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RESEARCH ARTICLE

Prevalence of COVID-19 and Long COVID by Industry and Occupation: Behavioral Risk Factor Surveillance System 2022

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ABSTRACT

Background: Workers in healthcare and other essential occupations had elevated risks for COVID-19 infection early in the pandemic. No survey of U.S. workers to date has comprehensively assessed the prevalence of both COVID-19 and Long COVID across industries and occupations (I&O) at a detailed level.

Methods: Behavioral Risk Factor Surveillance System data for 2022 from 39 states, Guam, and the U.S. Virgin Islands were used to estimate prevalence of self-reported history of COVID-19 and Long COVID, as well as the prevalence of Long COVID among those reporting prior COVID-19, by broad and detailed I&O. Adjusted prevalence ratios were used to compare outcome prevalence in each I&O to prevalence among all other workers combined.

Results: By broad I&O, workers in healthcare, protective services, and education had elevated prevalences of COVID-19. The prevalence of Long COVID was elevated in healthcare and protective service but not education workers. Detailed I&O with significantly elevated prevalences of COVID-19 but not Long COVID included Dairy Product Manufacturing industry workers and subsets of mining workers. Both COVID-19 and Long COVID were elevated among bartenders/drinking places and personal care and appearance workers. The prevalence of Long COVID was elevated among farmworkers who reported having had COVID-19.

Conclusions: Industries and occupations with elevated levels of COVID-19 or Long COVID in this study may warrant increased measures to prevent transmission of airborne respiratory viruses. Accommodations are a key component for supporting workers in all workplaces. This new information about the distribution of Long COVID by I&O suggests where employer understanding and implementation of tailored workplace supports and accommodations are most needed to support continued employment of affected workers.

1 | Introduction

The COVID-19 pandemic has led to disruptions in the workplace, including early-pandemic business closures, reduced hours, and increased worker absences due to illness [1, 2]. Additionally, Long COVID and post-COVID conditions have led to job changes, modifications in job duties, reduced work hours, workplace accommodations, and exits from employment for some workers [3–9].

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Not all workers have been at equal risk for COVID-19 illness or for Long COVID. The earliest studies that examined risk of COVID-19 focused on healthcare workers and other subsets of essential workers. Outbreaks of COVID-19 in correctional and food processing facilities brought attention to those industries and occupations [10, 11]. Early in the pandemic, many COVID-19 surveillance systems did not collect industry and occupation (I&O) systematically; research on occupational risk focused instead on workers at increased risk through contact with healthcare patients [12], working closely with coworkers or the public [13, 14], or the inability to work from home [15]. Thus, understanding of the distribution of COVID-19 across industries and occupations was limited.

Surveys that collected information in 2020 and 2021 on self-reported COVID-19 and I&O were informative in filling this gap. Findings include elevated adjusted prevalence ratios for COVID-19 in the Healthcare and Social Assistance industry and three broad occupations: Health Practitioners and Technical; Healthcare Support; and Protective Services [16] and elevated proportionate morbidity ratios for COVID-19 among workers in the service occupations and two broad industry groupings: transportation and utilities, and leisure and hospitality [17]. In addition, state-level case report data revealed that workplace outbreaks in Utah were most likely to occur in the Manufacturing, Construction, and Wholesale Trade sectors [18] and that excess prevalences of COVID-19 in Wisconsin occurred in the Agriculture, Forestry, Fishing and Hunting; Health Care and Social Assistance; and Manufacturing sectors [19].

While identifying large I&O groupings at elevated risk for SARS-COV-2 infection provided a useful starting point for recognizing workforces with greatest needs for prevention efforts, this approach can miss smaller workforces with elevated risks. This is particularly true for sectors like services that span a wide range of workplaces and work activities. To date, only one large study from the United States (U.S.) has assessed the incidence of COVID-19 by I&O at a granular level: in Wisconsin, cumulative incidence of COVID-19 was examined using free-text I&O collected from case investigation interviews and state-run COVID-19 testing sites between September 2020 and May 2021, along with denominators from the 2020 American Community Survey [20]. The study found that while, as in other studies, broad (2-digit SOC) occupational groups like Healthcare Practitioners and Support, Protective Services, and Personal Care and Services had high incidence rates, more granular analysis revealed substantial differences within these broader groups. For example, Physicians had an incidence rate close to the average for all workers (7.8 per 100 full-time equivalents), but Nursing Assistants and Orderlies had a much higher rate of 32.4, with Registered Nurses at an intermediate rate of 19.9 [20]. Although the study did not address reasons for these differences, an analysis of pre-pandemic BRFSS data observed higher prevelances of chronic conditions and lower levels of healthcare coverage and access among nursing, psychiatric, and home health aides (a group encompassing Nursing Assistants and Orderlies) compared to registered nurses [21]. Moreover, the substantially lower wages in groups such as healthcare support workers correlate with higher prevalences of circumstances associated with higher COVID-19 illness rates such as crowded living conditions [22]. These findings highlight the need to examine data at a detailed level to identify and address the distinct risks posed by COVID-19 and Long COVID, in light of health inequities faced by specific sub-groups within larger occupational categories.

Anyone who has had SARS-CoV-2 infection can develop Long COVID. Long COVID can affect multiple organ systems and includes both newly diagnosed diseases such as diabetes and a wide range of symptoms [23, 24]. Because Long COVID can adversely affect the ability to work [24–30], identifying industries and occupations with the highest prevalences of this outcome is important for understanding where mitigation resources are most needed. To date, no large U.S. population-based studies have examined the prevalence of Long COVID by I&O. However, the United Kingdom's Office of National Statistics conducted a survey from February 2021–April 2022 and examined odds of SARS-CoV-2 infection (self-reported and PCR confirmed) and Long COVID symptoms by industry sector groupings, major Standardized Occupational Classification (SOC) code groups, and a new set of occupational groupings based 2-digit SOC codes [31]. Industries with increased odds of Long COVID compared to the general population were teaching and education; social care; healthcare; civil service or local government; retail; and transportation. Occupations with the highest elevations were education and social care; police and protective services, hospitality, and transportation were also elevated [31, 32].

To address these gaps, this study comprehensively assessed the prevalence of COVID-19 and Long COVID across various industries and occupations in the United States using the 2022 Behavioral Risk Factor Surveillance System (BRFSS) data. Comparing prevalences of self-reported COVID-19 and Long COVID at both broad and granular levels of I&O facilitates identification of specific workforces at elevated risk, including smaller workforce segments that may have previously been obscured by aggregation. Identifying occupations and industries with elevated prevalences of COVID-19 may be useful for future efforts to limit transmission of airborne respiratory viruses. In addition, given associations observed between Long COVID and disabilities precluding or limiting work [4], examination of Long COVID prevalence by I&O can identify where accommodations and other resources are likely to be needed to retain employees with Long COVID.

2 | Methods

The core BRFSS survey, administered annually, is a state-based, nationally representative survey of the noninstitutionalized U.S. civilian population aged 18 years and older. The survey collects information about healthcare access, health-related risk behaviors, and health outcomes from all states, the District of Columbia, and three U.S. territories using random-digit dialed landline and cellular telephone calls to conduct the survey. Median U.S. BRFSS response rates for 2022 across states and territories were 46.3% for landline and 44.7% for cellphone. Response rates overall and by the state are found at https://www.cdc.gov/brfss/data_documentation/index.htm.2.1.

The core survey includes a question about employment status: “Are you currently employed for wages, self-employed, out of work for 1 year or more, out of work for less than 1 year, a student, a homemaker, retired, or unable to work?” We included in our study

population respondents who reported their employment status as employed for wages and self-employed (employed and self-employed respondents are referenced together, henceforth, as "workers" or "employed respondents").

In addition to the core survey, BRFSS includes optional modules that states and territories can choose to administer. Data from these modules can be combined with data from the BRFSS core, yielding subnational estimates.

2.1 | Industry and Occupation

Since 2013, I&O have been elicited in an optional module; in 2022, 39 states, Guam, and the U.S. Virgin Islands administered the I&O module. Occupation was elicited through the open-ended question "What kind of work do you do?" and industry by "What kind of business or industry do you work in?" The responses were coded to North American Industry Classification System (NAICS) 2017 and Standard Occupational Classification (SOC) 2018 codes using the National Institute for Occupational Safety and Health's Industry and Occupation Computerized Coding System, with validation of a subset of codes by trained human coder.

NAICS has a hierarchical structure. The least granular groupings, two-digit NAICS codes, reference industry sectors. Three sectors have a range of two-digit codes rather than an individual code: Manufacturing (31–33), Retail Trade (44–45) and Transportation and Warehousing (48–49). Three-digit codes map to subsectors, four-digit codes to industry groups, and 5-digit codes to a NAICS industry. Still more granular 6-digit codes are available but were not used in the current analysis; BRFSS I&O responses infrequently contain detail sufficient for 6-digit coding, leading to low likelihood of statistically reportable results. The NAICS structure and links to the codes are described at https://www.census.gov/programs-surveys/economic-census/year/2022/guidance/understanding-naics.html#par_textimage_0. The 2017 NIACS codes assigned to this BRFSS data set are detailed at https://www.census.gov/naics/?58967?yearbck=2017.

SOC codes have six digits, with increasing numbers of non-zero digits after the first two indicating greater specificity. The first two digits represent a major occupation group, the third and fourth digits together a minor occupation group, the fifth digit a broad occupation group, and the sixth digit a detailed occupation group. Thus, for example, the SOC code 31-0000 is the Healthcare Support Occupations major occupation, 31-1000 the Home Health and Personal Care Aides and Nursing Assistants, Orderlies, and Psychiatric Aides minor occupation; 31-1130 the Nursing Assistants, Orderlies, and Psychiatric Aide broad occupation group, and 31-1133 the Psychiatric Aides detailed occupation group. The full list of 2018 SOC codes can be found at https://www.bls.gov/soc/2018/soc_structure_2018.pdf.

Previous research on the distribution of COVID-19 and Long COVID by I&O has used a variety of coding schemes, including standardized systems such as NAICS, SOC, U.S. Census Industry and Occupation codes, and the United Kingdom's Office of National Statistics (ONS) codes at different levels of granularity, as well as categories developed for specific analyses. Because I&O groups in other coding systems are not coextensive with NAICS and SOC, we henceforth capitalize the standardized NAICS and SOC titles at all levels of granularity and use full lowercase to describe results from other coding schemes. We also use full lowercase as to describe patterns in our results that apply across I&O (e.g., "healthcare" or "healthcare support").

2.2 | COVID-19 and Long COVID Status

In 2022, BRFSS respondents were asked in the core survey, "Has a doctor, nurse, or other health professional ever told you that you tested positive for COVID 19?" Those who said yes or reported they had tested positive on a home test were classified as having a history of COVID-19 and then asked, "Did you have any symptoms lasting 3 months or longer that you did not have prior to having coronavirus or COVID-19?" Those who said "no" to the second question were categorized as "reported COVID-19, no Long COVID" and those who said yes were categorized as "reported COVID-19 and Long COVID." For brevity, we refer to the former henceforth as "COVID-19" and the latter as "Long COVID". Respondents who responded "don't know/not sure" or refused to answer the question about having had COVID-19 were excluded from the study population. Those who reported having had COVID-19 but did not provide information about Long COVID were included in the study population but excluded from analyses of Long COVID.

2.3 | Demographic Characteristics

We examined the demographic distribution of respondents in each COVID-19/Long COVID status by generating weighted prevalences within multiple descriptors: respondent-reported sex (male/female); age in years (18–24, 25–34, 35–44, 45–54, 55–64, ≥ 65); race/Hispanic ethnicity combined (Non-Hispanic (NH) White, Non-Hispanic Black, non-Hispanic Asian, Hispanic, Non-Hispanic other or multiracial), with Hispanic ethnicity including those who identified as Hispanic, Latino/a or Spanish origin); and annual household income (< $15,000, $15,000–< $20,000, $20,000–< $25,000, $25,000–< $35,000, $35,000–< $50,000, $50,000–< $75,000, $75,000–$100,000, $100,000–$150,000, $150,000–$200,000, and ≥ $200,000). Income was missing for 19% of respondents in 2022; we did not adjust for income and therefore did not impute missing values. BRFSS provides imputed values for age and race/Hispanic ethnicity; < 2.5% of responses in each category were missing before imputation. Sex and educational attainment were missing for fewer than 1% of respondents. We used only a subset of these characteristics for adjustment in subsequent modeling: age, race/Hispanic ethnicity, and sex. These characteristics have been strongly associated with COVID-19 illness, with severe COVID-19, or with prevalence of Long COVID [12, 22, 24].

