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Who are the essential and frontline workers?

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Abstract
Identifying essential and frontline workers and understanding their characteristics is useful for policymakers and researchers in targeting social insurance and safety net policies in response to the COVID-19 crisis and allocating scarce resources like personal protective equipment (PPE) and vaccines. We develop a working definition and provide data on the demographic and labor market composition of these workers. We first apply the official industry guidelines issued by the Department of Homeland Security (DHS) in March 2020 to microdata from the 2018 and 2019 American Community Survey to identify essential workers regardless of actual operation status of their industry. We then use the feasibility of work from home in the worker's occupation group (Dingel and Neiman 2020) to identify those most likely to be frontline workers who worked in-person early in the COVID-19 crisis in March/April 2020. In a third step, we exclude industries that were shut down or running under limited demand at that time (Vavra 2020). We find that the broader group of essential workers comprises a large share of the labor force and tends to mirror its demographic and labor market characteristics. In contrast, the narrower category of frontline workers is, on average, less educated, has lower wages, and has a higher representation of men, disadvantaged minorities, especially Hispanics, and immigrants. These results hold even when excluding industries that were shut down or operating at a limited level. Results for essential and frontline workers are similar when accounting for changes in the federal guidelines over time by using the December 2020 guidelines which include a few additional groups of workers, including the education sector.

Keywords COVID-19 · Essential workers · Frontline workers · Race and gender differences · Occupational risk

1 Introduction

The COVID-19 pandemic has required the identification of essential workers, who are vital for the core functioning of societal infrastructure. Formation of policies to protect and meet the needs of these essential workers and to allocate scarce resources like personal protective equipment (PPE) and vaccines depends on knowing their composition and characteristics. However, identifying essential workers is not straightforward. The definition of essential work may differ by state, or even locality, and change rapidly over time. Moreover, the risk essential workers face is influenced by whether they are frontline workers who must provide their labor in person or whether they can work from home. As some industries, even those deemed essential, may at times be mostly shut down or facing steep decreases in demand, who is really at work also depends on the current shut down or demand status of their industry.

We address these data issues to provide information on the characteristics of essential workers and, more specifically, frontline workers. We begin by applying the official industry guidelines issued by the Department of Homeland Security (DHS) Cybersecurity and Infrastructure Security Agency (CISA) in March 2020 to microdata from the 2018 and 2019 American Community Survey (ACS) to identify the broader group of essential workers.[1] We then use data on the feasibility of work from home in the worker's occupation group (Dingel and Neiman 2020) to identify those most likely to be frontline workers. We find that the broader group of essential workers comprises a large share of the labor force and tends to mirror its demographic characteristics. In

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[1] Previous versions of this paper used 2017 and 2018 ACS data as the 2019 data was not available at the time.

contrast, frontline workers are a less educated, lower wage, group, with a higher representation of men, disadvantaged minorities, especially Hispanics, and immigrants, on average. Both conclusions remain unchanged when excluding industries that were considered shut down/diminished demand during the early stages of the COVID crisis (Vavra 2020). Results for essential and frontline workers are similar when accounting for changes in the federal guidelines over time by using the December 2020 DHS guidelines which include a few additional groups of workers, including workers in the education sector.

2 Data and methods

A common and clear-cut definition of essential workers would facilitate the rapidly evolving social science literature on COVID-19. However, the designation of "essential" requires interpretation and depends on the policy context. We propose a three-step approach narrowing from essential industries to "frontline" workers to "frontline excluding shutdown industries", capturing those who provide their labor in person in active industries. We implement our approach using the 2018 and 2019 waves of the American Community Survey (ACS), a nationally-representative, survey that is fielded monthly to produce annual data designed to provide communities with estimates on a broad range of social, economic, housing, and demographic data.[2] We restrict our sample to individuals who are employed at the time of the survey and provide valid information on the industry of their current job.[3]

Although various states and cities under lockdown and other restrictions applied their own definitions of essential, the federal guidelines provide a logical starting point for an analysis of essential workers. Thus, our first step began with the federal guidelines listing essential infrastructure workers during the COVID-19 epidemic who "protect their communities, while ensuring continuity of functions critical to public health and safety, as well as economic and national security" issued by the Department of Homeland Security (DHS) Cybersecurity and Infrastructure Security Agency (CISA) on March 28, 2020.[4] Based on the sectors listed by DHS, we used our judgment to manually assign each North American Industry Classification System (NAICS) industry as being essential or non-essential. We identified 197 out of 287 four-digit industry categories as essential.[5] By this process of matching the broader sector information from the DHS to the NAICS 2017 four-digit industry classification, we attempted to refrain from subjective decision-making to the maximum extent possible by including all DHS-designated industries regardless of actual operation. This estimate of essential workers that we proposed in an Econofact memo (Blau *et al*. 2020) has also been used in Montenovo *et al*. (2020) and Gupta *et al*. (2020), both studying various COVID-19 repercussions on the labor market. In some of our analyses, we present results for employed individuals categorized by major (2-digit) occupation (or occupation group).[6]

In a second step, we identified frontline workers by focusing on a subcategory of essential workers; those in occupation groups where a third or less of workers can feasibly work from home, based on analysis by Dingel and Neiman (2020). They constructed a work-from-home measure using pre-pandemic surveys from the Occupational Information Network that describe the typical experience of US workers to calculate the share of jobs that can be done at home by occupation at the major group (2 digit) level.[7] Making use of this measure allows us to focus on the composition and characteristics of frontline workers, a subset of essential workers who arguably face a higher level of risk of infection by providing their labor in person.

