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RESEARCH ARTICLE

Employment Status, Work Limitations, Cognitive Dysfunction, and Sickness Absenteeism Among US Adults With and Without Long COVID

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ABSTRACT

Introduction: Long COVID may limit people's ability to carry out daily activities, including work. Little is known about the potential effect of long COVID on work limitations and absenteeism. We describe employment status and characteristics, work limitations, cognitive dysfunction, and sickness absenteeism among adults with and without long COVID.

Methods: Using data from the cross-sectional 2022 National Health Interview Survey, we estimated the prevalence (95% confidence intervals [CI]) of work-related outcomes by long COVID status among US adults ≥ 18 years ($n = 26{,}270$). Among employed adults with prior COVID-19 illness, we estimated crude and adjusted odds ratios for work limitations (compared to no limitations), cognitive dysfunction (some or a lot of difficulty with memory or concentration compared to no difficulty), and sickness absenteeism (≥ 11 sick days compared to 0–10 days) in the prior year. All estimates account for survey design and are weighted to the US noninstitutionalized population. Analyses were conducted in 2024.

Results: 3.4% of adults reported long COVID. Adults with long COVID more often reported being unable to work due to health or disability compared to adults without long COVID ($p = 0.0006$). Among employed adults with prior COVID-19 illness, long COVID was associated with higher odds of work limitations (aOR 1.3, 95% CI 1.1–1.5), cognitive dysfunction (aOR 1.3, 95% CI 1.1–1.5), and sickness absenteeism (aOR 1.4, 95% CI 1.2–1.5) compared to those who did not develop long COVID.

Conclusions: Long COVID was associated with work limitations, cognitive dysfunction, and sickness absenteeism among employed US adults. Workplace accommodations may be important considerations for people with long COVID.

1 | Introduction

Long COVID is an infection-associated chronic condition that occurs after SARS-COV-2 infection and is present for at least 3 months as a continuous, relapsing and remitting, or progressive disease state that affects one or more organ systems [1]. Common symptoms include fatigue and difficulty with memory or concentration [2]. Long COVID may limit people's ability to carry out daily activities, including work.

Self-reported long COVID prevalence is highest among adults in prime working years (25–54 years). In 2022, 8.5% of all

employed adults had ever had long COVID [3]; yet few studies have examined long COVID's impact on employment status in the United States (US). Perlis and colleagues reported US adults with long COVID had 16% lower adjusted odds of working full time and 23% higher adjusted odds of being unemployed compared to adults who did not develop long COVID after SARS-CoV-2 infection [4].

Specific long COVID symptoms or clusters of symptoms may differentially impact function and the ability to work. For example, cognitive dysfunction, including "brain fog" – a heterogenous group of neuro-cognitive symptoms characterized by a lack of mental clarity, forgetfulness, and inattention – is associated with a lower likelihood of full-time employment [4–6]. Long COVID symptoms may affect work function where they interfere with routine tasks (e.g., brain fog affecting decision making, post-exertional malaise precluding physical labor) and are recognized as a potentially disabling condition under the Americans with Disabilities Act [7].

Although some studies have examined the association between long COVID and employment status, less is known about the potential effect of long COVID on both workplace limitations and sickness absenteeism. Existing literature with respect to workplace limitations and sickness absenteeism has focused on the effects of acute COVID-19 illness or the COVID-19 pandemic more broadly [8].

Additionally, studies on long COVID and employment status are largely based in Europe, which has different labor laws, healthcare systems, health insurance, and cultural norms related to illness and work than the United States. Studies of US adults have used subnational or nonrepresentative samples (e.g., workers' compensation claims) – limiting their generalizability [4, 9, 10]. Further, studies have been largely restricted to adults aged < 65 years; however, roughly 19% of US adults aged ≥ 65 years were employed in 2023 [11].

Using data from the 2022 National Health Interview Survey (NHIS), we describe employment status and characteristics, work limitations, cognitive dysfunction, and sickness absenteeism in a nationally representative sample of US adults aged ≥ 18 years by long COVID status.

2 | Methods

2.1 | Study Population

The NHIS is a large, nationally representative cross-sectional household survey of US noninstitutionalized civilian adults [12]. Complete information about the survey is described elsewhere [12]. Briefly, NHIS samples households; one randomly selected adult aged ≥ 18 years per selected household is invited to answer questions about their health as part of an interviewer-administered interview. The adult response rate in 2022 was 47.7% [12].

In 2022, NHIS sampled 27,651 adults aged ≥ 18 years. We excluded adults who were missing information about age ($n = 64$, 0.2%), COVID-19 history ($n = 182$, 0.7%), long-term symptoms ($n = 82$, 0.3%), or employment ($n = 1{,}053$, 3.8%). The final analytic sample included 26,270 adults.

NHIS deidentified data are available free online to the public. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.

2.2 | Measures

Participants with an affirmative response to either survey question about COVID-19 ("Has a doctor or other health professional ever told you that you had or likely had coronavirus or COVID-19?" or "Did you ever take a test that showed you had coronavirus or COVID-19?") were classified as having had COVID-19 illness. Those reporting symptomatic COVID-19 illness and those who did not know their symptom severity were asked about long-term symptoms ("Did you have any symptoms lasting 3 months or longer than you did not have prior to having coronavirus or COVID-19?") and whether they had symptoms at the time of the survey ("Do you have symptoms NOW?"). Adults with affirmative responses to both questions were classified as having long COVID.