2.4 | Statistical Analyses

We assessed prevalences of ever having had COVID-19 (regardless of whether the respondent developed Long COVID) and ever

having experienced Long COVID by demographic charactersitics, as well as by I&O at different levels of granularity, with a maximum granularity of five digits for NAICS and six digits for SOC. To identify groups disproportionately affected by Long COVID, we also calculated the percentage of Long COVID among those who reported having had COVID-19 (henceforth, "prior COVID-19"). To account for the complex survey design and respondent sampling weights in BRFSS, we conducted all analyses using survey procedures in SAS version 9.4 (SAS Institute Inc.) and SAS-callable SUDAAN version 11.0.1 (RTI International, Research Triangle Park). The BRFSS program provides sampling weights based on state demographic distributions. We aggregated the results to obtain combined estimates across states and territories that administered the I&O module. To estimate population counts and weighted unadjusted prevalences (95% Confidence Intervals [CI]) for all three outcome metrics, we used the SURVEYFREQ procedure. We used Rao-Scott chi-square tests to examine whether prevalences of each outcome differed among categories of each demographic characteristic.

We examined the history of COVID-19 and Long COVID for I&O categories using the RLOGISTIC procedure to perform logistic regression and estimate adjusted prevalence ratios (aPRs). We also generated aPRs comparing the adjusted prevalence of each outcome for each specific industry to the adjusted prevalence for workers in all other industries (except the one being compared) combined. Hence, the aPR compares the prevalence for workers in each group to the expectation based on the prevalence for all other workers combined, after adjustment for age, sex, and race/Hispanic ethnicity. We repeated this process to generate aPRs for each occupation, and for each metric (COVID-19, Long COVID, and Long COVID among those reporting prior COVID-19). aPRs with the lower 95% CI above 1.0 are considered to indicate statistically significant prevalence elevations (i.e., above expected prevalence), while aPRs with the upper 95% CI below 1.0 are considered to be in statistically significant deficit (i.e., below expectation). Prevalence estimates with relative standard errors (RSEs) > 30% or involving cells with fewer than 50 respondents are not reported because they are not considered statically stable and the point estimates, taken alone, may be misleading. However, we report aPRs for cells with RSE > 30%, as aPR is an indicator of prevalence difference, and the statistical significance of an aPR can be unambiguously determined by its 95% CI.

3 | Results

Of 340,326 respondents to the 2022 BRFSS survey, 143,019 reported they were employed and 29,368 said they were self-employed. Of the 172,387 employed or self-employed respondents, 905 were excluded because they were active-duty military (BRFSS data are not representative for this group). Another 105 were excluded because when asked about I&O, they indicated they were retired, not working for pay, or not working because they were disabled. From the 171,356 currently working non-military respondents, 18,748 were not asked whether they had had COVID-19, 168 did not know, and 311 refused to answer the question, leaving 152,129 for analysis. Of the 58,505 respondents reporting they had had COVID-19 (Table 1), 1280 did not provide a response for Long COVID status and were thus included in analyses of COVID-19 but not Long COVID or the Long COVID among those reporting prior COVID-19 metric. The 10.9% ($n = 16,613$) of workers who did not have codable industry (e.g., recorded text was too vague to be assigned a 2-digit or more specific NAICS code) were excluded from the "all other industries combined" comparison group. Likewise, the 15.5% ($n = 23,637$) of workers who did not have codable occupation were excluded from the "all other occupations combined" group. These workers are, however, part of the 152,129 respondents in the analytic data set and are included in the demographic analyses (Table 1).

3.1 | Demographics

Among all workers, self-reported prevalences were 39.9% for COVID-19, 8.5% for Long COVID, and, among workers reporting having had COVID-19, 21.4% for Long COVID (Table 1). Workers most likely to report COVID-19 were aged 25–44 years, female, and had higher household incomes. Hispanic and non-Hispanic other/multiracial respondents were most likely and non-Hispanic Asians respondents least likely to report COVID-19. Patterns were similar for workers reporting Long COVID, except that the prevalence of Long COVID was lowest among those with household incomes over $100,000. Notably, while female respondents were somewhat more likely than males to have had COVID-19 (43.3% vs 37.1%), they were nearly twice as likely to have had Long COVID (11.1% vs. 6.2%). Given these differences, we adjusted for age, sex, and race/Hispanic ethnicity in regression analyses. We did not adjust for income in light of the high percentage of missing data and the potential for overadjustment.

3.1.1 | COVID-19

For each industry sector, prevalences for having had COVID-19 and Long COVID, as well as the prevalence of Long COVID among those who reported having had COVID-19, are shown in Table 2. Table 2 also displays aPRs comparing prevalence in the sector to prevalence among all other workers combined. More granular subsectors, industry groups, and NAICS industries with statistically significant elevations for any of the three outcome metrics are shown, along with results for the corresponding broader groupings (regardless of statistical significance). When a broader grouping is coextensive with a more granular grouping (same number of workers), only results for the broader grouping are displayed. The Supplemental Appendix displays results for all reportable levels of I&O and separately lists subsectors and industry groups for which no results were reportable.

Healthcare and Social Assistance was the sector with the highest prevalence of ever having COVID-19 (47.1%), with a statistically significant aPR elevation comparing this group to workers from all other industries combined. Within the sector, several levels within Nursing and Residential Care, Ambulatory Healthcare Services (Offices of Physicians, Offices of Chiropractors), and Hospitals had prevalences above 50% and/or aPRs with statistically significant elevations.

TABLE 1 | Prevalence of having had COVID-19* and Long COVID** by Demographic Categories: Employed and Self-employed Respondents, Behavioral Risk Factor Surveillance System, 2022***.

Demographic	Category	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents *P* (%)**** (95% CI)	Long COVID among all employed respondents *P* (%)**** (95% CI)	Long COVID among employed respondents who ever tested positive for COVID-19 *P* (%)**** (95% CI)
All		152,129	107,787	39.9 (39.4, 40.4)	8.5 (8.2, 8.7)	21.4 (20.7, 22.1)
Age in years*****	18–24	10,521	11,973	41.6 (39.9, 43.3)	7.9 (7.0, 8.8)	19.0 (17.0, 21.2)
	25–34	25,057	24,579	43.1 (42.0, 44.2)	9.1 (8.4, 9.7)	21.2 (19.8, 22.6)
	35–44	31,613	24,299	42.6 (41.5, 43.7)	9.8 (9.1, 10.5)	23.3 (21.8, 24.8)
	45–54	33,732	21,401	39.5 (38.4, 40.6)	8.6 (8.0, 9.2)	22.1 (20.7, 23.6)
	55–64	33,182	18,327	35.2 (34.1, 36.4)	7.5 (6.8, 8.1)	21.5 (19.9, 23.3)
	≥ 65	18,024	7209	30.3 (28.8, 31.8)	4.8 (4.3, 5.5)	16.2 (14.3, 18.2)
	p value******			< 0.01	< 0.01	< 0.01
Sex*****	Male	80,450	58,409	37.1 (36.4, 37.7)	6.2 (5.9, 6.6)	17.0 (16.1, 17.8)
	Female	71,679	49,378	43.3 (42.5, 44.0)	11.1 (10.6, 11.6)	25.9 (24.9, 27.0)
	p value******			< 0.01	< 0.01	< 0.01
Race/Hispanic ethnicity*****	Non-Hispanic White	113,981	63,927	40.2 (39.6, 40.7)	8.5 (8.2, 8.8)	21.4 (20.7, 22.2)
	Non-Hispanic Black	11,639	11,428	38.8 (37.1, 40.4)	8.0 (7.1, 9.0)	20.8 (18.6, 23.1)
	Non-Hispanic Asian	5089	7249	35.2 (32.7, 37.7)	4.2 (3.1, 5.5)	12.1 (9.1, 15.7)
	Hispanic	15,701	20,340	41.0 (39.5, 42.5)	9.4 (8.6, 10.4)	23.2 (21.2, 25.3)
	Non-Hispanic other or multiracial	5719	4842	41.3 (38.7, 43.9)	10.9 (9.2, 12.7)	26.6 (22.9, 30.5)
	p-value******			< 0.01	< 0.01	< 0.01
Household income*****	< $15,000	2189	2144	28.0 (23.8, 32.4)	8.4 (5.3, 12.5)	30.2 (20.6, 41.2)
	$15,000–< $20,000	2401	2139	33.7 (29.8, 37.7)	8.6 (6.7, 10.7)	25.5 (20.1, 31.6)
	$20,000–< $25,000	4218	3422	34.8 (31.9, 37.9)	9.0 (7.4, 10.8)	25.9 (21.7, 30.5)
	$25,000–< $35,000	11,515	9195	39.1 (37.3, 41.0)	9.8 (8.8, 10.9)	25.3 (22.8, 27.9)
	$35,000–< $50,000	14,999	10,551	38.9 (37.3, 40.5)	9.0 (8.1, 9.9)	23.4 (21.2, 25.6)
	$50,000–< $75,000	22,916	15,156	40.9 (39.6, 42.2)	9.8 (9.0, 10.6)	24.1 (22.4, 25.9)
	$75,000–< $100,000	21,308	14,057	41.9 (40.6, 43.2)	9.3 (8.6, 10.1)	22.5 (20.8, 24.3)

(Continues)

TABLE 1 | (Continued)

Demographic	Category	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents *P* (%)**** (95% CI)	Long COVID among all employed respondents *P* (%)**** (95% CI)	Long COVID among employed respondents who ever tested positive for COVID-19 *P* (%)**** (95% CI)
	$100,000–< $150,000	26,153	1607	43.4 (42.2, 44.6)	8.5 (7.8, 9.3)	19.8 (18.2, 21.5)
	$150,000–< $200,000	12,757	8656	41.1 (39.3, 42.9)	6.7 (5.9, 7.5)	16.4 (14.5, 18.4)
	≥ $200,000	13,727	9785	42.0 (40.3, 43.6)	6.8 (5.9, 7.8)	16.5 (14.4, 18.8)
	p value******			< 0.01	< 0.01	< 0.01

*Respondent replied yes to question "Has a doctor, nurse, or other health professional ever told you that you tested positive for COVID 19?" or reported a positive home test.
**Respondent replied yes to the question "Did you have any symptoms lasting 3 months or longer that you did not have prior to having coronavirus or COVID-19?".
***39 states, Guam, and U.S. Virgin Islands.
****Weighted & unadjusted prevalence (95% CI).
*****Income was missing for 19% of respondents. BRFSS provides imputed values for age and race/ethnicity; < 2.5% of responses in each category were missing before imputation. Sex and educational attainment were missing for fewer than 1% of respondents.
******Rao-Scott chi-square tests for differences within a demographic characteristic for a single column (COVID-19, Long COVID, or Long COVID among respondents reporting having had COVID-19).

Both the Educational Services and Public Administration sectors had prevalences of 43.0% with significantly elevated aPRs. Within Educational Services, the aPR for the Elementary and Secondary Schools subsector was significantly elevated. Within Public Assistance, aPRs for the subsector Justice, Public Order, and Safety Activities and the nested industry groups Correctional Institutions, Police Protection, and Fire Protection were significantly elevated.

Some sectors and subsectors had aPRs that spanned the null but contained more granular groupings with high prevalences of COVID-19 and significantly elevated aPRs. These included the Dairy Product Manufacturing industry group (70.3%); the Coal Mining industry group (67.6%); the Oil and Gas Extraction subsector (49.9%); the Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing industry group (61.2%) and the Other Support Services industry group (59.9%) within Administrative and Support and Waste Management and Remediation Services.

Several sectors had aPRs for COVID-19 with statistically significant deficits: Agriculture, Forestry, Fishing and Hunting; Construction; Transportation and Warehousing; Professional, Scientific, and Technical Services; Administrative and Support and Waste Management and Remediation Services; Arts, Entertainment, and Recreation; and Construction. Of these, Agriculture, Forestry, Fishing and Hunting had the lowest reported prevalence of COVID-19 (30.1%).

3.1.2 | Long COVID

Because having experienced Long COVID was less common than having had COVID-19, prevalences for more industries had RSEs > 30% and were thus not reportable (Table 2). The only sector with a statistically significant elevation for Long COVID was Healthcare and Social Assistance, with a prevalence of 12.0% and aPR = 1.28 (95% CI 1.17–1.40). Within Healthcare and Social Assistance, the Nursing and Residential Care Facilities subsector had the highest prevalence of Long COVID (15.1%); aPRs were significantly elevated for this group of workers and for both the Hospitals and Outpatient Care Centers subsectors. Although the Public Administration sector did not have an elevated aPR, its Justice, Public Order, and Safety Activities subsector did, along with the nested Police Protection, Correctional Institutions, and Fire Protection groupings.

