RSF*. 2019;5(4):258-281. doi:10.7758/RSF.2019.5.4.09.
41. Vanroelen C. Employment quality: an overlooked determinant of workers' health and well-being? *Ann Work Expo Heal*. 2019;(63):619–23. doi:10.1093/annweh/wxz049.
42. Van Aerden K, Puig-Barrachina V, Bosmans K, Vanroelen C. How does employment quality relate to health and job satisfaction in Europe? A typological approach. *Soc Sci Med*. 2016;(158): 132–140. doi: /10.1016/j. socscimed.2016.04.017.
43. Juli`a M, Vanroelen C, Bosmans K, Van Aerden K, Benach J. Precarious employment and quality of employment in relation to health and well-being in Europe. *Int J Health Serv*. 2017;(47)389–409. doi: /10.1177/ 0020731417707491.
44. Rosette AS, Akinola M, Ma A. Subtle discrimination in the workplace. In: Collela AJ, King EB, eds. *The Oxford Handbook of Workplace Discrimination*. New York, NY: Oxford University Press; 2018.
45. Hudson DL, Puterman E, Bibbins-Domingo K, Matthews KA, Adler NE. Race, life course socioeconomic position, racial discrimination, depressive symptoms and self-rated health. *Soc Sci Med*. 2013; 97:7–14. doi:10.1016/j.socscimed.2013.07.031.
46. Lewchuk W, Clarke M, de Wolff A. Working without commitments: Precarious employment and health. *Work Employ Soc*. 2008;22(3):387–406.
47. Doussard M. *Degraded Work: The Struggle at the Bottom of the Market.* Minneapolis: University of Minnesota Press; 2013.
48. Landsbergis PA, Grzywacz JG, LaMontagne AD. Work organization, job insecurity, and occupational health disparities. *Am J Ind Med*. 2014;57(5):495-515. doi:10.1002/ajim.22126.
49. Kreshpaj B, Orellana C, Burström B, Davis L, Hemmingsson T, Johansson G, et al. What is precarious employment? A systematic review of definitions and operationalizations from quantitative and qualitative studies. *Scand J Work Environ Health.* 2020;46(3):235-247. doi:10.5271/sjweh.3875.
50. Siegmann KA, Schiphorst F. Understanding the globalizing precariat: from informal sector to precarious work. *Prog Dev Stud*. 2016;16(2):1–13.
51. Bodin T, Caglayan C, Garde AH, Gnesi M, Jonsson J, Kiran S, et al. Precarious employment in occupational health—an OMEGA-NET working group position paper. *Scand J Work Environ Health.* 2019;46(3):1–9.
52. Katz LF, Krueger AB. The rise and nature of alternative work arrangements in the United States, 1995–2015. *ILR Rev*. 2019;72(2):382-416.
53. Benach J, Vives A, Amable M, Vanroelen C, Tarafa G, Muntaner C. Precarious employment: understanding an emerging social determinant of health. *Annu Rev Public Health*. 2014;35:229–253.
54. O'Connor A, Peckham T, Seixas N. Considering Work Arrangement as an "Exposure" in Occupational Health Research and Practice. *Front Public Health*. 2020;8:363. doi:10.3389/fpubh.2020.00363.
55. Quinlan M. The Effects of Non-Standard Forms of Employment on Worker Health and Safety. In: *Conditions of Work and Employment Series. Report No. 67*. Geneva International Labour Organization. 2015.
56. Al-Tarawneh IS, Wurzelbacher SJ, Bertke SJ. Comparative analyses of workers' compensation claims of injury among temporary and permanent employed workers in Ohio. *Am J Ind Med*. 2020;63(1):3-22. doi:10.1002/ajim.23049.
57. Grzywacz JG, Marks NF. Reconceptualizing the work-family interface: an ecological perspective on the correlates of positive and negative spillover between work and family. *J Occup Health Psychol*. 2000;5(1):111-126. doi:10.1037//1076-8998.5.1.111.

58. Demerouti E, Peeters MC, van der Heijden BI. Work-family interface from a life and career stage perspective: the role of demands and resources. *Int J Psychol*. 2012;47(4):241-258. doi:10.1080/00207594.2012.699055.
59. Frone MR, Russell M, Barnes GM. Work-family conflict, gender, and health-related outcomes: a study of employed parents in two community samples. *J Occup Health Psychol*. 1996;1(1):57-69. doi:10.1037//1076-8998.1.1.57.

Exposure to Hazardous Materials

Chemicals

1. Administrative Council on Toxics Use Reduction. Toxic use Reduction in Massachusetts, 2008. https://www.turi.org/content/download/6382/96279/file/Governor/'s%20Report%20Final%20Low%20Res.pdf. Updated 2021. Accessed March 1, 2021.
2. Massey RI, Tenney H, Harriman E. Higher hazard substances under The Massachusetts Toxics Use Reduction Act: lessons from the first four years. *New Solut*. 2011;21(3):457-476. doi:10.2190/NS.21.3.k.
3. Jacobs MM, Massey RI, Tenney H, Harriman E. Reducing the use of carcinogens: the Massachusetts experience. *Rev Environ Health*. 2014;29(4):319-340. doi:10.1515/reveh-2014-0048.
4. The Toxics Use Reduction Institute. University of Massachusetts Lowell. Categorization of the Toxics Use Reduction List of Toxic and Hazardous Substances. Methods and Policy Report No. 18. 1999. https://www.turi.org/TURI_Publications/TURI_Methods_Policy_Reports/Categorization_of_the_Toxics_Use_Reduction_List_of_Toxic_and_Hazardous_Substances._1999. Accessed May 21, 2021.
5. Department of Environmental Protection. Complete List of TURA Chemicals, May 2020. Updated may 1, 2020. https://www.mass.gov/doc/complete-list-of-tura-chemicals-may-2020. Accessed May 1, 2020.
6. Toxics Use Reduction Institute. University of Massachusetts Lowell. Updated 2020. https://www.turi.org. Accessed May 1, 2020.
7. U.S. Census Bureau. North American Industry Classification System. Updated November 14, 2019. https://www.census.gov/eos/www/naics/concordances/concordances.html. Accessed May 1, 2020.
8. U.S. Census Bureau. North American Industry Classification System 2012 NAICS. Last revised May 13, 2021. https://www.census.gov/naics/?58967?yearbck=2012. Accessed May 13, 2021.
9. U.S. Census Bureau. Explore Census Data. https://data.census.gov/cedsci/. Accessed May 13, 2021.
10. Centers for Disease Control and Prevention. The National Institute for Occupational Safety and Health. Chemicals: Managing Chemical Safety in the Workplace. Updated February 6, 2017. https://www.cdc.gov/niosh/chemicals/. Accessed May 13, 2021.
11. Centers for Disease Control and Prevention. Agency for Toxic Substances and Disease Registry. Toxic Substances Portal: Toxicological Profiles. Updated February 10, 2021. https://wwwn.cdc.gov/TSP/index.aspx. Accessed May 13, 2021.
12. Centers for Disease Control and Prevention. Agency for Toxic Substances and Disease Registry. Toxic Substances Portal. Updated July 25, 2019. https://www.atsdr.cdc.gov/toxicsubstances.html. Accessed May 13, 2021.
13. Plog BA, Quinlan PJ, Eds. *Fundamentals of Industrial Hygiene*, 6th Ed. Itsaca, IL:National Safety Council; 2012.
14. Centers for Disease Control and Prevention. National Report on Human Exposures to Environmental Chemicals. Updated April 20, 2021. https://www.cdc.gov/exposurereport/. Accessed May 13, 2021.

Lead

1. Hernberg S. Lead poisoning in a historical perspective. *Am J Ind Med*. 2000;38(3):244-254. doi:10.1002/1097-0274(200009)38:3<244::aid-ajim3>3.0.co;2-f.

2. Riva MA, Lafranconi A, D'Orso MI, Cesana G. Lead poisoning: historical aspects of a paradigmatic "occupational and environmental disease." *Saf Health Work*. 2012;3(1):11-16. doi:10.5491/SHAW.2012.3.1.11.
3. Centers for Disease Control and Prevention, National Institute of Occupational Safety and Health, Adult Blood Lead Epidemiology and Surveillance. Elevated blood lead level case definition in perspective. Slide updated 2/08/2012. https://www.cdc.gov/niosh/topics/ABLES/pdfs/ABLES_EBLL_050112.pdf. Accessed March 1, 2021.
4. U.S. Department of Health and Human Services, National Toxicology Program. Health Effects of Low-Level Lead. 2012. https://ntp.niehs.nih.gov/whatwestudy/assessments/noncancer/completed/lead/index.html?utm_source=direct&utm_medium=prod&utm_campaign=ntpgolinks&utm_term=36443. Accessed May 21, 2021.
5. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Toxicological Profile for Lead. 2020:10-276. http://www.atsdr.cdc.gov/toxprofiles/tp13.pdfpdf icon. Accessed May 21, 2021.
6. Nakhaee S, Amirabadizadeh A, Brent J, Mehrpour O. Impact of chronic lead exposure on liver and kidney function and haematologic parameters. *Basic Clin Pharmacol Toxicol*. 2019;124(5):621-628. doi:10.1111/bcpt.13179.
7. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Toxicological Profile for Lead. 2020:355-428. http://www.atsdr.cdc.gov/toxprofiles/tp13.pdfpdf icon. Accessed May 21, 2021.
8. Sipahi H, Girgin G, Palabiyik SS, Tutkun E, Yilmaz OH, Baydar T. Possible changes of New-Generation inflammation markers with occupational lead exposure. *J Occup Health*. 2017;59(4):345-351. doi:10.1539/joh.16-0273-OA.
9. Cooper WC. Deaths from chronic renal disease in U.S. battery and lead production workers. *Environ Health Perspect*. 1988;78:61-63. doi:10.1289/ehp.887861.
10. Gerhardsson L, Chettle DR, Englyst V, Nordberg GF, Nyhlin H, Scott MC, et al. Kidney effects in long term exposed lead smelter workers. *Br J Ind Med*. 1992;49(3):186-192. doi:10.1136/oem.49.3.186.
11. Oktem F, Arslan MK, Dündar B, Delibas N, Gültepe M, Ergürhan, et al. Renal effects and erythrocyte oxidative stress in long-term low-level lead-exposed adolescent workers in auto repair workshops. *Arch Toxicol*. 2004;78(12):681-687. doi:10.1007/s00204-004-0597-5.
12. Rodrigues EG, Virji MA, McClean MD, Weinberg J, Woskie S, Pepper LD. Personal exposure, behavior, and work site conditions as determinants of blood lead among bridge painters. *J Occup Environ Hyg*. 2010;7(2):80-87. doi:10.1080/15459620903418316.
13. Reilly R, Spalding S, Walsh B, Wainer J, Pickens S, Royster, M, et al. Chronic environmental and occupational lead exposure and kidney function among African Americans: Dallas Lead Project II. *Int J Environ Res Public Health*. 2018;15(12):2875. doi:10.3390/ijerph15122875.
14. Gelberg KH, Fletcher A. Adult blood lead reporting in New York State, 1994-2006. *Public Health Rep*. 2010;125(1):103-110. doi:10.1177/003335491012500114.
15. Nwudu V, Fletcher AM, Bauer M. Patterns and predictors of personal protection compliance and workplace hygiene behaviors among workers with elevated blood lead levels in New York State. *J Occup Environ Hyg.* 2018;15(9):654-663. doi:10.1080/15459624.2018.1487066.
16. Levin R. The attributable annual health costs of US occupational lead poisoning. *Int J Occup Environ Health*. 2016;22:107–120.
17. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Adult Blood Lead Epidemiology and Surveillance. ABLES Data Summaries. https://www.cdc.gov/niosh/topics/ables/data.html. Accessed May 21, 2021.
18. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Adult Blood Lead Epidemiology and Surveillance. Understanding Blood Lead Levels and BLL Reference Guide. https://www.cdc.gov/niosh/topics/ables/ReferenceBloodLevelsforAdults.html. Accessed May 21, 2021.

19. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, National Occupational Research Agenda. Sectors: What are the Sectors? https://www.cdc.gov/nora/sectorapproach.html. Accessed May 21, 2021.
20. U.S. Census Bureau, County Business Patterns Tables. https://www.census.gov/programs-surveys/cbp/data/tables.2014.html. Accessed May 21, 2021.

Silica

1. Sauvé JF. Historical and emerging workplaces affected by silica exposure since the 1930 Johannesburg conference on silicosis, with special reference to construction. *Am J Ind Med*. 2015;58 Suppl 1:S67-S71. doi:10.1002/ajim.22507.
2. Rosner D, Markowitz G. Deadly Dust: Silicosis and the On-Going Struggle to Protect Workers' Health. Ann Arbor, MI: The University of Michigan Press. 2006.
3. Dahmann D, Taeger D, Kappler M, Büchte S, Morfeld P, Brünin T, et al. Assessment of exposure in epidemiological studies: the example of silica dust. *J Expo Sci Environ Epidemiol*. 2008;18(5):452-461. doi:10.1038/sj.jes.7500636.
4. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. NIOSH Hazard Review: Health Effects of Occupational Exposure to Respirable Crystalline Silica. 2002. DHHS (NIOSH) publication no. 2002- 129. https://www.cdc.gov/niosh/docs/2002-129/pdfs/2002129.pdf?id=10.26616/NIOSHPUB2002129. Accessed May 21, 2021.
5. Bang KM, Attfield MD, Wood JM, Syamlal G. National trends in silicosis mortality in the United States, 1981–2004. *Am J Ind Med*. 2008;51:633–9.
6. Bang KM, Mazurek JM, Wood JM, White GE, Hendricks SA, Weston A, et al. Silicosis mortality trends and new exposures to respirable crystalline silica - United States, 2001-2010. *MMWR Morb Mortal Wkly Rep*. 2015;64(5):117-120.
7. Mazurek JM, Schleiff PL, Wood JM, Hendricks SA, Weston A; Centers for Disease Control and Prevention (CDC). Notes from the Field: Update: Silicosis Mortality - United States, 1999-2013. *MMWR Morb Mortal Wkly Rep*. 2015;64(23):653-654.
8. Steenland K, Ward E. Silica: a lung carcinogen. *CA Cancer J Clin*. 2014;64(1):63-69. doi:10.3322/caac.21214.
9. Steenland K, Mannetje A, Boffetta P, Stayner L, Attfield M, Chen J, et al. Pooled exposure-response analyses and risk assessment for lung cancer in 10 cohorts of silica-exposed workers: an IARC multicentre study [published correction appears in Cancer Causes Control 2002 Oct;13(8):777]. *Cancer Causes Control*. 2001;12(9):773-784. doi:10.1023/a:1012214102061.
10. Hoy RF, Chambers DC. Silica-related diseases in the modern world. *Allergy*. 2020;75(11):2805-2817. doi:10.1111/all.14202.
11. Leung CC, Yu IT, Chen W. Silicosis. *Lancet.* 2012;379(9830):2008-2018. doi:10.1016/S0140-6736(12)60235-9.
12. Krefft S, Wolff J, Rose C. Silicosis: An Update and Guide for Clinicians. *Clin Chest Med*. 2020;41(4):709-722. doi:10.1016/j.ccm.2020.08.012.
13. Mazurek JM, Attfield MD. Silicosis mortality among young adults in the United States, 1968–2004. *Am J Ind Med*. 2008;51:568–78.
14. Yassin A, Yebesi F, Tingle R. Occupational exposure to crystalline silica dust in the United States, 1988-2003. *Environ Health Perspect*. 2005;113(3):255-260.
15. Hall NB, Blackley DJ, Halldin CN, Laney AS. Current Review of Pneumoconiosis Among US Coal Miners [published online ahead of print, 2019 Sep 6]. Curr Environ Health Rep. 2019;10.1007/s40572-019-00246-4. doi:10.1007/s40572-019-00246-4.
16. Akbar-Khanzadeh F, Brillhart RL. Respirable crystalline silica dust exposure during concrete finishing (grinding) using hand-held grinders in the construction industry. *Annal Occup Hyg*. 2002;46(3):341-346.