NHIS measures employment status based on self-report of work for pay at a job or business during the week preceding the survey. Adults who reported not working for pay and who were not on temporary leave (e.g., vacation) were asked the main reason for not working. Based on these two indicators, we classified employment status as employed (both employed for wages and self-employed), unemployed, taking care of house or family, student, disabled/unable to work for health reasons, retired, and "other" (seasonal or contract work, working at a family-owned job or business but not for pay, or other type of work). Duration of unemployment (< 12 months, ≥ 12 months) was classified among unemployed participants who reported previously working.

Employed adults reported average working hours, which NHIS classified as full-time (≥ 35 h per week) and part-time (< 35 h per week). Employed adults reported whether paid sick leave was available if needed and whether the workplace offered health insurance (yes/no).

Work limitations among employed adults were classified based on an affirmative response to the question "are you limited in kind OR amount of work you can do because of a physical, mental, or emotional problem?" Those responding "yes" were classified as having work limitations.

Among employed adults, cognitive dysfunction was measured using the Washington Group Extended Set on Functioning (WG-ES), a tool that was designed for use in population-based surveys [13]. The WG-ES was tested in adult populations in six countries to allow for cross-national comparison of data between populations living in a variety of cultural and economic conditions but not validated specifically in US adults or adults with long COVID [13]. Cognitive dysfunction as identified by the WG-ES is ascertained in generalnot in the context of the workplace. The module was developed to describe the functional status of adults and focus

on domains of functioning that are likely to identify adults at risk of participation restrictions in an unaccommodating environment [12]. Participants were asked about difficulty with memory and concentration ("Do you have difficulty remembering or concentrating?"). Difficulty was classified as no difficulty, some difficulty, or a lot of difficulty/cannot do at all. Among employed adults reporting any difficulty, participants reported whether the difficulty was with memory only, concentration only, or both memory and concentration.

Employed adults were asked how many days of work they missed due to illness, injury, or disability (not including family or parental leave) during the 12 months preceding the survey. We categorized days of work missed as 0, 1–5, 6–10, 11–15, 16–20, and ≥ 21 days. The US Centers for Disease Control and Prevention uses ≥ 6 workdays missed due to illness, injury, or disability for surveillance of health-related workplace absenteeism [14]. Because COVID-19 illness is associated with work absence [15], we selected a higher cut point for these analyses in an effort to capture potential associations between long COVID and work absence beyond acute COVID-19 illness. Sickness absenteeism was defined as reporting ≥ 11 sick days during the previous year.

We examined age in years, sex (male, female), and race/Hispanic ethnicity (Hispanic, Non-Hispanic Black, Non-Hispanic White, and another single or multiple race[s]). Another single or multiple race(s) included Non-Hispanic Asian, Non-Hispanic American Indian/Alaska Native, and other single or multiple races. Family income-to-poverty ratio was classified as < 100%, 100%–199%, 200%–399%, and ≥ 400% [12].

Because co-morbidities may influence employment status, work limitations, and use of sick leave, we included self-reported chronic conditions [16, 17]. Respondents reporting anxiety or depression were classified as having a mental health condition (yes/no). Respondents reporting hypertension, asthma, diabetes, chronic fatigue syndrome, chronic obstructive pulmonary disorder, weakened immune system, angina, heart attack, stroke, coronary heart disease, or cancer were classified as having a chronic health condition (yes/no). Having seen a doctor in the previous 12 months (yes/no) was used to approximate healthcare use. Participants were considered to have completed the primary COVID-19 vaccine series if they reported having received ≥ 1 dose for single-dose series (i.e., Johnson and Johnson [Janssen]) or ≥ 2 doses for any two-dose series (e.g., Moderna) or unknown vaccine types [18].

2.3 | Statistical Analyses

We estimated weighted prevalence (95% confidence interval [CI]) for all sociodemographic and health characteristics and employment status for the total adult population and by long COVID status.

Among employed adults, we estimated weighted prevalence (95% CI) of employment characteristics by long COVID status and used Rao-Scott chi-square tests to identify differences.

Acute COVID-19 illness is associated with work absence [15], irrespective of whether long COVID develops. We estimated the prevalence of sick day categories (0, 1–5, 6–10, 11–15, 16–20, and ≥ 21 days) for employed adults who ever had COVID-19 illness (irrespective of whether they developed long COVID), those with long COVID (all of whom reported prior COVID-19), and those who did not have long COVID (irrespective of COVID-19 history).

To better understand how long COVID may be associated with the study outcomes beyond acute COVID-19 illness, we identified employed adults with prior COVID-19 for multivariable modeling. This design helps control for confounding by acute COVID-19 effects, which may otherwise bias estimates in the full sample. In this restricted sample, we used logistic regression to estimate crude and adjusted odds ratios for work limitations, cognitive dysfunction, and sickness absenteeism. Adjusted models controlled for age, sex, mental health conditions, chronic health conditions, and family income-to-poverty ratio. The model for sickness absenteeism additionally adjusted for healthcare use and the availability of paid sick leave.