[2] "The Census Bureau selects a random sample of addresses to be included in the ACS. Each address has about a 1-in-480 chance of being selected in a month, and no address should be selected more than once every 5 years. The Census Bureau mails questionnaires to approximately 295,000 addresses a month across the United States… The ACS creates period estimates, which means they represent the characteristics of the population and housing over a specific data collection period. These are the 1-year and 5-year estimates (American Community Survey Information Guide 2017)."

[3] The industry variable is not asked of those under 16 in the ACS. This leads to a minimum age of 16 for our sample.

[4] https://www.cisa.gov/sites/default/files/publications/CISA_Guidance_on_the_Essential_Critical_Infrastructure_Workforce_Version_2.0_1.pdf.

[5] Our code for this classification is available in the online Appendix at pamelameyerhofer.com. In January 2021, the Centers for Disease Control and Prevention (CDC) released a mapping of the federal guidelines to NAICS codes (CDC, 2021). We use our own mapping based directly on the DHS guidance for our March and December 2020 analyses since the DHS guidelines best represent the state of knowledge at those dates. We compare our estimates of essential workers to the CDC categorization in the "Other Estimates" section below.

[6] For a study that highlights employment, wages, and education in specific essential occupations using U.S. Bureau of Labor Statistics (BLS) data, see Torpey (2020).

[7] Dingel and Neiman (2020) use the ONET description of the job tasks to judge if the job can be performed at home or not. They report the percent of jobs in 2-digit occupation groups that can be done at home. Using the same 2-digit occupation group definition, we define frontline workers as those working in occupations where less than 33% of the occupations in that occupation group can be done from home. For example, grocery store cashiers are in the "Sales and Related Occupations" 2-digit occupation group. Since only 28% of those in "Sales and Related Occupations" can work from home, we classify grocery store cashiers as frontline workers.

For the larger group of essential workers as well as the narrower subset of frontline workers, in a third step we additionally excluded industries that were shut down or running under limited demand at the time of the initial COVID-outbreak in March 2020 as designated by Vavra (2020)[8] e.g., restaurants and other food services, traveler accommodation, air transportation, and a number of manufacturing industries.[9]

Finally, we account for changes in the federal guidelines over time by comparing the groups defined above to the essential and frontline workers using guidelines issued by DHS CISA on December 16, 2020.[10] The December 2020 DHS guidelines differ from those issued in March 2020 in adding the education sector, automobile dealers, other motor vehicle dealers, sporting good stores, and office supply stores. For the December 2020 breakdowns, we do not present results excluding shut down industries as these were far fewer and more heterogeneous across states than they were in the early stages of the COVID-19 crisis in the U.S. in March 2020.

3 Findings

We begin by presenting our findings using the March 2020 DHS guidelines. We then explore how our results are affected when updated based on the December 2020 DHS guidelines that include the education sector as well as some other additional categories.

4 Essential workers: March 2020

Tables 1 and 2 show our results for essential and frontline workers at the aggregate level and, for frontline workers (our primary focus), separately at the major (2-digit) occupation level using the March 2020 definitions. Table 1 reports demographic characteristics and Table 2 reports labor market characteristics. As may be seen in the tables, essential workers, using this definition, comprise a large and varied group. Overall, they make up 70% of all workers (see Panel A in Tables 1 and 2). Women are well represented, although the female share (44%) is somewhat lower than for the labor force as a whole (47%). The other demographic characteristics of essential workers are also very similar to the general labor market on the aggregate level, although they are slightly more likely to be Hispanic or immigrant (foreign born) and have somewhat lower educational attainment (see Panel A in Table 1). The share of workers in predominantly (70%+) female and predominantly (30%−) male occupations (as classified based on 4 digit occupational categories) is broadly similar between essential and all workers, although a somewhat larger share of essential workers are in predominantly male occupations as shown in Panel A of Table 2. Average wages of essential workers are virtually the same as for all workers and about the same share of essential workers as all workers earn low wages (in the bottom quartile of the overall wage distribution) and high wages (in the top quartile of the overall wage distribution).[11] Taking into account the shutdowns in the early stage of the crisis by excluding workers in affected industries does substantially reduce the estimated number of essential workers—to 60% of all workers; with average wages somewhat higher at $28.42 (compared to $27.05 for all workers). However, the demographic characteristics of essential workers are almost identical when excluding shut down and limited demand industries.

