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Brief Report

Long COVID Is Associated with Severe Cognitive Limitations Among U.S. Adults

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Abstract: Long COVID is characterized by persistent symptoms following the resolution of an acute COVID-19 infection. Long COVID may affect cognition due to possible ischemia, neuro-inflammation, and hypoxia related to COVID-19. The purpose of this study was to analyze the association of long COVID with severe cognitive limitations. Utilizing data from the 20 September–2 October 2023 Census Household Pulse Survey among adults, COVID status was categorized as: (1) long COVID, (2) COVID-19, or (3) no COVID. The cognitive limitations were abstracted from the Washington Group Short Set on Functioning, as follows: No difficulty; Some difficulty; A lot of difficulty; and Cannot do at all; we combined "a lot of difficulty" or "unable to do" under the category "severe cognitive limitation". Rao–Scott Chi-square tests and multivariable multinomial logistic regressions that accounted for replicate weights were used to analyze the adjusted association of long COVID with cognitive limitations. Overall, 15.1% had long COVID. A higher percentage of adults with long COVID (13.1% vs. 4.1%) reported severe cognitive limitations compared to no COVID ($p < 0.001$). In a fully adjusted logistic regression model, adults with long COVID were more likely to report at least a lot of difficulty in cognition (aOR = 1.64 95% CI = 1.38, 1.96) compared to no COVID.

Keywords: long COVID; cognition; COVID

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1. Introduction

As of March 2023, the COVID-19 pandemic continues to pose significant challenges worldwide, with over 100 million reported cases and more than one million reported deaths in the United States, according to data from the Johns Hopkins School of Medicine [1]. Though COVID was initially thought to be an acute illness, emerging evidence has shed light on a phenomenon termed "long COVID", characterized by persistent symptoms following an acute COVID resolution [2]. The Centers for Disease Control and Prevention (CDC) defines long COVID as "a chronic condition that occurs after SARS-CoV-2 infection and is present for at least 3 months" [3].

Long COVID is a serious condition with common symptoms such as fatigue, dyspnea, cough, myalgia, smell and taste disturbances, palpitations, and serious consequences such as cognitive impairment [4]. Cognitive impairment refers to difficulties with cognitive functions such as memory, learning, concentration, or decision-making that are beyond typical age-related changes. These impairments can range from mild to severe and may affect an individual's ability to perform everyday activities [5]. Cognitive limitations specifically pose significant challenges for both patients and healthcare providers because of their negative sequelae. For example, adults with cognitive limitations are more likely

to develop dementia, be hospitalized, incur higher costs, and report poor health-related quality of life [6–8]. Many factors, such as gender, age, education level, lifestyle choices, and comorbid health conditions, have been reported to affect cognitive limitations [9–13]. For example, a cohort study performed by Levine et al. showed that women, compared to men, had a higher baseline in global cognition, memory, and executive function [13]. However, women also had a faster decline in global cognition and executive function (-0.06 points faster 95%: -0.07, -0.05; $p < 0.001$) [14]. In a systematic review and meta-analysis of 247 epidemiological studies, low education, low levels of physical activity, smoking, elevated homocysteine levels, and low intake of n-3 fatty acids were identified as risk factors for cognitive decline and dementia. Conversely, higher levels of physical activity and increased intake of n-3 fatty acids were associated with a protective effect against cognitive decline [15].

Recent studies have begun exploring long COVID as one of the risk factors for cognitive limitations [16,17]. A study conducted by Zhao et al. (2024) examined cognitive slowing through simple reaction time and number vigilance tests in patients with chronic symptoms that lasted 3 months after a COVID diagnosis. They found that a higher percentage of patients with chronic symptoms (19.4% vs. 4%) experienced severe impairment (defined as any speed slower than two standard deviations from the norm) compared to the no-COVID group [16]. These findings suggest that long COVID may lead to severe cognitive impairment. In one large community sample study from the UK (2024), those with unresolved persistent symptoms experienced larger deficits in cognition as compared with the no-COVID-19 group [17]. Despite advancements in the mechanism behind long COVID, nationwide studies on the association of long COVID with cognitive limitations are limited. Therefore, the primary objective of our study is to assess the association between long COVID and severe cognitive limitation using a nationally representative survey of adults in the United States (U.S.).