As with COVID-19, some more granular levels of industry had high prevalences of Long COVID or significantly elevated aPRs, although their corresponding sectors did not. These included Transportation Equipment Manufacturing; Broadcasting (except internet); Motor Vehicle Body and Trailer Manufacturing; Lawn and Garden Equipment and Supplies Stores; Other Support Services (under Administrative and Waste Remediation Support Services); Specialty Food Stores; Drinking Places (Alcoholic Beverages); and Personal Care Services (particularly the nested Hair, Nail, and Skin Care Services grouping). For many of the highly granular NAICS groupings,

TABLE 2 | COVID-19* and Long COVID** by North American Industry Classification System (NAICS) code: Employed and self-employed respondents, Behavioral Risk Factor Surveillance System, 2022***.

NAICS code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
All		152,129	107,787	39.9 (39.4, 40.4)	NA	8.5 (8.2, 8.7)	NA	21.4 (20.7, 22.1)	NA
11	Agriculture, Forestry, Fishing & Hunting	4063	1732	30.2 (26.1, 34.6)	*0.79* (*0.69, 0.90*)	7.4 (4.1, 12.0)	0.97 (0.61, 1.55)	24.7 (15.0, 36.8)	1.21 (0.84, 1.76)
21	Mining, Quarrying, & Oil & Gas Extraction	976	569	43.7 (37.1, 50.5)	1.12 (0.97, 1.30)	7.1 (5.0, 9.6)	0.97 (0.71, 1.33)	16.4 (11.5, 22.2)	0.87 (0.64, 1.19)
211	Oil & Gas Extraction	562	331	49.0 (40.5, 57.5)	*1.25* (*1.06, 1.47*)	6.8 (4.4, 10.0)	0.95 (0.64, 1.40)	14.1 (8.8, 21.0)	0.76 (0.51, 1.13)
212	Mining (except Oil & Gas)	120	70	41.9 (23.4, 62.2)	1.06 (0.67, 1.68)	[******]	0.58 (0.20, 1.68)	NR	NR
2121	Coal Mining	53	31	67.6 (45.9, 84.8)	*1.71* (*1.31, 2.23*)	[******]	0.55 (0.17, 1.78)	NR	NR
22	Utilities	1808	1194	40.9 (35.4, 46.6)	1.06 (0.93, 1.20)	7.5 (5.2, 10.4)	1.00 (0.72, 1.39)	18.5 (12.8, 25.4)	0.93 (0.68, 1.29)
23	Construction	10,472	7783	35.0 (33.2, 36.8)	*0.89* (*0.84, 0.94*)	6.3 (5.3, 7.3)	*0.84* (*0.71, 0.98*)	18.0 (15.5, 20.7)	0.95 (0.82, 1.09)
31 - 33	Manufacturing	12,812	8850	40.0 (38.3, 41.7)	1.02 (0.97, 1.06)	7.6 (6.7, 8.5)	0.95 (0.85, 1.07)	19.1 (17.1, 21.2)	0.95 (0.85, 1.06)
311	Food Mfg.	1382	881	43.6 (38.1, 49.2)	1.08 (0.95, 1.22)	8.6 (6.1, 11.8)	1.01 (0.73, 1.39)	19.9 (14.1, 26.8)	0.97 (0.72, 1.32)
3115	Dairy Product Mfg.	67	55	70.3 (45.4, 88.6)	*1.74* (*1.32, 2.31*)	[******]	1.38 (0.53, 3.64)	NR	NR
331	Primary Metal Mfg.	220	191	45.4 (33.3, 58.0)	1.17 (0.90, 1.51)	11.5 (6.2, 19.0)	1.50 (0.89, 2.53)	25.5 (13.2, 41.4)	1.27 (0.75, 2.15)
3311	Iron & Steel Mills & Ferroalloy Mfg.	141	121	36.5 (25.5, 48.6)	0.96 (0.71, 1.30)	[******]	1.71 (0.93, 3.14)	34.9 (19.1, 53.6)	*1.78* (*1.14, 2.79*)
333	Machinery Mfg.	401	256	46.0 (36.3, 55.9)	1.17 (0.97, 1.42)	7.4 (4.1, 11.9)	0.97 (0.60, 1.57)	16.0 (8.9, 25.7)	0.81 (0.50, 1.31)
3334	Ventilation, Heating, Air-Conditioning, & Commercial Refrigeration Equipment Manufacturing	71	68	61.2 (40.1, 79.6)	*1.50* (*1.10, 2.05*)	[******]	1.35 (0.54, 3.34)	NR	NR
336	Transportation Equipment Manufacturing	1727	1234	41.5 (37.5, 45.6)	1.08 (0.98, 1.18)	10.0 (7.6, 12.9)	*1.38* (*1.07, 1.78*)	24.4 (18.9, 30.6)	*1.29* (*1.03, 1.62*)
3362	Motor Vehicle Body & Trailer Manufacturing	54	34	54.6 (37.0, 71.5)	1.35 (0.98, 1.84)	[******]	*2.02* (*1.00, 4.05*)	NR	NR
42	Wholesale Trade	1515	1159	39.6 (34.1, 45.3)	1.01 (0.89, 1.15)	6.2 (4.5, 8.4)	0.79 (0.58, 1.08)	15.7 (11.2, 21.2)	0.77 (0.56, 1.05)
44 - 45	Retail Trade	10,445	7520	39.7 (37.8, 41.6)	0.97 (0.92, 1.02)	8.6 (7.5, 9.7)	0.98 (0.87, 1.12)	21.9 (19.4, 24.5)	1.03 (0.92, 1.16)

(Continues)

TABLE 2 | (Continued)

NAICS code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
444	Building Material & Garden Equipment & Supplies Dealers	725	396	35.8 (29.3, 42.6)	0.91 (0.76, 1.09)	8.7 (5.4, 13.2)	1.11 (0.73, 1.68)	24.8 (15.8, 35.9)	1.26 (0.88, 1.80)
4442	Lawn & Garden Equipment & Supplies Stores	174	69	42.8 (28.6, 57.9)	1.07 (0.77, 1.48)	[******]	*2.31* (*1.10, 4.85*)	NR	NR
445	Food & Beverage Stores	1735	1225	37.9 (33.2, 42.8)	0.92 (0.81, 1.05)	8.3 (5.9, 11.4)	0.94 (0.68, 1.30)	22.2 (16.0, 29.4)	1.05 (0.80, 1.37)
4452	Specialty Food Stores	107	72	51.7 (32.1, 70.9)	1.26 (0.86, 1.85)	[******]	*2.72* (*1.15, 6.45*)	NR	NR
48 - 49	Transportation & Warehousing	6036	4726	35.7 (33.3, 38.0)	*0.91* (*0.85, 0.97*)	7.9 (6.6, 9.4)	1.02 (0.86, 1.21)	22.4 (19.0, 26.1)	1.13 (0.97, 1.31)
51	Information	2401	1598	38.2 (34.5, 42.0)	0.97 (0.88, 1.07)	9.2 (6.9, 12.1)	1.13 (0.86, 1.49)	24.6 (18.8, 31.1)	1.19 (0.93, 1.52)
515	Broadcasting (except Internet)	350	243	42.5 (32.6, 52.9)	1.08 (0.87, 1.35)	15.2 (7.6, 26.0)	*1.85* (*1.07, 3.19*)	36.1 (20.7, 54.0)	*1.62* (*1.03, 2.55*)
52	Finance & Insurance	6506	4342	39.7 (37.5, 41.9)	0.98 (0.92, 1.04)	9.1 (7.9, 10.5)	1.03 (0.89, 1.19)	23.4 (20.4, 26.5)	1.06 (0.93, 1.21)
524	Insurance Carriers & Related Activities	2520	1667	38.7 (35.1, 42.3)	0.94 (0.86, 1.04)	11.6 (9.2, 14.4)	1.24 (0.99, 1.55)	30.3 (24.8, 36.4)	*1.32* (*1.09, 1.60*)
5241	Insurance Carriers	1663	1123	38.1 (33.8, 42.6)	0.92 (0.82, 1.03)	12.2 (9.3, 15.7)	1.28 (0.99, 1.65)	32.4 (25.6, 39.8)	*1.39* (*1.11, 1.74*)
53	Real Estate & Rental & Leasing	3080	2124	40.0 (35.9, 44.1)	1.02 (0.92, 1.12)	8.9 (6.3, 12.2)	1.04 (0.75, 1.44)	22.4 (16.3, 29.5)	1.01 (0.74, 1.36)
54	Professional, Scientific, & Technical Services	9919	6489	36.3 (34.5, 38.1)	*0.91* (*0.87, 0.96*)	5.7 (5.0, 6.5)	*0.69* (*0.60, 0.80*)	16.0 (14.0, 18.2)	*0.77* (*0.67, 0.88*)
55	Management of Companies & Enterprises	193	130	41.1 (26.1, 57.4)	0.98 (0.66, 1.46)	[******]	0.76 (0.33, 1.79)	[******]	0.85 (0.41, 1.77)
56	Administrative & Support & Waste Management & Remediation Services	3484	2702	34.0 (31.0, 37.0)	*0.83* (*0.76, 0.90*)	8.9 (7.2, 10.9)	0.99 (0.81, 1.21)	26.6 (22.0, 31.5)	1.19 (1.00, 1.42)
561	Administrative & Support Services	3152	2515	33.6 (30.5, 36.8)	*0.82* (*0.74, 0.89*)	9.0 (7.2, 11.0)	0.98 (0.79, 1.21)	27.0 (22.1, 32.2)	1.20 (1.00, 1.45)
5619	Other Support Services	73	50	59.9 (42.9, 75.3)	*1.49* (*1.15, 1.93*)	[******]	*3.21* (*1.77, 5.81*)	NR	NR
61	Educational Services	14,469	7558	43.0 (41.3, 44.7)	*1.05* (*1.01, 1.09*)	8.6 (7.7, 9.5)	*0.88* (*0.79, 0.98*)	20.2 (18.3, 22.3)	*0.83* (*0.75, 0.93*)

(Continues)

TABLE 2 | (Continued)

NAICS code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
6111	Elementary & Secondary Schools	10,438	5537	46.2 (44.2, 48.2)	*1.12* (*1.07, 1.17*)	9.5 (8.4, 10.7)	0.94 (0.83, 1.07)	20.8 (18.5, 23.2)	*0.84* (*0.75, 0.95*)
62	Health Care & Social Assistance	22,955	14,864	47.1 (45.7, 48.4)	*1.17* (*1.13, 1.21*)	12.0 (11.0, 12.9)	*1.28* (*1.17, 1.40*)	25.7 (23.9, 27.5)	*1.09* (*1.01, 1.19*)
621	Ambulatory Health Care Services	7189	4728	44.3 (41.8, 46.8)	*1.07* (*1.01, 1.13*)	11.3 (9.7, 13.0)	1.15 (0.99, 1.33)	25.8 (22.5, 29.3)	1.07 (0.94, 1.23)
6211	Offices of Physicians	1357	990	46.1 (40.3, 52.0)	*1.15* (*1.01, 1.30*)	10.2 (7.2, 13.9)	1.09 (0.79, 1.51)	22.9 (16.4, 30.6)	0.95 (0.70, 1.29)
6213	Offices of Other Health Practitioners	422	235	48.5 (36.2, 61.0)	1.20 (0.94, 1.52)	4.7 (2.5, 8.0)	*0.49* (*0.28, 0.85*)	[******]	*0.38* (*0.20, 0.74*)
62131	Offices of Chiropractors	81	65	63.9 (34.6, 87.1)	*1.57* (*1.05, 2.35*)	[******]	*0.09* (*0.02, 0.56*)	NR	NR
6214	Outpatient Care Centers	2646	1482	48.5 (44.6, 52.5)	*1.15* (*1.05, 1.25*)	14.4 (11.0, 18.4)	*1.40* (*1.09, 1.81*)	29.9 (23.4, 36.9)	1.24 (1.00, 1.54)
622	Hospitals	10,703	7017	47.6 (45.7, 49.5)	*1.16* (*1.11, 1.21*)	11.8 (10.5, 13.3)	*1.22* (*1.08, 1.39*)	25.1 (22.4, 27.9)	1.06 (0.94, 1.18)
6221	General Medical & Surgical Hospitals	10,415	6838	47.8 (45.9, 49.7)	*1.16* (*1.11, 1.21*)	11.8 (10.4, 13.3)	*1.22* (*1.08, 1.39*)	25.0 (22.3, 27.8)	1.05 (0.93, 1.18)
623	Nursing & Residential Care Facilities	2295	1491	56.3 (51.9, 60.7)	*1.37* (*1.26, 1.48*)	15.1 (12.2, 18.5)	*1.55* (*1.26, 1.90*)	27.0 (21.9, 32.7)	1.14 (0.94, 1.38)
6231	Nursing Care Facilities (Skilled Nursing Facilities)	1824	1198	58.6 (53.6, 63.5)	*1.43* (*1.31, 1.56*)	16.3 (12.7, 20.3)	*1.65* (*1.31, 2.07*)	27.9 (22.0, 34.4)	1.16 (0.94, 1.45)
71	Arts, Entertainment, & Recreation	2279	1444	35.9 (32.3, 39.7)	*0.89* (*0.80, 0.99*)	7.3 (5.7, 9.1)	0.85 (0.68, 1.06)	20.4 (16.2, 25.1)	0.97 (0.79, 1.19)
72	Accommodation & Food Services	5804	5190	43.8 (41.3, 46.4)	1.05 (0.99, 1.12)	8.9 (7.6, 10.4)	0.98 (0.83, 1.15)	20.5 (17.5, 23.7)	0.93 (0.80, 1.08)
722	Food Services & Drinking Places	4965	4615	44.0 (41.4, 46.7)	1.05 (0.99, 1.12)	9.1 (7.7, 10.8)	1.01 (0.85, 1.19)	20.9 (17.7, 24.4)	0.95 (0.81, 1.12)
7224	Drinking Places (Alcoholic Beverages)	146	98	49.2 (33.2, 65.3)	1.17 (0.85, 1.62)	21.0 (10.3, 35.9)	*2.30* (*1.30, 4.05*)	43.1 (20.0, 68.6)	*1.98* (*1.16, 3.37*)
81	Other Services (except Public Administration)	6505	4436	39.0 (36.6, 41.4)	0.95 (0.89, 1.02)	9.5 (8.1, 11.0)	1.05 (0.90, 1.23)	24.5 (21.2, 28.1)	1.11 (0.96, 1.29)
812	Personal & Laundry Services	1515	1174	44.2 (39.2, 49.4)	1.05 (0.93, 1.17)	12.5 (9.2, 16.6)	1.26 (0.93, 1.70)	28.7 (21.4, 36.8)	1.22 (0.92, 1.60)