5 Frontline workers: March 2020

Frontline workers also vary but come disproportionately from socio-economically disadvantaged groups compared to the overall workforce (see Panel A in Table 1) and receive lower wages on average (Panel A in Table 2). Frontline workers include (but are not limited to) health care workers, protective service workers (police and EMS), cashiers in grocery and general merchandise stores, production and food processing workers, janitors and maintenance workers, agricultural workers, and truck drivers. Such workers constitute 43% of all workers. While women are overrepresented in a number of specific frontline occupations, the average female share of frontline workers (39%) is lower than for essential workers as a whole. Frontline workers are on average less well educated than all workers, with a higher share

[8] Dey and Lowenstein (2020) state, based on personal communication from the author, that Vavra's designation was subjective but the authors found his listing to be "quite reasonable". We agree with this assessment and, therefore, use his designation to move from essential to essential excluding shutdown.

[9] Specifically, we exclude: Restaurants and bars: 7223-7225. Travel and Transportation: 4811,4812, 4853, 4854, 4859, 4881,4883, 7211. Personal Services: 6212, 8121,8129. Entertainment: 7111, 7112, 7115, 7131, 7132, 7139. Other sensitive retail: 4411, 4412, 4421, 4422, 4481, 4482, 4483,4511,4512, 4522, 4531, 4532, 4539, 5322, 5323, 4243, 4413, 4543. Sensitive Manufacturing: 3352, 3361, 3362, 3363, 3364, 3366, 3371, 3372, 3379, 3399, 4231, 4232, 4239, 3132, 3141, 3149, 3152.

[10] The guidelines issued on December 16, 2020 (version 4) are identical to the August 2020 (version 3). The December guidelines are available here: https://www.cisa.gov/sites/default/files/publications/ECIW_4.0_Guidance_on_Essential_Critical_Infrastructure_Workers_Final3_508_0.pdf.

[11] Wages are calculated by dividing annual wages by the product of usual hours per week worked and usual weeks per year worked. Wages are adjusted to 2019 dollars.

Table 1 Demographic characteristics of essential and frontline workers: March 2020

	% Female	% White	% Black	% Hispanic	% Asian	% Other Race	% Immigrant	% Single Mother	% < HS	% HS	% Some College	% BA or higher	N	% All	% Frontline	% Frontline excl. Shutdown
Panel A: Group Averages																
All	0.47	0.62	0.12	0.18	0.06	0.03	0.19	0.08	0.09	0.24	0.31	0.35	3,042,378			
Essential	0.44	0.60	0.12	0.19	0.06	0.03	0.20	0.08	0.10	0.27	0.33	0.30	2,128,330	70.0%		
Essential excl. Shutdown	0.44	0.62	0.12	0.18	0.06	0.03	0.19	0.08	0.09	0.26	0.32	0.33	1,809,150	59.5%		
Frontline	0.39	0.57	0.13	0.22	0.05	0.03	0.22	0.08	0.14	0.33	0.34	0.19	1,301,854	42.8%		
Frontline excl. Shutdown	0.38	0.58	0.13	0.22	0.05	0.03	0.21	0.08	0.13	0.32	0.33	0.21	1,025,969	33.7%		
Panel B: Frontline by Occupation Group																
Healthcare Practitioners & Technical	0.75	0.67	0.11	0.09	0.10	0.03	0.17	0.11	0.01	0.06	0.33	0.60	183,208		14.1%	
Healthcare Support	0.86	0.45	0.25	0.20	0.07	0.03	0.24	0.23	0.10	0.31	0.46	0.13	81,774		6.3%	
Protective Service	0.22	0.59	0.20	0.15	0.03	0.03	0.11	0.05	0.03	0.24	0.46	0.28	55,699		4.3%	
Food Preparation & Serving	0.53	0.51	0.13	0.26	0.07	0.04	0.23	0.10	0.23	0.34	0.34	0.09	132,965		10.2%	
Building & Grounds Cleaning & Maintenance	0.39	0.42	0.14	0.39	0.03	0.03	0.38	0.11	0.29	0.41	0.23	0.07	73,099		5.6%	
Personal Care & Service	0.80	0.56	0.16	0.21	0.05	0.03	0.20	0.15	0.12	0.30	0.40	0.18	22,974		1.8%	
Sales & Related	0.48	0.65	0.10	0.16	0.06	0.03	0.15	0.08	0.09	0.27	0.35	0.29	192,579		14.8%	
Farming, Fishing, & Forestry	0.24	0.42	0.04	0.51	0.02	0.02	0.45	0.06	0.44	0.31	0.17	0.08	19,911		1.5%	
Construction & Extraction	0.03	0.55	0.06	0.35	0.01	0.02	0.30	0.01	0.24	0.43	0.27	0.06	135,904		10.4%	
Installation, Maintenaince, & Repair Workers	0.04	0.67	0.08	0.20	0.03	0.03	0.17	0.01	0.11	0.41	0.41	0.07	77,228		5.9%	
Production	0.26	0.57	0.13	0.22	0.05	0.02	0.22	0.06	0.15	0.44	0.32	0.09	134,555		10.3%	
Transportation & Material Moving	0.19	0.53	0.18	0.22	0.04	0.03	0.21	0.04	0.15	0.44	0.31	0.10	180,599		13.9%	
Panel C: Frontline excluding Shutdown by Occupation Group																
Healthcare Practitioners & Technical	0.75	0.67	0.12	0.09	0.10	0.03	0.17	0.11	0.01	0.06	0.33	0.60	175,294			17.1%
Healthcare Support	0.85	0.44	0.26	0.19	0.07	0.03	0.25	0.23	0.10	0.32	0.45	0.13	75,884			7.4%
Protective Service	0.21	0.59	0.19	0.15	0.03	0.03	0.10	0.05	0.02	0.23	0.46	0.29	54,278			5.3%
Food Preparation & Serving	0.62	0.53	0.19	0.19	0.06	0.03	0.20	0.14	0.18	0.40	0.33	0.08	16,630			1.6%
Building & Grounds Cleaning & Maintenance	0.35	0.44	0.13	0.39	0.02	0.02	0.37	0.10	0.29	0.41	0.24	0.07	63,202			6.2%
Personal Care & Service	0.83	0.57	0.15	0.21	0.04	0.03	0.20	0.16	0.12	0.30	0.40	0.18	21,126			2.1%
Sales & Related	0.47	0.68	0.09	0.15	0.05	0.03	0.15	0.08	0.07	0.26	0.36	0.32	169,471			16.5%
Farming, Fishing, & Forestry	0.24	0.42	0.04	0.51	0.02	0.02	0.45	0.06	0.44	0.31	0.17	0.08	19,888			1.9%
Construction & Extraction	0.03	0.55	0.06	0.36	0.01	0.02	0.30	0.01	0.24	0.43	0.27	0.06	134,048			13.1%
Installation, Maintenaince, & Repair Workers	0.04	0.67	0.08	0.20	0.03	0.03	0.16	0.01	0.11	0.41	0.40	0.07	68,626			6.7%
Production	0.26	0.57	0.12	0.23	0.06	0.02	0.23	0.06	0.16	0.43	0.32	0.09	112,688			11.0%
Transportation & Material Moving	0.17	0.54	0.17	0.23	0.03	0.03	0.19	0.04	0.16	0.46	0.30	0.07	139,722			13.6%