Due to high missingness on questions related to family income (19.5%), NHIS imputed missing values using multiple imputation, creating 10 replicate data sets. Estimates using family income-to-poverty ratio (i.e., characterization of the sample presented in Table 1 and modeling) accounted for multiple imputation using SAS' PROC MIANALYZE procedure. For Table 1, we combined the estimates of family income-to-poverty ratio from the 10 replicate data sets provided by NHIS, averaging the mean across replicates and calculating the standard error [19]. For the univariate and multivariable models that included family income-to-poverty ratio, we conducted logistic regression in the 10 replicate data sets before pooling results according to Rubin's rules [19]. For models that did not include family income-to-poverty ratio, the single analytic (i.e., non-imputed) data set was used.

In a sensitivity analysis, we examined an alternative classification of work hours (≥ 20 h per week for full-time compared to <20 h per week for part-time) and sickness absenteeism (≥ 16 days compared to 0–15 days). Additionally, we repeated the multivariable modeling to examine associations between ever having long COVID (i.e., ever having symptoms lasting ≥ 3 or more months irrespective of symptom status at the time of interview) and the outcomes of interest.

Analyses were conducted using SAS v.9.4 and SAS-callable SUDAAN (Cary, North Carolina). To account for complex sampling, we used sampling weights, domain analysis, and the appropriate SAS or SUDAAN survey procedures. Two-sided p-values < 0.05 were considered significant.

3 | Results

3.1 | Sample Characteristics

In this cross-sectional sample of 26,270, 3.4% of US adults aged ≥ 18 years reported long COVID at the time of the survey (Table 1). Approximately two-thirds of adults with long COVID were female, 69.7% were non-Hispanic White, 45.8% had ≥ 1

mental health condition, and 57.2% % had ≥ 1 chronic health condition. Adults with long COVID less frequently reported having completed the primary COVID-19 vaccine series compared to adults without long COVID (70.2% and 77.8%, respectively).

3.2 | Employment Status and Characteristics

Employment status differed by long COVID status (Table 1). Prevalence figures for being employed (67.7% compared to 63.4%), taking care of house or family (6.8% compared to 4.7%),

TABLE 1 | Sociodemographic and health characteristics and employment status by long COVID status, among US adults aged 18 years and older.[a]

Characteristic	All Adults ($n = 26{,}270$)	Adults with long COVID[b] ($n = 881$)	Adults without long COVID ($n = 25{,}389$)	p value[c]
Total	100.0	3.4 (3.1, 3.6)	96.6 (96.4, 96.9)	N/A
Age (years)				< 0.0001
18–34	28.7 (27.9, 29.5)	22.1 (18.6, 25.6)	28.9 (28.1, 29.7)	
35–49	24.3 (23.7, 24.9)	34.8 (31.0, 38.6)	23.9 (23.3, 24.6)	
50–64	24.7 (24.1, 25.3)	28.1 (24.6, 31.5)	24.6 (24.0, 25.2)	
≥ 65	22.3 (21.7, 22.9)	15.0 (12.7, 17.4)	22.6 (21.9, 23.2)	
Sex				< 0.0001
Male	48.7 (48.0, 49.4)	34.1 (30.3, 37.8)	49.2 (48.5, 49.9)	
Female	51.3 (50.6, 52.0)	65.9 (62.2, 69.7)	50.8 (50.1, 51.5)	
Race/Hispanic Ethnicity				< 0.0001
Hispanic	17.2 (15.9, 18.5)	17.4 (14.0, 20.9)	17.2 (15.9, 18.5)	
Non-Hispanic Black	11.4 (10.5, 12.2)	7.5 (5.5, 9.4)	11.5 (10.6, 12.4)	
Non-Hispanic White	62.7 (61.1, 64.2)	69.7 (65.7, 73.6)	62.4 (60.8, 64.0)	
Another single or multiple race(s)[d]	8.8 (8.0, 9.5)	5.4 (3.6, 7.2)	8.9 (8.1, 9.7)	
Family income-to-poverty ratio				< 0.0001
< 100%	9.6 (9.0, 10.2)	9.2 (7.5, 11.9)	9.6 (9.0, 10.2)	
100%–199%	17.7 (16.9, 18.4)	18.1 (15.0, 21.3)	17.7 (16.9, 18.4)	
200%–399%	29.3 (28.5, 30.1)	32.8 (29.0, 36.6)	29.2 (28.4, 29.9)	
≥ 400%	43.4 (42.3, 44.6)	39.3 (35.5, 43.2)	43.6 (42.4, 44.7)	
Saw doctor in previous 12 months	83.4 (82.8, 84.0)	89.4 (86.9, 91.9)	83.2 (82.5, 83.8)	< 0.0001
Ever had COVID-19	39.5 (38.7, 40.2)	100.0	37.4 (36.6, 38.2)	N/A[e]
Ever had long COVID[f]	6.9 (6.5, 7.3)	100.0	3.7 (3.4, 4.0)	N/A[e]
Completed at least primary COVID-19 vaccine series[g]	77.5 (76.7, 78.4)	70.2 (66.4, 74.0)	77.8 (76.9, 78.7)	< 0.0001
Mental health condition(s)[h]	25.8 (25.1, 26.5)	45.8 (42.1, 49.5)	25.1 (24.4, 25.8)	< 0.0001
Chronic health condition(s)[i]	42.3 (41.5, 43.0)	57.2 (53.1, 61.3)	41.8 (41.0, 42.5)	< 0.0001
Employment status				
Employed	63.5 (62.7, 64.3)	67.7 (64.1, 71.2)	63.4 (62.6, 64.1)	0.02
Unemployed	2.2 (1.9, 2.4)	1.4 (0.5, 2.4)	2.2 (1.9, 2.5)	0.19
Taking care of house or family	4.7 (4.4, 5.1)	6.8 (4.7, 8.9)	4.7 (4.3, 5.0)	0.02
Student	2.4 (2.1, 2.7)	1.7 (0.6, 2.9)	2.4 (2.1, 2.7)	0.35
Unable to work for health reasons/disability	6.1 (5.7, 6.5)	9.2 (7.0, 11.4)	6.0 (5.6, 6.4)	0.0006
Retired	19.4 (18.8, 20.0)	12.2 (10.0, 14.4)	19.7 (19.1, 20.2)	< 0.0001
Other employment status[k]	1.7 (1.5, 1.9)	1.0 (0.2, 1.8)	1.7 (1.5, 1.9)	0.17