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TABLE 2 | (Continued)

NAICS code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
8121	Personal Care Services	862	714	49.0 (42.4, 55.7)	1.14 (0.99, 1.31)	17.1 (12.0, 23.3)	*1.64* (*1.16, 2.31*)	35.2 (25.4, 46.0)	*1.44* (*1.05, 1.97*)
81211	Hair, Nail, & Skin Care Services	669	606	49.5 (42.0, 57.0)	1.16 (0.99, 1.35)	16.8 (11.0, 23.9)	*1.61* (*1.09, 2.39*)	34.2 (23.3, 46.5)	1.40 (0.97, 2.01)
92	Public Administration	9794	5205	43.0 (40.9, 45.1)	*1.08* (*1.03, 1.14*)	9.9 (8.6, 11.2)	*1.15* (*1.00, 1.32*)	23.2 (20.5, 26.1)	1.08 (0.96, 1.22)
922	Justice, Public Order, & Safety Activities	2571	1529	50.2 (45.8, 54.6)	*1.26* (*1.16, 1.38*)	13.0 (10.1, 16.4)	*1.57* (*1.24, 1.99*)	26.0 (20.8, 31.9)	*1.25* (*1.01, 1.54*)
92212	Police Protection	1146	758	47.0 (40.0, 54.1)	*1.19* (*1.03, 1.37*)	13.0 (9.0, 17.9)	*1.61* (*1.16, 2.23*)	27.8 (20.2, 36.3)	*1.33* (*1.00, 1.77*)
92214	Correctional Institutions	464	258	59.3 (50.9, 67.2)	*1.48* (*1.28, 1.70*)	14.3 (9.7, 20.0)	*1.64* (*1.15, 2.34*)	24.4 (16.6, 33.6)	1.17 (0.84, 1.63)
92216	Fire Protection	416	261	56.1 (45.8, 66.0)	*1.40* (*1.19, 1.66*)	[******]	*2.11* (*1.12, 4.00*)	[******]	1.48 (0.86, 2.56)

Abbrevation: aPR, adjusted prevalence ratio.

Note: Listing includes all sectors and subcategories with $N >= 50$ and a significantly elevated aPR for any of the three outcomes. Cells labeled "NR" for "not reportable" have fewer than 50 respondents. See online appendix for reportable results for all 2-to-5-digit NAICS codes.

Italicization indicates aPR elevation or deficit comparing adjusted prevalence for the industry to that for all other industries combined is statistically significant.

*Respondent replied yes to question "Has a doctor, nurse, or other health professional ever told you that you tested positive for COVID 19?" or reported a positive home test.

**Respondent replied yes to the question "Did you have any symptoms lasting 3 months or longer that you did not have prior to having coronavirus or COVID-19?".

***39 states, Guam, and U.S. Virgin Islands.

****Weighted & unadjusted prevalence (95% CI).

*****aPR (95% CI) for industry compared to all other industries combined, adjusted for age, sex, and race/Hispanic ethnicity.

******Not reportable because relative standard error > 30%.

the aPRs were reportable but prevalences of Long COVID were not.

Sectors with the lowest prevalences of Long COVID were Wholesale Trade (6.2%) and Construction (6.3%). Only the deficit for Construction was statistically significant.

3.1.3 | Long COVID Among Employed Respondents Who Reported Having Had COVID-19

The third metric was Long COVID among workers reporting prior COVID-19 (Table 2). Two sectors had prevalences of at least 25% for this metric: Administrative and Support and Waste Management and Remediation Services; and Healthcare and Social Assistance. The aPR was statistically significant only for the latter. Subsectors with statistically significant elevations were Transportation and Equipment Manufacturing; Broadcasting (except internet); Insurance Carriers and Related; and Justice and Public Order, and Safety Activities (and the nested Police Protection group). More granular groups with very high prevalences were Drinking Places (Alcoholic Beverages) at 43.1%, followed by Personal Care Services (35.2%). In addition, Iron and Steel Mills and Ferroalloy Manufacturing had a prevalence of nearly 35% and the highest aPR (1.78, 95% CI 1.14, 2.79).

Despite having an elevated aPR for COVID-19, the Educational Services sector had an aPR significantly below expectation for Long COVID among workers reporting prior COVID-19. The Professional, Scientific, and Technical Services sector also had a statistically significant deficit for this metric.

3.2 | Occupation

3.2.1 | COVID-19

Findings by occupation (Table 3) largely mirrored those by industry, with self-reported prevalences of at least 44% for COVID-19 among five broad occupations: Healthcare Practitioners and Technical Occupations; Healthcare Support Occupations; Community and Social Services Occupations; Protective Services Occupations; and Educational Instruction and Library Occupations. Within healthcare, more granular groupings with statistically significant aPR elevations included Therapists; Registered Nurses; Nurse Practitioners; Licensed Practical and Licensed Vocational Nurses; Emergency Medical Technicians; Surgical Technologists; Nursing Assistants, Orderlies, and Psychiatric Aides; Occupational Therapy and Physical Therapists Assistants and Aides; and Other Healthcare Support Occupation. Healthcare Social Workers had the highest prevalence of COVID-19 (65.7%).

As with industries, some more granular occupations had statistically significant elevations, although the corresponding broader groupings did not. These included four subgroups of Food Preparation and Serving Related Occupations: Chefs and Head Cooks; Cooks, Institution and Cafeteria; Bartenders; and Food Servers, Nonrestaurant. Within Life Scientists, Zoologists and Wildlife Biologists had a significantly elevated aPR and a prevalence above 60%; the same was true for several groups within Personal Care and Service: the nested Personal Appearance Workers and its component Barbers, Hairdressers, Hairstylists, and Cosmetologists detailed occupations had significantly elevated aPRs, as did the detailed occupation, Barbers. The Extraction Workers minor occupation grouping had a statistically significant aPR elevation, as did the nested groups Extraction Workers, Underground Mining Operators, and Miscellaneous Extraction Workers. Within Food Processing Workers, the aPR was significantly elevated only for the Food Processing Workers, All Other grouping. Across levels of granularity, the highest aPR (1.71, 95% CI 1.36–2.16) was for Airline Pilots, Copilots, and Flight Engineers. Other occupations with elevations can be found in Table 3.

The lowest prevalence of COVID-19 among major occupational groupings was observed for Farming, Fishing, and Forestry Occupations (27.0%).

3.2.2 | Long COVID

The major occupational group reporting the highest prevalence of Long COVID was Healthcare Support Occupations (12.2%); the prevalence for the nested group Nursing Assistants, Orderlies and Psychiatric Aides was even higher (16.0%). Healthcare Practitioners and Technical Occupations had a prevalence of 11.6%; aPRs were significantly elevated for this category and the nested Healthcare Diagnosing or Treating Occupations (primarily reflecting an elevation among the largest subgroup, Registered Nurses). As with COVID-19, Community and Social Services Occupations and several nested groups had significantly elevated aPRs for Long COVID, as did Substance Abuse Counselors.

Protective Service Occupations had a significantly elevated aPR for Long COVID, along with many subgroups. aPRs for the Personal Appearance Workers minor occupation and the nested Barbers, Hairdressers, Hairstylists and Cosmetologists grouping had statistically significant elevations; for Barbers, the aPR exceeded 4.0. Other granular groups with elevated aPRs included several Assembler and Fabricator subgroups, along with Supervisors of Building and Grounds Cleaning and Maintenance Workers and its nested group First-Line Supervisors of Housekeeping & Janitorial Workers. Pest Control Workers group had a statistically significant aPR elevation above 3.0. Bartenders had the highest prevalence of Long COVID (19.8%); the aPR was above 2.0 and statistically significant. Other occupations with elevations can be found in Table 3.

The major occupational group with the lowest prevalence of Long COVID was Architecture and Engineering Occupations (4.7%). Significant deficits were also seen in Computer and Mathematical Occupations, Business and Financial Operations Occupations, and Legal Occupations major occupational groups. Despite the significant elevation for COVID-19,

TABLE 3 | COVID-19* and Long COVID** by Standardized Occupational Classification (SOC) code: Employed and Self-Employed Respondents Behavioral Risk Factor Surveillance System 2022***.

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
All		152,129	107,787	39.9 (39.4, 40.4)	NA	8.5 (8.2, 8.7)	NA	21.4 (20.7, 22.1)	NA
11-0000	Management Occupations	15571	8756	40.0 (38.4, 41.7)	1.03 (0.98, 1.07)	8.3 (7.3, 9.3)	1.01 (0.89, 1.14)	20.9 (18.7, 23.3)	0.98 (0.88, 1.10)
11-3000	Operations Specialties Managers	2446	1577	42.4 (38.6, 46.3)	1.09 (0.99, 1.19)	7.7 (6.1, 9.6)	0.97 (0.78, 1.20)	18.4 (14.6, 22.6)	0.91 (0.73, 1.12)
11-3050	Industrial Production Managers	206	139	50.4 (37.9, 62.8)	*1.29* (*1.03, 1.61*)	[******]	1.47 (0.72, 3.03)	[******]	1.07 (0.52, 2.21)
11-9000	Other Management Occupations	10,859	5758	39.4 (37.4, 41.4)	1.01 (0.96, 1.06)	8.6 (7.3, 9.9)	1.04 (0.90, 1.21)	22.0 (19.1, 25.1)	1.02 (0.89, 1.17)
11-9030	Education & Childcare Administrators	984	513	42.6 (36.5, 48.8)	1.05 (0.91, 1.21)	7.5 (4.8, 11.1)	0.80 (0.54, 1.18)	17.9 (11.6, 25.7)	0.75 (0.52, 1.09)
11-9039	Education Administrators, All Other	176	99	53.7 (40.4, 66.7)	*1.33* (*1.05, 1.67*)	[******]	1.00 (0.45, 2.21)	[******]	0.76 (0.36, 1.61)
11-9050	Food Service Managers	734	496	48.8 (42.0, 55.7)	*1.21* (*1.05, 1.39*)	8.2 (5.1, 12.3)	0.96 (0.63, 1.44)	17.0 (10.6, 25.1)	0.78 (0.52, 1.17)
11-9110	Medical & Health Services Managers	1036	641	47.6 (41.1, 54.2)	*1.19* (*1.04, 1.36*)	13.4 (7.9, 20.7)	1.48 (0.95, 2.30)	28.5 (18.0, 41.1)	1.25 (0.87, 1.81)
13-0000	Business & Financial Operations Occupations	8019	4953	41.8 (39.7, 44.0)	1.04 (0.98, 1.09)	7.7 (6.7, 8.8)	*0.84* (*0.73, 0.97*)	18.6 (16.2, 21.1)	*0.81* (*0.70, 0.93*)
13-1000	Business Operations Specialists	4943	3119	42.9 (40.3, 45.5)	1.05 (0.99, 1.12)	8.3 (7.1, 9.8)	0.90 (0.77, 1.06)	19.7 (16.8, 22.9)	0.86 (0.74, 1.01)
13-1070	Human Resources Workers	788	501	49.2 (42.9, 55.6)	*1.18* (*1.03, 1.34*)	11.1 (7.7, 15.3)	1.12 (0.80, 1.57)	22.8 (15.9, 31.0)	0.98 (0.71, 1.35)
13-1071	Human Resources Specialists	769	489	49.0 (42.5, 55.5)	*1.17* (*1.02, 1.34*)	11.3 (7.8, 15.7)	1.14 (0.81, 1.59)	23.4 (16.3, 31.8)	1.00 (0.72, 1.39)
13-2000	Financial Specialists	3076	1833	40.0 (36.3, 43.7)	1.00 (0.92, 1.10)	6.5 (4.9, 8.4)	0.74 (0.57, 0.96)	16.5 (12.5, 21.1)	0.72 (0.56, 0.94)
13-2080	Tax Examiners, Collectors &	154	110	44.8 (29.3, 61.1)	1.12 (0.80, 1.57)	[******]	1.94 (0.84, 4.48)	[******]	1.71 (0.86, 3.40)

