Characterizing occupations that cannot work from home: a means to identify susceptible worker groups during the COVID-19 pandemic

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Abstract

Introduction

As the COVID-19 pandemic spreads globally, public health guidance is advising all workers to work from home. However, not all workers are employed in occupations which can be done from home. These workers are at an increased risk for exposure to SARS-CoV-2due to increased interaction with the public and other workers, and also potentially at an increased risk for job displacement as more extreme public health measures (such as closing of retail operations or enforcing shelter in place) occur.

Methods

To characterize the occupations least likely to be able to work from home, national employment and wage data maintained by the United States Bureau of Labor Statistics (BLS) was merged with measures from the BLS O*NET survey data, which ranks occupations by a variety of physical, ergonomic, psychosocial, and structural exposures. Noting that the work that could most easily be done at home would be work done on a computer that does not rely on interaction with the public, O*NET measures quantifying the importance of computer use at work, and the importance of working with or performing for the public at work were utilized.

Results

From this analysis, 19.5% (28.2 M) of the United States workforce covered by O*NET are employed in occupations where working from home would be difficult, due to minimal use of computer at work, and a high level of interaction with the public. These workers tend to be in service occupations, including retail and food service, protective service occupations, and transportation occupations such as bus drivers. About 25% (35.6 M) of the United States

workforce covered by O*NET are employed in occupations where working from home could likely be more easily accommodated, as these workers do much of their work on computers and interaction with the public is not important. These workers tend to be in technology, computer, management, administrative, financial, engineering, and some science occupations, which typically have higher pay than occupations which cannot be done at home.

Conclusions

The workers in occupations that have minimal computer use, and high interaction with the public are least likely to be able to work from home during a public health emergency. These workers could also be at an increased risk for job displacement if public-facing establishments close or alter their business model in the face of increased public health restrictions. Occupations where working from home is not possible tend to have lower annual median incomes than occupations where working from home is possible, increasing the vulnerability of these workers. Characterizing which occupational groups are least likely to be able to work from home can inform public health risk management and prioritize occupational sectors where additional workplace protections are necessary.

Introduction

Initial public health guidance for workers during the 2019-2020 COVID-19 pandemic was focused on ensuring workers stay home when sick, minimize non-essential travel, and practice good hygiene in order to slow the transmission of disease between workers and community members (1). As the number of cases continued to grow, and community transmission was apparent, subsequent guidance focused on encouraging all workers to work from home, with many workplaces adopting a work from home requirement (2,3). In many parts of the country, schools were closed or moved fully online (4,5), retail establishments closed or severely reduced hours (6,7), and bar and restaurants either closed or moved to a model of takeout and delivery only (8,9). This public health guidance, while necessary for halting the spread of a global pandemic such as COVID-19, can have drastic effects on workers.

When thinking about worker health during a pandemic crisis, exposure to disease or infection is often the first thought, particularly for front line workers such as those in healthcare sectors. Previously, we calculated the burden of workers in occupations where exposure to infection or disease occurs at least weekly or monthly using United States Bureau of Labor Statistics (BLS)

occupational employment and O*NET data (10). From this analysis, we found that about 18% of the workforce is exposed to disease or infection at least once a month at work, making these workers at increased susceptibility to not only contracting a disease due to work, but also transmitting a disease into the community.

While disease exposure is an important occupational health concern during a pandemic, job security is another important metric of worker health to consider during a pandemic. Several researchers have shown a relationship between acute and chronic job insecurity and measures of adverse physical and mental health outcomes including depression, stress, and physiologic markers such as increased blood pressure (11–14). Job displacement, or involuntary job loss stemming from a layoff, downsizing, or plant closure, also has been shown to be related to a variety of adverse mental health outcomes including depression, suicide, and stress (15–18), negative changes in diet (19,20), and physical health outcomes such as coronary heart disease and other physiologic markers of adverse health (21,22). After a job displacement event, workers may take jobs of lower quality, resulting in long-term economic and psychosocial effects for once-displaced workers (23). Additionally, with many workers in the United States receiving healthcare and other benefits from their work arrangement, a layoff or reduction in hours can affect access to healthcare or long term stability for these workers (24).