2. Methods

2.1. Study Design and Data Sources

This study used a cross-sectional design and analyzed data on adults aged 18 or older from the Census Household Pulse Survey (HPS) administered between 20 September 2023 and 2 October 2023. HPS is an online survey conducted by the U.S. Census Bureau and other federal agencies [18]. The HPS collects data regularly to provide near real-time information on how the COVID pandemic impacts American households and the impact of emerging issues on the social and economic conditions in the U.S. We included adults aged 18 or older in this study. Adults who had COVID for the first time in the past four weeks were excluded from the study. Participants who had missing data on COVID status and cognitive limitation were also excluded. The final sample consisted of 59,532 respondents representing approximately 194.3 million adults in the U.S.

2.2. Key Independent Variable: COVID Status

COVID status was grouped into three categories: (1) long COVID; (2) COVID-19; and (3) no COVID. Respondents who did not test positive or were not told by a doctor or provider that they had COVID were classified as "No COVID". Among respondents with a COVID history, long COVID status was derived from the affirmative response to the following question: "Did you have any symptoms lasting 3 months or longer that you did not have prior to having coronavirus or COVID-19? Long-term symptoms may include: tiredness or fatigue, difficulty thinking, or concentrating, forgetfulness, or memory problems (sometimes referred to as "brain fog"), difficulty breathing or shortness of breath, joint or muscle pain, fast-beating or pounding heart (also known as heart palpitations),

chest pain, dizziness on standing, changes to your menstrual cycle, changes to taste/smell, or inability to exercise". Those with a COVID history and did not report long COVID were classified as having COVID-19. Respondents who had reported a new COVID infection within the past four weeks were excluded.

2.3. Dependent Variable(s): Severe Cognitive Limitation (Yes/No)

Cognition was measured using the Washington Group short set on functioning questions [19]. Adults in the study were asked whether they had limitations in remembering or concentrating. The respondents either responded no, yes with some difficulty, yes with a lot of difficulty, or cannot do it at all. We created an indicator variable for severe cognitive limitation (Yes/No) by combining adults who responded no or yes with some difficulty into one group and adults who responded yes with a lot of difficulty or cannot do at all.

2.4. Other Explanatory Variables

As cognitive limitations may be affected by many factors, we controlled for biological factors as follows: age, race and ethnicity, social determinants of health (SDOH), and mental health. Race and ethnicity were categorized as non-Hispanic White (NHW), non-Hispanic Black (NHB), Hispanic, non-Hispanic Asian (NHA), and other races. Biological factors included gender (transgender, men, and women) and age (18–34, 35–44, 45–54, 55–64, 65–74, 75+ years old). SDOH included education (less than high school, high school, some college, college); poverty relative to the federal poverty line (FPL) [20] (<100% FPL, 100–200% FPL, 200–400% FPL, >400% FPL); food insufficiency (yes, no); lost employment income of a household member in the past four weeks (yes/no); health insurance status (yes, no); marital status (married divorced/separated, widowed, and never married); region (Northeast, Midwest, South, and West); and COVID-19 vaccination status (Yes/No). Mental health included anxiety (Yes/No) and depression (Yes/No) measured with Patient Health Questionnaire-2 (PHQ-2). A score of 3 points was used as the cut-off for identifying possible cases. For individuals with missing data on explanatory variables, we created missing indicators.

2.5. Statistical Analyses

In the HPS, replicate weights are provided to help estimate variances accurately. The Rao–Scott Chi-square tests integrate weights into the variation estimation process [21]. By adjusting for the survey design, the Rao–Scott tests reduce the risk of falsely declaring associations (or missing real ones) that may be artifacts of the complex survey design. Therefore, we used Rao–Scott Chi-square statistics to determine statistically significant group differences in cognitive limitations by COVID status. Multivariable logistic regression analyses with replicate weights were used to determine the association of COVID status with severe cognitive limitations. All analyses were performed with SAS 9.4 survey procedures.