(Continues)

TABLE 1 | (Continued)

Characteristic	All Adults ($n = 26{,}270$)	Adults with long COVID[b] ($n = 881$)	Adults without long COVID ($n = 25{,}389$)	p value[c]
Duration of unemployment[k]				—
Fewer than 12 months	64.4 (58.9, 69.9)	[l]	64.3 (58.7, 69.9)	—
12 months or longer	35.6 (30.1, 41.1)	[l]	35.7 (30.1, 41.3)	—

[a]Data are from the National Health Interview Survey, 2022. Estimates are % (95% CI), are weighted and account for complex sampling.
[b]Long COVID was classified as people reporting any symptoms lasting ≥ 3 months that they did not have before having COVID-19 and reporting ongoing symptoms at the time of the survey.
[c]p-values are for Rao-Scott Chi Squared test of independence comparing sociodemographic and health characteristics by long COVID status.
[d]Another single or multiple race(s) included Non-Hispanic Asian, Non-Hispanic American Indian/Alaska Native, and other single race and multiple races.
[e]Not applicable.
[f]People reporting *ever* having any symptoms lasting for ≥ 3 months that they did not have before having COVID-19 irrespective of symptom status at the time of interview were classified as *ever* having long COVID.
[g]Completed primary COVID-19 vaccine series classified as reporting having received at least 1 dose for single dose series (i.e., Johnson and Johnson [Janssen]) and at least 2 doses for either a two-dose series (i.e., Pfizer, Moderna, Novavax) or unknown vaccine types.
[h]Mental health conditions included anxiety and depression.
[i]Chronic health conditions included hypertension, asthma, diabetes, chronic obstructive pulmonary disease, chronic fatigue syndrome, weakened immune system, angina, heart attack, stroke, coronary heart disease, and cancer.
[j]Other employment status includes seasonal or contract work, working at a family-owned job or business but not for pay, or other work.
[k]Among unemployed adults who reported ever working ($n = 415$).
[l]Estimate suppressed due to small n.

and being disabled/unable to work for health reasons (9.2% compared to 6.0%) were higher among those with Long COVID compared to those without ($p < 0.05$ for all comparisons).

Among employed adults, 80.6% worked full-time, 69.0% had paid sick leave available, and 71.1% had health insurance offered by their employer (Table 2).

3.3 | Work Limitations and Cognitive Dysfunction

Among employed adults, 20.0% of those with long COVID reported work limitations for health reasons compared to 9.6% without. Employed adults with long COVID reported higher prevalence of reporting some (25.7%) or a lot (2.7%) of difficulty with memory or concentration compared to those without long COVID (12.8% and 1.1%, respectively) (Table 2). Notably, 2.7% of employed adults with long COVID reported a lot of difficulty with memory or concentration or not being able to engage in these functions at all. Among all employed adults with any difficulty, 47.6% reported difficulty with both memory and concentration.

3.4 | Sickness Absenteeism

Employed adults with long COVID reported more sick days during the 12 months preceding the survey compared to those without (Figure 1). More than 1 in 8 employed adults with long COVID reported ≥ 21 sick days compared to 4.3% of those without long COVID and 6.3% of those who ever had COVID-19 (irrespective of long COVID status).

3.5 | Multivariable Analyses

In the multivariable models of employed adults who ever had COVID-19, long COVID was associated with 30% higher odds of work limitations (aOR 1.3, 95% CI 1.1, 1.5) and cognitive dysfunction (aOR 1.3, 95% CI 1.1, 1.5), and 40% higher odds of sickness absenteeism (aOR 1.4, 95% CI 1.2, 1.5) compared to those without long COVID after adjusting for sociodemographic, health, and employment characteristics (Table 3). Availability of paid sick leave was associated with lower odds of sickness absenteeism in the crude (OR 0.8, 95% CI 0.7, 1.0) but not adjusted models (aOR 1.0, 95% CI 0.9, 1.1).