17. Bello A, Mugford C, Murray A, Shepherd S, Woskie SR. Characterization of Occupational Exposures to Respirable Silica and Dust in Demolition, Crushing, and Chipping Activities. *Ann Work Expo Health.* 2019;63(1):34-44. doi:10.1093/annweh/wxy089.
18. Hammond DR, Shulman SA, Echt AS. Respirable crystalline silica exposures during asphalt pavement milling at eleven highway construction sites. *J Occup Environ Hyg*. 2016;13(7):538-548. doi:10.1080/15459624.2016.1153803.
19. Barnes H, Goh NSL, Leong TL, Hoy R. Silica-associated lung disease: An old-world exposure in modern industries. *Respirology*. 2019;24(12):1165-1175. doi:10.1111/resp.13695.
20. Koksal N, Kahraman H. Acute silicosis in teflon-coated pan manufacturing due to metal sandblasting. Int J Occup Environ Health. 2011;17(3):210-213.
21. Akgun M, Araz O, Ucar EY, et al. Silicosis appears inevitable among former denim sandblasters: a 4-year follow-up study. Chest 2015;148:647–54.
22. Akgun M, Gorguner M, Meral M, et al. Silicosis caused by sandblasting of jeans in Turkey: a report of two concomitant cases. J Occup Health. 2005;47:346–9.
23. Suratt PM, Winn WC Jr, Brody AR, Bolton WK, Giles RD. Acute silicosis in tombstone sandblasters. Am Rev Respir Dis. 1977;115(3):521-529.
24. Barnes H, Goh NSL, Leong, TL, Hoy, R. Silica-associated lung disease: An old-world exposure in modern industries. Respirology (Carlton, Vic.), 2019;24(12):1165-1175.
25. Centers for Disease Control and Prevention (CDC). Silicosis in dental laboratory technicians--five states, 1994-2000. MMWR Morb Mortal Wkly Rep. 2004;53(9):195-197.
26. Esswein EJ, Breitenstein M, Snawder J, Kiefer M, Sieber WK. Occupational exposures to respirable crystalline silica during hydraulic fracturing. J Occup Environ Hyg 2013;10:347–56.
27. Witter RZ, Tenney L, Clark S, Newman LS. Occupational exposures in the oil and gas extraction industry: State of the science and research recommendations. Am J Ind Med. 2014;57(7):847-856. doi:10.1002/ajim.22316.
28. Hoy RF, Baird T, Hammerschlag G, et al. Artificial stone-associated silicosis: a rapidly emerging occupational lung disease. Occup Environ Med. 2018;75(1):3-5. doi:10.1136/oemed-2017-104428.
29. Rose C, Heinzerling A, Patel K, et al. Severe Silicosis in Engineered Stone Fabrication Workers - California, Colorado, Texas, and Washington, 2017-2019. MMWR Morb Mortal Wkly Rep. 2019;68(38):813-818.
30. Leso V, Fontana L, Romano R, Gervetti P, Iavicoli I. Artificial Stone Associated Silicosis: A Systematic Review. Int J Environ Res Public Health. 2019;16(4):568. doi:10.3390/ijerph16040568.
31. U.S. Department of Labor, Occupational Safety and Health Administration. Occupational Exposure to Respirable Crystalline Silica; Final Rule. Fed Regist 2016;81:16285–890.
32. U.S. Department of Labor, Occupational Safety and Health Administration. Preliminary Economic Analysis and Initial Regulatory Flexibility Analysis Supporting document for the Notice of Proposed Rulemaking for Occupational Exposure to Crystalline Silica. 2013.
33. U.S. Department of Labor, Occupational Safety and Health Administration. Eastern Research Group. Rulemaking Support for Supplemental Economic Feasibility Data for a Preliminary Economic Impact Analysis of a Proposed Crystalline Silica Standard; Updated Cost and Impact Analysis of the Draft Crystalline Silica Standard for Construction. Task Report. Submitted to Directorate of Evaluation and Analysis, Office of Regulatory Analysis under Task Order 11, Contract No. DOLJ049F10022. April 20, 2007.
34. U.S. Department of Labor, Occupational Safety and Health Administration. Eastern Research Group. Technological Feasibility Study of Regulatory Alternatives for a Proposed Crystalline Silica Standard for General Industry, Volumes 1 and 2. 2008.

35. U.S. Department of Labor, Occupational Safety and Health Administration. Eastern Research Group. Technological feasibility study of regulatory alternatives for a proposed crystalline silica standard for construction. Revised Excel Spreadsheet Support for OSHA's Preliminary Economic Analysis for Proposed Respirable Crystalline Silica Standard: Excel Spreadsheets of Economic Costs and Impacts. Submitted to Directorate of Standards and Guidance, Office of Regulatory Analysis under Task Order 34, Contract No. Contract No. GS–10F–0125P. 2013.

Asbestos

1. Henderson DW, Leigh J. The history of asbestos utilization and recognition of asbestos-induced disease. In: Dodson RF, Hammar S, eds. Asbestos: risk assessment, epidemiology and health effects. Boca Raton: CRC Press; 2017:1–27.
2. Castleman BI. Asbestos: Medical and Legal Aspects, 2nd ed. Clifton, NJ:Law & Business, Inc. 1986.
3. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Toxicological Profile for Asbestos. 2001. https://www.atsdr.cdc.gov/toxprofiles/tp61.pdf. Accessed May 21, 2021.
4. Stayner L, Welch LS, Lemen R. The worldwide pandemic of asbestos-related diseases. Annu Rev Public Health. 2013;34:205-216. doi:10.1146/annurev-publhealth-031811-124704.
5. Henderson DW, Rödelsperger K, Woitowitz HJ, Leigh J. After Helsinki: a multidisciplinary review of the relationship between asbestos exposure and lung cancer, with emphasis on studies published during 1997-2004. Pathology. 2004;36(6):517-550. doi:10.1080/00313020400010955
6. Odgerel CO, Takahashi K, Sorahan T, Driscoll T, Fitzmaurice C, Yoko-O M, et al. Estimation of the global burden of mesothelioma deaths from incomplete national mortality data. Occup Environ Med. 2017;74(12):851-858. doi:10.1136/oemed-2017-104298.
7. International Agency for Research on Cancer. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 100C. 2012. http://monographs.iarc.fr/ENG/Monographs/vol100C/. Accessed May 22, 2021
8. Straif K, Benbrahim-Tallaa L, Baan R, Grosse Y, Secretan B, El Ghissassi F, et al. A review of human carcinogens--Part C: metals, arsenic, dusts, and fibres. Lancet Oncol. 2009;10(5):453-454. doi:10.1016/s1470-2045(09)70134-2.
9. National Institute of Health, National Institute for Environmental Health Science, National Toxicology Program. 14th Report on Carcinogens. 2016. https://ntp.niehs.nih.gov/whatwestudy/assessments/cancer/roc/index.html. Accessed May 22, 2021.
10. Selikoff IJ, Churg J, Hammond EC. Asbestos exposure and neoplasia. JAMA. 1964;188:22-26. doi:10.1001/jama.1964.03060270028006.
11. Selikoff IJ, Churg J, Hammond EC. Relation between exposure to asbestos and mesothelioma. N Engl J Med. 1965;272:560-565. doi:10.1056/NEJM196503182721104.
12. Hammond EC, Selikoff IJ, Churg J. Neoplasia among insulation workers in the United States with special reference to intra-abdominal neoplasia. Ann NY Acad Sci. 1965;132(1):519-525. doi:10.1111/j.1749-6632.1965.tb41132.x.
13. Selikoff IJ, Churg J, Hammond EC. The occurrence of asbestosis among insulation workers in the United States. Ann NY Acad Sci. 1965;132(1):139-155. doi:10.1111/j.1749-6632.1965.tb41097.x.
14. Price B, Ware A. Time trend of mesothelioma incidence in the United States and projection of future cases: an update based on SEER data for 1973 through 2005. Crit Rev Toxicol 2009;39:576–88.
15. Bang KM, Mazurek JM, Wood JM, Hendricks SA. Diseases attributable to asbestos exposure: years of potential life lost, United States, 1999-2010. Am J Ind Med. 2014;57(1):38-48. doi:10.1002/ajim.22261.
16. Environmental Working Group. Sonya Lunder. New Estimate Finds Asbestos Kills 12,000–15,000 Americans a Year. http://www.asbestosnation.org/new-estimate-finds-asbestos-kills-12000-15. Accessed May 22, 2021.
17. Environmental Working Group. Asbestos-Related Deaths in New York. 2017. http://www.asbestosnation.org/facts/asbestos-deaths/ny/. Accessed May 22, 2021.

18. McCormack V, Peto J, Byrnes G, Straif K, Boffetta P. Estimating the asbestos-related lung cancer burden from mesothelioma mortality. Brit J Cancer. 2012;106:575-584.
19. Lemen RA. Mesothelioma from asbestos exposures: Epidemiologic patterns and impact in the United States. J Toxicol Environ Health. 2016;19:250–265. doi:10.1080/10937404.2016.1195323.
20. Lilienfeld DE, Mandel JS, Coin P, Schuman LM. Projection of asbestos related diseases in the United States, 1985-2009. I. Cancer. Br J Ind Med. 1988;45(5):283-291. doi:10.1136/oem.45.5.283.
21. Mazurek JM, Syamlal G, Wood JM, Hendricks SA, Weston A. Malignant Mesothelioma Mortality - United States, 1999-2015. MMWR Morb Mortal Wkly Rep. 2017;66(8):214-218. doi:10.15585/mmwr.mm6608a3.
22. Landrigan PJ, Kazemi H, eds. The Third Wave of Asbestos Disease: Exposure to Asbestos in Place, Public Health Control. Annals of the New York Academy of Sciences. New York, NY: New York Academy of Sciences;643.1991.
23. Lemen RA. Asbestos in brakes: exposure and risk of disease. Am J Ind Med. 2004;45(3):229–37.
24. Madl AK, Scott LL, Murbach DM, Fehling KA, Finley BL, Paustenbach DJ. Exposure to chrysotile asbestos associated with unpacking and repacking boxes of automobile brake pads and shoes. Ann Occup Hyg. 2008;52(6):463-479. doi:10.1093/annhyg/men028.
25. Neitzel RL, Sayler SK, Demond AH, d'Arcy H, Garabrant DH, Franzblau A. Measurement of asbestos emissions associated with demolition of abandoned residential dwellings. Sci Total Environ. 2020;722:137891. doi:10.1016/j.scitotenv.2020.137891.
26. Franzblau A, Demond AH, Sayler SK, D'Arcy H, Neitzel RL. Asbestos-containing materials in abandoned residential dwellings in Detroit. Sci Total Environ. 2020;714:136580. doi:10.1016/j.scitotenv.2020.136580.
27. Zichella L, Baudana F, Zanetti G, Marini P. Vinyl-Asbestos Floor Risk Exposure in Three Different Simulations. Int J Environ Res Public Health. 2021;18(4):2073. doi:10.3390/ijerph18042073…
28. Garabrant DH, Alexander DD, Miller PE, Fryzek JP, Boffetta P, Teta MJ, et al. Mesothelioma among motor vehicle mechanics: An updated review and meta-analysis. Ann Occup Hyg. 2016;60(1):8-26. doi:10.1093/annhyg/mev060.
29. Daniels RD, Kubale TL, Yiin JH, Dahm MM, Hales TR, Baris D, et al. Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950-2009). Occup Environ Med. 2014;71(6):388-397. doi:10.1136/oemed-2013-101662.
30. Markowitz SB, Moline JM. Malignant mesothelioma due to asbestos exposure in dental tape. Am J Ind Med. 2017;60(5):437-442. doi:10.1002/ajim.22696.
31. Emmett EA. Asbestos in High-Risk Communities: Public Health Implications. Int J Environ Res Public Health. 2021;18(4):1579. doi:10.3390/ijerph18041579.
32. Landrigan, Lioy PJ, Thurston G, Berkowitz G, Chen LC, Chillrud SN, et al. Health and environmental consequences of the world trade center disaster. Environ Health Perspect 2004; 112(6):731-9. doi: 10.1289/ehp.6702.
33. Environmental Protection Agency. Asbestos. www.epa.gov/asbestos. Accessed May 22, 2021.
34. Lemen RA, Landrigan PJ. Toward an Asbestos Ban in the United States. Int J Environ Res Public Health. 2017;14(11):1302. doi:10.3390/ijerph14111302.
35. Rosner D. Deregulating safety: The case of the effort to ban asbestos. Milbank Q. 2017;95:257–260. doi:10.1111/1468-0009.12260. - DOI - PMC – PubMed.
36. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Current Intelligence Bulletin 62: Asbestos Fibers and Other Elongate Mineral Particles: State of the Science and Roadmap for Research, Revised Edition. 2011:9-10. https://www.cdc.gov/niosh/docs/2011-159/pdfs/2011-159.pdf. Accessed May 22, 2021.
37. Virta RL. U.S. Department of the Interior, U.S. Geological Survey. Worldwide Asbestos Supply and Consumption Trends from 1900 through 2003, Circular 1928. 2006. https://pubs.usgs.gov/circ/2006/1298/c1298.pdf. Accessed May 22, 2021.

38. Centers for Disease Control and Prevention, National Institute for Occupational Health. NIOSH Revised Recommended Asbestos Standard. 1976. https://www.cdc.gov/niosh/docs/77-169/. Accessed May 22, 2021.
39. U.S. Environmental Protection Agency. Restrictions on discontinued uses of asbestos: significant new use rule. Fed Regist. 2019; 84:17345-60.
40. Nicholson WJ, Perkel G, Selikoff IJ. Occupational exposure to asbestos: population at risk and projected mortality--1980-2030. Am J Ind Med. 1982;3(3):259-311. doi:10.1002/ajim.4700030305.
41. Centers for Disease Control, National Institute of Occupational Safety and Health. Work-Related Lung Disease Surveillance Report. 2003. https://www.cdc.gov/niosh/docs/2003-111/pdfs/2003-111.pdf?id=10.26616/NIOSHPUB200311. Accessed May 24, 2021.
42. Centers for Disease Control, National Institute of Occupational Safety and Health. Work-Related Lung Disease Surveillance Report. 2008. https://www.cdc.gov/niosh/docs/2008-143/pdfs/2008-143.pdf?id=10.26616/NIOSHPUB2008143a. Accessed May 24, 2021.

Ergonomic Exposure

43. Hulshof CTJ, Pega F, Neupane S, van der Molen HF, Colosio C, Daams JG, et al. The prevalence of occupational exposure to ergonomic risk factors: a systematic review and meta-analysis from the WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury. Environ Int 2021;146:106157.
44. Buckle P. Ergonomics and musculoskeletal disorders: overview. Occup Med (Lond). 2005;55(3):164-167. doi:10.1093/occmed/kqi081.
45. da Costa JT, Baptista JS, Vaz M. Incidence and prevalence of upper-limb work related musculoskeletal disorders: A systematic review. Work. 2015;51(4):635-644. doi:10.3233/WOR-152032.
46. Umer W, Antwi-Afari MF, Li H, Szeto GPY, Wong AYL. The prevalence of musculoskeletal symptoms in the construction industry: a systematic review and meta-analysis. Int Arch Occup Environ Health. 2018;91(2):125-144. doi:10.1007/s00420-017-1273-4.
47. Algarni FS, Alkhaldi HA, Zafar H, Kachanathu SJ, Al-Shenqiti AM, Altowaijri AM. Self-Reported Musculoskeletal Disorders and Quality of Life in Supermarket Cashiers. Int J Environ Res Public Health. 2020;17(24):9256. doi:10.3390/ijerph17249256.
48. Davis KG, Kotowski SE. Prevalence of musculoskeletal disorders for nurses in hospitals, long-term care facilities, and home health care: A comprehensive review. Hum Factors. 2015;57(5):754-792. doi:10.1177/0018720815581933.
49. Dick RB, Lowe BD, Lu ML, Krieg, EF. Trends in work-related musculoskeletal disorders from the 2002 to 2014, General Social Survey, Quality of Work Life Supplement, J Occ Environ Med. 2020;62(8):595-610. doi: 10.1097/JOM.0000000000001895.
50. Yang H, Hitchcock E, Haldeman S, Swanson N, Lu ML, Choi BK, et al. Workplace psychosocial and organizational factors for neck pain in workers in the United States. Am J Ind Med. 2016; 59:549–560.
51. Yang H, Haldeman S, Lu ML, Baker D. Low back pain prevalence and related workplace psychosocial risk factors: a study using data from the 2010 National Health Interview Survey. J Manip Physiol Ther 2016; 39:459–472.
52. Wang X, Dong XS, Choi SD, Dement J. Work-related musculoskeletal disorders among construction workers in the United States. Occup Environ Med 2017; 74:374–380.
53. Vroman T, Whitaker C, Schoonover T. Industrial Hygiene Exposure Assessment Measurements in Washington State: Summary Results from the Division of Occupational Safety and Health (DOSH) Compliance Inspections, 2008–2016. 2018. https://www.lni.wa.gov/Safety/Research/FACE/Files/WorkerExposureAssessmentInWashingtonState.pdf. Accessed August 21, 2018.
54. Council of State and Territorial Epidemiologists. Occupational Health: Indicators. https://www.cste.org/group/OHIndicators. Accessed September 3, 2018.
55. Delp L, Mojtahedi Z, Sheikh H, Lemus J. A legacy of struggle: the OSHA ergonomics standard and beyond, Part I. New Solut. 2014;24(3):365-389. doi:10.2190/NS.24.3.i.

56. Delp L, Mojtahedi Z, Sheikh H, Lemus J. A legacy of struggle: the OSHA ergonomics standard and beyond, Part II. New Solut. 2014;24(3):391-408. doi:10.2190/NS.24.3.j.
57. Marcum J, Adams D. Work-related musculoskeletal disorder surveillance using the Washington state workers' compensation system: Recent declines and patterns by industry, 1999-2013. Am J Ind Med. 2017 May;60(5):457-471. doi: 10.1002/ajim.22708. Epub 2017 Mar 15. PMID: 28295479.
58. Doubleday A, Baker MG, Lavoué J, Siemiatycki J, Seixas NS. Estimating the population prevalence of traditional and novel occupational exposures in Federal Region X. Am J Ind Med. 2019;62(2):111-122. doi:10.1002/ajim.22931.
59. O*NET Resource Center. O*NET Data Collection Overview. https://www.onetcenter.org/database.html#overview. Accessed May 24, 2021.
60. O*NET Resource Center. The O*NET® Content Model. https://www.onetcenter.org/content.html. Accessed May 24, 2021.
61. United States Department of Labor. Integrated Management Information System (IMIS): Establishment Search. 2018. https://www.osha.gov/pls/imis/establishment.html. Accessed May 24, 2021.
62. E-mail correspondence Jack Kevin, Deputy Director, Division of Research & Statistics New York Data Center, NYS DOL, 7/19/2019 12:59:36 PM.