For many workers, being able to work productively from home is one way to continue to work through a public health emergency, such as COVID-19. Working from home allows these workers continued job security, access to healthcare and other benefits, and a full paycheck while still allowing them to practice social distancing and reduce contact with other people. However, it is known that not all workers are able to work from home due to differences in job tasks. Jobs that lend themselves to being completed at home are jobs that require limited interaction with the public, so the work can be done in relative solitary. Additionally, jobs that primarily use a computer to complete tasks may lend themselves to be done at home, given the portability of laptop computers.

Here, I characterize which, and how many United States workers are likely to not be able to work from home, due to high importance of interaction with the public at work, and limited importance of computer use at work. Additionally, I investigate whether median annual wages differ between occupations where work from home can occur, and occupations that cannot be done at home, therefore making workers in these jobs more susceptible to voluntary or involuntary layoff or hours reduction as child care and schooling is moved home (due to school

closures), retail establishments close, and public interaction decreases due to social distancing measures.

Methods

This analysis utilized measures from two existing data sources, as previously detailed in Baker et al. (10) and Doubleday et al. (25). Briefly, United States employment by occupation, and median annual wage by occupation, was downloaded from the United States Bureau of Labor Statistics (BLS) Occupational Employment Statistics database (26).These data were last updated in May 2018, and give a count of the number of United States workers employed and the national median annual wage for each 2010 Standard Occupational Classification code (2010 SOC). Guidance around SOC codes is detailed elsewhere (27) but briefly, SOC codes range from two digits (Major Group Code) to six digits (Detailed Occupation Code) and are hierarchical in nature. For this analysis, six-digit occupation codes were utilized, and then aggregated over larger occupational groupings (i.e. two-digit codes).

To estimate the number of workers and types of occupations that would not be able to work from home, two measures from the O*NET database were utilized. O*NET is a survey that asks employees and employers across nearly all SOC codes about exposures encountered at work, knowledge and skills utilized in the occupation, types of tasks performed, and workplace characteristics (28). O-NET does not collect data from military occupations; thus, SOC codes beginning with 55 “Military Specific Occupations” are not included in O*NET data. Similarly, employment numbers for “Military Specific Occupations” is not reported in the BLS Occupational Employment Statistics Database. All other SOC codes are included in the O*NET database, with updates made every year to ensure the database is completely refreshed every few years (29). Over a ten-year period (2001 to 2011) over 150,000 employees from 125,000 workplaces had responded to the O*NET questionnaire, making it a robust source of occupational information (30).

Two O*NET measures were utilized in this analysis. The first characterized the importance of computer use at work via the question, “How important is working with computers to the performance of your current job?”. The second O*NET question investigated was, “How important is performing for or working directly with the public to the performance of your current job?” For both questions, respondents could select from the following multiple choice answers:

Not Important, Somewhat Important, Important, Very Important, Extremely Important. Both of these measures are converted to a 0-100 score within O*NET, representing weighted-average score for each SOC code. A score of 50 is equivalent to a respondent answering “important” for both of the questions considered in this analysis.

Importance scores for both O*NET metrics were merged with the national employment data and annual median wage data. Both O*NET measures were plotted against each other, with the resultant scatterplot divided into four quadrants. The upper left quadrant represents jobs where computer use is rated as “Important” or higher, but performing for or working directly with the public was rated as less than important; jobs that could easily be done at home. The lower right quadrant represents jobs where computer use was rated as less than “Important” but performing for or working directly with the public was rated as “Important” or higher; jobs which would not be easily to perform at home. Each SOC on the scatterplot was weighted by annual median wage, to visualize differences in income between the four quadrants.

To further explore relationships in these data, the distribution of median annual wages was compared between quadrants using an ANOVA.

All data analysis was conducted using the statistical software package R version 3.6.3.

Results

BLS reports a total of 144.7 million persons employed in the United States in May 2018; this number does not include workers in military occupations or in jobs that comprise the gig economy, such as app-based drivers. Figure 1 shows the relationship between “Importance of computer use at work” and “Importance of interaction with or performing for the public at work” for all SOC codes. Each SOC plotted here is sized in proportion to the national median annual wage reported for that occupation by BLS, with larger points denoting a higher median annual wage. Each SOC on the plot is color-coded broadly by occupational sector

Figure 1 is divided into four quadrants. SOCs in the upper left quadrant represent those occupations that most lend themselves to being done at home, that is, computer use is important to the work, but interaction with the public is not important. As detailed in Table 2, this quadrant represents 24.6% (35.6 M) of the workforce covered by BLS and tends to include

occupational sectors such as administration, finance, management, computer, technical, science, engineering, and architecture occupations.