3.6 | Sensitivity Analyses

In a sensitivity analysis using a different threshold for full time compared to part time work (≥ 20 h per week and < 20 h per week), we found no difference in work hours by long COVID status among employed adults [81.9%, 95% CI 78.4, 85.3 of employed adults with long COVID worked full time compared to 90.0%, 95% CI 9.4, 10.5 of employed adults without Long COVID; $p = 0.26$].

Using an alternate cut point (≥ 16 sick days compared to 0-15 sick days), long COVID was associated with 40% higher adjusted odds of sickness absenteeism (aOR 1.4, 95% CI 1.2, 1.6) compared to those without long COVID among employed adults who ever had COVID-19 (Table S1).

In multivariable models among employed adults who ever had COVID-19, the associations between *ever* having long COVID (i.e., recovered or still experiencing symptoms) and the outcomes were attenuated compared to the associations in the main analyses examining current long COVID (Table SII). After adjustment for confounding, among employed adults who ever had COVID-19, ever having long COVID was significantly associated with cognitive dysfunction (aOR 1.2, 95% CI 1.1, 1.4; $p = 0.002$) compared to those who never had long COVID but not with work limitations or sickness absenteeism.

4 | Discussion

In this 2022 nationally-representative cross-sectional sample, 3.4% of US adults aged ≥ 18 years had long COVID at the time

TABLE 2 | Employment characteristics, work limitations, and cognitive dysfunction by long COVID status, among employed US adults aged 18 years and older.[a]

Characteristic	Employed adults ($n = 15{,}239$)	Employed adults with long COVID[b] ($n = 565$)	Employed adults without long COVID ($n = 14{,}674$)	p value[c]
Age (years)				< 0.0001
18–34	34.8 (33.9, 35.8)	24.8 (20.6, 29.1)	35.2 (34.2, 36.1)	—
35–49	31.7 (30.9, 32.5)	39.8 (34.9, 44.7)	31.4 (30.5, 32.2)	—
50–64	26.9 (26.1, 27.6)	29.8 (25.5, 34.1)	26.7 (25.9, 27.6)	—
≥ 65	6.7 (6.3, 7.1)	5.6 (4.0, 7.2)	6.7 (6.3, 7.1)	—
Work hours[d]				0.47
Full time	80.6 (79.8, 81.4)	81.9 (78.4, 85.3)	80.5 (79.8, 81.3)	—
Part time	19.4 (18.6, 20.2)	18.1 (14.7, 21.6)	19.5 (18.7, 20.2)	—
Health insurance offered through workplace	71.1 (70.1, 72.0)	73.7 (69.8, 77.6)	71.0 (70.0, 71.9)	0.17
Paid sick leave available	69.0 (68.0, 70.0)	71.1 (66.9, 75.2)	68.9 (67.9, 70.0)	0.34
Work limited by health issue(s)[e]	10.0 (9.4, 10.6)	20.0 (16.2, 23.9)	9.6 (9.0, 10.3)	< 0.0001
Difficulty with memory or concentration				< 0.0001
No difficulty	85.5 (84.8, 86.3)	71.6 (67.1, 76.2)	86.0 (85.3, 86.8)	—
Some difficulty	13.3 (12.6, 14.0)	25.7 (21.2, 30.2)	12.8 (12.1, 13.5)	—
A lot of difficulty or cannot do at all	1.2 (1.0, 1.4)	2.7 (1.3, 4.0)	1.1 (0.9, 1.3)	—
Type of difficulty[f]				0.35
Memory only	29.3 (27.1, 31.5)	27.9 (20.2, 35.7)	29.4 (27.1, 31.7)	—
Concentration only	23.1 (20.9, 25.3)	19.2 (12.4, 25.9)	23.4 (21.0, 25.7)	—
Both memory and concentration	47.6 (45.1, 50.2)	52.9 (44.5, 61.2)	47.2 (44.6, 49.9)	—

[a]Data are from the National Health Interview Survey, 2022. Estimates are % (95% CI) and are weighted to account for complex sampling.
[b]Long COVID was classified as people reporting any symptoms lasting ≥ 3 months that they did not have before having COVID-19 and reporting ongoing symptoms at the time of the survey.
[c]p-values are for Rao-Scott chi squared test of independence comparing employment characteristics by long COVID status.
[d]Full time defined as ≥ 35 h per week. Part-time defined as less than < 35 h per week.
[e]Work limited in kind or amount of work due to a physical, mental, or emotional problem.
[f]Among employed adults reporting any difficulty remembering or concentration ($n = 2146$).

of the interview. Although most adults with long COVID were employed, roughly one in ten adults with long COVID reported being unable to work for health reasons/disability compared to one in fifteen adults without long COVID. Work limitations and cognitive dysfunction – both of which can affect work productivity – were common among employed adults with long COVID. One in five employed adults with long COVID reported work limitations due to health problems and nearly one in three reported at least some difficulty with memory or concentration. Additionally, employed adults with long COVID had a high frequency of work absenteeism, with more than 1 in 8 reporting ≥ 21 sick days in the year preceding the survey. Among employed adults who reported ever having COVID-19, long COVID was associated with 1.3 times higher odds of work limitations and cognitive dysfunction and 1.4 times higher odds of reporting sickness absenteeism compared to those without long COVID. The findings were robust to using a stricter threshold for sickness absenteeism (≥ 16 sick days). Taken together, these findings suggest long COVID may be associated with increased work limitations, cognitive dysfunction, and sickness absenteeism among employed US adults. Workplace accommodations may be important considerations for people experiencing long COVID.