This table lists demographic characteristics of essential and frontline workers. Essential workers are identified by mapping official industry guidelines issued by the Department of Homeland Security (DHS) on March 28, 2020 to microdata from the 2018 and 2019 American Community Survey. Frontline workers are approximated by their feasibility of work from home in the worker's occupation group (Dingel and Neiman 2020). Shutdown adjusts for industries that were shutdown or running under limited demand early in the COVID crisis (Vavra 2020). Group averages are shown in Panel A. Panel B reports demographic characteristics at the major (2-digit) occupation group level for frontline workers, while Panel C additionally excludes shutdown industries. Demographic characteristics consist of the share of females, racial background (White, Black, Hispanic, Asian, Other Race), immigrant status (foreign born), single mother, and highest educational attainment (less than High-School (HS), HS degree, some college, higher than Bachelor Degree (BA)). Military is excluded as an occupation group, so share does not sum to 100

Table 2 Labor market characteristics of essential and frontline workers: March 2020

	Female Dominated Occ	Male Dominated Occ	Hourly wages ($)	% Low Wage	% High Wage	N	% All	% Frontline	% Frontline excl. Shutdown
Panel A: Group Averages									
All	0.28	0.30	$27.05	0.25	0.25	3,042,378			
Essential	0.26	0.35	$27.10	0.24	0.25	2,128,330	70.0%		
Essential excl. Shutdown	0.26	0.37	$28.42	0.22	0.27	1,809,150	59.5%		
Frontline	0.26	0.44	$22.76	0.30	0.18	1,301,854	42.8%		
Frontline excl. Shutdown	0.24	0.48	$24.00	0.27	0.20	1,025,969	33.7%		
Panel B: Frontline by Occupation Group									
Healthcare Practitioners & Technical	0.70	0.04	$41.30	0.09	0.47	183,208		14.1%	
Healthcare Support	0.99	0.00	$16.33	0.36	0.06	81,774		6.3%	
Protective Service	0.01	0.92	$27.96	0.14	0.30	55,699		4.3%	
Food Preparation & Serving	0.30	0.09	$13.31	0.53	0.04	132,965		10.2%	
Building & Grounds Cleaning & Maintenance	0.24	0.31	$14.23	0.48	0.06	73,099		5.6%	
Personal Care & Service	0.68	0.05	$12.75	0.57	0.05	22,974		1.8%	
Sales & Related	0.26	0.14	$26.11	0.34	0.22	192,579		14.8%	
Farming, Fishing, & Forestry	0.00	0.93	$14.30	0.47	0.05	19,911		1.5%	
Construction & Extraction	0.00	1.00	$20.85	0.28	0.18	135,904		10.4%	
Installation, Maintenaince, & Repair Workers	0.00	1.00	$23.64	0.18	0.22	77,228		5.9%	
Production	0.00	0.50	$20.97	0.20	0.14	134,555		10.3%	
Transportation & Material Moving	0.01	0.78	$19.69	0.31	0.11	180,599		13.9%	
Panel C: Frontline excluding Shutdown by Occupation Group									
Healthcare Practitioners & Technical	0.71	0.02	$40.63	0.09	0.47	175,294			17.1%
Healthcare Support	0.98	0.00	$16.10	0.37	0.05	75,884			7.4%
Protective Service	0.00	0.93	$28.20	0.13	0.31	54,278			5.3%
Food Preparation & Serving	0.05	0.10	$14.22	0.48	0.03	16,630			1.6%
Building & Grounds Cleaning & Maintenance	0.19	0.36	$14.16	0.48	0.06	63,202			6.2%
Personal Care & Service	0.73	0.05	$12.39	0.59	0.05	21,126			2.1%
Sales & Related	0.20	0.15	$27.76	0.31	0.24	169,471			16.5%
Farming, Fishing, & Forestry	0.00	0.93	$14.30	0.47	0.05	19,888			1.9%
Construction & Extraction	0.00	1.00	$20.77	0.28	0.17	134,048			13.1%
Installation, Maintenaince, & Repair Workers	0.00	1.00	$23.20	0.19	0.21	68,626			6.7%
Production	0.00	0.52	$20.88	0.20	0.14	112,688			11.0%
Transportation & Material Moving	0.00	0.79	$18.80	0.29	0.10	139,722			13.6%