The bottom right quadrant in Figure 1 represents occupations that likely cannot be done at home, due to the fact that computer work is not important, and interaction with the public is important. As detailed in Table 2, this quadrant is 19.5% of the workforce covered by BLS (28.2 M workers) and consists of occupational sectors such retail, food service, beauty services (e.g. barbers, hairdressers, manicurists), protective services, and transportation operators such as bus drivers or subway operators.

The other two quadrants on Figure 1 represent professions where interaction with the public and computer use are important (upper right quadrant; largely including education, healthcare, and sales in addition to some administration and management jobs) and where interaction with the public and computer are both not important (lower left quadrant; largely including production, transportation, natural resources, construction, and maintenance).

Table 1 summarizes the distribution of median annual wages in each quadrant. A one-way ANOVA indicated that the median annual wage between these quadrants were significantly different.

Discussion

During the COVID-19 pandemic, workers across the world were instructed to work from home in order to increase social distancing and ultimately halt disease transmission. However, not all workers can effectively perform work duties from home, and this analysis estimates the number of workers that may not be able to work from home using two O*NET metrics. Additionally, this work investigates what types of occupations are most and least likely to be able to work from home, and investigates differences in annual median wage between these groups of workers. Several other data sources quantify the number of American workers that work from home, such as data collected from the American Time Use Survey, United States Census American Community Study, or the National Compensation Survey. However, these data sources are not able to quantify how many which types of workers have work that can be done at home (e.g. during a public health emergency when workers are ordered to work from home) but rather which workers have access to a remote working benefit as part of a compensation package, whether or not a respondent took advantage of it (31), or worked from home on the day the

survey was administered, regardless of whether it was paid work or not (32,33). The work presented here is novel, as it uses existing data sources to attempt to quantify the number and types of workers who could do work from home if working from home was ordered in an emergency situation, regardless of whether a worker typically works from home, or are typically given permission to work from home from their workplace.

During a pandemic, such as COVID-19, not being able to work from home could make workers particularly susceptible for adverse occupational health outcomes. Notably, this could be exposure to disease or infection in the workplace due to increased interaction with the public or coworkers in the workplace, and commuting to and from the workplace. Also importantly, not being able to work from home could also make workers job insecure. These workers are particularly vulnerable to being laid off or facing reductions in hours as the public chooses to stay home and not interact with many public-facing occupations, or if the public-facing occupations are asked to close or restrict services (such as restaurants being restricted to only takeout or delivery) as was practice during the COVID-19 pandemic. Additionally, if schools close, as happened during the COVID-19 pandemic, workers that cannot work from home may be forced to choose between staying home with children, or going into work without adequate back-up care for their children, further contributing to a feeling of insecure employment. Understanding the unique challenges that these workers could face during a pandemic or other public health emergency can help to inform appropriate risk management and policy-based strategies for these workers, to ensure that their livelihood can continue. This could include increased access to paid sick leave, guaranteed hours even if hours are cut, access to emergency childcare services, access to unemployment that pays full wage replacement, priority hiring for other related jobs, and subsidized healthcare even if layoff occurs.

Additionally, this analysis showed that the distribution of median annual wages differed between those workers that would be likely to work from home, and those workers that would likely not be able to work from home, further adding to the vulnerability of these workers. It is, on average, higher paid workers who are able to work from home, thus ensuring some continuity in pay, increased ability to care for a child out of school, decreased risk of being laid off or having hours substantially cut, and decreased potential exposure to disease or infection via other workers or community members

Given this analysis relied on existing data sources, some limitations must be acknowledged. BLS data does not count self-employed (including gig economy workers), undocumented, contingent, and domestic workers. Many workers in these groups likely are performing work

tasks that cannot be done at home, and are of a lower-income. Therefore, it is likely that the number of American workers who cannot work from home is underestimated in this analysis, as it does not include the groups listed above. As for O*NET, it is important to remember that results are aggregated on the occupation level, and therefore doesn't account for within-job variation (34). Additionally, O*NET relies on employee and employer self-report, so is subject to inherent bias and misclassification. The O*NET metrics used in this analysis were measures of the importance of using a computer for work and importance of interacting with the public, which differs from the frequency of using a computer or interacting with the public. Therefore, some jobs for which computer use is rated as very important, may not actually require use of a computer very frequently, and jobs where interaction with the public is important may not due it frequently. This would lead to some misclassification in the analysis for who could work from home most easily.