Our findings are consistent with existing studies showing most adults with long COVID continue to work [4–6, 20]. However, employment status alone may not reflect the ability to work. For example, one study found that while most adults with long COVID reported being employed, their employment status alone did not capture short-term disability, sick leave, or modified work schedules to accommodate their illness [20]. Previous studies found that adults with long COVID may be more likely to change work status, employment type, or work hours than adults without long COVID [4, 21]. We found no differences in full-time work hours (≥ 35 h per week or ≥ 20 h per week), unemployment, or duration of unemployment by long COVID status. Because of how NHIS identifies unemployment, we were not able to determine whether people were actively looking for work. Employment status was based

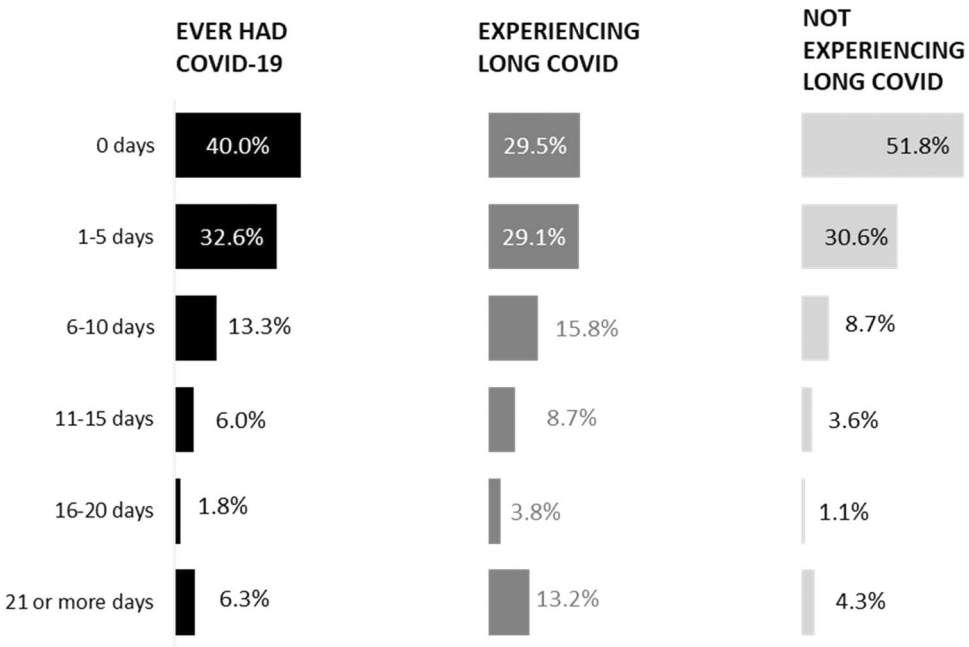

FIGURE 1 | Days of work missed for health reasons during the 12 months preceding the survey among employed US adults. Data are from the National Health Interview Survey, 2022. Prevalence estimates are weighted and account for complex sampling. $p < 0.0001$. p-value is for a Rao-Scott Chi Squared test of independence for categories of days of work missed for health reasons comparing adults with and without long COVID.

on 7-day recall, so we could not examine change in employment relative to Long COVID onset.

Long COVID symptoms may limit people's ability to carry out day-to-day activities and significantly affect functioning at work. In 2022, approximately one in four adults with long COVID reported significant activity limitations [22]. In our study, one in five employed adults with long COVID reported their work was limited due to their health. One study found that for every 10% increase in employee-reported work limitations, work productivity decreased by 4-5% [23]. Taken together, cognitive dysfunction and work limitations due to health could lead to loss of productivity, absent accommodations. Few studies have attempted to calculate the economic impact of long COVID from sick leave and reduced work hours [24, 25]; economic loss due to long COVID-associated work limitations and cognitive dysfunction has not been estimated at the national level in the United States.

Along with fatigue, cognitive dysfunction – which affected nearly one in three employed adults with long COVID in our study – is a primary determinant of functioning in adults with long COVID [6]. One study found that reporting ≥ 1 daily cognitive symptoms was associated with a 30% increased likelihood of reporting at least moderate interference with functioning [5]. A study of patients attending a long COVID clinic found that cognitive impairment was associated with both cognitive difficulties in daily life and poorer work function [26]. Although there is no definitive treatment for long COVID, interventions for cognitive symptoms – drawing on research from brain injury – include graduated return to activity and use of compensatory techniques (e.g., memory notebooks) [27]. Employers could make these techniques available along with other accommodations to support workers experiencing cognitive symptoms or other symptoms [28], such as gradual work titration, modified job roles [29], remote work options [20], flexible schedules [29], rest breaks, or quiet work areas. According to the Office of Disability Employment Policy, roughly half of job accommodations cost employers nothing [30].