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
	Preparers, & Revenue Agents								
13-2081	Tax Examiners & Collectors, & Revenue Agents	53	55	[******]	1.05 (0.58, 1.91)	[******]	*2.85* (*1.06, 7.64*)	NR	NR
15-0000	Computer & Mathematical Occupations	5773	3885	32.9 (30.6, 35.3)	*0.85* (*0.79, 0.91*)	5.8 (4.7, 7.1)	0.82 (0.67, 1.00)	17.8 (14.6, 21.3)	0.98 (0.81, 1.17)
17-0000	Architecture & Engineering Occupations	4303	2738	36.3 (33.6, 39.0)	0.96 (0.89, 1.03)	4.7 (3.7, 5.8)	*0.69* (*0.56, 0.86*)	13.1 (10.5, 16.1)	*0.73* (*0.59, 0.90*)
19-0000	Life, Physical, & Social Science Occupations	2511	1289	34.8 (30.9, 38.9)	*0.87* (*0.78, 0.97*)	6.3 (4.6, 8.5)	0.77 (0.57, 1.03)	18.5 (13.6, 24.2)	0.89 (0.67, 1.17)
19-1000	Life Scientists	676	335	34.2 (26.3, 42.7)	0.85 (0.68, 1.08)	7.0 (3.9, 11.4)	0.83 (0.50, 1.37)	20.7 (11.7, 32.5)	0.99 (0.62, 1.56)
19-1020	Biological Scientists	173	78	48.2 (28.7, 68.0)	1.24 (0.85, 1.82)	[******]	0.69 (0.28, 1.69)	[******]	0.57 (0.22, 1.52)
19-1023	Zoologists & Wildlife Biologists	53	32	61.6 (28.4, 88.3)	*1.62* (*1.05, 2.50*)	[******]	0.38 (0.07, 2.26)	NR	NR
19-5000	Occupational Health & Safety Specialists & Technicians	92	47	53.8 (31.7, 74.9)	1.36 (0.94, 1.96)	[******]	0.98 (0.45, 2.12)	NR	NR
19-5011	Occupational Health & Safety Specialists	82	43	56.9 (33.9, 78.0)	*1.44* (*1.01, 2.04*)	[******]	0.98 (0.45, 2.12)	NR	NR
21-0000	Community & Social Service Occupations	3502	1727	45.6 (42.4, 48.7)	*1.11* (*1.03, 1.19*)	11.6 (9.8, 13.6)	*1.20* (*1.02, 1.42*)	25.8 (22.1, 29.8)	1.11 (0.95, 1.28)
21-1000	Counselors, Social Workers, & Other Community & Social Service Specialists	2907	1466	46.8 (43.4, 50.1)	*1.12* (*1.04, 1.20*)	12.1 (10.1, 14.4)	*1.21* (*1.01, 1.44*)	26.4 (22.3, 30.7)	1.10 (0.93, 1.29)
21-1010	Counselors	921	421	42.6 (36.7, 48.5)	1.02 (0.89, 1.17)	12.2 (8.4, 17.1)	1.25 (0.89, 1.75)	29.1 (20.8, 38.7)	1.25 (0.93, 1.67)

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
21-1011	Substance Abuse & Behavioral Disorder Counselors	79	35	46.6 (29.3, 64.6)	1.15 (0.80, 1.64)	[******]	*2.14* (*1.01, 4.52*)	NR	NR
21-1020	Social Workers	1399	721	50.5 (45.7, 55.2)	*1.20* (*1.09, 1.32*)	13.5 (10.5, 16.9)	*1.31* (*1.03, 1.65*)	27.0 (21.5, 33.1)	1.10 (0.89, 1.37)
21-1022	Healthcare Social Workers	87	46	65.7 (47.8, 80.9)	*1.56* (*1.21, 2.03*)	[******]	1.18 (0.51, 2.75)		
21-1029	Social Workers, All Other	1097	569	51.4 (46.0, 56.8)	*1.22* (*1.10, 1.36*)	14.6 (11.1, 18.7)	*1.43* (*1.11, 1.85*)	28.8 (22.3, 36.0)	1.18 (0.93, 1.49)
23-0000	Legal Occupations	2033	1163	38.9 (35.0, 43.0)	0.98 (0.89, 1.09)	6.5 (4.8, 8.5)	0.75 (0.57, 1.00)	17.1 (12.8, 22.2)	0.80 (0.61, 1.06)
25-0000	Educational Instruction & Library Occupations	9249	4581	44.3 (42.2, 46.4)	*1.07* (*1.02, 1.13*)	8.8 (7.7, 10.0)	0.88 (0.77, 1.01)	20.1 (17.7, 22.7)	*0.83* (*0.72, 0.94*)
25-2000	Preschool, Elementary, Middle, Secondary, & Special Education Teachers	5975	2980	48.2 (45.6, 50.7)	*1.15* (*1.09, 1.22*)	9.2 (7.9, 10.6)	0.89 (0.77, 1.04)	19.3 (16.6, 22.1)	*0.78* (*0.67, 0.90*)
25-2020	Elementary & Middle School Teachers	4170	2113	49.3 (46.2, 52.4)	*1.18* (*1.10, 1.26*)	9.3 (7.7, 11.0)	0.89 (0.74, 1.07)	19.0 (15.8, 22.4)	*0.76* (*0.64, 0.91*)
25-2030	Secondary School Teachers	1281	591	46.9 (41.5, 52.4)	*1.14* (*1.02, 1.28*)	7.0 (5.1, 9.4)	*0.74* (*0.55, 1.00*)	15.2 (10.8, 20.4)	*0.65* (*0.47, 0.89*)
25-3000	Other Teachers & Instructors	559	329	36.1 (25.1, 48.3)	0.87 (0.63, 1.21)	12.5 (6.8, 20.5)	1.37 (0.82, 2.29)	34.6 (17.5, 55.4)	*1.65* (*1.04, 2.63*)
25-3090	Miscellaneous Teachers & Instructors	246	140	32.3 (21.4, 44.8)	0.79 (0.55, 1.13)	[******]	1.75 (0.88, 3.49)	49.7 (29.2, 70.3)	*2.30* (*1.46, 3.62*)
27-0000	Arts, Design, Entertainment, Sports, & Media Occupations	3098	1851	36.2 (33.0, 39.6)	*0.90* (*0.82, 0.99*)	7.1 (5.5, 9.0)	0.82 (0.64, 1.05)	19.9 (15.6, 24.8)	0.93 (0.75, 1.16)
27-4000	Media & Communication Equipment Workers	305	220	40.8 (31.5, 50.7)	1.03 (0.82, 1.30)	[******]	1.71 (0.94, 3.10)	33.7 (18.6, 51.8)	*1.71* (*1.08, 2.70*)

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
27-4010	Broadcast, Sound, & Lighting Technicians	112	74	47.6 (32.2, 63.3)	1.22 (0.89, 1.66)	[******]	*3.03* (*1.52, 6.02*)	NR	NR
29-0000	Healthcare Practitioners & Technical Occupations	10,915	6674	48.8 (46.9, 50.7)	*1.20* (*1.15, 1.25*)	11.6 (10.5, 12.9)	*1.21* (*1.08, 1.36*)	24.1 (21.9, 26.5)	1.02 (0.92, 1.13)
29-1000	Healthcare Diagnosing or TreatingPractitioners	8926	5277	49.8 (47.7, 51.9)	*1.22* (*1.17, 1.28*)	11.8 (10.4, 13.2)	*1.22* (*1.08, 1.38*)	23.9 (21.3, 26.6)	1.01 (0.90, 1.14)
29-1120	Therapists	1039	572	50.4 (44.1, 56.7)	*1.20* (*1.05, 1.37*)	10.9 (7.8, 14.6)	1.08 (0.80, 1.47)	21.7 (15.7, 28.8)	0.90 (0.67, 1.20)
29-1129	Therapists, All Other	347	160	56.0 (47.0, 64.7)	*1.32* (*1.12, 1.55*)	11.7 (7.3, 17.5)	1.13 (0.74, 1.72)	21.1 (13.2, 31.0)	0.86 (0.57, 1.30)
29-1140	Registered Nurses	4974	3034	52.9 (50.2, 55.6)	*1.27* (*1.20, 1.35*)	13.8 (12.0, 15.9)	*1.37* (*1.18, 1.59*)	26.4 (23.0, 29.9)	1.09 (0.95, 1.25)
29-1170	Nurse Practitioners	339	148	58.2 (49.2, 66.8)	*1.37* (*1.17, 1.61*)	16.0 (8.7, 26.1)	1.49 (0.89, 2.50)	27.8 (15.7, 42.8)	1.12 (0.70, 1.78)
29-2000	Health Technologists & Technicians	1943	1371	45.1 (40.6, 49.7)	1.07 (0.97, 1.18)	11.2 (8.9, 13.9)	1.15 (0.93, 1.42)	25.2 (20.5, 30.4)	1.06 (0.87, 1.28)
29-2040	Emergency Medical Technicians & Paramedics	320	250	50.6 (32.6, 68.4)	1.23 (0.88, 1.72)	12.1 (6.3, 20.6)	1.47 (0.90, 2.42)	24.2 (14.5, 36.3)	1.15 (0.76, 1.73)
29-2042	Emergency Medical Technicians	179	133	60.6 (48.0, 72.2)	*1.46* (*1.19, 1.78*)	[******]	1.45 (0.77, 2.75)	[******]	1.00 (0.55, 1.81)
29-2050	Health Practitioner Support Technologists & Technicians	469	349	43.0 (36.0, 50.2)	0.98 (0.82, 1.16)	10.8 (6.6, 16.5)	1.01 (0.65, 1.58)	25.3 (16.1, 36.5)	1.04 (0.69, 1.56)
29-2055	Surgical Technologists	55	39	61.2 (40.4, 79.5)	*1.41* (*1.00, 1.98*)	[******]	1.01 (0.37, 2.72)	NR	NR
29-2060	Licensed Practical & Licensed Vocational Nurses	287	241	58.8 (47.1, 69.7)	*1.41* (*1.16, 1.71*)	15.2 (9.1, 23.2)	1.47 (0.95, 2.28)	26.0 (15.6, 38.8)	1.02 (0.67, 1.57)
31-0000	Healthcare Support Occupations	3820	2972	45.3 (42.1, 48.6)	1.07 (0.99, 1.16)	12.2 (10.2, 14.5)	*1.21* (*1.01, 1.44*)	27.2 (23.0, 31.7)	1.13 (0.96, 1.33)