Psychosocial Exposure

63. Karasek R, Theorell T. Healthy Work: Stress, Productivity, and the Reconstruction of Working Life. New York, NY: Basic Books. 1990.
64. Bakker AB, Demerouti E. The job demands-resources model: state of the art. J Manag Psych. 2007;22: 309–28.
65. Siegrist J. Effort-reward imbalance at work. In: Perrowe PL, Ganster DC, eds. Historical and Current Perspectives on Stress and Health. New York, NY: Elsevier. 2002.
66. Sterud T, Hanvold TN. Effects of adverse social behaviour at the workplace on subsequent mental distress: a 3-year prospective study of the general working population in Norway. Int Arch Occup Environ Health. 2021;94(2):325-334. doi:10.1007/s00420-020-01581-y.
67. Leigh JP, De Vogli R. Low wages as occupational health hazards. J Occup Environ Med. 2016;58(5):444-7. doi: 10.1097/JOM.0000000000000717.
68. Hudson DL, Puterman E, Bibbins-Domingo K, Matthews KA, Adler NE. Race, life course socioeconomic position, racial discrimination, depressive symptoms and self-rated health. Soc Sci Med. 2013; 97:7–14. doi:10.1016/j.socscimed.2013.07.031.
69. Väänänen A, Anttila E, Turtiainen J, Varje P. Formulation of work stress in 1960–2000: Analysis of scientific works from the perspective of historical sociology. Soc Sci Med. 2012;75(5),784-794. doi:10.1016/j.socscimed.2012.04.014.
70. Tausig M, Fenwick R. Work and Mental Health in Social Context. New York, NY:Springer. 2011.
71. Shahidi FV, Gignac MAM, Oudyk J, Smith PM. Assessing the Psychosocial Work Environment in Relation to Mental Health: A Comprehensive Approach. Ann Work Expo Health. 2021;65(4):418-431. doi:10.1093/annweh/wxaa130.
72. O*NET Resource Center. O*NET Data Collection Overview. https://www.onetcenter.org/database.html#overview. Accessed May 24, 2021.
73. O*NET Resource Center. The O*NET® Content Model. https://www.onetcenter.org/content.html. Accessed May 24, 2021.
74. United States Department of Labor. Integrated Management Information System (IMIS): Establishment Search. 2018. https://www.osha.gov/pls/imis/establishment.html. Accessed May 24, 2021.

COVID-19 and Infectious Disease in the Workplace

1. COVID-19 Dashboard. Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. https://coronavirus.jhu.edu/map.html. Accessed March 15, 2021.

2. Faghri PD, Dobson M, Landsbergis P, Schnall PL. COVID-19 Pandemic: What has work got to do with it? *J Occup Environ Med*. 2021;63(4):e245-e249. doi:10.1097/JOM.0000000000002154.
3. Ramazzini Bologna Italy C. 24th Collegium Ramazzini statement. Prevention of work-related infection in the COVID-19 pandemic. *Int J Occup Med Environ Health*. 2020;33(4):535-557. doi:10.13075/ijomeh.1896.01657.
4. World Health Organization. Transmission of SARS-CoV-2: implications for infection prevention precautions. https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions. Accessed May 24, 2021.
5. Baker MG, Peckham TK, Seixas NS. Estimating the burden of United States workers exposed to infection or disease: a key factor in containing risk of COVID-19 infection. *PLoS ONE.* 2020;15(4):e0232452.
6. Gamio L. The Workers Who Face the Greatest Coronavirus Risk. The New York Times. https://www.nytimes.com/interactive/2020/ 03/15/business/economy/coronavirus-worker-risk.html. Accessed August 10, 2020.
7. Danovaro-Holliday MC, LeBaron CW, Allensworth C, Raymond R, Borden TG, Murray AB, et al. A large rubella outbreak with spread from the workplace to the community. *JAMA*. 2000;284(21):2733-2739. doi:10.1001/jama.284.21.2733.
8. Wang Z, Ma W, Zheng X, Wu G, Zhang R. Household transmission of SARS-CoV-2. *J Infect*. 2020;81(1):179-182. doi:10.1016/j.jinf.2020.03.040.
9. Baker MG, McDonald A, Zhang J, Howden-Chapman P. He Kainga Oranga/Housing and Health Research Programme. Infectious Diseases Attributable to Household Crowding in New Zealand: A Systematic Review and Burden of Disease Estimate. Wellington:University of Otago. 2013.
10. Li W, Zhang B, Lu J, Liu S, Chang Z, Peng C, et al. Characteristics of household transmission of COVID-19. *Clin Infect Dis*. 2020;71(8):1943-1946. doi:10.1093/cid/ciaa450.
11. López M, Gallego C, Abós-Herrándiz R, Tobella A, Turmo AM, Monclus, A, et al. Impact of isolating COVID-19 patients in a supervised community facility on transmission reduction among household members. *J Public Health (Oxf)*. 2021;fdab002. doi:10.1093/pubmed/fdab002.
12. Lekfuangfu WN, Piyapromdee S, PorapakkarmP, Wasi N. On Covid-19: new implications of job task requirements and spouse's occupational sorting. *Social Science Research Network*. 2020;(12):87–103. doi: /10.2139/ssrn. 3583954.
13. Palomino JC, Rodriguez JG, Sebastian R. Wage inequality and poverty effects of lockdown and social distancing in Europe. *Eur Econ Rev*. 2020;129:1–25. doi: /10.2139/ssrn.3615615.
14. Gaitens J, Condon M, Fernandes E, McDiarmid M. COVID-19 and Essential Workers: A Narrative Review of Health Outcomes and Moral Injury. *Int J Environ Res Public Health.* 2021;18(4):1446. doi:10.3390/ijerph18041446.
15. The Lancet. The plight of essential workers during the COVID-19 pandemic. *Lancet.* 2020;395(10237):1587. doi: /10.1016/S0140-6736(20)31200-9.
16. Nguyen LH, Drew DA, Joshi AD, Guo CG, Ma W, Mehta RS, et al. Risk of COVID-19 among frontline healthcare workers and the general community: a prospective cohort study. Preprint. *medRxiv*. 2020;2020.04.29.20084111. Published 2020 May 25. doi:10.1101/2020.04.29.20084111.
17. Matilla-Santander N, Ahonen E, Albin M, Baron S, Bolibar M., Bosmans K, et al. COVID-19 and Precarious Employment: Consequences of the Evolving Crisis. *Int J Health Serv*. 2021;51(2):226-228. doi:10.1177/0020731420986694.
18. Kantamneni N. The impact of the COVID-19 pandemic on marginalized populations in the United States: a research agenda. *J Vocat Behav*. 2020;119:103439. doi:10.1016/j.jvb.2020.103439.
19. Kinman G, Grant C. Presenteeism during the COVID-19 pandemic: risks and solutions [published online ahead of print, 2020 Nov 18]. *Occup Med (Lond)*. 2020;kqaa193. doi:10.1093/occmed/kqaa193.

20. Altan D, Cediel A. COVID's Hidden Toll. Frontline. United States: PBS; 2020. https://www.pbs.org/wgbh/frontline/film/covids-hidden-toll/. Accessed May 24, 2021.
21. Eisenstadt M. Inside Green Empire Farm: Upstate NY's biggest coronavirus outbreak slams migrant workers. *Advance Local Media LLC, Syracuse.com.* May 8, 2020. Accessed May 24, 2021. https://www.syracuse.com/coronavirus/2020/05/inside-green-empire-farm-upstate-nys-biggest-coronavirus-outbreak-slams-migrant-workers.html.
22. Neff Roth, Amy. A Central New York Greenhouse Becomes a Hot Spot for Coronavirus. *Rochester Democrat and Chronicle.* May 6, 2020. Access May 24, 2021. https://www.democratandchronicle.com/story/news/politics/albany/2020/05/06/new-york-greenhouse-spike-in-covid-19-cases/5174328002/.
23. Fielding-Miller RK, Sundaram ME, Brouwer K. Social determinants of COVID-19 mortality at the county level. Preprint. *medRxiv*. 2020;2020.05.03.20089698. Published 2020 Jul 1. doi:10.1101/2020.05.03.20089698.
24. Bambra C, Riordan R, Ford J, Matthews F. The COVID-19 pandemic and health inequalities. *J Epidemiol Community Health*. 2020;74:964-968.
25. Singu S, Acharya A, Challagundla K, Byrareddy SN. Impact of social determinants of health on the emerging COVID-19 pandemic in the United States. *Front Public Health*. 2020;8:406. doi: /10.3389/fpubh.2020.00406.
26. Nicola M, Alsafi Z, Sohrabi C, Kerwan A, Al-Jabir A, Iosifidis C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): a review. *Int J Surg*. 2020;78:185–193. doi: /10.1016/j.ijsu.2020.04.018.
27. Hawkins D. Differential occupational risk for COVID-19 and other infection exposure according to race and ethnicity. *Am J Ind Med*. 2020;63:1–4. doi: 10.1002/ajim.23145.
28. Philbin MM, Flake M, Hatzenbuehler ML, Hirsch JS. State-level immigration and immigrant-focused policies as drivers of Latino health disparities in the United States. *Soc Sci Med*. 2018; 199:29–38.
29. Gemelas J, Davison J, Keltner C, Ing S. Inequities in Employment by Race, Ethnicity, and Sector During COVID-19 [published online ahead of print, 2021 Jan 15]. *J Racial Ethn Health Disparities*. 2021;1-6. doi:10.1007/s40615-021-00963-3.
30. Dye TD, Alcantara L, Siddiqi S, Barbosu M, Sharma S, Panko T, et al. Risk of COVID-19-related bullying, harassment and stigma among healthcare workers: an analytical cross-sectional global study. *BMJ Open*. 2020;10(12):e046620. Published 2020 Dec 30. doi:10.1136/bmjopen-2020-046620.
31. Fortuna LR, Tolou-Shams M, Robles-Ramamurthy B, Porche MV. Inequity and the disproportionate impact of COVID-19 on communities of color in the United States: The need for a trauma-informed social justice response. *Psychol Trauma*. 2020;12(5):443-445. doi:10.1037/tra0000889.
32. Devakumar D, Shannon G, Bhopal S, Abubakar I. Racism and discrimination in COVID-19 responses. *Lancet.* 2020;395(10231):1194. doi: 10.1016/s0140-6736(20)30792-3.
33. O'Connor R, Hayes J, Gault B. Institute for Women's Policy Research. Paid Sick Days Access Varies by Race/Ethnicity, Sexual Orientation, and Job Characteristics. 2014. https://iwpr.org/iwpr-general/paid-sick-days-access-varies-by-race-ethnicity-sexual-orientation-and-job-characteristics/. Accessed May 24, 2021.
34. Siqueira CE, Gaydos M, Monforton C, Slatin C, Borkowski L, Dooley P, et al. Effects of social, economic, and labor policies on occupational health disparities. *Am J Ind Med*. 2014;57(5):557-572. doi:10.1002/ajim.22186.
35. University of Massachusetts Labor Center and Center for Employment Equity. Stressed, Unsafe, and Insecure: Essential Workers Need A New, New Deal. 2020. https://www.umass.edu/employmentequity/stressed-unsafe-and-insecure-essential-workers-need-new-new-deal#:~:text=Both%20corporate%20leadership%20and%20workers,covered%20by%20that%20minimum%20wage. Accessed May 25, 2021.
36. Luckhaupt S, Burrer S, de Perio M, Sweeney MH. Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health. Science Blog: Collecting Occupation and Industry Data in Public Health Surveillance Systems for COVID-19. https://blogs.cdc.gov/niosh-science-blog/2020/06/11/covid-surveillance/. Accessed August 10, 2020.

37. Zhang M. Estimation of differential occupational risk of COVID-19 by comparing risk factors with case data by occupational group. *Am J Ind Med*. 2021;64(1):39-47. doi:10.1002/ajim.23199.
38. Hawkins D, Davis L, Kriebel D. COVID-19 deaths by occupation, Massachusetts, March 1–July 31, 2020. *Am J Ind Med*. 2021;1–7. doi: /10.1002/ajim.23227.
39. New York State. Governor Cuomo Issues Guidance on Essential Services Under the "New York State on PAUSE' Executive Order. https://www.governor.ny.gov/news/governor-cuomo-issues-guidance-essential-services-under-new-york-state-pause-executive-order . Accessed May 25, 2021.
40. New York Coronavirus Map and Case Count. The New York Times. March 25, 2021. https://www.nytimes.com/interactive/2020/us/new-york-coronavirus-cases.html. Accessed March 25, 2021.
41. Weinberger DM, Chen J, Cohen T, Crawford FW, Mostashari F, Olson D, et al. Estimation of Excess Deaths Associated With the COVID-19 Pandemic in the United States, March to May 2020. *JAMA Intern Med*. 2020;180(10):1336-1344. doi:10.1001/jamainternmed.2020.3391.
42. Pomeroy C. A Tsunami of Disability Is Coming as a Result of 'Long COVID.' *Scientific American.* July 6, 2021. Accessed September 1, 2021. https://www.scientificamerican.com/article/a-tsunami-of-disability-is-coming-as-a-result-of-lsquo-long-covid-rsquo/

Chapter 3

Work and Inequities of Health: Unequal Risk of Occupational Disease

1. Baron SL, Beard S, Davis LK, Delp L, Forst L, Kidd-Taylor A, et al. Promoting integrated approaches to reducing health inequities among low-income workers: applying a social ecological framework. Am J Ind Med. 2014;57(5):539-556. doi:10.1002/ajim.22174.
2. Clougherty JE, Souza K, Cullen MR. Work and its role in shaping the social gradient in health. Ann N Y Acad Sci. 2010;1186:102-124. doi:10.1111/j.1749-6632.2009.05338.x.
3. Lipscomb HJ, Loomis D, McDonald MA, Argue RA, Wing S. A conceptual model of work and health disparities in the United States. Int J Health Serv. 2006;36(1):25-50. doi:10.2190/BRED-NRJ7-3LV7-2QCG.
4. Quinn MM, Sembajwe G, Stoddard AM, Kriebel D, Krieger N, Sorensen G, et al. Social disparities in the burden of occupational exposures: results of a cross-sectional study. Am J Ind Med. 2007;50(12):861-875. doi:10.1002/ajim.20529.
5. Baron S, Beard S, Davis L, Delp L, Forst L, Liebman, AK, et al. The Health of the Low-income Workforce: Integrating Public Health and Occupational Health Approaches - An Issue Paper for Discussion at the Eliminating Health and Safety Disparities at Work Conference, Chicago, Illinois. 2011. http://www.aoecdata.org/conferences/healthdisparities/whitepapers/Health-of-the-Low-income-Workforce.pdf. Accessed May 25, 2021.
6. Siqueira CE, Gaydos M, Monforton C, Slatin C, Borkowski L, Dooley P, et al. Effects of social, economic, and labor policies on occupational health disparities. Am J Ind Med. 2014;57(5), 557-572. doi:10.1002/ajim.22186.
7. Peckham T, Fujishiro K, Hajat A, Flaherty BP, Seixas N. Evaluating Employment Quality as a Determinant of Health in a Changing Labor Market. RSF. 2019;5(4):258-281. doi:10.7758/RSF.2019.5.4.09.
8. Katz LF, Krueger AB. The rise and nature of alternative work arrangements in the United States, 1995–2015. ILR Rev. 2019;72(2):382-416.
9. National Academies of Sciences, Engineering, and Medicine. 2017. Communities in action: Pathways to health equity. Washington, DC: The National Academies Press. doi: 10.17226/24624.
10. Mishel L, Bivens J, Gould E, Shierholz H. The State of Working America, 12th Edition. Ithaca, NY: An Economic Policy Institute Book, Cornell University Press. 2012.

11. Elvery JA. Research Department of the Federal Reserve Bank of Cleveland. Economic Commentary 2019-09. Changes in the Occupational Structure of the United States: 1860 to 2015. https://www.clevelandfed.org/newsroom-and-events/publications/economic-commentary/2019-economic-commentaries/ec-201909-changes-in-us-occupational-structure.aspx. Accessed May 25, 2021.
12. Price RH, Burgard SA. The new employment contract and worker health in the United States. In: Schoeni RF, House JS, Kaplan GA, Pollack H, eds. Making Americans Healthier: Social and Economic Policy as Health Policy. New York, NY: Russell Sage Foundation. 2008, 201–28.
13. Lipscomb HJ, Loomis D, McDonald MA, Argue RA, Wing S, HJ L, et al. A conceptual model of work and health disparities in the United States. Int J Heal Serv. 2006; 36:25–50. doi: 10.2190/BRED-NRJ7-3LV7-2QCG.
14. Hagedorn J, Paras CA, Greenwich H, Hagopian A. The Role of Labor Unions in Creating Working Conditions That Promote Public Health. Am J Public Health. 2016;106(6):989-995. doi:10.2105/AJPH.2016.303138.
15. Malinowski B, Minkler M, Stock L. Labor unions: A public health institution. Amer J Public Health. 2015;105(2):261-271.
16. Baker R, Stock L, Velazquez V. The roles of labor unions. In: Levy BS, Wegman DH, Baron SL, Sokas RK, eds. Occupational and Environmental Health: Recognizing and Preventing Disease and Injury. 6th ed. Oxford, England: Oxford University Press; 2011:699---713.
17. Western B, Rosenfeld J. Unions, norms, and the rise in U.S. wage inequality. Am Sociol Rev. 2011;76(4): 513–537.
18. Reynolds MM, Brady D. Bringing you more than the weekend: union membership and self-rated health in the United States. Soc Forces. 2012;90(3):1023---1049.
19. Mishel L, Walters M. How Unions Help All Workers. Washington, DC: Economic Policy Institute; 2003.
20. Lax M. New York State's COSH movement: A brief history. New Solut. 2018;28(2):202-226. doi:10.1177/1048291117752462.
21. Lax M. The Occupational Health Clinical Center Network in New York State. New Solut. 1992;3(1):41-54. doi:10.2190/NS3.1.i.
22. Lax M. 25 years on: An assessment of the occupational health clinic network in New York State. 141st APHA Annual Meeting and Exposition. Boston. 2013.
23. Fine J. Worker Centers: Organizing Communities at the Edge of a Dream. Ithaca, NY: ILR Press, Cornell University Press; 2006:7–26, 224–243.
24. Monforton C, Von Bergen J. On the Job: The Untold Story of Worker Center and the New Fight for Wages, Dignity, and Health. New York, NY:The New Press. 2021.
25. O'Connor T, Flynn M, Weinstock D, Zanoni J. Occupational safety and health education and training for underserved populations. New Solut. 2014;24(1):83-106. doi:10.2190/NS.24.1.d.
26. ABO. Fundamental Principles of Occupational Health and Safety. 2nd ed. Geneva:International Labour Organization. 2008.
27. International Labour Organization. Global Commission on the Future of Work. Work for a brighter future. Health and safety policy, research on hazards & controls, funding for training, setting and enforcing standards. 2019. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_662410.pdf. Accessed May 21, 2021.
28. Braverman H. Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century. New York: Monthly Review Press; 1998, 1974.
29. Siqueira CE, Gaydos M, Monforton C, Slatin, C, Borkowski L, Dooley P, et al. Effects of social, economic, and labor policies on occupational health disparities. Am J Ind Med. 2014;57(5):557-572. doi:10.1002/ajim.22186.
30. Applebaum E, Barnes J, Behgam C, Blau M, Bruno B, Carlson P, et al. AFL-CIO Commission on the Future of Work and Unions: Report to the AFL-CIO General Board. 2019.
31. Thiess R. The Future of Work: Trends and Challenges for Low-Wage Workers. Economic Policy Institute. 2012. http://www.epi.org/files/2012/bp341-future-of-work.pdf. Accessed May 25, 2021.