This table lists labor market characteristics of essential and frontline workers. Essential workers are identified by mapping official industry guidelines issued by the Department of Homeland Security (DHS) on March 28, 2020 to microdata from the 2018 and 2019 American Community Survey. Frontline workers are approximated by their feasibility of work from home in the worker's occupation group (Dingel and Neiman 2020). Shutdown adjusts for industries that were shutdown or running under limited demand early in the COVID crisis (Vavra 2020). Group averages are shown in Panel A. Panel B reports labor market characteristics at the major (2-digit) occupation group level for frontline workers, while Panel C additionally excludes shutdown industries. Labor market charateristics consist of the share of females, share of workers that work in predominantly female 4-digit occupations (70% or more of workers are female) or predominantly male 4-digit occupations (30% or less of the workers are female), hourly wages (income in 2019 dollars using the CPI divided by the product of usual hours worked per week and the midpoint of usual weeks worked per year), share of workers earning low wages (in the bottom quartile of the overall wage distribution) and high wages (in the top quartile of the overall wage distribution). Military is excluded as an occupation group, so share does not sum to 100

comprised of high school dropouts and a lower share having a college degree or higher. They also have a considerably higher share of Hispanics and a somewhat higher share of Blacks. Immigrants are also disproportionately represented. Average wages of frontline workers ($22.76) are lower than those of all workers and essential workers. A higher share of frontline workers earns low wages (in the bottom quartile) and a smaller share earns high wages (in the top quartile).

As would be expected, health care workers comprise an important share—20% of frontline workers (see Panel B in Tables 1 and 2). Heath care workers include two major occupational categories: (i) healthcare practitioners and technical occupations and (ii) health care support. Practitioners and technical occupations, including doctors, registered nurses and pharmacists (among others), constitute the bulk of health care workers (69%). They are a relatively highly educated, high paying group. While doctors are still a majority male occupation, overall women comprise a majority of health care practitioners (75%). Health support workers, such as nursing assistants and home health aides, constitute the remainder of health care workers. They are an even more heavily female group (86%). In contrast to health care practitioners, they are a relatively less well educated and low wage group. Additionally, this group is majority

non-white (55%, including 25% Black and 20% Hispanic), immigrants are more heavily represented, and a substantial share are single mothers (23% compared to 8% of frontline workers and all workers), suggesting they may face greater childcare burdens.

Sales and related occupations in essential industries also constitute a large share of frontline workers, 15%. Women constitute a little under half of all workers in this occupation group, with a quarter of workers employed in predominantly female occupations. Overall, the average wage is slightly below that for all workers and an above average share earn wages in the bottom quartile. Almost a quarter of workers in this group are cashiers at essential retailers such as grocery stories and general merchandise stores.[12]

A number of heavily male, blue collar categories together constitute a large share of frontline occupations, including transportation and material moving occupations (14%), production occupations (10%), construction and extraction (10%), building and grounds cleaning and maintenance (6%), installation maintenance and repair (6%), as well as farming, fishing and forestry occupations (2%). Average wages for workers in these occupation groups are substantially below the average for all workers.

Protective service occupations constitute another crucial component of the frontline workforce, accounting for 4% of frontline workers. This is a primarily male category that earns about the same wage as the average for all workers.