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
31-1100	Home Health & Personal Care Aides; & Nursing Assistants, Orderlies, & Psychiatric Aides	2859	2173	43.3 (39.5, 47.1)	1.03 (0.94, 1.13)	11.8 (9.5, 14.4)	1.18 (0.95, 1.45)	27.4 (22.4, 32.9)	1.15 (0.95, 1.40)
31-1130	Nursing Assistants, Orderlies, & Psychiatric Aides	1044	788	55.6 (49.4, 61.7)	*1.32* (*1.18, 1.48*)	16.0 (11.3, 21.8)	*1.58* (*1.15, 2.17*)	28.9 (20.7, 38.3)	1.21 (0.89, 1.63)
31-1131	Nursing Assistants	966	739	56.1 (49.6, 62.5)	*1.33* (*1.18, 1.50*)	16.5 (11.5, 22.7)	*1.62* (*1.16, 2.25*)	29.5 (20.9, 39.4)	1.23 (0.90, 1.67)
31-2000	Occupational Therapy & Physical Therapist Assistants & Aides	62	38	66.9 (41.1, 86.9)	*1.63* (*1.12, 2.39*)	[******]	0.79 (0.30, 2.07)	NR	NR
31-9000	Other Healthcare Support	899	761	50.1 (43.8, 56.5)	*1.15* (*1.01, 1.32*)	13.8 (9.6, 19.0)	1.28 (0.92, 1.78)	27.6 (19.7, 36.7)	1.10 (0.81, 1.49)
31-9090	Miscellaneous Healthcare Support	729	673	51.0 (44.0, 57.9)	*1.17* (*1.01, 1.35*)	14.5 (9.8, 20.3)	1.34 (0.94, 1.90)	28.5 (19.9, 38.5)	1.13 (0.82, 1.56)
31-9092	Medical Assistants	356	332	57.7 (47.9, 67.0)	*1.33* (*1.11, 1.59*)	12.1 (7.1, 18.8)	1.06 (0.67, 1.69)	21.0 (12.4, 32.2)	0.80 (0.50, 1.28)
33-0000	Protective Service Occupations	2438	1690	44.4 (40.1, 48.8)	*1.15* (*1.04, 1.26*)	10.7 (8.1, 13.8)	*1.44* (*1.11, 1.85*)	24.2 (18.9, 30.2)	*1.26* (*1.01, 1.56*)
33-1010	First-Line Supervisors of Law Enforcement Workers	64	26	61.3 (42.5, 77.9)	*1.63* (*1.24, 2.12*)	[******]	0.94 (0.30, 2.98)	NR	NR
33-2000	Firefighting & Prevention Workers	364	238	57.1 (45.8, 67.8)	*1.43* (*1.20, 1.72*)	[******]	*2.06* (*1.00, 4.23*)	[******]	1.42 (0.75, 2.67)
33-2010	Firefighters	339	218	56.8 (44.9, 68.1)	*1.43* (*1.18, 1.73*)	[******]	*2.22* (*1.08, 4.57*)	[******]	1.54 (0.84, 2.84)
33-3000	Law Enforcement Workers	1165	764	50.4 (43.3, 57.4)	*1.29* (*1.12, 1.48*)	13.3 (9.4, 18.1)	*1.72* (*1.25, 2.35*)	26.5 (19.4, 34.7)	*1.32* (*1.01, 1.73*)
33-3010	Bailiffs, Correctional Officers, & Jailers	245	137	56.1 (44.8, 67.0)	*1.41* (*1.16, 1.71*)	16.5 (9.9, 25.1)	*1.99* (*1.28, 3.09*)	29.3 (17.6, 43.5)	1.40 (0.92, 2.13)
33-3012	Correctional Officers & Jailers	233	133	56.1 (44.5, 67.3)	*1.41* (*1.15, 1.72*)	16.9 (10.1, 25.8)	*2.05* (*1.31, 3.19*)	30.2 (18.1, 44.8)	1.45 (0.95, 2.20)

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
33-3050	Police Officers	826	570	49.2 (40.3, 58.2)	*1.27* (*1.06, 1.51*)	12.9 (8.1, 19.2)	*1.69* (*1.12, 2.53*)	26.3 (17.3, 36.9)	1.33 (0.94, 1.88)
33-3051	Police & Sheriff's Patrol Officers	825	570	49.2 (40.3, 58.2)	*1.27* (*1.06, 1.51*)	12.9 (8.1, 19.2)	*1.69* (*1.12, 2.53*)	26.3 (17.3, 36.9)	1.33 (0.94, 1.88)
35-0000	Food Preparation & Serving Related Occupations	3605	3095	43.5 (40.3, 46.6)	1.04 (0.97, 1.13)	9.2 (7.6, 11.1)	1.02 (0.84, 1.23)	21.4 (17.8, 25.4)	0.97 (0.81, 1.16)
35-1011	Chefs & Head Cooks	381	379	49.7 (39.0, 60.4)	*1.24* (*1.01, 1.51*)	9.1 (4.9, 15.1)	1.13 (0.68, 1.90)	18.3 (9.3, 30.6)	0.92 (0.55, 1.53)
35-2000	Cooks & Food Preparation Workers	1455	1252	41.7 (36.5, 47.0)	1.01 (0.89, 1.14)	9.7 (7.0, 13.2)	1.07 (0.79, 1.46)	23.6 (17.2, 31.1)	1.06 (0.80, 1.41)
35-2010	Cooks	1112	965	42.3 (36.2, 48.5)	1.03 (0.89, 1.19)	9.4 (6.3, 13.5)	1.06 (0.73, 1.52)	22.5 (15.3, 31.2)	1.02 (0.72, 1.43)
35-2012	Cooks, Institution & Cafeteria	225	136	52.5 (40.3, 64.4)	*1.30* (*1.03, 1.63*)	[******]	0.98 (0.54, 1.78)	[******]	0.77 (0.43, 1.39)
35-3000	Food & Beverage Serving Workers	1180	1034	45.3 (40.2, 50.6)	1.07 (0.95, 1.20)	9.9 (7.2, 13.2)	1.05 (0.78, 1.42)	22.0 (16.2, 28.7)	0.99 (0.74, 1.31)
35-3010	Bartenders	270	209	52.7 (41.6, 63.5)	*1.25* (*1.01, 1.54*)	19.8 (11.4, 30.8)	*2.09* (*1.28, 3.39*)	37.7 (22.5, 54.9)	*1.68* (*1.09, 2.60*)
35-3040	Food Servers, Nonrestaurant	65	51	61.3 (39.5, 80.3)	*1.47* (*1.06, 2.06*)	[******]	0.48 (0.14, 1.67)	NR	NR
37-0000	Building & Grounds Cleaning & Maintenance Occupations	4267	3396	34.3 (31.6, 37.2)	*0.85* (*0.78, 0.92*)	8.3 (6.8, 9.9)	0.93 (0.77, 1.12)	24.3 (20.3, 28.7)	1.11 (0.93, 1.32)
37-1000	Supervisors of Building & Grounds Cleaning & Maintenance Workers	227	163	38.2 (26.6, 50.9)	0.97 (0.71, 1.31)	[******]	*2.08* (*1.14, 3.78*)	45.9 (26.8, 66.0)	*2.19* (*1.47, 3.28*)
37-1011	First-Line Supervisors of Housekeeping & Janitorial Workers	157	106	43.6 (28.4, 59.8)	1.08 (0.76, 1.54)	[******]	*2.14* (*1.03, 4.47*)	43.2 (21.5, 67.0)	*2.02* (*1.19, 3.41*)
37-2000	Building Cleaning & Pest Control Workers	3165	2487	36.3 (32.9, 39.7)	0.89 (0.81, 0.98)	8.3 (6.7, 10.1)	0.88 (0.72, 1.09)	23.1 (18.8, 27.9)	1.01 (0.83, 1.23)
37-2020	Pest Control Workers	79	57	[******]	0.87 (0.46, 1.62)	[******]	*3.16* (*1.36, 7.35*)	NR	NR

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
39-0000	Personal Care & Service Occupations	2443	1835	46.5 (42.1, 50.9)	1.10 (0.99, 1.21)	11.3 (8.8, 14.1)	1.11 (0.87, 1.42)	24.5 (19.3, 30.3)	1.02 (0.80, 1.30)
39-5000	Personal Appearance Workers	625	546	51.0 (43.1, 58.9)	*1.19* (*1.02, 1.40*)	17.1 (10.9, 24.9)	*1.63* (*1.06, 2.49*)	33.8 (22.2, 46.9)	1.39 (0.93, 2.05)
39-5010	Barbers, Hairdressers, Hairstylists & Cosmetologists	530	464	51.8 (43.0, 60.5)	*1.22* (*1.03, 1.45*)	17.9 (11.0, 26.9)	*1.72* (*1.09, 2.71*)	34.8 (22.1, 49.2)	1.44 (0.95, 2.18)
39-5011	Barbers	55	60	61.8 (33.4, 85.3)	*1.54* (*1.02, 2.31*)	[******]	*4.57* (*1.75, 11.93*)	NR	NR
39-9000	Other Personal Care & Service Workers	1201	866	46.4 (39.6, 53.3)	1.09 (0.93, 1.28)	10.7 (7.9, 14.1)	1.02 (0.76, 1.38)	23.2 (16.9, 30.6)	0.95 (0.70, 1.29)
39-9090	Miscellaneous Personal Care & Service Workers	52	45	[******]	0.75 (0.36, 1.54)	[******]	2.59 (1.00, 6.67)	NR	NR
41-0000	Sales & Related Occupations	10,900	8081	40.9 (39.0, 42.9)	1.02 (0.97, 1.07)	8.9 (7.7, 10.1)	1.04 (0.90, 1.19)	21.8 (19.2, 24.6)	1.03 (0.91, 1.17)
41-9000	Other Sales & Related Workers	1754	1175	43.2 (37.7, 48.9)	1.10 (0.97, 1.25)	10.2 (6.1, 15.8)	1.22 (0.77, 1.92)	23.8 (15.0, 34.5)	1.12 (0.74, 1.68)
41-9090	Miscellaneous Sales & Related Workers	443	291	48.6 (40.5, 56.8)	*1.21* (*1.03, 1.43*)	10.9 (6.4, 16.9)	1.29 (0.82, 2.04)	22.7 (13.5, 34.3)	1.12 (0.73, 1.70)
43-0000	Office & Administrative Support Occupations	10,942	7371	40.6 (38.7, 42.5)	0.96 (0.92, 1.01)	10.6 (9.4, 12.0)	1.08 (0.95, 1.23)	26.5 (23.7, 29.5)	*1.13* (*1.00, 1.26*)
43-4000	Information & Record Clerks	2643	1969	41.1 (37.4, 45.0)	0.97 (0.88, 1.06)	11.3 (8.9, 14.2)	1.13 (0.89, 1.44)	27.8 (22.4, 33.8)	1.18 (0.96, 1.46)
43-4050	Customer Service Representatives	1449	1129	44.5 (39.6, 49.6)	1.05 (0.94, 1.18)	14.1 (10.3, 18.7)	*1.43* (*1.07, 1.93*)	32.1 (24.5, 40.6)	*1.38* (*1.07, 1.80*)
43-5000	Material Recording, Scheduling, Dispatching, & Distributing Workers	1199	840	41.2 (35.8, 46.8)	1.03 (0.90, 1.17)	9.3 (6.6, 12.7)	*1.12* (*0.82, 1.53*)	22.9 (16.5, 30.3)	1.11 (0.84, 1.47)
43-5030	Dispatchers	151	97	43.0 (29.7, 57.1)	1.07 (0.77, 1.48)	[******]	*1.88* (*1.01, 3.49*)	39.2 (18.6, 63.0)	*1.83* (*1.12, 3.00*)

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
43-5031	Public Safety Telecommunicators	61	36	44.3 (26.3, 63.5)	1.05 (0.70, 1.58)	[******]	*2.15* (*1.07, 4.31*)	NR	NR
45-0000	Farming, Fishing, & Forestry Occupations	891	582	27.0 (17.9, 37.7)	*0.68* (*0.49, 0.94*)	[******]	1.23 (0.50, 3.02)	[******]	1.75 (0.98, 3.15)
45-2000	Agricultural Workers	728	471	27.7 (17.1, 40.5)	0.69 (0.47, 1.01)	[******]	1.37 (0.53, 3.51)	[******]	*1.92* (*1.05, 3.49*)
45-2090	Miscellaneous Agricultural Workers	687	454	27.2 (16.3, 40.6)	0.68 (0.46, 1.01)	[******]	1.37 (0.51, 3.65)	[******]	*1.94* (*1.05, 3.59*)
45-2092	Farmworkers & Laborers, Crop, Nursery, & Greenhouse	401	334	29.2 (15.0, 47.1)	0.72 (0.45, 1.18)	[******]	1.66 (0.59, 4.69)	[******]	*2.18* (*1.16, 4.10*)
47-0000	Construction & Extraction Occupations	7792	5938	34.5 (32.5, 36.6)	*0.89* (*0.84, 0.95*)	6.1 (5.1, 7.3)	0.86 (0.72, 1.03)	17.8 (14.9, 20.9)	0.97 (0.82, 1.14)
47-5000	Extraction Workers	275	148	55.2 (43.9, 66.2)	*1.41* (*1.17, 1.69*)	[******]	0.92 (0.49, 1.71)	[******]	0.67 (0.35, 1.28)
47-5040	Underground Mining Machine Operators	53	31	60.3 (36.0, 81.3)	*1.54* (*1.08, 2.19*)	[******]	1.16 (0.36, 3.77)	NR	NR
47-5049	Underground Mining Machine Operators, All Other	50	31	60.4 (35.8, 81.7)	*1.54* (*1.08, 2.21*)	NR	NR	NR	NR
47-5090	Miscellaneous Extraction Workers	157	82	65.2 (50.2, 78.3)	*1.65* (*1.36, 2.00*)	[******]	1.23 (0.59, 2.58)	[******]	0.76 (0.35, 1.66)
49-0000	Installation, Maintenance, & Repair Occupations	4248	3317	38.7 (35.8, 41.6)	1.01 (0.94, 1.09)	7.6 (6.1, 9.3)	1.12 (0.92, 1.37)	19.7 (16.2, 23.7)	1.11 (0.92, 1.32)
49-2000	Electrical & Electronic Equipment Mechanics, Installers, & Repairers	309	215	40.6 (30.5, 51.3)	1.07 (0.85, 1.36)	****	0.99 (0.54, 1.82)	****	0.91 (0.50, 1.66)
49-2020	Radio & Telecommunications Equipment Installers & Repairers	99	89	50.4 (31.1, 69.6)	1.31 (0.93, 1.85)	NR	NR	NR	NR