32. Bernhardt A, Boushey H, Dresser L, Tilly C, eds. The Gloves-off Economy: Workplace Standards at the Bottom of America's Labor Market. Champaign, IL:Labor and Employment Relations Association. 2008.
33. Bernhardt A, Milkman R, Theodore N, Heckathorn D, Auer M, DeFilippis J, et al. Broken Laws, Unprotected Workers: Violations of employment and labor laws in America's cities. 2009. http://www.nelp.org/content/uploads/2015/03/BrokenLawsReport2009.pdf. Accessed May 25, 2021.
34. Bronfenbrenner K. No Holds Barred—The Intensification of Employer Opposition to Organizing. Washington, D.C.: Economic Policy Institute and American Rights at Work Education Fund, 2009.
35. Lafer G, Loustaunau L. Economic Policy Institute. Fear at work: An inside account of how employers threaten, intimidate, and harass workers to stop them from exercising their right to collective bargaining. https://www.epi.org/publication/fear-at-work-how-employers-scare-workers-out-of-unionizing/. Accessed May 21, 2021.
36. McAlevey JA. Collective Bargain: Unions, Organizing, and the Fight for Democracy. New York:HarperCollins. 2020.
37. Macpherson DA, Hirsch BT. Institute of Labor Economics. Five decades of union wages, nonunion wages and union wage gaps at Unionsats.com. 2021. http://ftp.iza.org/dp14398.pdf. Accessed June 1, 2021.
38. Pransky GS, Fassier JB, Besen E, Blanck P, Ekberg K, Feuerstein, et al. Sustaining Work Participation Across the Life Course. J Occup Rehabil. 2016;26(4):465-479. doi:10.1007/s10926-016-9670-1.
39. Murray LR. Sick and tired of being sick and tired: scientific evidence, methods, and research implications for racial and ethnic disparities in occupational health. Am J Public Health. 2003;93:221–6.
40. Yearby R. Racial disparities in health status and access to healthcare: the continuation of inequality in the United States due to structural racism. Am J Econ Sociol. 2018;77:1113–1152. doi: 10.1111/ajes.12230.
41. McCall L. Complex Inequality: Gender, Class, and Race in the New Economy. New York, NY: Routledge. 2001.
42. Messing K, Stellman JM. Sex, gender, and women's occupational health: The importance of considering mechanism. Environ Res. 2006; 101:146–162.
43. Milkman, Ruth. On Gender, Labor and Inequality. Chicago,IL:University of Illinois Press. 2016.
44. Orrenius PM, Zavodny M. Immigrants in risky occupations. In: International Handbook on the Economics of Migration. Cheltenham, UK: Edward Elgar Publishing; 2013:214–226.
45. Kosny A, MacEachen E, Lifshen M, Smith P, Jafri GJ, Neilson C, et al. Delicate dances: immigrant workers' experiences of injury reporting and claim filing. Ethn Health. 2012;17(3):267-290. doi:10.1080/13557858.2011.614327.
46. Moyce SC, Schenker M. Occupational Exposures and Health Outcomes Among Immigrants in the USA. Curr Environ Health Rep. 2017;4(3):349-354. doi:10.1007/s40572-017-0152-1.
47. Lax MB. Falling Short: The State's Role in Workplace Safety and Health. New Solut. 2020;30(1):27-41. doi:10.1177/1048291120903116.
48. McNicholas C, Shierholz H, von Wilpert M. Economic Policy Institute. Workers' health, safety and pay are among the casualties of Trump's war on regulations: A deregulation year in review. 2018. https://www.epi.org/publication/deregulation-year-in-review/ Accessed May 21, 2021.
49. Dworsky M, Broten N. Rand Corporation. How can workers' compensation systems promote occupational safety and health? Stakeholders views on policy and research priorities. 2018. https://www.rand.org/pubs/research_reports/RR2566.html. Accessed May 21, 2021.
50. Smith R. Immigrant workers and worker's compensation: the need for reform. Am J Ind Med. 2012;55(6):537-44.
51. Strunin L, Boden LI. The workers' compensation system: worker friend or foe? Am J Ind Med. 2004;45(4):338-345. doi:10.1002/ajim.10356.
52. Strunin L, Boden LI. (Re) Assessing the Grand Bargain: Compensation for Work Injuries in the United States, 1900–2017. Rutgers Law Rev. 2017;69:891-1014.
53. Spieler EA, Burton JF Jr. The lack of correspondence between work-related disability and receipt of workers' compensation benefits. Am J Ind Med. 2012;55(6):487-505. doi:10.1002/ajim.21034.

54. Riley K, Morier D. Report to the Commission of Health and Safety and Workers' Compensation, California Department of Industrial Relations: Patterns of Work-Related Injury and Common Injury Experiences of Workers in the Low-Wage Labor Market. Los Angeles, CA. 2015. http://www.irle.ucla.edu/publications/documents/Patterns_Work_Related_Injury.pdf. Accessed May 25, 2021.
55. Leigh JP, Marcin JP. Workers' compensation benefits and shifting costs for occupational injury and illness. J Occup Environ Med. 2012;54:445–450.
56. U.S. Department of Labor, Occupational Safety and Health Administration. Adding inequality to injury: the costs of failing to protect workers on the job. https://www.osha.gov/sites/default/files/inequality_michaels_june2015.pdf. Accessed May 25, 2021.
57. Boden, LL, Galizzi M. Economic consequences of workplace injuries and illnesses: lost earnings and benefit adequacy. Am J Ind Med. 1999;36:487–503.
58. Gray SE, Lane TJ, Sheehan L, Collie A. Association between workers' compensation claim processing times and work disability duration: Analysis of population level claims data. Health Policy. 2019;123(10):982-991. doi:10.1016/j.healthpol.2019.06.010.
59. Boden LI. Reexamining workers' compensation: a human rights perspective. Am J Ind Med. 2012;55(6):483-486. doi:10.1002/ajim.22054.
60. Kalleberg AL, Vallas SP. Probing Precarious Work: Theory, Research and Politics. In: Kalleberg AL, Vallas SP, eds. Research in the Sociology of Work Volume 31: Precarious Work. Bingley, UK:Emerald Publishing Limited. 2018:1-20.
61. Ross M, Bateman N. Metropolitan Policy Program at Brookings. Meet the Low-Wage Workforce. 2019. https://www.brookings.edu/research/meet-the-low-wage-workforce/. Accessed May 21, 2021Lewchuk WMC, Wolff A. Working Without Commitments: The Health Effects of Precarious Employment. Montreal: McGill-Queen's University Press. 2011.

Low-wage Work as High Risk for Occupational Disease

62. Doussard M. Degraded Work: The Struggle at the Bottom of the Labor Market. Minneapolis, MN:Minneapolis University of Minnesota Press. 2013.
63. Weil D. The Fissured Workplace: Why work became so bad for so many and what can be done to improve it. Cambridge, MA:Harvard University Press. 2014.
64. Hoopes S, Abrahamson A; Anglin A, Connelly C, Holdsworth M, Treglia D. United Way of New York State. Asset Limited, Income Constrained, Employed (ALICE) Study of Financial Hardship New York Report. 2020. https://www.unitedforalice.org/new-york. Accessed May 25, 2021.
65. Leigh JP, Vogli R. Are low wages an occupational health hazard? J Occup Environ Med. 2016;58(5):444–7.
66. Leigh JP. (2012). Number and costs of occupational injury and illness in low-wage occupations. Center for Poverty Research and Center for Health Care Policy and Research. University of California Davis. Davis, CA. https://www.issuelab.org/resources/14420/14420.pdf. Accessed May 25, 2021.
67. Leigh JP, De Vogli R. Low Wages as Occupational Health Hazards. J Occup Environ Med. 2016;58(5):444-447. doi:10.1097/JOM.0000000000000717.
68. Centers for Disease Control and Prevention. National Center for Health Statistics. Health, United States, 2016: With Chartbook on Long-term Trends in Health. 2017. https://www.cdc.gov/nchs/data/hus/hus16.pdf. Accessed May 25, 2021.
69. Herin F, Vézina M, Thaon I, Soulat JM, Paris C; ESTEV group. Predictive risk factors for chronic regional and multisite musculoskeletal pain: a 5-year prospective study in a working population. Pain. 2014;155(5):937-943. doi:10.1016/j.pain.2014.01.033.
70. Leigh JP, Du J. Are low wages risk factors for hypertension? Eur J Public Health. 2012;22(6):854-859. doi:10.1093/eurpub/ckr204.
71. O'Connor A, Peckham T, Seixas N. Considering Work Arrangement as an "Exposure" in Occupational Health Research and Practice. Front Public Health. 2020; 8:363. doi:10.3389/fpubh.2020.00363.

72. Quinlan M. Conditions of Work and Employment Series, Report No. 67. The Effects of Non-Standard Forms of Employment on Worker Health and Safety. Geneva. 2015. https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---travail/documents/publication/wcms_443266.pdf. Accessed May 25, 2021.
73. Wong IS, Smith PM, Mustard CA, Gignac MAM. Health and occupational outcomes among injured, nonstandard shift workers. J Occup Environ Med. 2015;57:1244–9. doi: 10.1097/JOM.0000000000000551.
74. Bodin T, Çaglayan Ç, Garde AH, Gnesi M, Jonsson J, Kiran S, et al. Precarious employment in occupational health – an OMEGA-NET working group position paper. Scand J Work Environ Health. 2019; 46:321–9. doi: 10.5271/sjweh.3860.
75. Muntaner C, Solar O, Vanroelen C, Martinez JM, Vergara M, Santana V, et al. Unemployment, informal work, precarious employment, child labor, slavery, and health inequalities: pathways and mechanisms. Int J Health Serv. 2010;40(2):281-295. doi:10.2190/HS.40.2.h.
76. Benach J, Vives A, Amable M, Vanroelen C, Tarafa G, Muntaner C. Precarious employment: understanding an emerging social determinant of health. Annu Rev Public Health. 2014;35:229-253. doi:10.1146/annurev-publhealth-032013-182500.
77. Vives A, Vanroelen C, Amable M, Ferrer M, Moncada S, Llorens C, et al. Employment precariousness in Spain: prevalence, social distribution, and population-attributable risk percent of poor mental health. Int J Health Serv. 2011;41(4):625-646. doi:10.2190/HS.41.4.b.
78. Kalleberg AL. Precarious Lives: Job Insecurity and Well-Being in Rich Democracies. Medford, MA:Polity Press. 2018.
79. Kalleberg AL. Good Jobs, Bad Jobs: The Rise of Polarized and Precarious Employment Systems in the United States, 1970s to 2000s. New York, NY:Russell Sage Foundation. 2013.
80. Kalleberg AL. 2009. Precarious work, insecure workers: employment relations in transition. Am. Socio. Rev. 74, 1–22. doi: /10.1177/ 000312240907400101.
81. Kalleberg AL. Vallas SP. 2018. Probing precarious work: theory, research, and politics. In: Kalleberg AL, Vallas SP, eds. Precarious Work: Causes, Characteristics, and Consequences, Research in the Sociology of Work, Volume 31. Bingley, UK:Emerald Publishing, 1–30.
82. Hanley C, Branch, A. A racial-gender lens on precarious employment: Skill bias and the durability of inequality. In: Kalleberg AL, Vallas SP, eds. Precarious Work: Causes, Characteristics, and Consequences, Research in the Sociology of Work, Volume 31. Bingley UK: Emerald. 2018, 183-214.
83. Mouw T. Kalleberg AL. Occupations and the structure of wage inequality in the United States, 1980s to 2000s. Amer Soc Rev. 2010;75(3):402–31. doi:10.1177/0003122410363564.
84. Vanroelen C. Employment quality: an overlooked determinant of workers' health and well-being? Ann Work Expo Heal. 2019;63:619–23. doi: 10.1093/annweh/wxz049.
85. Schwartz A, Wasser M, Gillard M, Paarlberg M. Unpredictable, Unsustainable: The Impact of Employers' Scheduling Practices in DC. DC Jobs with Justice, the DC Fiscal Policy Institute, and the Georgetown University Kalmanovitz Initiative for Labor and the Working Poor. 2015. http://www.dcjwj.org/wp-content/uploads/2015/06/DCJWJ_ Scheduling_Report_2015.pdf. Accessed May 25, 2021.
86. Watson L, Frohlich L, Johnston E. Collateral Damage: Scheduling Challenges for Workers in Low-Wage Jobs and Their Consequences. National Women's Law Center. 2014. http://www.nwlc.org/sites/default/files/pdfs/collateral_damage_s. Accessed by May 25, 2021.
87. Lewchuk W, Clarke M, De Wolff A. Precarious employment and the internal responsibility system: some Canadian experiences. In: Walters D and Nichols T, eds. Workplace Health and Safety: International Perspectives on Worker Representation. Basingstoke: Palgrave, MacMillan, 2009, 109–133.
88. Lambert SJ. Passing the Buck: Labor Flexibility Practices that Transfer Risk onto Hourly Workers. Hum Relat. 2008;61(9):1203-1227.
89. Lewchuk W. The limits of voice: are workers afraid to express their health and safety rights? Osgoode Hall Law J 2013; 50: 789–812.
90. Besen-Cassino, Y. Consuming work: Youth labor in America. Philadelphia, PA: Temple University Press. 2014.
91. Davis GF. The vanishing American corporation: Navigating the hazards of a new economy. Oakland, CA: Berrett-Koehler Publishers, Inc. 2016.

92. Julià M, Vanroelen C, Bosmans K, Van Aerden K, Benach J. Precarious employment and quality of employment in relation to health and well-being in Europe. Int J Heal Serv. 2017;47:389–409. doi: 10.1177/00207314177 07491.
93. New York State Department of Labor. Occupational Wages. https://statistics.labor.ny.gov/lswage2.asp. Accessed May 25, 2021.
94. Steven Ruggles, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas and Matthew Sobek. IPUMS USA: Version 10.0 [dataset]. Minneapolis, MN: IPUMS, 2020. https://doi.org/10.18128/D010.V10.0 https://usa.ipums.org/usa/sda/. Accessed May 25, 2021.

Women

1. International Labour Organization. Women at Work: Trends 2016. International Labour Organization: Geneva:ILO. 2016. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_457317.pdf. Accessed May 25, 2021.
2. Lyson TA. Industrial shifts, occupational recomposition, and the changing sexual division of labor in the five largest U. S. cities: 1910-1930. *Sociol Forum*. 1991;(6)1:157-177.
3. del Río C, Alonso-Villar O. The evolution of occupational segregation in the United States, 1940-2010: Gains and losses of gender-race/ethnicity groups. *Demography*. 2015;52(3):967-988. doi:10.1007/s13524-015-0390-5.
4. Eng A, 't Mannetje A, McLean D, Ellison-Loschmann L, Cheng S, Pearce N. Gender differences in occupational exposure patterns. *Occup Environ Med*. 2011;68(12):888-894. doi:10.1136/oem.2010.064097.
5. Mandel H. The role of occupational attributes in gender earnings inequality, 1970-2010. *Soc Sci Res*. 2016;55:122-138. doi:10.1016/j.ssresearch.2015.09.007.
6. Mandel H, Semyonov M. Gender pay gap and employment sector: sources of earnings disparities in the United States, 1970-2010. *Demography*. 2014;51(5):1597-1618. doi:10.1007/s13524-014-0320-y.
7. Pearlman J. Gender differences in the impact of job mobility on earnings: The role of occupational segregation. *Soc Sci Res*. 2018;74:30-44. doi:10.1016/j.ssresearch.2018.05.010.
8. Davis A. Economic Policy Institute. Women still earn less than men across the board. 2015. http://www.epi.org/publication/women-still-earn-less-than-men-across-the-board/. Accessed on November 12, 2018.
9. Hegewisch A, Ellis E. The Gender Wage Gap by Occupation 2014 and by Race and Ethnicity. Institute for Women's Policy Research. 2015. http://www.iwpr.org/publications/ pubs/the-gender-wage-gap-by-occupation-2014-and-by-race-andethnicity. Accessed on May 25, 2021.
10. Cha Y, Weeden KA. Overwork and the Slow Convergence in the Gender Gap in Wages. *Amer Sociol Rev.* 2014:79(3) 457-484. DOI: 10.1177/0003122414528936.
11. National Women's Law Center. Lifetime Wage Gap Losses for Women. https://nwlc.org/wpcontent/uploads/2017/03/Women-Lifetime-Losses-State-by-State.pdf. Accessed may 25, 2021.
12. Mandel H, Semyonov M. Gender pay gap and employment sector: sources of earnings disparities in the United States, 1970-2010. *Demography*. 2014;51(5):1597-1618. doi:10.1007/s13524-014-0320-y.
13. Blau FD, Kahn ML. The gender-wage gap: Extent, trends, and explanations. *J Econ Lit* 2017;55(3):789–865.
14. New York State Department of Labor. Closing the Gender Wage Gap in New York State: Pay, Equity and Advancement. 2018. https://dol.ny.gov/system/files/documents/2021/03/nysdol-pay-gap-study.pdf. Accessed May 25, 2021.
15. Campos-Serna J, Ronda-Pérez E, Artazcoz L, Moen BE, Benavides FG. Gender inequalities in occupational health related to the unequal distribution of working and employment conditions: a systematic review. *Int J Equity Health*. 2013;12:57. doi:10.1186/1475-9276-12-57.
16. Quinn MM, Smith PM. Gender, Work, and Health [published correction appears in *Ann Work Expo Health*. 2018 Apr 18;62(4):516]. *Ann Work Expo Health*. 2018;62(4):389-392. doi:10.1093/annweh/wxy019.