If we take the estimates of closures and greatly reduced demand into account in measuring the frontline workforce (see Panel A in Tables 1 and 2), the estimated number of frontline workers is substantially reduced—to 34% of all workers. The percent female in the occupation declines slightly to 38% and average wages rise somewhat to $24.00. However, our basic conclusion that the frontline group is disproportionately comprised of less educated, disadvantaged minority (especially Hispanic), and immigrant workers, earning below average wages and with a substantial share of workers in the bottom quartile, remains unchanged. Considering shut down industries is of particular relevance for food preparation and serving occupations which potentially comprise a substantial share of frontline workers (10%), but the smallest share (2%) when taking shut down into account (see Panel C in Tables 1 and 2). While some were working and taking the risk of exposure to clients at the early stage of the pandemic, the majority were not working in these jobs. For both definitions this is a majority female and a very low wage occupation group on average.

[12] In results not shown in the table, cashiers are 72% female, 44% non-white, and 62% earn wages in the lowest quartile of all workers.

6 Educators

The most significant change in the federal guidelines defining essential and thus also frontline workers in December 2020 was the addition of the education sector. Education moved almost universally to virtual instruction in the Spring of 2020, excluding educators from the essential and frontline definitions. By Fall 2020 and into early 2021 many, though far from all, districts and institutions had moved to mixed or in-person instruction.[13] Table 3 shows the demographic and occupational characteristics of workers in education occupations by industry, within the education sector. We focus on this occupation category to provide results that are comparable to those for other occupation groups in Panel B of Tables 1 and 2.[14]

As may be seen in the table, educators are a sizable group, making up 13% of frontline workers and 6% of all workers using the December 2020 definitions. As a whole, educators are more female (72%), more white (72%), and more educated (81% hold a BA or higher) than the labor force as a whole as well as other essential and frontline workers (Table 3, Panel A). The well-above average percent female is driven by the large share who are employees in primary and secondary schools, 78% of whom are female. Educators earn average wages overall and have a lower than average share of low wage workers, with workers in colleges, universities, and professional schools earning well above average wages.

7 Essential and frontline: December 2020

Table 4 replicates Panel A from Tables 1 and 2 adding the group averages for December 2020 essential and frontline workers for comparison.[15] The main difference between the December and earlier March definitions is the inclusion of the education sector. As mentioned above, we do not include shutdown versions of the December definitions. December essential workers make up an even larger share (82%) of the entire workforce and continue to have demographic and labor market characteristics that are almost identical to all workers. Because educators are highly educated, the main difference between March frontline workers and December

[13] According to Dingel and Neiman (2020), 85 % of educators can work from home, which would exclude them from our frontline definition where less than 33% of workers can work at home. We nonetheless include them in our December 2020 frontline worker group because at that time many were teaching in person and were required to do so. As of March 8, 2021, K-12 educators were officially eligible for vaccination in all U.S. states (Robertson 2021).

[14] Overall, workers in education occupations constitute 56.3% of employees in the education sector.

[15] Table 5 shows the share of December frontline for each occupation group, including education occupations.

Table 3 Demographic and Labor Market Characteristics of Workers in Education Occupations (within Education Sector)

Panel A: Education demographics by industry

	% Female	% White	% Black	% Hispanic	% Asian	% Other Race	% Immigrant	% Single Mother	% < HS	% HS	% Some college	% BA or higher
Education	0.72	0.72	0.09	0.11	0.06	0.03	0.14	0.08	0.01	0.05	0.13	0.81
Elementary & secondary schools	0.78	0.73	0.10	0.12	0.03	0.02	0.10	0.09	0.01	0.05	0.12	0.82
Colleges, universities, & professional schools	0.51	0.69	0.07	0.08	0.14	0.03	0.24	0.03	0.01	0.02	0.11	0.86
Business, technical, and trade schools & training	0.57	0.74	0.07	0.11	0.05	0.03	0.14	0.06	0.02	0.14	0.32	0.52
Other schools & instruction, & educational support services	0.67	0.69	0.07	0.11	0.10	0.03	0.16	0.05	0.05	0.09	0.24	0.62

Panel B: education labor market characteristics by industry

	Female dominated Occ	Male dominated Occ	Hourly wages ($)	% Low wage	% High wage	*N*	% All	% Frontline
Education	0.64	0.00	$27.96	0.17	0.27	174,602	5.7%	13.4%
Elementary & secondary schools	0.82	0.00	$26.59	0.15	0.24	128,327	4.2%	9.9%
Colleges, universities, & professional schools	0.13	0.00	$35.46	0.16	0.40	36,651	1.2%	2.8%
Business, technical, & trade schools and training	0.19	0.00	$26.72	0.23	0.28	923	0.0%	0.1%
Other schools and instruction, & educational support services	0.10	0.00	$17.63	0.49	0.13	8701	0.3%	0.7%

This table lists demographic and occupational characteristics of educators (those in NAICS industries 7860, 7870, 7880, and 7890 with occupation code between 2200 and 2555). Demographic charateristics consist of the share of females, racial background (White, Black, Hispanic, Asian, Other Race), immigrant status (foreign born), single mother, and highest educational attainment (less than High-School (HS), HS degree, some college, higher than Bachelor Degree (BA)). Labor market charateristics consist of the share of females, share of workers that work in predominantly female 4-digit occupations (70% or more of workers are female) or predominantly male 4-digit occupations (30% or less of the workers are female), hourly wages (income in 2019 dollars using the CPI divided by the product of usual hours worked per week and the mid-point of usual weeks worked per year), share of workers earning low wages (in the bottom quartile of the overall wage distribution) and high wages (in the top quartile of the overall wage distribution)