In conclusion, this work shows that a large proportion of the United States workforce are in jobs that may not be easy to do at home. These are workers primarily in food service, retail, the arts and sports, beauty services (e.g. barbers, hairdressers, manicurists), and transportation operators such as bus drivers or subway operators. These workers tend to be lower-paid than workers who can do jobs from home, further increasing their vulnerability if they lose their job, have a reduction in hours, or have to quit due to childcare responsibilities or due to illness. It is important that these workers be the focus of public health and policy interventions, in order to ensure that these workers can continue to have access to safe and healthy workplaces, and not bear an undue burden during a public health emergency such as COVID-19.

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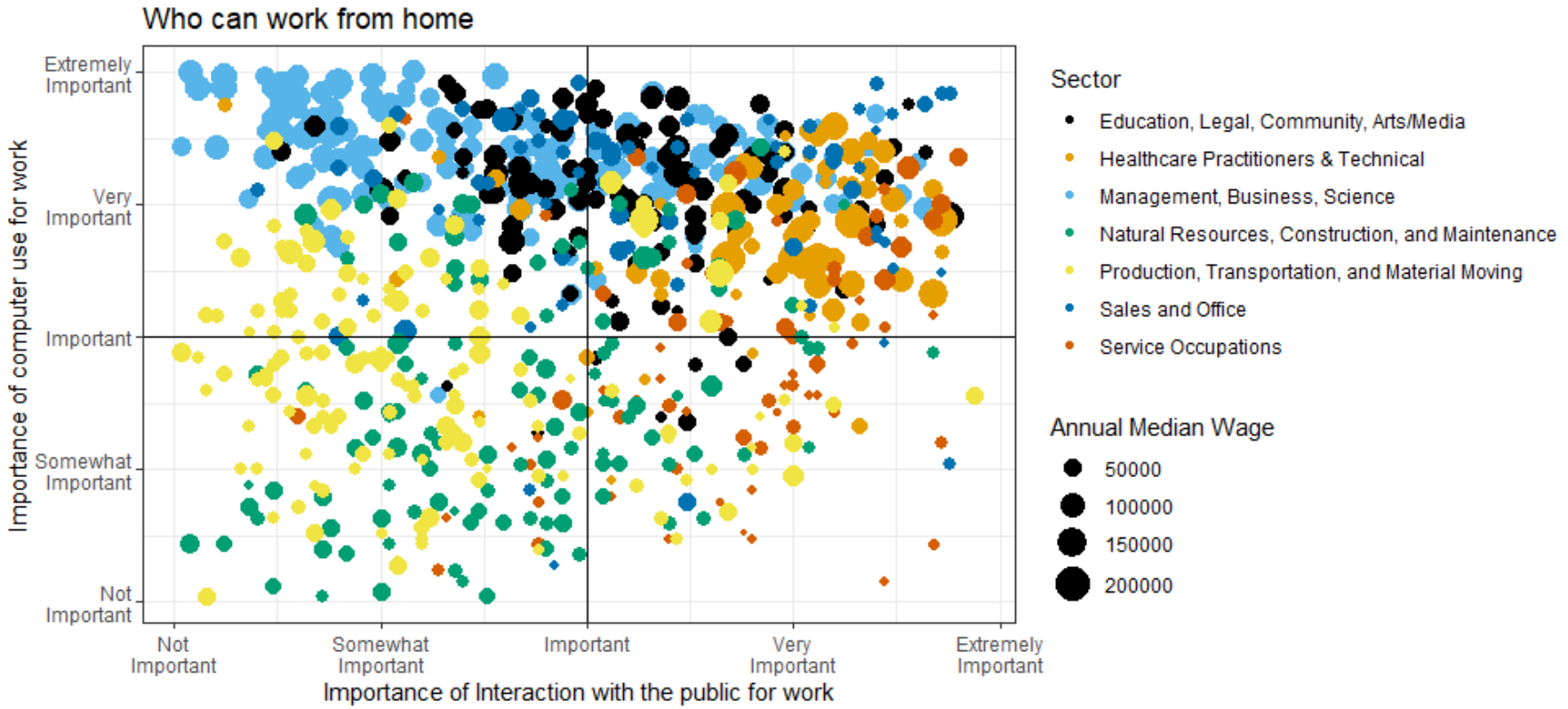