17. Messing K, Punnett L, Bond M, Alexanderson K, Pyle J, Zahm S, et al. Be the fairest of them all: challenges and recommendations for the treatment of gender in occupational health research. *Am J Ind Med*. 2003;43(6):618-629. doi:10.1002/ajim.10225.
18. Patten, E. Pew Research. Racial, gender wage gaps persist in U.S. despite some progress. 2016. https://www.pewresearch.org/fact-tank/2016/07/01/racial-gender-wage-gaps-persist-in-u-s-despite-some-progress/. Accessed May 25, 2021.
19. Padkapayeva K, Gilbert-Ouimet M, Bielecky A, Ibrahim S, Mustard C, Brisson C, et al. Gender/Sex Differences in the Relationship between Psychosocial Work Exposures and Work and Life Stress. *Ann Work Expo Health*. 2018;62(4):416-425. doi:10.1093/annweh/wxy014.
20. Macpherson RA, Lane TJ, Collie A, McLeod CB. Age, sex, and the changing disability burden of compensated work-related musculoskeletal disorders in Canada and Australia. *BMC Public Health*. 2018;18(1):758. doi:10.1186/s12889-018-5590-7.
21. Povich D, Roberts B, Mather M. Working Poor Families Project. Low-Income Working Mothers and State Policy: Investing for a Better Economic Future. 2014. http://www.workingpoorfamilies.org/wp-content/uploads/2014/02/WPFP_Low-Income-Working-Mothers-Report_021214.pdf. Accessed May 25, 2021.
22. Gjerdingen D, McGovern P, Bekker M, Lundberg U, Willemsen T. Women's work roles and their impact on health, well-being, and career: comparisons between the United States, Sweden, and The Netherlands. *Women Health*. 2000;31(4):1-20. doi:10.1300/j013v31n04_01.
23. Messing K. One-Eyed Science: Occupational Health and Women Workers. Philadelphia, PA:Temple University Press. 1998.
24. Clawson D, Gerstel N. Unequal Time: Gender, Class and Family in Employment Schedules. New York: Russell Sage. 2014. https://www.russellsage.org/publications/unequal-time. Accessed May 25, 2021.
25. Center for Law and Social Policy, Retail Action Project, and Women Employed. Tackling Unstable and Unpredictable Work Schedules. 2014. http://www.clasp.org/resources-and-publications/publication-1/TacklingUnstable-and-Unpredictable-Work-Schedules-3-7-2014-FINAL-1.pdf. Accessed May 25, 2021.
26. McCall, Leslie. Complex Inequality: Gender, Class and the Race in the New Economy. Routledge.New York. 2001.
27. Milkman, Ruth. On Gender, Labor and Inequality. Chicago,IL:University of Illinois Press. 2016.

Race/Ethnicity

28. Marmot M, Allen JJ. Social determinants of health equity. Am J Public Health. 2014;104(Suppl 4): S517–S519.
29. Marmot M. Income inequality, social environment, and inequalities in health. *J Policy Anal and Manag*. 2001;20(1):156-159.
30. Link B, Phelan J. Social Conditions as Fundamental Causes of Health Inequalities, In: Bird CE, Conrad P, Fremont AM, Timmermans S, eds. *Handbook of Medical Sociology*, 6th Ed. 2010, 3-17.
31. Dannefer D. Cumulative advantage/disadvantage and the life course: Cross-fertilizing age and social science theory. *J Gerontol B-Psychol*. 2003;58(6), S327-S337.
32. Krieger N, Waterman PD, Hartman C, et al. Social hazards on the job: workplace abuse, sexual harassment, and racial discrimination--a study of Black, Latino, and White low-income women and men workers in the United States. *Int J Health Serv*. 2006;36(1):51-85. doi:10.2190/3EMB-YKRH-EDJ2-0H19.
33. Stanbury M, Rosenman KD. Occupational health disparities: a state public health-based approach. *Am J Ind Med*. 2014;57(5):596-604.
34. Kirby JB, Taliaferro G, Zuvekas SH. Explaining racial and ethnic disparities in health care. *Med Care*. 2006;44(5 Suppl):I64–72.
35. Paradies Y, Ben J, Denson N, Elias A, Priest N, Pieterse A, et al. Racism as a Determinant of Health: A Systematic Review and Meta-Analysis. *PLoS One* 2015;10(9).

36. U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality. 2014 National Healthcare Quality & Disparities Report, Publication No. 15-0007. http://www.ahrq.gov/research/findings/nhqrdr/nhqdr14/index.html. Accessed May 25, 2021.
37. U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality. 2013 National Healthcare Disparities Report, Publication No. 14-0005. www.ahrq.gov/research/findings/nhqrdr/index.html. Accessed May 25, 2021.
38. Baron SL, Beard S, Davis LK, Delp L, Forst L, Kidd-Taylor A, et al. Promoting integrated approaches to reducing health inequities among low-income workers: applying a social ecological framework. *Am J Ind Med*. 2014;57(5):539-556. doi:10.1002/ajim.22174
39. Lipscomb H, Loomis D, McDonald M, Argue R, Wing S. A conceptual model of work and health disparities in the United States. *Int Journal Health Serv*. 2006;36(1) 25 - 50.
40. Benach J, Solar O, Santana V, Castedo A, Chung H, Muntaner C, et al. A micro-level model of employment relations and health inequalities. *Int J Health Serv*. 2010;40: 223–227.
41. Muntaner C, Chung H, Solar O, Santana V, Castedo A, Benach J, et al. 2010. A macro-level model of employment relations and health inequalities. *Int J Health Serv*, 40: 215–221.
42. Siqueira CE, Gaydos M, Monforton C, Slatin C, Borkowski L, Dooley P, et al. Effects of social, economic, and labor policies on occupational health disparities. *Am J Ind Med*. 2014;57(5):557-72.
43. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Occupational Health Equity. https://www.cdc.gov/niosh/programs/ohe/default.html. Accessed May 25, 2021.
44. Chokshi N. Poverty Report: Working Minority Families Lag Behind White Ones in Every State. Washington Post. March 16, 2015. http://www.washingtonpost.com/blogs/govbeat/wp/2015/03/16/poverty-report-working-minority-families-lagbehind-white-ones. Accessed May 25, 2021.
45. Shannon CA, Rospenda KM, Richman JA, Minich LM. Race, racial discrimination, and the risk of work-related illness, injury, or assault: findings from a national study. *J of Occup Environ Med*. 2009;51(4):44.
46. Mullany A, Valdez L, Gubrium A, Buchanan D. Precarious work, health, and African-American men: A qualitative study on perceptions and experiences [published online ahead of print, 2020 Dec 16]. *Int J Health Serv*. 2020;20731420981850. doi:10.1177/0020731420981850.
47. Williams JA, Rosenstock L. Squeezing blood from a stone: how income inequality affects the health of the American workforce. *Am J Public Health*. 2015;105(4):616-621. doi:10.2105/AJPH.2014.302424
48. Sears JM, Bowman SM, Silverstein BA. Trends in the disproportionate burden of work-related traumatic injuries sustained by Latinos. *J Occup Environ Med.* 2012;54(10):1239-45.
49. Yanar B, Kosny A, Smith PM. Occupational health and safety vulnerability of recent immigrants and refugees. *Int J Environ Res Public Health*. 2018;15(9):2004. doi:10.3390/ijerph15092004.
50. Panikkar B, Woodin MA, Brugge D, Hyatt R, Gute DM; Community Partners of the Somerville Community Immigrant Worker Project. Characterizing the low wage immigrant workforce: a comparative analysis of the health disparities among selected occupations in Somerville, Massachusetts. *Am J Ind Med*. 2014;57(5):516-526. doi:10.1002/ajim.22181.
51. Cedillo L, Lippel K, Nakache D. Factors influencing the health and safety of temporary foreign workers in skilled and low-skilled occupations in Canada [published correction appears in New Solut. 2019 Nov 12;:1048291119890220]. *New Solut*. 2019;29(3):422-458. doi:10.1177/1048291119867757.
52. Fan W, Qian Y. Native-immigrant occupational segregation and worker health in the United States, 2004-2014. *Soc Sci Med*. 2017;183:130-141. doi:10.1016/j.socscimed.2017.04.029.
53. Hsieh YC, Apostolopoulos Y, Hatzudis K, Sönmez S. Social, occupational, and spatial exposures and mental health disparities of working-class Latinas in the US. *J Immigr Minor Health.* 2016;18(3):589-599. doi:10.1007/s10903-015-0231-z.
54. Attell BK, Kummerow Brown K, Treiber LA. Workplace bullying, perceived job stressors, and psychological distress: gender and race differences in the stress process. *Soc Sci Res*. 2017; 65:210–21. doi: 10.1016/j.ssresearch.2017. 02.001.

55. Zavodny M. Joint Economic Committee of the U.S. Senate. Immigration and its Contribution to Our Economic Strength. 2013. http://www.aei.org/files/2013/05/08/-zavodny-immigration-and-itscontribution-to-our-economic-strength_141729556780.pdf. Accessed May 25, 2021.
56. Ross M, Bateman N. Metropolitan Policy Program at Brookings. Meet the Low-Wage Workforce. Washington, D.C. 2019. https://www.brookings.edu/research/meet-the-low-wage-workforce/. Accessed May 25, 2021.
57. Steege AL, Baron SL, Marsh SM, Menéndez CC, Myers JR. Examining occupational health and safety disparities using national data: a cause for continuing concern. *Am J Ind Med*. 2014;57(5):527-538. doi:10.1002/ajim.22297.
58. Krieger N. Methods for the scientific study of discrimination and health: An ecosocial approach. *Am J Public Health*. 2012;102(5):936-44.

Chapter 4

Expanding the Definition of Occupational Disease

Defining Workplace Stress and Stress-Related Illness

1. Smyth J, Zawadzki M, Gerin W. Stress and disease: A structural and functional analysis. *Soc Personal Psychol Compass*. 2013;7(4), 217-227. doi:10.1111/spc3.12020.
2. Belkic K, Savic C. *Job Stressors and Mental Health: A Proactive Clinical Perspective*. World Scientific Publishing Co. Pte. Ltd. Hackensack, NJ. 2013.
3. Rugulies R, Bültmann U, Aust B, Burr H. Psychosocial work environment and incidence of severe depressive symptoms: Prospective findings from a 5–year follow–up of the Danish work environment cohort study. *Am J Epidemiol.* 2005;163:877 887.
4. Stansfeld S, Candy B. Psychosocial work environment and mental health--a meta-analytic review. *Scand J Work Environ Health*. 2006;32(6):443-462. doi:10.5271/sjweh.1050.
5. Harvey SB, Modini M, Joyce S, Milligan-Saville JS, Tan L, Mykletun A, et al. Can work make you mentally ill? A systematic meta-review of work-related risk factors for common mental health problems. *Occup Environ Med*. 2017;74(4):301-310. doi: 10.1136/oemed-2016-104015.
6. Silva-Junior JS, Fischer FM. Long-term sickness absence due to mental disorders is associated with individual features and psychosocial work conditions. *PLoS One*. 2014;9(12):e115885. doi: 10.1371/journal.pone.0115885.
7. Aronsson G, Theorell T, Grape T, Hammarström A, Hogstedt C, Marteinsdottir I, et al. A systematic review including meta-analysis of work environment and burnout symptoms. *BMC Public Health*. 2017;17(1):264. doi:10.1186/s12889-017-4153-7.
8. Guo YF, Luo YH, Lam L, Cross W, Plummer V, Zhang JP. Burnout and its association with resilience in nurses: a cross-sectional study. *J Clin Nurs.* 2018;27(1–2):441–449. doi:10.1111/jocn.13952.
9. Karasek R, Baker D, Marxer F, Ahlbom A, Theorell T. Job decision latitude, job demands, and cardiovascular disease: a prospective study of Swedish men. *Am J Public Health.* 1981 Jul;71(7):694-705. doi: 10.2105/ajph.71.7.694.
10. Marmot M. Work and other factors influencing coronary health and sickness absence. *Work Stress*. 1994;8:191-201.
11. Landsbergis P, Schnall P, Dobson M. The workplace and cardiovascular disease. In: Schnall P, Dobson M, Rosskam E, eds. *Unhealthy work: causes, consequences, cures.* Amityville NY:Baywood Publishing Company, Inc; 2009:80-112.
12. Siegrist J, Klein D. Occupational stress and cardiovascular reactivity in blue–collar workers. *Work Stress.* 1990;4:295-304.
13. Vrijkotte TG, van Doornen LJ, de Geus EJ. Effects of work stress on ambulatory blood pressure, heart rate, and heart rate variability. *Hypertension*. 2000;35(4):880-6. doi:10.1161/01.hyp.35.4.880.

14. Herin F, Vézina M, Thaon I, Soulat JM, Paris C; ESTEV group. Predictive risk factors for chronic regional and multisite musculoskeletal pain: a 5-year prospective study in a working population. *Pain*. 2014;155(5):937-943. doi:10.1016/j.pain.2014.01.033.
15. Rugulies R, Krause N. Effort reward imbalance and incidence of low back and neck injuries in San Francisco transit operators. *Occup Environ Med.* 2008;65:525–533.
16. Koch P, Schablon A, Latza U, Nienhaus A. Musculoskeletal pain and effort-reward imbalance--a systematic review. *BMC Public Health*. 2014;14:37. doi:10.1186/1471-2458-14-37.
17. Li W, Yi G, Chen Z, Dai X, Wu J, Peng Y, et al. Is job strain associated with a higher risk of type 2 diabetes mellitus? A systematic review and meta-analysis of prospective cohort studies. [published online ahead of print, 2021 Jan 6] *Scand J Work Environ Health*. 2021;3938. doi:10.5271/sjweh.3938.
18. Bültmann U, Kant IJ, Van den Brandt PA, Kasl SV. Psychosocial work characteristics as risk factors for the onset of fatigue and psychological distress: Prospective results from the Maastricht Cohort Study. *Psychol Med.* 2002;32:333-45.
19. Jalilian H, Shouroki FK, Azmoon H, Rostamabadi A, Choobineh A. Relationship between job stress and fatigue based on job demand-control-support model in hospital nurses. *Int J Prev Med*. 2019;10:56.
20. Asplund S, Åhlin J, Åström S, Hedlund M, Lindgren BM, Ericson-Lidman E. Self-rated exhaustion disorder and associated health-related factors among municipal employees in rural areas of northern Sweden [published online ahead of print, 2020 Dec 9]. *Int Arch Occup Environ Health*. 2020; doi:10.1007/s00420-020-01617-3.
21. Eddy P, Heckenberg R, Wertheim EH, Kent S, Wright BJ. A systematic review and meta-analysis of the effort-reward imbalance model of workplace stress with indicators of immune function. *J Psychosom Res*. 2016;91:1-8. doi:10.1016/j.jpsychores.2016.10.003.
22. Sabina K. Impact of stress on physiology of endocrine system and on immune system: A review. *International Journal of Diabetes and Endocrinology*. 2017;2(3):40-42. doi: 10.11648/j.ijde.20170203.12.
23. Griep RH, Nobre AA, Alves MG, da Fonseca Mde J, Cardoso Lde O, Giatti L, et al. Job strain and unhealthy lifestyle: results from the baseline cohort study, Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). *BMC Public Health.* 2015;15:309. doi: 10.1186/s12889-015-1626-4.
24. Tausig M, Fenwick R. *Work and Mental Health in Social Context*. New York, NY:Springer; 2011.
25. Karasek RA, Theorell T. The demand-control-support model and cvd. *Occup Med State of the Art Reviews.* 2000;15:78-83.
26. Theorell T, Karasek RA. Current issues relating to psychosocial job strain and cardiovascular disease research. *J Occup Health Psychol*. 1996;1(1):9-26. doi: 10.1037//1076-8998.1.1.9.
27. Landsbergis PA, Schnall PL, Warren K, Pickering TG, Schwartz JE. Association between ambulatory blood pressure and alternative formulations of job strain. *Scand J Work Environ Health*. 1994;20(5):349-63. doi: 10.5271/sjweh.1386.
28. Johnson JV, Hall EM. Job strain, work place social support, and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. *Am J Public Health.* 1988; 78(10):1336-1342.
29. Thoits PA. Stress, coping, and social support processes: where are we? What next? *J Health Soc Behav.* 1995;53-79.
30. van der Doef M, Maes S. The job demand-control (-support) model and psychological well-being: a review of 20 years of empirical research. *Work Stress*. 1999;13:87–114. doi: 10.1080/026783799296084.
31. Blanch, A. Social support as a mediator between job control and psychological strain. *Soc Sci Med.* 2016;157:148–155.
32. Häusser JA, Mojzisch A, Niesel M, Schulz-Hardt S. Ten years on: A review of recent research on the job demand - control (-support) model and psychological well-being. *Work Stress*. 2010;24:1-35.
33. Siegrist, J. A theory of occupational stress. In Dunham J, ed. *Stress in the Workplace: Past, Present, and Future.* London: Whurr Publishers; 2000:63-66.