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
49-2022	Telecommunications Equipment Installers & Repairers, Except Line Installers	92	79	55.8 (35.7, 74.6)	*1.46* (*1.07, 1.98*)	NR	NR	NR	NR
49-3000	Vehicle & Mobile Equipment Mechanics, Installers, & Repairers	1881	1506	34.2 (30.2, 38.3)	0.89 (0.79, 1.00)	7.9 (5.7, 10.7)	1.16 (0.86, 1.56)	23.4 (17.4, 30.4)	*1.29* (*1.00, 1.67*)
49-9000	Other Installation, Maintenance, & Repair Occupations	1873	1440	42.9 (38.2, 47.8)	*1.13* (*1.02, 1.26*)	7.1 (5.0, 9.8)	1.05 (0.76, 1.44)	16.6 (11.8, 22.4)	0.94 (0.70, 1.26)
49-9020	Heating, Air Conditioning, & Refrigeration Mechanics & Installers	359	304	49.5 (39.4, 59.6)	*1.29* (*1.07, 1.56*)	[******]	1.00 (0.43, 2.29)	[******]	0.78 (0.35, 1.72)
49-9050	Line Installers & Repairers	219	185	50.6 (36.6, 64.5)	1.30 (1.00, 1.69)	[******]	0.82 (0.38, 1.75)	[******]	0.63 (0.29, 1.36)
49-9051	Electrical Power-Line Installers & Repairers	136	92	56.8 (41.7, 71.0)	*1.44* (*1.13, 1.83*)	[******]	0.72 (0.30, 1.76)	[******]	0.50 (0.20, 1.27)
51-0000	Production Occupations	5052	3494	37.5 (34.9, 40.2)	0.95 (0.89, 1.02)	8.4 (7.1, 9.9)	1.07 (0.91, 1.27)	22.9 (19.6, 26.4)	1.14 (0.98, 1.33)
51-2000	Assemblers & Fabricators	571	364	39.1 (32.3, 46.3)	0.98 (0.83, 1.17)	15.9 (10.0, 23.5)	*1.97* (*1.34, 2.89*)	41.1 (28.8, 54.2)	*1.99* (*1.50, 2.63*)
51-2090	Miscellaneous Assemblers & Fabricators	472	308	40.3 (32.7, 48.3)	1.01 (0.84, 1.21)	18.0 (11.2, 26.7)	*2.17* (*1.46, 3.22*)	45.0 (31.6, 58.9)	*2.15* (*1.63, 2.85*)
51-2092	Team Assemblers	81	36	36.9 (18.0, 59.4)	0.89 (0.50, 1.58)	[******]	*2.78* (*1.14, 6.76*)	NR	NR
51-2099	Assemblers & Fabricators, All Other	391	272	40.8 (32.6, 49.4)	1.03 (0.85, 1.24)	17.1 (9.9, 26.7)	*2.08* (*1.34, 3.23*)	42.4 (28.0, 57.8)	*2.03* (*1.47, 2.79*)

(Continues)

TABLE 3 | (Continued)

SOC Code	Title	*N*	Weighted *N* (*1000)	COVID-19 among all employed respondents		Long COVID among all employed respondents		Long COVID among employed respondents reporting history of COVID-19	
				P (%)****	aPR*****	*P* (%)****	aPR*****	*P* (%)****	aPR*****
51-3000	Food Processing Workers	559	303	35.1 (28.2, 42.5)	0.87 (0.71, 1.06)	6.9 (3.5, 12.1)	0.80 (0.44, 1.46)	19.9 (10.5, 32.6)	0.93 (0.53, 1.64)
51-3090	Miscellaneous Food Processing Workers	175	105	46.6 (34.0, 59.5)	1.17 (0.90, 1.53)	[******]	1.52 (0.66, 3.53)	[******]	1.31 (0.58, 2.95)
51-3099	Food Processing Workers, All Other	116	65	54.3 (38.3, 69.6)	*1.36* (*1.02, 1.82*)	[******]	NR	NR	NR
51-9000	Other Production Occupations	1825	1405	36.0 (31.5, 40.6)	0.90 (0.79, 1.02)	7.6 (5.8, 9.6)	0.91 (0.71, 1.17)	21.6 (17.0, 26.8)	1.04 (0.83, 1.31)
51-9110	Packaging & Filling Machine Operators & Tenders	131	94	58.7 (39.7, 76.0)	*1.38* (*1.01, 1.87*)	[******]	0.67 (0.34, 1.33)	[******]	0.59 (0.31, 1.12)
53-0000	Transportation & Material Moving Occupations	7120	5595	36.8 (34.5, 39.1)	0.94 (0.89, 1.00)	6.5 (5.5, 7.7)	0.88 (0.38, 2.05)	[******]	0.59 (0.26, 1.35)
53-2000	Air Transportation Workers	203	131	44.8 (31.4, 58.9)	1.18 (0.89, 1.55)	[******]	1.72 (0.60, 4.99)	NR	NR
53-2010	Aircraft Pilots & Flight Engineers	141	79	55.6 (39.7, 70.6)	*1.48* (*1.16, 1.88*)	[******]	0.67 (0.34, 1.33)	[******]	0.59 (0.31, 1.12)
53-2011	Airline Pilots, Copilots, & Flight Engineers	52	21	66.1 (47.9, 81.5)	*1.71* (*1.36, 2.16*)	[******]	0.88 (0.38, 2.05)	[******]	0.59 (0.26, 1.35)

Abbrevation: aPR, adjusted prevalence ratio.
Listing includes all sectors and subcategories with $N >= 50$ and a significantly elevated aPR for any of the three outcomes. Cells labeled "NR" for "not reportable" have fewer than 50 respondents. See online appendix for reportable results for all SOC subgroup codes.
Italicization indicates aPR elevation or deficit comparing adjusted prevalence for the occupation to that for all other occupations combined is statistically significant.
*Respondent replied yes to question "Has a doctor, nurse, or other health professional ever told you that you tested positive for COVID 19?" or reported a positive home test.
**Respondent replied yes to the question "Did you have any symptoms lasting 3 months or longer that you did not have prior to having coronavirus or COVID-19?".
***39 states, Guam, and U.S. Virgin Islands.
****Weighted & unadjusted prevalence (95% CI).
*****aPR (95% CI) comparing occupation to all other occupations combined, adjusted for age, sex, and race/Hispanic ethnicity.
******Not reportable because relative standard error >30%.

Educational Instruction and Library Occupations had an aPR for Long COVID that was somewhat below expectation.

3.2.3 | Long COVID Among Employed Respondents Who Reported Having Had COVID-19

Healthcare Support Occupations was the major occupation with the highest prevalence of Long COVID among respondents reporting a history of COVID-19 (27.2%). The aPR for Protective Service Occupations was elevated, as was the nested Law Enforcement Workers grouping. Assemblers and Fabricators at several levels of granularity had significantly elevated aPRs around 2.0. Agricultural Workers, a group that did not have statistically significant elevations for either COVID-19 or Long COVID, had a significantly elevated aPR for Long COVID among those who reported prior COVID-19, as did its nested Miscellaneous Agricultural Workers grouping; within the latter, the Farmworkers and Laborers, Crop, Nursery, and Greenhouse group had an aPR above 2.0.

Statistically significant aPR elevations were also observed for this metric for several other occupations (Table 3). Long COVID among those who had COVID-19 was lowest in the Architecture and Engineering Occupations major group.

4 | Discussion

Differences by I&O in prevalences of self-reported COVID-19 and Long COVID in the 2022 BRFSS reflect the interplay of changing circumstances such as viral evolution, understanding of viral transmission, mitigation strategies, and COVID-19 testing and vaccination availability, requirements, and uptake, as well as differences in characteristics of both workplaces and workers. Our findings of elevated prevalences of self-reported COVID-19 and Long COVID across industries and occupations such as healthcare and protective services were consistent with results from other large surveys, although results for education differed [16, 31].

Our assessment of detailed I&O identified several groups of workers not previously recognized as having elevated prevalences of COVID-19 and Long COVID. Elevations for COVID-19 were seen in the Coal Mining and the Dairy Product Manufacturing industries and among Zoologists and Wildlife Biologists; Airline Pilots, Copilots, and Flight Engineers; and several mining occupations. For the Long COVID metrics, examples of elevations in detailed industries and their related occupations include the Drinking Places (Alcoholic Beverage) industry and the Bartender occupation and the Hair, Nail, and Skin Care Services industry and the related occupations, particularly Barbers. The range of potential exposure scenarios and work requirements presented by the detailed I&O newly identified in this study as having elevated prevalences of COVID-19 and Long COVID highlights the need for development of job and setting-specific mitigation resources for workers and workplaces at increased risk from COVID-19 and other respiratory viruses with potential for long-term sequelae.

As in other research, in our study the prevalence of COVID-19 was high in the Healthcare and Social Assistance industry, particularly in the Nursing and Residential Care subsector. By occupation, prevalences were high among several Healthcare Practitioner and Technical and Healthcare Support occupations. Healthcare workers faced outbreaks in nursing homes [33, 34] and most continued to work in person. Healthcare workers also had elevated aPRs for Long COVID, despite, for example, more than 70% of hospital workers being up to date on COVID-19 vaccination in a survey in the spring of 2022 [35]. This prevalence may also reflect repeated COVID-19 illnesses [36] or timing of illness early in the pandemic before vaccines were available and exposure controls fully implemented and later, after some mitigation requirements were discontinued. This finding is of concern in light of the high pre-pandemic levels of poor mental health and suboptimal wellbeing among healthcare workers [37], and previously reported associations between Long COVID and poor mental health [38].

Many workers in protective services, another group with elevations across surveys, had no option for remote work, and some had increased exposure to SARS-CoV-2 in correctional facilities, where transmission was very high [10]. An analysis of the 2020–2021 NHIS survey identified elevated aPRs for self-reported COVID-19 in healthcare I&O and in the protective services occupations but not in education I&O [16]. In contrast, aPRs for COVID-19 were elevated for most education I&O in the current study. This discrepancy likely reflects differences in the timing of the two surveys. Education largely pivoted to remote learning during Spring 2020, with most not resuming in-person learning or a hybrid mode until Fall 2020 or Spring 2021; in contrast, by the time of the 2022 BRFSS study, most of education had been working in person through multiple COVID-19 waves. Mitigation strategies (e.g., engineering controls and use of personal protective equipment) also changed over time.

Prevalences of Long COVID by I&O diverged somewhat from findings for COVID-19 in the current study. If risks of developing Long COVID after COVID-19 were similar across I&O, we would expect findings for the two outcomes to be similar. The differences we observed suggest that risks for Long COVID (as well as protective factors) varied by I&O. For example, while in our study healthcare and social assistance and protective services I&O had elevated aPRs for COVID-19 and Long COVID, almost all education I&O had elevated aPRs only for COVID-19. Our findings for Long COVID are generally consistent with those from a UK survey which found increased odds for Long COVID in the teaching and education, social care, healthcare, civil service or local government, retail, and transportation industries and in several occupations: education and social care, police and protective services, hospitality, and transportation [31]. Exceptions are their findings of elevated odds of Long COVID in education and in the retail and transportation industries, which were not observed in our study.

The risk of Long COVID can involve factors that are personal, work-related, or reflect the effects of work on health. Chronic medical conditions are associated with acute COVID-19 disease severity [39], which is in turn associated with risk of Long

COVID [40], although cases can also occur following asymptomatic infection [41] and among persons with no known underlying conditions [42]. The prevalence of underlying medical conditions before the COVID-19 pandemic differed by I&O [43]. Differences in prevalences of both COVID-19 and Long COVID in the current study may reflect, in part, differences by I&O in deployment of strategies such as remote work, paid sick leave, and workplace respiratory protection requirements that reduced or delayed exposures to SARS-CoV-2 until testing, vaccines, and effective treatments were available. The feasiblity of implementing some strategies varied by I&O; for example, remote work was not possible for many workers in healthcare facilities and grocery stores who were considered essential during the first several months of the pandemic. Once vaccines were available, some I&O were more likely than others to provide workplace vaccination clinics or offer employees paid time to travel to vaccination sites. Other temporal changes also affect the risk of Long COVID; recent research suggests that infection with an omicron SARS-CoV-2 variant may be less likely to lead to Long COVID than infection with wild-type SARS-CoV-2 or previous common variants [24, 44, 48].