Employed adults with long COVID in our study had a high frequency of sickness absenteeism. More than 1 in 8 employed adults with long COVID reported ≥ 21 sick days in the year preceding the survey. Among employed adults who reported ever having COVID-19, long COVID was associated with 40% higher adjusted odds of having ≥ 11 or more sick days compared to those without long COVID. A cohort study of US adults with SARS-CoV-2 infection found that 7.2% of participants with ongoing symptoms reported missing ≥ 11 days of work 3-months postinfection [31]. High levels of sickness absenteeism may have financial implications for both the individual and the larger economy. A US modeling study found that the average total cost of a long COVID case – assuming symptom duration of 1 year – ranged from $5,084 to $11,646; 92.5% to 95.2% of the costs were attributable to productivity losses [32]. Findings were similar to a UK study which estimated an average aggregate value of productivity loss of £10,929 (approximately $14,000) due to loss of work hours following incident SARS-CoV-2 infection [21].

Availability of paid sick leave was not associated with sickness absenteeism in the adjusted model. Our findings might be explained by restrictions in quantity of sick leave, use of other types of leave or pooled paid time off if sick leave is not available, requirements for medical documentation of illness, financial concerns, job security, or organizational culture [33]. For example, people who are self-employed [34] and those working in healthcare [35] are more likely to work while ill. Further, workers may feel pressured to continue working

TABLE 3 | Multivariable modeling of work limitations, cognitive dysfunction, and sickness absenteeism among employed US adults ages 18 years and older who self-reported COVID-19.[a]

Characteristic	Odds Ratio (95% CI)	*p* value[b]	Adjusted odds ratio (95% CI)[c]	*p* value[b]
Work limited by health issue[d]				
Long COVID[e]	2.3 (1.8, 3.0)	< 0.0001	1.3 (1.1, 1.5)	0.0003
Mental health condition(s)[f]	2.6 (2.1, 3.1)	< 0.0001	1.6 (1.4, 1.7)	< 0.0001
Chronic health condition(s)[g]	2.1 (1.8, 2.5)	< 0.0001	1.2 (1.1, 1.4)	< 0.0001
Age (centered at 45 years)	1.0 (1.0, 1.0)	< 0.0001	1.0 (1.0, 1.0)	< 0.0001
Female sex (ref. male)	1.2 (1.0, 1.4)	0.08	1.0 (0.9, 1.1)	0.88
Family income-to-poverty ratio (ref. ≥ 400%)[h]				
< 100%	1.2 (0.9, 1.6)	0.29	1.2 (0.9, 1.6)	0.27
100%–199%	1.1 (0.9, 1.4)	0.41	1.1 (0.9, 1.4)	0.36
200%–399%	1.2 (1.0, 1.4)	0.08	1.1 (1.0, 1.4)	0.12
Cognitive dysfunction (difficulty with memory or concentration)[i]				
Long COVID[e]	2.4 (1.9, 3.1)	< 0.0001	1.3 (1.1, 1.5)	0.0002
Mental health condition(s)[f]	6.9 (5.8, 8.1)	< 0.0001	2.5 (2.2, 2.7)	< 0.0001
Chronic health condition(s)[g]	1.6 (1.4, 1.9)	< 0.0001	1.1 (1.0, 1.2)	0.005
Age (centered at 45 years)	1.0 (1.0, 1.0)	0.0003	1.0 (1.0, 1.0)	0.44
Female sex (ref. male)	1.6 (1.4, 1.9)	< 0.0001	1.1 (1.0, 1.2)	0.01
Family income-to-poverty ratio (ref. ≥ 400%)[h]				
< 100%	1.6 (1.2, 2.0)	0.0005	1.4 (1.1, 1.9)	0.006
100%–199%	1.1 (0.9, 1.4)	0.21	1.1 (0.9, 1.3)	0.43
200%–399%	1.0 (0.9, 1.2)	0.63	1.0 (0.9, 1.2)	0.63
Sickness absenteeism (≥ 11 sick days compared to 0–10 days)[j]				
Long COVID[e]	2.3 (1.8, 2.9)	< 0.0001	1.4 (1.2, 1.5)	< 0.0001
Paid sick leave	0.8 (0.7, 1.0)	0.04	1.0 (0.9, 1.1)	0.63
Mental health condition(s)[f]	2.0 (1.6, 2.3)	< 0.0001	1.3 (1.2, 1.4)	< 0.0001
Chronic health condition(s)[g]	1.9 (1.6, 2.2)	< 0.0001	1.3 (1.2, 1.4)	< 0.0001
Saw a doctor in the previous 12 mo.	1.3 (1.0, 1.7)	0.04	1.1 (1.0, 1.3)	0.16
Age (centered at 45 years)	1.0 (1.0, 1.0)	0.19	1.0 (1.0, 1.0)	0.59
Female sex (ref. male)	1.1 (1.0, 1.3)	0.14	1.0 (0.9, 1.1)	0.51
Family income to poverty ratio (ref. ≥ 400%)[h]				
< 100%	1.2 (0.9, 1.6)	0.15	1.2 (0.9, 1.6)	0.17
100%–199%	1.3 (1.0, 1.5)	0.02	1.3 (1.0, 1.6)	0.02
200%–399%	1.0 (0.8, 1.1)	0.64	0.9 (0.8, 1.1)	0.44