34. Siegrist J. Effort-reward imbalance at work and cardiovascular diseases. *Int J Occup Med Environ Health*. 2010;23(3):279-85. doi:10.2478/v10001-010-0013-8.
35. Turner RJ, Wheaton B, Lloyd DA. The epidemiology of social stress. *Am Sociol Rev*. 1995;60(1):104-125. doi: 10.2307/2096348.
36. Väänänen A, Anttila E, Turtiainen J, Varje P. Formulation of work stress in 1960–2000: Analysis of scientific works from the perspective of historical sociology. *Soc Sci Med*. 2012;75(5),784-794. doi:10.1016/j.socscimed.2012.04.014.
37. Pearlin LI. The sociological study of stress. *J Health Soc Behav*. 1989;30:241-256.
38. Pearlin LI. The Stress Process Revisited: Reflections on Concepts and their Interrelationships. In: Anashensel CS, Phelan JC. eds. *Handbook of Sociology of Mental Health*. New York, NY:Kluwer;1999:395-415.
39. Pearlin LI, Anashensel CS, LeBlanc AJ. The forms and mechanisms of stress proliferation: The case of AIDS caregivers. *J Health Soc Behav*. 1997;38:223-236.
40. Aneshensel CS, Rutter CM, Lachenbruch PA. Social structure, stress, and mental health: Competing conceptual and analytic models. *Am Soc Rev*. 1991;56(2):166-178. doi: 10.2307/2095777.
41. Moen P, Kelly EL, Lam J. Healthy work revisited: Do changes in time strain predict well-being? *J Occup Health Psych*. 2013;18(2):157-172. doi:10.1037/a0031804.
42. De Sio S, Letizia C, Petramala L, Saracino V, Cedrone F, Sanguigni P, et al. Work-related stress and cortisol levels: is there an association? Results of an observational study. *Eur Rev Med Pharmacol Sci.* 2018;22(24):9012-9017. doi: 10.26355/eurrev_201812_16672.
43. Miyama H, Shimura A, Furuichi W, Seki T, Ono K, Masuya J, et al. Association of chronotypes and sleep disturbance with perceived job stressors and stress response: A covariance structure analysis. *Neuropsychiatr Dis Treat*. 2020;21;16:1997-2005. doi: 10.2147/NDT.S262510. PMID: 32904619;
44. Schieman S, Milkie MA, Glavin P. When work interferes with life: Work-nonwork interference and the influence of work-related demands and resources. *Amer Soc Rev.* 2009;74(6),966-988. doi: 10.1177/000312240907400606.
45. Verkuil B, Atasayi S, Molendijk ML. Workplace Bullying and Mental Health: A Meta-Analysis on Cross-Sectional and Longitudinal Data. *PLoS One*. 2015 Aug 25;10(8):e0135225.
46. De Sio S, Cedrone F, Trovato Battagliola E, Buomprisco G, Perri R, Greco E. The perception of psychosocial risks and work-related stress in relation to job insecurity and gender differences: A cross-sectional study. *Biomed Res Int.* 2018;2018:7649085. doi: 10.1155/2018/7649085.
47. Wainwright D, Calnan M. Work Stress: The Making of a Modern Epidemic. Buckingham, UK: Open University Press; 2002.
48. Wainwright D, Calnan M. The Fall of Work Stress and the Rise of Wellbeing. In: Vickerstaff S, Phillipson C, Wilkie R, eds. *Work, Health and Wellbeing: The Challenges of Managing Health at Work.* Bristol, UK: The Policy Press; 2011.
49. Thoits PA. (2010). Stress and health: Major findings and policy implications. *J Health Soc Behav.* 2010;51:S41-S53. doi: 10.1177/0022146510383499.
50. Benach J, Solar O, Santana V, Castedo A, Chung H, Muntaner C. A micro-level model of employment relations and health inequalities. *Int J Health Serv.* 2010;40(2):223-227.
51. Muntaner C, Chung H, Solar O, Santana V, Castedo A, Benach J. A macro-level model of employment relations and health inequalities. *Int J Health Serv.* 2010;40(2):215-221.
52. Vanroelen C, Levecque K, Moors G, Gadeyne S, Louckx F. The structuring of occupational stressors in a post-Fordist work environment. Moving beyond traditional accounts of demand, control and support. *Soc Sci Med*. 2009;68(6): 1082-1090. doi:10.1016/j.socscimed.2009.01.012.
53. Landsbergis PA, Grzywacz JG, LaMontagne AD. Work organization, job insecurity, and occupational health disparities. *Amer J Ind Med*. 2014;57(5):495-515. doi:10.1002/ajim.22126
54. Picketty T, Saez E. Income inequality in the Unites States, 1913-1998. *Q J Econ*. 2003;118(1):1-39.
55. Doussard M. Degraded Work: *The Struggle at the Bottom of the Labor Market*. Minneapolis, MN:University of Minnesota Press; 2013.

56. Weil D. *The Fissured Workplace: Why Work Became So Bad for So Many and What Can Be Done to Improve It.* Cambridge, MA:Harvard University Press;2014.
57. Van Arsdale D. Recasualization of blue-collar workers: Industrial temporary help work's impact on the working class. *Labor Studies in Working Class History of the Americas*. 2008;5(1):75–99.
58. Schreibauer EC, Hippler M, Burgess S, Rieger MA, Rind E. Work-related psychosocial stress in small and medium-sized enterprises: An integrative review. *Int J Environ Res Public Health*. 2020;17(20):7446. doi:10.3390/ijerph17207446.
59. Lipscomb H, Loomis D, McDonald M, Argue R, Wing S. A conceptual model of work and health disparities in the United States. *Int J Health Serv.* 2006;25-50.
60. Williams JAR, Rosenstock L. Squeezing blood from a stone: How income inequality affects the health of the American workforce. *Amer J Public Health*. 2015;105(4):616-621.
61. Baron SL, Beard S, Davis LK, Delp L, Forst L, Kidd-Taylor A, et al. Promoting integrated approaches to reducing health inequities among low-income workers: applying a social ecological framework. *Am J Ind Med*. 2014;57(5):539-56. doi: 10.1002/ajim.22174.
62. Benach J, Vives A, Amable M, Vanroelen C, Tarafa G, Muntaner C. Precarious employment: understanding an emerging social determinant of health. *Annu Rev Public Health.* 2014;35:229-53. doi: 10.1146/annurev-publhealth-032013-182500.
63. Zoeckler J, Lax M, Zanoni J. *The Low-Wage Workers' Health Project: Mapping the Landscape of Low-Wage Work and Health in Syracuse…Continuing the Conversations.* Low-Wage Work in Syracuse. Occupational Health Clinical Center, Syracuse, NY. SUNY Upstate Medical University:2016.
64. Tang, K. A reciprocal interplay between psychosocial job stressors and worker well–being? A systematic review of the "reversed" effect. *Scand J Work Environ Health.* 2014;40:441-456.
65. van Hooff ML, Taris TW. Let's study how worker health affects the psychosocial work environment. *Scand J Work Environ Health*. 2014;40(5):437-40. doi:10.5271/sjweh.3448.
66. Babanataj R, Mazdarani S, Hesamzadeh A, Gorji MH, Cherati JY. Resilience training: effects on occupational stress and resilience of critical care nurses. *Int J Nurs Pract.* 2019;25(1):e12697. doi:10.1111/ijn.12697 - DOI – PubMed.
67. Lin RT, Lin CK, Christiani DC, Kawachi I, Cheng Y, Verguet S, et al. The impact of the introduction of new recognition criteria for overwork-related cardiovascular and cerebrovascular diseases: A cross country comparison. *Sci Rep- UK.* 2017;7(1):167.
68. Tsukerman D, Leger KA, Charles ST. Work-family spillover stress predicts health outcomes across two decades. *Soc Sci Med*. 2020;265:113516. doi:10.1016/j.socscimed.2020.113516.
69. Leigh JP, De Vogli R. Low wages as occupational health hazards. *J Occup Environ Med*. 2016;58(5):444-7. doi: 10.1097/JOM.0000000000000717.
70. He Y, Walker JM, Payne SC, Miner KN. Explaining the negative impact of workplace incivility on work and non-work outcomes: The roles of negative rumination and organizational support. *Stress Health*. 2020. doi:10.1002/smi.2988. Epub ahead of print.
71. Balducci C, Vignoli M, Dalla Rosa G, Consiglio C. High strain and low social support at work as risk factors for being the target of third-party workplace violence among healthcare sector workers. *Med Lav*. 2020;111(5):388-398. doi:10.23749/mdl.v111i5.9910.

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1. Hedegaard H, Miniño AM, Warner M. National Center for Health Statistics. Drug overdose deaths in the United States, 1999–2017. NCHS Data Brief, no 329. Hyattsville, MD: 2018. https://www.cdc.gov/nchs/products/databriefs/db329.htm. Accessed May 21, 2021.
2. Harduar Morano L, Steege AL, Luckhaupt SE. Occupational patterns in unintentional and undetermined drug-involved and opioid-involved overdose deaths - United States, 2007-2012. *MMWR Morb Mortal Wkly Rep*. 2018;67(33):925-930. doi:10.15585/mmwr.mm6733a3.
3. Kowalski-McGraw M, Green-McKenzie J, Pandalai SP, Schulte PA. Characterizing the interrelationships of prescription opioid and benzodiazepine drugs with worker health and workplace hazards. *J Occup Environ Med*. 2017;59(11):1114-1126. doi:10.1097/JOM.0000000000001154.

4. Massachusetts Department of Public Health. An Assessment of Fatal and Nonfatal Opioid Overdoses in Massachusetts (2011 – 2015). 2017. https://www.mass.gov/files/documents/2017/08/31/legislative-report-chapter-55-aug-2017.pdf. Accessed May 21, 2021.
5. Peters DJ, Monnat SM, Hochstetler AL, Berg MT. The opiod hydra: Understanding overdose mortality epidemics and syndemics across the rural-urban continuum. *Rural Sociol*. 2019;85(3):589-622. doi: /10.1111/ruso.12307.
6. Frone MR. Prevalence and distribution of illicit drug use in the workforce and in the workplace: findings and implications from a U.S. national survey. *J Appl Psychol.* 2006;91:856–69. https://doi.org/10.1037/0021-9010.91.4.856.
7. Choi, B. Opioid use disorder, job strain, and high physical job demands in US workers. *Int Arch Occup Environ Health.* 2020;93:577–588. doi: 10.1007/s00420-019-015014-4.
8. Cheng M, Sauer B, Johnson E, Porucznik C, Hegmann K. Comparison of opioid-related deaths by work-related injury. *Am J Ind Med*. 2013;56(3), 308-316.
9. Hawkins D, Roelofs C, Laing J, Davis L. Opioid-related overdose deaths by industry and occupation-Massachusetts, 2011-2015. *Am J Ind Med*. 2019 Oct;62(10):815-825. doi: 10.1002/ajim.23029.
10. Shaw WS, Roelofs C, Punnett L. Work environment factors and prevention of opioid-related deaths. *Am J Public Health*. 2020;110(8):1235-1241. doi:10.2105/AJPH.2020.305716.
11. New York State Department of Health. New York State Opioid Annual Report. 2019. https://www.health.ny.gov/statistics/opioid/data/pdf/nys_opioid_annual_report_2019.pdf. Accessed May 25, 2021.
12. New York State Department of Health AIDS Institute. New York State Opioid Poisoning, Overdose and Prevention: 2015 Report to the Governor and NYS Legislature. 2015. https://www.health.ny.gov/diseases/aids/general/opioid_overdose_prevention/docs/annual_report2015.pdf. Accessed May 25, 2021.
13. Degenhardt L, Whiteford HA, Ferrari AJ, Baxter AJ, Charlson FJ, Hall WD, et al. Global burden of disease attributable to illicit drug use and dependence: findings from the Global Burden of Disease Study 2010. *Lancet*. 2013;382(9904):1564-74. doi: 10.1016/S0140-6736(13)61530-5.
14. Substance Abuse and Mental Health Services Administration. Behavioral Health Barometer: New York, Volume 5: Indicators as Measured through the 2017 National Survey on Drug Use and Health and the National Survey of Substance Abuse Treatment Services. (HHS Publication No. SMA-19-Baro-17-NY). Rockville, MD. 2019.
15. Substance Abuse and Mental Health Services Administration. Key Substance Use and Mental Health Indicators in the United States: Results from the 2017 National Survey on Drug Use and Health (HHS Publication No. SMA 18–5068, NSDUH Series H-53). Rockville, MD. 2018.
16. Substance Abuse and Mental Health Services Administration. 2018-2019 National Survey on Drug Use and Health: Model-based Prevalence Estimates (50 States and the District of Columbia). https://www.samhsa.gov/data/sites/default/files/reports/rpt32805/2019NSDUHsaeExcelPercents/2019NSDUHsaeExcelPercents/2019NSDUHsaePercents.pdf. Accessed May 25, 2021.
17. Lipari RN, Van Horn SL. Trends in Substance Use Disorders Among Adults Aged 18 or Older. In: *The CBHSQ Report*. Rockville (MD): Substance Abuse and Mental Health Services Administration (US); June 29, 2017.1-10.
18. Bush DM, Lipari RN. Substance Use and Substance Use Disorder by Industry. In: *The CBHSQ Report.* Rockville (MD): Substance Abuse and Mental Health Services Administration (US); April 16, 2015.1-18.
19. Centers for Disease Control and Prevention. Current cigarette smoking prevalence among working adults--United States, 2004-2010. *MMWR Morb Mortal Wkly Rep.* 2011;60(38):1305-9.
20. Dobson KG, Gilbert-Ouimet M, Mustard CA, Smith PM. Association between dimensions of the psychosocial and physical work environment and latent smoking trajectories: a 16-year cohort study of the Canadian workforce. *Occup Environ Med*. 2018;75(11):814-821. doi: 10.1136/oemed-2018-105138.
21. Barbeau EM, Krieger N, Soobader MJ. Working class matters: socioeconomic disadvantage, race/ethnicity, gender, and smoking in NHIS 2000. *Am J Public Health.* 2004;94(2):269-78. doi: 10.2105/ajph.94.2.269.

22. Nilan K, McKeever TM, McNeill A, Raw M, Murray RL. Prevalence of tobacco use in healthcare workers: A systematic review and meta-analysis. *PLoS One*. 2019;14(7):e0220168.
23. Frone MR. Prevalence and distribution of alcohol use and impairment in the workplace: a U.S. national survey. *J Stud Alcohol*. 2006;67(1):147-56. doi: 10.15288/jsa.2006.67.147.
24. Frone MR. Employee alcohol and illicit drug use: Scope, causes, and organizational consequences. In: Barling J, Cooper CL, eds. *Handbook of Organizational behavior: Vol. 1. Micro approaches.* Thousand Oaks, CA: Sage; 2008:519–540.
25. Marchand A, Parent-Lamarche A, Blanc ME. Work and high-risk alcohol consumption in the Canadian workforce. *Int J Environ Res Public Health.* 2011;8:2692-705.
26. Virtanen M, Jokela M, Nyberg ST, Madsen IE, Lallukka T, Ahola K, et al. Long working hours and alcohol use: systematic review and meta-analysis of published studies and unpublished individual participant data. *BMJ*. 2015;350:g7772. doi: 10.1136/bmj.g7772.
27. Hughes A, Williams MR, Lipari RN, Van Horn S. State Estimates of Past Year Cocaine Use among Young Adults: 2014 and 2015. In: *The CBHSQ Report*. Rockville (MD): Substance Abuse and Mental Health Services Administration (US); December 20, 2016.1-9.
28. Cunradi CB, Ames GM, Xiao H. Binge drinking, smoking and marijuana use: The role of women's labor force participation. *J Workplace Behav Health*. 2014;29(3):210-223. doi:10.1080/15555240.2014.928600
29. New York State Department of Health Opioid Surveillance Team, Office of Public Health Practice. Opioid Prevention Program. *Data to Action: Fentanyl-related deaths in New York State outside of New York City, 2015-2017*. Albany, NY:2019.
30. Chiu SK, Hornsby-Myers JL, de Perio MA, et al. Health effects from unintentional occupational exposure to opioids among law enforcement officers: Two case investigations. *Am J Ind Med*. 2019;62(5):439-447. doi:10.1002/ajim.22967
31. Pachito DV, Pega F, Bakusic J, Boonen E, Clays E, Descatha A, et al. The effect of exposure to long working hours on alcohol consumption, risky drinking and alcohol use disorder: A systematic review and meta-analysis from the WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury. *Environ Int*. 2021;146:106205. doi:10.1016/j.envint.2020.106205.
32. Girotto E, Mesas AE, de Andrade SM, Birolim MM. Psychoactive substance use by truck drivers: a systematic review. *Occup Environ Med.* 2014;71(1):71-6. doi: 10.1136/oemed-2013-101452.
33. Williamson A. Predictors of psychostimulant use by long-distance truck drivers. *Am J Epidemiol*. 2007;166(11):1320-6. doi:10.1093/aje/kwm205.
34. Davey J, Richards N, Freeman J. Fatigue and beyond: patterns of and motivations for illicit drug use among long-haul truck drivers. *Traffic Inj Prev.* 2007;8:253–259. doi: /10.1080/15389580601186034.
35. Servies T, Hu Z, Eick-Cost A, Otto JL. Substance use disorders in the U.S. Armed Forces, 2000-2011. *MSMR*. 2012;19(11):11-6.
36. de Lange AH, Kompier MA, Taris TW, Geurts SA, Beckers DG, Houtman IL, et al. A hard day's night: a longitudinal study on the relationships among job demands and job control, sleep quality and fatigue. *J Sleep Res*. 2009;18(3):374-83. doi: 10.1111/j.1365-2869.2009.00735.x.
37. Kalleberg AL. Precarious work, insecure workers: Employment relations in transition. *Am Sociol Rev*. 2009;74(1):1-22.
38. Lewchuk WMC, Wolff A. *Working Without Commitments: The Health Effects of Precarious Employment.* Montreal: McGill-Queen's University Press. 2011.
39. Doussard M. *Degraded Work: The Struggle at the Bottom of the Market*. Minneapolis University of Minnesota Press. 2013.
40. Weil D. *The Fissured Workplace: Why work became so bad for so many and what can be done to improve it.* Cambridge, MA Harvard University Press. 2014.
41. Bernhardt A, Milkman R, Theodore N, Heckathorn D, Auer M, DeFilippis J, Spiller M. Broken Laws, Unprotected Workers: Violations of Employment and Laws in America's Cities. 2009. https://www.nelp.org/publication/broken-laws-unprotected-workers-violations-of-employment-and-labor-laws-in-americas-cities/ Accessed January 20, 2021.