Table 4 Demographic and labor market characteristics of essential and frontline workers March v. December 2020

Panel A: demographic characteristics by group

	% Female	% White	% Black	% Hispanic	% Asian	% Other Race	% Immigrant	% Single Mother	% < HS	% HS	% Some College	% BA or higher
All	0.47	0.62	0.12	0.18	0.06	0.03	0.19	0.08	0.09	0.24	0.31	0.35
March 2020—Essential	0.44	0.60	0.12	0.19	0.06	0.03	0.20	0.08	0.10	0.27	0.33	0.30
March 2020—Essential excl. Shutdown	0.44	0.62	0.12	0.18	0.06	0.03	0.19	0.08	0.09	0.26	0.32	0.33
March 2020—Frontline	0.39	0.57	0.13	0.22	0.05	0.03	0.22	0.08	0.14	0.33	0.34	0.19
March 2020—Frontline excl. Shutdown	0.38	0.58	0.13	0.22	0.05	0.03	0.21	0.08	0.13	0.32	0.33	0.21
December 2020—Essential	0.46	0.62	0.12	0.18	0.06	0.03	0.19	0.08	0.09	0.25	0.31	0.34
December 2020—Frontline	0.43	0.58	0.13	0.21	0.05	0.03	0.21	0.08	0.13	0.30	0.32	0.26

Panel B: Occupational characteristics by group

	Female dominated Occ	Male dominated Occ	Hourly wages ($)	% Low wage	% High wage	*N*	% All
All	0.28	0.30	$27.05	0.25	0.25	3,042,378	
March 2020—Essential	0.26	0.35	$27.10	0.24	0.25	2,128,330	70.0%
March 2020—Essential excluding Shutdown	0.26	0.37	$28.42	0.22	0.27	1,809,150	59.5%
March 2020—Frontline	0.26	0.44	$22.76	0.30	0.18	1,301,854	42.8%
March 2020—Frontline excluding Shutdown	0.24	0.48	$24.00	0.27	0.20	1,025,969	33.7%
December 2020—Essential	0.28	0.31	$27.03	0.24	0.25	2,481,637	81.6%
December 2020—Frontline	0.29	0.38	$23.16	0.29	0.19	1,578,959	51.9%

This table lists demographic and occupational characteristics of essential and frontline workers. Essential workers are identified by mapping official industry guidelines issued by the Department of Homeland Security (DHS) on March 28, 2020 and December 16, 2020 to microdata from the 2018 and 2019 American Community Survey. Frontline workers are approximated by their feasibility of work from home in the worker's occupation group (Dingel and Neiman 2020). Shutdown adjusts for industries that were shutdown or running under limited demand early in the COVID crisis (Vavra 2020). Demographic charateristics consist of the share of females, racial background (White, Black, Hispanic, Asian, Other Race), immigrant status (foreign born), single mother, and highest educational attainment (less than High-School (HS), HS degree, some college, higher than Bachelor Degree (BA)). Labor market charateristics consist of the share of females, share of workers that work in predominantly female 4-digit occupations (70% or more of workers are female) or predominantly male 4-digit occupations (30% or less of the workers are female), hourly wages (income in 2019 dollars using the CPI divided by the product of usual hours worked per week and the mid-point of usual weeks worked per year), share of workers earning low wages (in the bottom quartile of the overall wage distribution) and high wages (in the top quartile of the overall wage distribution). Military is excluded as an occupation group, so share does not sum to 100

frontline workers is that 26% of December frontline workers hold a BA or higher while this was true of only 19% of March frontline workers. Overall, however, frontline workers remain less well educated than all workers, with a higher share of workers without a high school degree and a lower share with a BA or higher. The inclusion of workers in the education sector also increases the share of frontline workers who are female, from 39 to 43%, but this remains below the female share of all workers. While there are some differences, our overall conclusions regarding the composition of frontline workers remain the same using the December definitions: frontline workers are, on average, a less educated group, with a higher representation of men, disadvantaged minorities (especially Hispanics), and immigrants, and are lower paid than all workers with a larger share in the low wage quartile.

8 Other estimates

As explained above, our estimates rest on our mapping of the DHS guidelines into NAICS industry codes. In this section, we briefly compare our results to three other studies that provide estimates of essential workers by interpreting the guidelines, Tomer and Kane (2020), Kearney and Pardue (2020)[16] and Selden and Berdahl (2020). Moreover, in mid-January 2021, the CDC published a listing mapping the DHS guidelines into NAICS industry codes (CDC 2021). We used our own mapping based directly on the DHS guidance for our March and December 2020 analyses since the DHS guidelines best represent the state of knowledge at those dates. However, in this section, we also compare our coding to that published by the CDC in January 2021.