[a]Data are from the National Health Interview Survey, 2022. Employed adults with prior COVID-19 illness and non-missing information about work limitations ($N = 6{,}662$), difficulty with concentration or memory ($N = 6603$), sick days ($N = 6542$) and covariates.
[b]*p*-values are for *t*-tests from Maximum Likelihood Estimates.
[c]Adjusted odds ratios control for all other indicators in the table.
[d]Work limited in kind or amount of work due to a physical, mental, or emotional problem (ref. work is not limited due to health).
[e]Long COVID was classified as people reporting any symptoms lasting ≥ 3 months that they did not have before having COVID-19 and reporting ongoing symptoms at the time of the survey.
[f]Mental health conditions included anxiety and depression.
[g]Chronic health conditions included hypertension, asthma, diabetes, chronic fatigue syndrome, chronic obstructive pulmonary disease, weakened immune system, angina, heart attack, stroke, coronary heart disease, and cancer.
[h]Estimates and *p*-values for family income account for multiple imputation.
[i]Some or a lot of difficulty with memory or concentration or cannot do at all (ref. no difficulty with memory or concentration).
[j]Missing 11 or more days of work due to illness, injury, or disability (ref. 0–10 days).

despite symptoms – especially if telework is available [36]. Given that more than 1 in 8 employed adults with long COVID reported ≥ 21 sick days in the year preceding the survey, the availability of paid sick leave, or at least flexible, nonpunitive sick leave, remains important. Guaranteed paid medical and family leave may help ill workers attend to their medical needs, and studies have shown such policies improve productivity and increase worker retention [28, 37].

Strengths of this study include data from a nationally representative sample of US adults. Our study included people aged ≥ 65 years – a demographic representing 1 in 15 US workers. NHIS captures self-reported cognitive dysfunction using a validated tool (WG-ES), which may not be captured reliably with diagnostic coding. This study highlights the importance of functional symptom assessment in long COVID surveillance and workplace research.

There are several limitations to this analysis. All data were self-reported and have the potential for recall bias. NHIS is cross-sectional data and did not collect information about the timing of long COVID relative to employment, work limitations, cognitive difficulties, sick days, or chronic conditions, so we could not examine causal relationships. Some chronic conditions associated with increased risk of developing long COVID may also be associated with functional limitations and decreased ability to work [16, 17]. Cognitive dysfunction as identified by the WG-ES was ascertained in general, not in the context of the workplace. Functional limitations, including cognitive dysfunction, may not impact specific jobs or jobs for which accommodations can be provided. NHIS collects limited information about employment. We did not have information about participants' industry or occupation. Our findings are generalizable to US adults; however, associations between long COVID, employment, work limitations, cognitive dysfunction, and sickness absenteeism may differ across industries and occupations. For example, the US Bureau of Labor Statistics reported differences in paid sick leave by worker characteristics such as occupation, work hours, union status, and wage category [38]. Future work may assess the outcomes in our study by industry and occupation. Further, NHIS does not capture whether people who were unemployed were looking for work. With a 7-day recall of employment, we were not able to assess a change in employment status. NHIS captured sick days during the 12 months preceding the survey. Another tool with a shorter recall period, such as the Work Productivity and Activity Impairment – General Health (WPAI-GH), may more accurately capture absenteeism because of a health problem. Self-reported history of SARS-CoV-2 infection underestimates the prevalence compared to seroprevalence studies [39]. Long COVID questions were not asked to participants reporting asymptomatic SARS-CoV-2 infection, so the prevalence of long COVID may be underestimated in this study.

Our findings highlight the burden of work limitations, cognitive dysfunction, and sickness absenteeism among employed US adults with long COVID. As the long-term effects of COVID-19 become clearer, there is mounting evidence highlighting the importance of disability support systems and healthcare resources for US workers. Workplace accommodations may be important considerations for people experiencing long COVID. Workplace policies that are inclusive of workers with different limitations and abilities could benefit all workers. Employers can check with their local public health agencies and health care organizations for resources on workplace accommodations.

Author Contributions

Dr. Ford conceptualized and designed the study, conducted the analyses, drafted the initial manuscript, critically reviewed the results, reviewed and revised the manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work. Dr. Saydah supervised the project, critically reviewed the results, reviewed and revised the manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work. Drs. Dalton, King, Luckhaupt, and Ma, Ms. Edwards, Mr. Slaughter, and Ms. Silver critically reviewed the results, reviewed and revised the manuscript, and approved the final manuscript as submitted and agrees to be accountable for all aspects of the work.

Disclosure

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC).

Ethics Statement

This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.

Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.
Supplemental material_employment and Long COVID.