Differences in prevalence of Long COVID across I&O may be explained in part by vaccination rates. Vaccination has been observed to reduce the risk of developing Long COVID, although estimates of the magnitude of the reduction vary widely, reflecting differences in study design, definition of Long COVID, inclusion criteria, timing, location, as well as number and timing of vaccinations and infections, analytic approach, and more [45–48]. Initial access to vaccination (and, in some workplaces, vaccination requirements) differed by I&O. Recommendations from the Advisory Committee on Immunization Practices initially prioritized health care workers, followed by non-healthcare frontline essential workers (workers in correctional facilities; food and beverage stores; agriculture, forestry, fishing, or nursing; food manufacturing facilities; nonfood manufacturing facilities; public transit; U.S. Postal Service, and first responders), and then remaining essential workers, along with non-essential individuals at risk due to age or certain medical conditions [49], before expanding to all eligible individuals. Some states created their own prioritization lists, and additional requirements for federal employees and certain entities receiving federal payments were in place by late 2020 or early 2021 [50–52]. Vaccination requirements in education were more localized. Some states required teachers (and other educational personnel) to be vaccinated, while others prohibited vaccination requirements, and a third group left the decision to localities or school districts [53].

Data from a number of internet surveys conducted during the spring, summer, and fall of 2021 were used to compare vaccine uptake and hesitancy across groups of workers [54–57]. Vaccination uptake (reflecting, in part, workplace requirements) and intent were generally highest in healthcare and in the education and scientific and legal occupations, and lowest among construction and extraction; installation, maintenance and repair; agriculture; transportation and material moving; and protective services. A more granular assessment identified subgroups with particularly low vaccination levels: Police and Sheriff Officers within Protective Services; Pest Control workers within Building and Grounds Cleaning and Maintenance; and Emergency Medical Technicians and Paramedics within Healthcare Practitioners and Technicians [55]. In our analysis, the first two groups had statistically significant aPR elevations for Long COVID.

4.1 | Study Limitations

Many of the I&O reported by other studies to have low vaccine uptake or high vaccine hesitancy had high prevalences of Long COVID in the current study. However, limitations of BRFSS data preclude attribution of differences in Long COVID by I&O to vaccination or other workplace and individual differences. Adjustment for vaccination history in the analyses was not feasible because BRFSS collected information about vaccination only in an optional module administered by 27 states. In addition to vaccination status, the results for Long COVID may be affected by differences in distribution of chronic conditions, treatment for acute COVID-19 illness, and workplace norms and practices around mitigation strategies. While chronic conditions have been associated with severe COVID-19 illness and Long COVID [58], BRFSS collects information on a limited set of diagnosed chronic conditions that does not include immunosuppressed status or neurological conditions. Finally, workplace transmission of SARS-CoV-2 differed by numerous workplace characteristics and mitigation measures. Workplace and individual practices and behaviors associated with transmission could impact the number of SARS-CoV-2 infections experienced by workers, and a larger number of infections has been associated with higher risk of Long COVID [36]. Attitudes towards vaccination were associated with behaviors such as masking early in the pandemic, according to survey data [59], with differences observed by occupational group [60]. However, BRFSS did not collect information about workplace transmission mitigation practices or individual behaviors at or outside of work. In the absence of comprehensive data on workplace mitigation practices, individual behaviors, chronic conditions, the number and timing of COVID-19 infections and vaccination, the relative contributions of vaccination, workplace practices, and individual characteristics and behaviors to differences in prevalances of Long COVID by I&O cannot be determined.

Additional limitations of our survey include the use of self-reported data to estimate prevalences of COVID-19 and Long COVID. While 39.9% of BRFSS respondents included in this study reported having had COVID-19, 70.3% of blood donors had antibodies to SARS-CoV-2 from infection by the third quarter of 2022 [61]. Although the populations differ somewhat, the discrepancy suggests substantial underascertainment of COVID-19 among BRFSS respondents. This gap likely reflects 1) low levels of testing for COVID-19, particularly early in the pandemic when tests were not widely available, 2) limited testing among asymptomatic or minimally symptomatic cases even after tests were more widely available, and 3) differences in ascertainment stemming from testing objectives and methods. Long COVID is likely underascertained as well, with respondents who did not realize they had had COVID-19 attributing any lasting symptoms to other causes. The underascertainment of COVID-19 may not be random by I&O and may reflect, in part, differences in workplace testing

requirements, individual and workplace attitudes to testing, and consequences of testing positive across I&O. Workers with adequate paid sick leave may be more likely to test voluntarily than those who lack sick leave, are unable to telework, or are employed in workplaces that penalize absences.

Other limitations include that across I&O, some respondents might have reported having Long COVID although their symptoms are attributable to other health conditions. Others with mild Long COVID symptoms that have resolved may not recall those symptoms and have classified themselves as "COVID-19, no Long COVID." I&O reflect current work only, not work history. Self-reported I&O may also be misclassified. The level of detail provided for I&O varies, so some responses for industry were codable to more NAICS digits than other. Therefore, the results reported at more granular levels might not include all workers who belong in those categories, although these omissions are more likely to affect precision than to induce bias.

4.2 | Comparisons of Findings of Survey and Other Data Sources

These and other limitations may be illustrated by comparison of our findings for specific I&O with those from non-survey data. Construction industry workers had elevated SARS-CoV-2 seroprevalence from May-December 2021 in a study of Red Cross blood donors [62] and one of the highest prevalences of Long COVID (12%) in an analysis of U.S. workers' compensation claims data by industry [63]. While other findings from these sources are generally consistent with those from the 2022 BRFSS data, the Construction industry did not have elevated aPRs for COVID-19 or Long COVID in the current study. The consequences of having Long COVID on the ability to work may also differ by I&O. Because many occupations within the construction industry are physically demanding, construction workers with Long COVID might be more likely than workers in a more sedentary industry to have changed to less demanding jobs or stopped working completely.

Comparison of our findings for agriculture-related I&O with information from four non-survey data sources also suggests limitations of self-reported COVID-19 history. This group had high COVID-19 mortality based on death certificate data from 2020 for 46 states and New York City [64], and the prevalence of COVID-19 was high in an analysis of Household Pulse survey data from late spring/early summer 2021 [57]. Agriculture, Forestry, Fishing and Hunting had a disproportionate percentage of COVID-19 cases and the highest rate of hospitalized COVID-19 cases and COVID-19 deaths in a study using Washington State case data [19]. We saw no elevations and some significant deficits for COVID-19, Long COVID, and Long COVID among COVID-19 positive in the Agriculture, Forestry, Fishing & Hunting industry. However, by occupation, the aPR for Long COVID among workers reporting prior to COVID-19 was significantly elevated for the Agricultural Workers grouping and the nested Farmworkers and Laborers, Crop, Nursery, and Greenhouse occupations in our study. In light of the results from non-survey data, these findings suggest that this metric may be useful for identifying some excess risks not reflected by self-reported COVID-19 or Long COVID.

Finally, the high COVID-19 mortality and morbidity in transportation and material moving occupations and the transportation and warehousing industries seen in early-pandemic (2020, early 2021) studies [17, 64] was not mirrored by elevations of any metrics in our analyses, with the exception of elevated aPRs for COVID-19 and Long COVID among the Airline Pilots, Copilots, and Flight Engineers occupation, a small subset of transportation workers. This more granular result aligns with the findings of the Washington State case data analysis, which found Air Transportation to have the highest case rate within the Transportation and Warehousing sector [19]. Reasons for the discrepancies among transportation and related workers at the broad I&O level are unclear. The high mortality may be a signal of a vulnerable workforce (through demographics such as age or through frequent workplace exposures early in the pandemic). Alternatively, our results could reflect a healthy worker survivor effect among workers still employed in transportation in 2022. Collectively, the differences between findings from surveys and other types of data highlight the value of augmenting survey data with case finding, seroprevalence, hospitalization and mortality data to identify groups of workers at highest risk for transmission and severe illness from respiratory viruses. This is particularly important for viral illnesses that can present asymptomatically or with only minor symptoms and may involve disincentives to testing.

4.3 | Strengths

This study has several strengths. Collection of I&O as free text in a large population-based survey such as BRFSS that includes many workers facilitated this first detailed examination of the distribution of Long COVID by I&O in the U.S. Although the I&O questions are in a module that states can opt to administer, rather than in the core survey and results are thus not nationally representative, 39 states, Guam, and the U.S. Virgin Islands chose to administer the I&O module in 2022. The resulting sample allowed identification of smaller I&O with some of the highest prevalences of COVID-19 and Long COVID, such as Drinking Places/Bartenders and Personal Care and Appearance Workers (especially Barbers). The finding for Personal Care and Appearance workers likely reflects in part their proximity to clients. Bartenders had high prevalences for both COVID-19 and Long COVID, and the Drinking Places (Alcoholic Beverages) industry had significant elevations for Long COVID and the Long COVID among COVID-19 positive metric. In these groups, lower vaccination uptake and fewer requirements or norms around masking might also play a role, as could lower likelihood of improved ventilation and filtration compared to less affected I&O, some of which might have had access to more resources to make protective changes. In addition, although in the current study results for the food manufacturing industry overall did not reflect effects of outbreaks in food processing facilities during the first year of the pandemic, the Dairy Product Manufacturing industry group had a very high prevalence (70.3%) for self-reported COVID-19. In general, our findings for COVID-19 are concordant with those of the most granular state-level incidence study to date [20], while adding information about the prevalence of Long COVID by I&O.

4.4 | Health Equity Considerations

Across studies, some demographic categories and underlying conditions have been associated with increased risk for Long COVID: female sex, severity of acute COVID-19 illness, and medical comorbidities [58, 65]. Earlier studies associated higher risk of Long COVID with increased age [58, 65], but a more recent study found the lowest self-reported prevalences of Long COVID among those reporting previous COVID-19 illness in persons aged 18–29 or 60 or older [66]. In the current study, many workforces with higher than average prevalences of Long COVID are disproportionately female (> 75% of Registered Nurses, Nurse Practitioners, Licensed Practical & Licensed Vocational Nurses, Nursing Assistants, and elementary school teachers), non-White or of Hispanic Ethnicity (> 25% of Nursing Assistants and Greenhouse Workers) or had household incomes below $25,000 (≥ 15% of Nursing Assistants and Greenhouse Workers). While we adjusted for age, sex, and race/Hispanic ethnicity, our findings may be affected by residual confounding by considerations such as the influence of income and healthcare access on ability to treat chronic conditions and seek care for acute illnesses such as COVID-19 [67] and by the joint impact of income and other work-related influences on the risk of exposure to respiratory viruses. For example, the Nursery and Greenhouse Worker occupation also has many immigrant and migrant workers and is impacted by lack of health insurance and paid sick leave. High levels of reliance on shared transportation to work and crowded living conditions due to low wages may increase the likelihood of multiple infections in this group. Additional mitigation strategies are needed for workers in I&O who have 1) multiple employment-related routes of exposure to airborne respiratory viruses with potential for severe acute consequences and long-term sequelae, 2) lower access to means of prevention and treatment, and 3) high potential for household economic instability, should long-term sequelae decrease their ability to work.

5 | Conclusions

More research, including robust longitudinal studies, is needed to clarify the etiology of and best practices for preventing and mitigating long COVID. Other questions warranting more attention include the trajectory of Long COVID; the consequences of Long COVID on employment status, work hours, and productivity; and best practices for treating and managing Long COVID among the general population and workers. Continually updated guidance from the American Academy of Physical Medicine and Rehabilitation on Long COVID symptoms and conditions includes management strategies [68]. Identification of accommodations specific to the workplace and type of work performed is key to ensuring continued employment of affected employees.

Understanding which workforces have elevated prevalence of COVID-19 and Long COVID could be helpful for tailoring information campaigns and prevention and mitigation strategies to limit the impact of future waves of respiratory viruses on workers and workforces. Examples of prevention and mitigation strategies include vaccination, engineering controls, administrative controls, and use of respirators and masks designed to reduce exposure to respiratory viruses transmitted through the air. Information about the distribution of Long COVID can identify groups of workers that may be most likely to require workplace supports (modifications of the workplace, hours, or tasks) to maintain productive employment. Identification of impacted I&O at a more granular level, as in this study, may facilitate more efficient direction of resources and tailored prevention, intervention, and support measures.

Author Contributions

Sharon Silver and Jia Li conceived of the paper. Jia Li conducted the analyses. All authors have participated in a) interpretation of the data; b) drafting the article or revising it critically for important intellectual content; and c) approval of the final version. All authors approved the version to be published; all authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Disclosure

The authors have nothing to report.

Data Availability Statement

The BRFSS I&O dataset can be accessed through CDC's National Center for Health Statistics (NCHS) Research Data Center (RDC).

Disclaimer

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

Human Subjects Review

The BRFSS study protocol was reviewed and approved by the Institutional Review Board of the U.S. Centers for Disease Control and Prevention (CDC).

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.