Figure 1: Who can work from home? Workers in the top left quadrant are workers that are likely able to work from home, whereas those in the bottom right quadrant would not be able to work from home. Each point on the graph is weighted by the annual median wage for the occupation, and color-coded by broad occupational sector.

Table 1: Distribution of median annual wages by quadrant, as shown in Figure 1

	Median Annual Wage					
Quadrant	**Mean ($)**	**Median ($)**	**Range ($)**	**% workers**	**# workers**	***p****
Low computer, high public	34,258	32,040	(20,120--70,910)	19.5%	28,222,992	
Low computer, low public	40,068	38,190	(22,330--73,780)	19.6%	28,367,725	
High computer, high public	62,653	56,950	(22,260--201,100)	36.3%	52,538,184	
High computer, low public	66,196	62,710	(25,250--142,530)	24.6%	35,604,389	
All	55,518	48,690	(20,120--201,100)	100%	144,733,290	<0.0001

*One-way ANOVA of median annual wages by quadrant

Table 2: Number and percent of workers in jobs that would be difficult to do from home (high public interaction, low computer use), and easier to do from home (low public interaction, high computer use) by major (2-digit) standard occupational classification code (SOC).

				Public interaction: High Computer Use: Low		Public Interaction: Low Computer Use: High	
	2-digit SOC	Median Annual Wage	total in SOC	#	%	#	%
11	Management	$104,240	7,616,650	--	--	2,434,670	32.0%
13	Business and Financial Operations	$68,350	7,721,300	--	--	5,208,720	67.5%
15	Computer and Mathematical	$86,340	4,384,300	--	--	4,382,270	99.9%
17	Architecture and Engineering	$80,170	2,556,220	--	--	2,307,550	90.3%
19	Life, Physical, and Social Science	$66,070	1,171,910	--	--	739,070	63.1%
21	Community and Social Services	$44,960	2,171,820	48,520	2.2%	--	--
23	Legal	$80.810	1,127,900	--	--	68,530	6.1%
25	Education, Training, and Library	$49,700	8,779,780	243,080	2.8%	2,217,040	25.3%
27	Arts, Design, Entertainment, Sports, and Media	$49,290	1,951,170	181,150	9.3%	825,260	42.3%
29	Healthcare Practitioners and Technical	$66,440	8,646,730	162,290	1.9%	341,950	4.0%
31	Healthcare Support	$29,740	4,117,450	960,630	23.3%	53,730	1.3%
33	Protective Service	$40,640	3,437,410	1,402,780	40.8%	152,020	4.4%
35	Food Preparation and Serving Related	$23,070	13,374,620	10,814,489	80.9%	--	--
37	Building and Grounds Cleaning and Maintenance	$26,840	4,421,980	1,180,279	26.7%	--	--
39	Personal Care and Service	$24,420	5,451,330	1,919,080	35.2%	--	--
41	Sales and Related	$28,180	14,542,290	3,716,800	25.6%	1,824,250	12.5%
43	Office and Administrative Support	$35,760	21,828,990	342,410	1.6%	9,949,290	45.6%
45	Farming, Fishing, and Forestry	$25,380	480,130	37,780	7.9%	--	--
47	Construction and Extraction	$46,010	5,962,640	1,269,520	21.3%	--	--
49	Installation, Maintenance, and Repair	$45,540	5,628,880	396,800	7.0%	1,725,840	30.7%
51	Production	$35,070	9,115,530	276,940	3.0%	1,925,250	21,1%
53	Transportation and Material Moving	$32,730	10,244,260	4,113,300	40.2%	69,920	0.7%
	All SOCs		144,733,290	28,222,992	19.5%	35,604,389	24.6%