Tomer and Kane (2020) estimate that 34% to 43% of the overall workforce may be deemed essential. While notably lower than our estimate of essential workers, their definition is similar to what we call frontline workers, who make up 43% of the total workforce in our estimate (frontline excluding shutdown makes up 34%, similar to the lower bound of their estimate). In addition to excluding several manufacturing industries that we include, Tomer and Kane (2020) additionally exclude restaurants and food services, child care services, agricultural industries, and military that are described as essential by DHS though may not have been fully operational. Like our frontline results, they find these workers face larger risk due to work environments requiring close proximity but earn lower wages and are less likely to have health insurance.

Kearney and Pardue (2020) estimate that 53% of the overall workforce are essential workers. Using our data and their essential industry classification, 63% of the overall workforce would be deemed essential. Their estimate is similar to our "essential excluding shutdown" measure which makes up 60% of the overall workforce. Like our shutdown definition, Kearney and Pardue exclude food services and traveler accommodations. Also in line with our analysis, they find that essential workers are very similar to the overall labor force, but this is not the case when divided by ability to work from home. Those working in person are disproportionately lower wage, less educated, and non-white workers just as our frontline workers are.

Selden and Berdahl (2020) estimate how many adults at increased risk of severe COVID-19 held essential jobs and could not work at home or lived in households with such workers. They use deidentified data from the 2014 to 2017 Medical Expenditure Panel Survey (MEPS) and their interpretation of the federal guidelines yield a similar share of essential workers as our analysis (72% compared to our share of 70%).

Finally, applying the CDC mapping of the DHS guidelines to our data results in 230 of the 287 industries being defined as essential (our December 2020 definition, which uses the same December 2020 guidelines as the CDC mapping, includes 206 industries).[17] Some of the industries they include that we do not are book stores and news dealers, florists, legal services, libraries and archives, museums, and religious organizations. This broader definition means that 92% of the overall workforce is deemed essential and the characteristics of this group are almost identical to the overall population.[18] While this mapping does provide a potential authority, its inclusiveness limits its usefulness to policy makers and researchers and does not appear to reflect the population of essential and frontline workers at the height of the lockdown in March/April 2020.

Overall, we believe our measure of essential workers as well as our step-wise approach narrowing down to frontline workers provides the most complete picture to study those differentially impacted by in person work and exposure to the virus. Additionally, to the best of our knowledge, our paper is first to update results as the guidelines have evolved.

[16] Both studies have publicly shared their coding definitions for replication.

[17] The NAICs codes they include that we exclude are: 337, 3399, 4232, 4239, 4243, 45121, 4531, 45322, 4533, 4539, 45439, 51912, 5242, 5324, 533, 5411, 5413, 5414, 5415, 5419 exc. 54194, 55, 5613, 5614, 6243, 712, 713 exc. 71395, 8114, 8123, 8131, 814. Additionally, we include the military as essential and they do not.

[18] This slightly overestimates the CDC recommended coding as they often drill down to the 6-digit NAICS but the ACS data is coding using the 4-digit NAICS. Consequently, we over-include some industries since we must include the entire 4-digit industry.

9 Discussion and conclusion

During the course of COVID-19, we relied on a subset of essential workers to meet our basic needs while significant portions of the population isolated at home. While some essential workers could themselves work from home, this was not feasible for a significant share of individuals, whom we designate as frontline workers, who must take on considerable risk to do their jobs. Although there is variation within this group, we have found that frontline workers are disproportionately comprised of less educated and disadvantaged minority workers, especially Hispanics, and immigrants, and earn below average wages, with a substantial share of workers in the bottom wage quartile. During the COVID-19 pandemic, these workers, even healthcare workers, faced much higher risks than traditionally incurred in these occupations. Identifying essential and frontline workers and understanding their characteristics is useful for policymakers in targeting social insurance, personal protective equipment, and vaccine distribution in response to the COVID-19 crisis and researchers estimating the impact of the pandemic on different groups.

Appendix

See Table 5.

Table 5 Occupation group as share of December 2020 frontline

Occupation group	*N*	% Dec frontline
Education occupations	194,281	12.3%
Healthcare practitioners and Technical	191,311	12.1%
Healthcare support	82,599	5.2%
Protective service occupations	58,607	3.7%
Food preparation and serving occupations	140,681	8.9%
Building and grounds cleaning and maintenance	84,698	5.4%
Personal care and service	30,429	1.9%
Sales and related	212,110	13.4%
Farming, fishing, and forestry	20,006	1.3%
Construction and extraction	137,182	8.7%
Installation, maintenance, and repair workers	85,846	5.4%
Production	137,013	8.7%
Transportation and material moving	192,837	12.2%

This table lists count of frontline workers by occupational group and share of December Frontline workers. Essential workers are identified by mapping official industry guidelines issued by the Department of Homeland Security (DHS) on December 16, 2020 to microdata from the 2018 and 2019 American Community Survey. Frontline workers are approximated by their feasibility of work from home in the worker's occupation group (Dingel and Neiman 2020). Military is excluded as an occupation group, so share does not sum to 100

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