42. Muntaner C, Solar O, Vanroelen C, Martínez JM, Vergara M, Santana V, et al. Unemployment, informal work, precarious employment, child labor, slavery, and health inequalities: pathways and mechanisms. *Int J Health Serv*. 2010;40(2):281-95. doi:10.2190/HS.40.2h.
43. McLean K. "There's nothing here": Deindustrialization as risk environment for overdose. *Int J Drug Policy*. 2016;29:19-26. doi: 10.1016/j.drugpo.2016.01.009.
44. Marchand A, Blanc ME. Occupation, work organization conditions and alcohol misuse in Canada: an 8-year longitudinal study. *Subst Use Misuse*. 2011;46:1003-14.
45. Kowalski-McGraw M, Green-McKenzie J, Pandalai SP, Schulte PA. Characterizing the interrelationships of prescription opioid and benzodiazepine drugs with worker health and workplace hazards. *J Occup Environ Med*. 2017;59(11):1114–1126.
46. Ross CA, Berry NS, Smye V, Goldner EM. A critical review of knowledge on nurses with problematic substance use: The need to move from individual blame to awareness of structural factors. *Nurs Inq*. 2018;25(2), e12215.
47. Ross CA, Jakubec SL, Berry NS, Smye V. "A Two Glass of Wine Shift": Dominant Discourses and the Social Organization of Nurses' Substance Use. *Glob Qual Nurs Res*. 2018;5:2333393618810655. Published 2018 Nov 19. doi:10.1177/2333393618810655.
48. Choi B. Opioid use disorder, job strain, and high physical job demands in US workers. *Int Arch Occup Environ Health*. 2020;93(5):577-588. doi:10.1007/s00420-019-01514-4.
49. Shaw WS, Roelofs C, Punnett L. Work Environment Factors and Prevention of Opioid-Related Deaths. *Am J Public Health*. 2020;110(8):1235-1241. doi:10.2105/AJPH.2020.305716.
50. Alterman T, Luckhaupt SE, Dahlhamer JM, Ward BW, Calvert GM. Job insecurity, work-family imbalance, and hostile work environment: prevalence data from the 2010 National Health Interview Survey. *Am J Ind Med.* 2013;56:660–9. doi: 10.1002/ajim.22123 8.
51. Soravia LM, Schwab S, Walther S, Müller T. Rescuers at Risk: Posttraumatic Stress Symptoms Among Police Officers, Fire Fighters, Ambulance Personnel, and Emergency and Psychiatric Nurses. *Front Psychiatry*. 2021;11:602064. doi:10.3389/fpsyt.2020.602064.
52. Barnes AJ, Zimmerman FJ. Associations of occupational attributes and excessive drinking. *Soc Sci Med*. 2013;92:35-42. doi:10.1016/j.socscimed.2013.05.023.
53. White A, Castle IJ, Chen CM, Shirley M, Roach D, Hingson R. Converging patterns of alcohol use and related outcomes among females and males in the United States, 2002 to 2012. *Alcohol Clin Exp Res*. 2015;39(9):1712-1726. doi:10.1111/acer.12815.
54. Slade T, Chapman C, Swift W, Keyes K, Tonks Z, Teesson M. Birth cohort trends in the global epidemiology of alcohol use and alcohol-related harms in men and women: systematic review and metaregression. *BMJ Open*. 2016;6(10):e011827. doi: 10.1136/bmjopen-2016-011827.
55. Erol A, Karpyak VM. Sex and gender-related differences in alcohol use and its consequences: Contemporary knowledge and future research considerations. *Drug Alcohol Depend.* 2015;156:1-13. doi: 10.1016/j.drugalcdep.2015.08.023.
56. Colell E, Sanchez-Niubo A, Ferrer M, Domingo-Salvany A. Gender differences in the use of alcohol and prescription drugs in relation to job insecurity. Testing a model of mediating factors. *Int J Drug Policy*. 2016;37:21-30. doi: 10.1016/j.drugpo.2016.07.002.
57. Dong XS, Wang X, Fujimoto A, Dobbin R. Chronic back pain among older construction workers in the United States: a longitudinal study. *Int J Occup Environ Health*. 2012;18(2):99-109. doi: 10.1179/10773 52512Z.0000000004.
58. Dale AM, Buckner-Petty S, Evanoff BA, Gage BF. Predictors of long-term opioid use and opioid use disorder among construction workers: Analysis of claims data. *Am J Ind Med*. 2021;64(1):48-57. doi:10.1002/ajim.23202.
59. Jacobsen HB, Caban-Martinez A, Onyebeke LC, Sorensen G, Dennerlein JT, Reme SE. Construction workers struggle with a high prevalence of mental distress, and this is associated with their pain and injuries. *J Occup Environ Med*. 2013;55(10):1197-1204. doi:10.1097/JOM.0b013e31829c76b3.

60. Quesada J, Hart LK, Bourgois P. Structural vulnerability and health: Latino migrant laborers in the United States. *Med Anthropol*. 2011;30(4):339-362. doi:10.1080/01459740.2011.576725
61. Arcury TA, Talton JW, Summers P, Chen H, Laurienti PJ, Quandt SA. Alcohol Consumption and Risk for Dependence Among Male Latino Migrant Farmworkers Compared to Latino Non-farmworkers in North Carolina. *Alcohol Clin Exp Res*. 2016;40(2):377-384. doi:10.1111/acer.12969.
62. Frone MR, Brown AL. Workplace substance-use norms as predictors of employee substance use and impairment: a survey of U.S. workers. *J Stud Alcohol Drugs*. 2010;71(4):526-34. doi: 10.15288/jsad.2010.71.526.
63. Yang MJ, Yang MS, Kawachi I. Work experience and drinking behavior: alienation, occupational status, workplace drinking subculture and problem drinking. *Public Health*. 2001;115(4):265-271. doi:10.1038/sj/ph/1900761.
64. Ghodse H. Drugs and alcohol in the workplace. In: Ghodse H. *Addiction at work*. London: Routledge; 2017:21-8.
65. Roche AM, Chapman J, Duraisingam V, Phillips B, Finnane J, Pidd K. Construction workers' alcohol use, knowledge, perceptions of risk and workplace norms. *Drug Alcohol Rev*. 2020;39(7):941-949. doi:10.1111/dar.13075.
66. Leignel S, Schuster JP, Hoertel N, Poulain X, Limosin F. Mental health and substance use among self-employed lawyers and pharmacists. *Occup Med (Lond).* 2014;64(3):166-71. doi: 10.1093/occmed/kqt173.
67. Room R. Stigma, social inequality and alcohol and drug use. *Drug Alcohol Rev*. 2005;24(2):143-155. doi:10.1080/09595230500102434.
68. Wolfenden L, Goldman S, Stacey FG, Grady A, Kingsland M, Williams CM, et al. Strategies to improve the implementation of workplace-based policies or practices targeting tobacco, alcohol, diet, physical activity and obesity. *Cochrane Database Syst Rev*. 2018;11(11):CD012439. doi:10.1002/14651858.CD012439.pub2.
69. Massachusetts Department of Industrial Accidents. Treatment guidelines/protocols for injured workers, Opioid/controlled substance protocol. 2016. https://www.mass.gov/files/documents/2017/09/27/opioid-controlled-substanceprotocol.pdf
70. Roelofs C, Sugerman-Brozan J, Kurowski A, Russell L, Punnett L. Promoting opioid awareness through a union-based peer training model [published online ahead of print, 2021 Jan 10]. *New Solut*. 2021;1048291120982597. doi:10.1177/1048291120982597.
71. Bush DM, Lipari RN. Workplace Policies and Programs Concerning Alcohol and Drug Use. In: *The CBHSQ Report*. Rockville (MD): Substance Abuse and Mental Health Services Administration (US); August 7, 2014.1-9.
72. National Academies of Sciences, Engineering, and Medicine. Committee on Pain Management and Regulatory Strategies to Address Prescription Opioid Abuse. In: Phillips JK, Ford MA, Bonnie RJ, eds. *Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use.* Washington, DC: National Academies Press. 2017. https:// www.ncbi.nlm.nih.gov/books/NBK458651.
73. Midford R, Welander F, Allsop S. Preventing alcohol and other drug problems in the workplace. In: Stockwell T, Gruenewald PJ, Toumbourou JW, Loxley W, eds. *Preventing Harmful Substance Use: The Evidence Base for Policy and Practice.* The Atrium, England: John Wiley & Sons, Ltd; 2005.
74. National Academies of Sciences, Engineering, and Medicine. *Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use.* Washington, DC: The National Academies Press; 2017. doi:10.17226/24781.
75. Phillips JA, Holland MG, Baldwin DD, Gifford-Meuleveld L, Mueller KL, Perskison B, et al. Marijuana in the workplace: Guidance for occupational health professionals and employers: Joint Guidance Statement of the American Association of Occupational Health Nurses and the American College of Occupational and Environmental Medicine. *Workplace Health Saf*. 2015;63(4):139-164. doi:10.1177/2165079915581983.

76. Goplerud E, Hodge S, Benham T. A substance use cost calculator for US employers with an emphasis on prescription pain medication misuse. *J Occup Environ Med*. 2017;59(11):1063-1071. doi:10.1097/JOM.0000000000001157.
77. Dembe A, Wickizer T, Sieck C, Partridge J, Balchick R. Opioid use and dosing in the workers' compensation setting. A comparative review and new data from Ohio. *Am J Ind Med.* 2012;55(4):313-24. doi: 10.1002/ajim.21021.

Work and the Incidence of Overweight and Obesity

1. Iversen LB, Strandberg-Larsen K, Prescott E, Schnohr P, Rod NH. Psychosocial risk factors, weight changes and risk of obesity: The Copenhagen City Heart Study. *Eur J Epidemiol*. 2012;27:119–30.
2. Shrestha N, Pedisic Z, Neil-Sztramko S, Kukkonen-Harjula KT, Hermans V. The impact of obesity in the workplace: A review of contributing factors, consequences and potential solutions. *Curr Obes Rep*. 2016;5:344–360. doi:10.1007/s13679-016-0227-6.
3. Yarborough CM, Brethauer S, Burton WN, Fabius RJ, Hymel P, Kothari S, et al. Obesity in the workplace: Impact, outcomes, and recommendations. *J Occup Environ Med*. 2018;60(1):97-107. doi: 10.1097/JOM.0000000000001220.
4. Jackson CL, Wee CC, Hurtado DA, Kawachi I. Obesity trends by industry of employment in the United States, 2004 to 2011. *Obesity.* 2016;3:20. doi 10.1186/s40608=016-0100-x.
5. Schmier JK, Jones ML, Halpern MT. Cost of obesity in the workplace. *Scand J Work Environ Health*. 2006;32:5-11.
6. Kleinman N, Abouzaid S, Andersen L, Wang Z, Powers A. Cohort analysis assessing medical and nonmedical cost associated with obesity in the workplace. *J Occup Environ Med*. 2014;56(2):161-70. doi:10.1097/JOM.0000000000000099.
7. Finkelstein EA, DiBonaventura MD, Burgess SM, Hale BC. The costs of obesity in the workplace. *J Occup Environ Med*. 2010;52(10):971-6. doi:10.1097/JOM.0b013e3181f274d2.
8. Otero G, Pechlaner G, Liberman G, Gurcan E. The neoliberal diet and inequality in the United States. *Soc Sci Med.* 2015;142:47-55.
9. Nestle, M. What to Eat. New York, NY: North Point Press; 2006.
10. Nestle, M. Food politics: How the food industry influences nutrition and health, revised and expanded, tenth anniversary edition. Berkely, CA: University of California Press. 2013.
11. US Dept of Agriculture. Laws and Regulations. https://www.usda.gov/our-agency/about-usda/laws-and-regulations. Accessed May 27, 2021.
12. Pearson N, Biddle SJH. Sedentary behavior and dietary intake in children, adolescents, and adults. *Amer J of Prev Med*. 2011;41(2):178–188.
13. Shulte PA, Wagner A, Downes A, Miller DB. A framework for the concurrent consideration of occupational hazards and obesity. *Ann Occup Hyg.* 2008;52(7):555–566. doi:10.1093/annhyg/men055.
14. Schulte PA, Pana-Cryan R, Schnorr T, Schill AL, Guerin R, Felknor S, et al. An approach to assess the burden of work-related injury, disease, and distress. *Am J Public Health*. 2017;107(7):1051-1057. doi:10.2105/AJPH.2017.303765.
15. Hales CM, Carroll MD, Fryar CD, Ogden CL. National Center for Health Statistics. Prevalence of obesity among adults and youth: United States, 2015-2016. *NCHS Data Brief*. 2017;(288):1–8.
16. Krueger PM, Coleman-Minahan K, Rooks RN. Race/ethnicity, nativity and trends in BMI among U.S. adults. *Obesity*. 2014;22(7):1739-1746.
17. Schulte PA, Wagner GR, Ostry A, Blanciforti LA, Cutlip RG, Krajnak KM et al. Work, obesity, and occupational safety and health. *Am J Public Health.* 2007;97(3):428-36. doi:10.2105/AJPH.2006.086900.
18. Lee BY, Bartsch SM, Mui Y, Haidari LA, Spiker ML, Gittelsohn J. A systems approach to obesity. *Nutr Rev*. 2017;75(suppl 1):94-106. doi:10.1093/nutrit/nuw049.
19. Shrestha N, Pedisic Z, Neil-Sztramko S, Kukkonen-Harjula KT, Hermans V. The impact of obesity in the workplace: A review of contributing factors, consequences and potential solutions. *Curr Obes Rep*. 2016;5(3):344-360. doi:10.1007/s13679-016-0227-6

20. DiBonaventura M, Lay AL, Kumar M, Hammer M, Wolden ML. The association between body mass index and health and economic outcomes in the United States. *J Occup Environ Med.* 2015;57(10):1047-54. doi:10.1097/JOM.0000000000000539.
21. Roos E, Lallukka T, Rahkonen O, Lahelma E, Laaksonen M. Working conditions and major weight gain: A prospective cohort study. *Arch Environ Occup Health*. 2013;68(3):166-172. doi:10.1080/19338244.2012.686931.
22. Pandalai SP, Schulte PA, Miller DB. Conceptual heuristic models of the interrelationships between obesity and the occupational environment. *Scand J Work Environ Health*. 2013;39(3): 221–232. doi:10.5271/sjweh.3363.
23. Nobrega S, Champagne N, Abreu M. Goldstein-Gelb M, Montano M, Isabel Lopez I, et al. Obesity/Overweight and the role of working conditions: A qualitative, participatory investigation. *Health Promot Pract*. 2016;17(1):127-36. doi:10.1177/1524839915602439.
24. McAllister EJ, Dhurandhar NV, Keith SW, Aronne LJ, Barger J, Baskin M, Benca RM, et al. Ten putative contributors to the obesity epidemic. *Crit Rev Food Sci Nutr*. 2009;49(10):868-913. doi: 10.1080/10408390903372599.
25. Choi B, Schnall PL, Yang H, Dobson M, Landsbergis P, Israel L, et al. Sedentary work, low physical job demand, and obesity in US workers. *Amer J of Ind Med.* 2010;53:1088-1101. doi:10.1002/ajim.20886.
26. Tudor-Locke C, Leonardi C, Johnson WD, Katzmarzyk PT. Time spent in physical activity and sedentary behaviors on the working day: the American time use survey. *J Occup Environ Med*. 2011;53(12):1382-1387. doi:10.1097/JOM.0b013e31823c1402
27. Thorp AA, Healy GN, Winkler E, Clark BK, Gardiner PA, Owen N, et al. Prolonged sedentary time and physical activity in workplace and non-work contexts: a cross-sectional study of office, customer service and call centre employees. *Int J Behav Nutr Phys Act*. 2012;9:128. doi:10.1186/1479-5868-9-128
28. Waters CN, Ling EP, Chu AHY, Ng SHX, Chia A, Lim YW, et al. Assessing and understanding sedentary behaviour in office-based working adults: a mixed-method approach. *BMC Public Health* 2016;16:360. doi 10.1186/s12889-016-3023-z
29. Fransson EI, Heikkilä K, Nyberg ST, Zins M, Westerlund H, Westerholm P, et al. Job strain as a risk factor for leisure-time physical inactivity: an individual-participant meta-analysis of up to 170,000 men and women: the IPD-Work Consortium. *Am J Epidemiol*. 2012;176(12):1078-89. doi:10.1093/aje/kws336.
30. Block JP, He Y, Zaslavsky AM, Ding L, Ayanian JZ. Psychosocial stress and change in weight among US adults. *Am J Epidemiol*. 2009;170(2):181-92. doi: 10.1093/aje/kwp104.
31. Solovieva S, Lallukka T, Virtanen M, Viikari-Juntura E Psychosocial factors at work, long work hours, and obesity: a systematic review. *Scand J Work Environ Health*.2013;39(3):241-258. doi:10.5271/sjweh.3364.
32. Nyberg ST, Heikkila K, Fransson EI, Alfredsson L. DeBacquer D, Bjorner JB, et al. Job strain in relation to body mass index: pooled analysis of 160,000 adults from 13 cohort studies. *J Intern Med*. 2012;272(1):65-73. doi:10.1111/j.1365-2796.2011.02482.x.
33. Marchand A, Beauregard N, Blanc ME. Work and non-work stressors, psychological distress and obesity: evidence from a 14-year study on Canadian workers. *BMJ Open.* 2015;5(3):e006285. doi:10.1136/bmjopen-2014006285.
34. Kivimäki M, Head J, Ferrie JE, Shipley MJ, Brunner E, Vahtera J, et al. Work stress, weight gain and weight loss: evidence for bidirectional effects of job strain on body mass index in the Whitehall II study. *Int J Obes (Lond).* 2006 Jun;30(6):982-7. doi: 10.1038/sj.ijo.0803229. PMID: 16418750.
35. Ishizaki M, Nakagawa H, Morikawa Y, Honda R, Yamada Y, Kawakami N; Japan Work Stress and Health Cohort Study Group. Influence of job strain on changes in body mass index and waist circumference--6-year longitudinal study. *Scand J Work Environ Health*. 2008;34(4):288-96.
36. Brunner EJ, Chandola T, Marmot MG. Prospective effect of job strain on general and central obesity in the Whitehall II study. *Am J Epidemiol*. 2007;165(7):828-837. doi:10.1093/aje/kwk058.

37. Klingberg S, Mehlig K, Johansson I, Lindahl B, Winkvist A, Lissner L. Occupational stress is associated with major long-term weight gain in a Swedish population-based cohort. *Int Arch Occup Environ Health*. 2019;92(4):569-576. doi: 10.1007/s00420-018-1392-6.
38. Myers S, Govindarajulu U, Joseph MA, Landsbergis P. Work Characteristics, Body Mass Index, and Risk of Obesity: The National Quality of Work Life Survey [published online ahead of print, 2020 Oct 30]. Ann Work Expo Health. 2020;wxaa098. doi:10.1093/annweh/wxaa098.
39. Yamada Y, Kameda M, Noborisaka Y, Suzuki H, Honda M, Yamada S. Excessive fatigue and weight gain among cleanroom workers after changing from an 8-hour to a 12-hour shift. *Scand J Work Environ Health*. 2001;27(5):318–26.
40. Niedhammer I, Lert F, Marne MJ. Prevalence of overweight and weight gain in relation to night work in a nurses' cohort. *Int J Obes Relat Metab Disord.* 1996;20(7):625–33. 23.
41. Di Lorenzo L, De Pergola G, Zocchetti C, L'Abbate N, Basso A, Pannacciulli N, et al. Effect of shift work on body mass index: results of a study performed in 319 glucose-tolerant men working in a Southern Italian industry. *Int J Obes Relat Metab Disord.* 2003;27(11):1353–8.
42. Zhao I, Bogossian F, Turner C. The effects of shift work and interaction between shift work and overweight/obesity on low back pain in nurses: results from a longitudinal study. *J Occup Environ Med*. 2012;54(7):820-825. doi:10.1097/JOM.0b013e3182572e6a
43. McGlynn N, Kirsh VA, Cotterchio M, Harris MA, Nadalin V, Kreiger N. Shift work and obesity among Canadian women: A cross-sectional study using a novel exposure assessment tool. *PLoS One*. 2015;10(9):e0137561. doi:10.1371/journal.pone.0137561.
44. Amato AA, Wheeler HB, Blumberg B. Obesity and endocrine-disrupting chemicals. *Endocr Connect*. 2021;10(2):R87-R105. doi:10.1530/EC-20-0578.
45. Egusquiza RJ, Blumberg B. Environmental Obesogens and Their Impact on Susceptibility to Obesity: New Mechanisms and Chemicals. *Endocrinology*. 2020;161(3):bqaa024. doi:10.1210/endocr/bqaa024.
46. Heindel JJ, Blumberg B. Environmental obesogens: mechanisms and controversies. *Annu Rev Pharmacol Toxicol*. 2019;59:89–106.
47. Darbre PD. Endocrine disruptors and obesity. *Curr Obes Rep*. 2017;6(1):18–27.
48. Kortt M, Baldry J. The association between musculoskeletal disorders and obesity. *Aust Health Rev*. 2002;25:207-214.
49. Barbour KE, Moss S, Croft JB, Charles G. Helmick CG, Theis, KA, et al. Geographic variations in arthritis prevalence, health-related characteristics, and management - United States, 2015. *MMWR Surveill Summ.* 2018;67(4):1–28.
50. Lane NE, Ivanova J, Emir B, Mobasheri A, Jensen MG. Characterization of individuals with osteoarthritis in the United States and their use of prescription and over-the-counter supplements. *Maturitas*. 2021;145:24-30. doi:10.1016/j.maturitas.2020.12.001.
51. Chen Y, Dales R, Tang M, Krewski D. Obesity may increase the incidence of asthma in women but not in men: longitudinal observations from the Canadian National Population Health Surveys. *Am J Epidemiol*. 2002;155(3):191–7.
52. Ford ES. The epidemiology of obesity and asthma. *J Allergy Clin Immunol*. 2005;115(5):897–909.
53. Huovinen E, Kaprio J, Koskenvuo M. Factors associated to lifestyle and risk of adult onset asthma. *Respir Med*. 2003;97(3):273–80.
54. Beuther DA, Sutherland ER. Overweight, obesity, and incident asthma: a meta-analysis of prospective epidemiologic studies. *Am J Respir Crit Care Med*. 2007;175(7):661–6.
55. Boudreau M, Bacon SL, Ouellet K, Jacob A, Lavoie KL. Mediator effect of depressive symptoms on the association between BMI and asthma control in adults. *Chest*. 2014;146(2):348–54.
56. Stream AR, Sutherland ER. Obesity and asthma disease phenotypes. *Curr Opin Allergy Clin Immunol.* 2012;12(1):76–81.
57. Sutherland ER. Linking obesity and asthma. *Ann N Y Acad Sci*. 2014;1311:31–41.
58. Nigatu YT, Reijneveld SA, Penninx BW, Schoevers RA, Bültmann U. The longitudinal joint effect of obesity and major depression on work performance impairment. *Am J Public Health*. 2015;105(5):e80-e86. doi:10.2105/AJPH.2015.302557.

59. Shaikh RA, Sikora A, Siahpush M, Singh GK. Occupational variations in obesity, smoking, heavy drinking, and non-adherence to physical activity recommendations: findings from the 2010 National Health Interview Survey. *Am J Ind Med*. 2015;58(1):77-87. doi:10.1002/ajim.22405.
60. Buchvold HV, Pallesen S, Øyane NM, Bjorvatn B. Associations between night work and BMI, alcohol, smoking, caffeine and exercise--a cross-sectional study. *BMC Public Health*. 2015;15:1112. doi: 10.1186/s12889-015-2470-2.
61. Poulsen K, Cleal B, Clausen T, Andersen LL. Work, diabetes and obesity: a seven-year follow-up study among Danish health care workers. *PLoS One*. 2014;9(7):e103425. doi:10.1371/journal.pone.0103425.
62. Heraclides AM, Chandola T, Witte DR, Brunner EJ. Work stress, obesity and the risk of type 2 diabetes: gender-specific bidirectional effect in the Whitehall II Study. *Obesity (Silver Spring).* 2012;20(2):428-33. doi: 10.1038/oby.2011.95.
63. Gilbert-Ouimet M, Glazier RH, Brisson C, Mustard C, Smith PM. Job strain, overweight, and diabetes: A 13-year prospective study among 12,896 men and women in Ontario. *Psychosom Med*. 2021;83(2):187-195. doi:10.1097/PSY.0000000000000898.

Chapter 5

COSTS OF OCCUPATIONAL DISEASE

1. Leigh JP. Economic burden of occupational injury and illness in the United States. *Milbank Q*. 2011;89(4):728-772. doi:10.1111/j.1468-0009.2011.00648.x.
2. Leigh JP, Marcin JP. Workers' compensation benefits and shifting costs for occupational injury and illness. *J Occup Environ Med*. 2012;54(4):445-450. doi:10.1097/JOM.0b013e3182451e54
3. Bhushan A, Leigh JP. National trends in occupational injuries before and after 1992 and predictors of workers' compensation costs. *Public Health Rep*. 2011;126(5):625-634. doi:10.1177/003335491112600504.
4. Leigh JP, Waehrer G, Miller TR, McCurdy SA. Costs differences across demographic groups and types of occupational injuries and illnesses. *Am J Ind Med*. 2006;49(10):845-853. doi:10.1002/ajim.20374.
5. Leigh JP. Expanding research on the economics of occupational health. *Scand J Work Environ Health*. 2006;32(1):1-4. doi:10.5271/sjweh.969.
6. Waehrer G, Leigh JP, Miller TR. Costs of occupational injury and illness within the health services sector. *Int J Health Serv*. 2005;35(2):343-359. doi:10.2190/RNQ3-0C13-U09M-TENP.
7. Waehrer G, Leigh JP, Cassady D, Miller TR. Costs of occupational injury and illness across states. *J Occup Environ Med*. 2004;46(10):1084-1095. doi:10.1097/01.jom.0000141659.17062.4b.
8. Conversation via e-mail, J. Paul Leigh June 23, 2017.
9. Leigh JP, Waehrer G, Miller TR, Keenan C. Costs of occupational injury and illness across industries. *Scand J Work Environ Health*. 2004;30(3):199-205. doi:10.5271/sjweh.780.
10. Leigh JP. Number and costs of occupational injury and illness in low-wage occupations. Center for Poverty Research and Center for Health Care Policy and Research. David, CA: University of California Davis. 2012.
11. Leigh JP, Robbins JA. Occupational disease and workers' compensation: coverage, costs, and consequences. *Milbank Q*. 2004;82(4):689-721. doi:10.1111/j.0887-378X.2004.00328.x.
12. Leigh JP, Yasmeen S, Miller TR. Medical costs of fourteen occupational illnesses in the United States in 1999. *Scand J Work Environ Health*. 2003;29(4):304-313. doi:10.5271/sjweh.735.
13. Leigh JP, Romano PS, Schenker MB, Kreiss K. Costs of occupational COPD and asthma. *Chest*. 2002;121(1):264-272. doi:10.1378/chest.121.1.264.
14. Leigh JP, McCurdy SA, Schenker MB. Costs of occupational injuries in agriculture. *Public Health Rep*. 2001;116(3):235-248. doi:10.1093/phr/116.3.235.
15. Leigh JP, Schnall P. Costs of occupational circulatory disease. *Occup Med*. 2000;15(1):257-v.
16. Leigh JP, Markowitz SB, Fahs M, Shin C, Landrigan PJ. Occupational injury and illness in the United States. Estimates of costs, morbidity, and mortality. *Arch Intern Med*. 1997;157(14):1557-1568.

17. Tom's Inflation Calculator, JS v3.61, Copyright 2021, Tom R. Halfhill, https://www.halfhill.com/inflation_js.html. Accessed March15, 2021.
18. Boden LI, Biddle EA, Spieler EA. Social and economic impacts of workplace illness and injury: current and future directions for research. *Am J Ind Med*. 2001;40(4):398-402. doi:10.1002/ajim.10013.
19. Davis KG, Freeman AM, Ying J, Huth JR. Workers' compensation costs for healthcare caregivers: Home healthcare, long-term care, and hospital nurses and nursing aides [published online ahead of print, 2021 Feb 22]. *Am J Ind Med*. 2021;10.1002/ajim.23237. doi:10.1002/ajim.23237.
20. Hassard J, Teon K, Cox T, Dew P, Cosmar M, Gründler R, et al. Calculating costs of work-related stress and psychosocial risks. Luxenbourgh: European Agency for Safety and Health at Work. 2014. doi:10.2802/20493.
21. Collins JJ, Baase CM, Sharda CE, et al. The assessment of chronic health conditions on work performance, absence, and total economic impact for employers. *J Occup Environ Med*. 2005;47(6):547-557. doi:10.1097/01.jom.0000166864.58664.29.
22. Goetzel RZ, Carls GS, Wang S, et al. The relationship between modifiable health risk factors and medical expenditures, absenteeism, short-term disability, and presenteeism among employees at Novartis. *J Occup Environ Med*. 2009;51(4):487-499. doi:10.1097/JOM.0b013e31819eb902.
23. Goetzel RZ, Long SR, Ozminkowski RJ, Hawkins K, Wang S, Lynch W. Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting U.S. employers. *J Occup Environ Med*. 2004;46(4):398-412. doi:10.1097/01.jom.0000121151.40413.bd.
24. Gustafsson K, Marklund S. Consequences of sickness presence and sickness absence on health and work ability: a Swedish prospective cohort study. *Int J Occup Med Environ Health*. 2011;24(2):153-165. doi:10.2478/s13382-011-0013.
25. Skagen K, Collins AM. The consequences of sickness presenteeism on health and wellbeing over time: A systematic review. *Soc Sci Med*. 2016;161:169-177. doi:10.1016/j.socscimed.2016.06.005.
26. Lauby S. Recruiter's Handbook: A Complete Guide for Sourcing, Selecting, and Engaging the Best Talent. Alexandria, VA: Society for Human Resource Management. 2018.

Chapter 6

CLINICAL OCCUPATIONAL HEALTH RESOURCES

1. Landrigan PJ, Markowitz SB. *Proposal for a Statewide Network of Occupational Disease Diagnosis and Prevention Centers. Report to the New York State Legislature*. New York, NY: Environmental and Occupational Medicine, Department of Community Medicine. Mount Sinai School of Medicine of the City University of New York; 1987.
2. New York State Department of Health. Occupational Health Clinic Network: Prevention and Protection for the NYS Workforce. https://www.health.ny.gov/environmental/workplace/occupational_health_clinic/clinic_report/docs/occupational_health_report.pdf. Accessed May 25, 2021.
3. New York State Department of Health. New York State Occupational Health Clinic Network Report: Key Updates 2004-2012. https://www.health.ny.gov/environmental/workplace/occupational_health_clinic/clinic_report/docs/clinic_report_2004-2012.pdf. Accessed May 25, 2021.
4. Tuminaro D. Organizing for a statewide network of occupational disease diagnostic centers. *New Solut* 1990;1:18–19.
5. Lax MB. The occupational health clinical center network in New York State: achievements, prospects, and constraints. *New Solut* 1992; 3: 41–54.
6. Lax, MB. Saúde Ocupacional na região central do estado de Nova York: um ambulatório de doenças ocupacionais com financiamento público 25 anos depois. *Revista Brasileira de Saúde Ocupacional*. 2013;*38*(127), 149-161. doi: /10.1590/S0303-76572013000100016.

7. LaDou J. The rise and fall of occupational medicine in the United States. *Am J Prev Med*. 2002; 22:285–295.
8. Association of Occupational and Environmental Clinics. Post-Graduate Training Opportunities in Occupational & Environmental Medicine. http://www.aoec.org/training.htm. Accessed May 25, 2021.
9. Sengupta I, Reno V, Burton J, Baldwin M. National Academy of Social Insurance. Workers' Compensation: Benefits, Coverage, and Costs, 2010. 2012. https://www.nasi.org/sites/default/files/research/NASI_Workers_Comp_2010.pdf. Accessed May 25, 2021.
10. Telles CA, Tanabe RP. Workers Compensation Research Institute. Early Impact of the 2007 Reforms in New York. 2011. https://www.wcrinet.org/reports/early-impact-of-the-2007-reforms-in-new-york. Accessed May 25, 2021.
11. Occupational Health Clinical Center, Syracuse NY, unpublished data.
12. Occupational Health Clinical Center, survey (n=310), unpublished data.
13. Merriam-Webster Dictionary. Medical Definition of board-certified. https://www.merriam-webster.com/dictionary/board-certified#medicalDictionary. Accessed May 25, 2021.
14. Association of American Medical Colleges. New York State Physician Workforce Profile. https://www.aamc.org/system/files/2019-12/state-physician-New_York-2019%5B1%5D.pdf. Accessed 5/1/20.
15. Thomson Reuters Westlaw. New York Codes, Rules and Regulations. 12 CRR-NY 323.1 NY-CRR. Official Compilation of Codes, Rules and Regulations of the State of New York. https://govt.westlaw.com/nycrr/Document/I1b3abe92e8ff11e99a56fe5b0cea0162?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default) . Accessed May 25, 2021.
16. New York State Workers' Compensation Board. Search for Health Care Providers and Independent Medical Examiners https://www.wcb.ny.gov/HealthCareProviderSearch/?submitHome=Search+-for+Health+Care+Provider+or+IME. Accessed May 27, 2021.
17. Harber P, Levin M, Weinberg JL, Oversier J. Industrial hygienist as a clinical consultant. *Am J Ind Med*. 1994;26(3):339-347. doi:10.1002/ajim.4700260307.
18. Moshe S, Cinamon T, Zack O, Segal N, Chodick G, Krakov A, et al. The need for social work services in occupational medicine [published online ahead of print, 2017 Feb 10]. *Occup Med (Lond)*. 2017;10.1093/occmed/kqx009. doi:10.1093/occmed/kqx009.
19. Ribner DS. Crisis in the workplace: The role of the occupational social worker. *Soc Work*. 1993;38(3):333-337.
20. New York State Department of Health, Bureau of Occupational Health and Injury Prevention. Data obtained from Alicia Fletcher, Epidemiologist. March 26, 2021 via e-mail.
21. Lax MB, Klein R. More than meets the eye: social, economic, and emotional impacts of work-related injury and illness. *New Solut*. 2008;18(3):343-360. doi:10.2190/NS.18.3.i.
22. Lax MB. Occupational medicine: toward a worker/patient empowerment approach to occupational illness. *Int J Health Serv*. 2002;32(3):515-549. doi:10.2190/MQPA-30W3-M4YY-TLBD.
23. New York State Department of Health. Occupational Health Clinic Network – Prevention and Protection for the NYS Workforce. https://www.health.ny.gov/environmental/workplace/clinic.htm. Published October 2018. Accessed January 19, 2021.

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