3. Results

Table 1 describes the characteristics of adults in the U.S. by COVID status. Overall, 15.1% (~29.4 million) adults reported long COVID; 40.9% reported COVID-19 (~79.5 million); and 44.0% (~85.5 million) reported no COVID (Table 1). We observed significant differences in long COVID prevalence by all subgroups. For example, a higher percentage of women and transgender people (18.4%, 25.0% vs. 11.5%) had long COVID compared to men. Those without food sufficiency had higher rates of long COVID (20.0% vs. 14.4%) compared to those with food sufficiency. Similarly, individuals residing in households with loss of employment income had higher rates of long COVID (20.7% vs. 14.4%) compared to those without loss of employment income. Adults with anxiety (22.6% vs. 12.2%) and depression

(23.3% vs. 12.8%) had higher rates of long COVID compared to adults without anxiety and depression.

Table 1. Description of adults (age > 18 years) by COVID status (Row%). Census Household Pulse Survey, 20 September 2023–2 October 2023.

	Long COVID Wt. N = 29,377,678		COVID-19 Wt. N = 79,477,605		No COVID Wt. N = 85,482,551		
	N	**Wt.%**	**N**	**Wt.%**	**N**	**Wt.%**	***p*-Value**
ALL	**8453**	**15.1**	**25,238**	**40.9**	**25,841**	**44.0**	
Gender							
Women	5448	18.4	13,086	39.8	13,299	41.8	
Men	2725	11.5	11,457	42.8	11,567	45.7	
Transgender	198	25.0	356	30.4	464	44.5	
Age							<0.001
18–34 years	1515	17.5	4487	45.9	3145	36.6	
35–44 years	1869	16.8	5513	45.6	3890	37.6	
45–54 years	1811	18.9	4509	40.6	3979	40.4	
55–64 years	1699	14.1	4670	38.9	5436	47.1	
65–74 years	1163	10.2	4405	34.6	6564	55.2	
75+ years	396	7.7	1654	31.7	2827	60.6	
Race and Ethnicity							<0.001
NHW	6400	14.8	19,600	42.0	19,554	43.2	
NHB	507	11.7	1421	33.2	2175	55.0	
Hispanic	883	19.0	2079	41.1	1945	40.0	
NHA	213	7.5	1231	46.5	1116	45.9	
Other	450	22.2	907	36.5	1051	41.3	
Education							<0.001
LT HS	155	12.7	365	29.3	696	58.0	
HS	3238	16.6	7093	36.4	9751	47.0	
Associate	1083	17.2	2438	41.1	2806	41.8	
College	3977	13.1	15,342	49.4	12,588	37.6	
Poverty Status							< 0.001
Poor	901	15.2	1441	27.7	3021	57.1	
Low Income	1441	17.8	2932	36.1	4134	46.1	
Middle Income	2517	15.9	6554	40.1	7341	44.0	
High Income	3203	12.9	13,120	49.9	10,004	37.2	
Food Sufficiency							<0.001
Insufficiency	1080	20.0	1380	28.1	2553	52.0	
Sufficiency	7345	14.4	23,794	42.7	23,203	42.9	
Lost Employment Income							<0.001
Lost	1012	20.7	1729	32.9	2214	46.4	
No Loss	7429	14.4	23,478	41.9	23,574	43.7	
Health Insurance							<0.001
Insured	7908	15.0	24,100	41.8	24,152	43.2	
Not Insured	427	16.7	844	30.5	1274	52.8	

Table 1. *Cont.*

	Long COVID Wt. N = 29,377,678		COVID-19 Wt. N = 79,477,605		No COVID Wt. N = 85,482,551		
	N	**Wt.%**	**N**	**Wt.%**	**N**	**Wt.%**	***p*-Value**
Marital Status							<0.001
Married	4611	14.3	15,840	44.3	13,493	41.4	
Widowed	424	11.4	1076	31.1	2013	57.6	
Divorced/Separated	1686	16.6	3414	31.9	5190	51.5	
Never Married	1706	16.9	4855	40.3	5072	42.8	
Region							<0.001
Northeast	1125	14.6	3967	43.2	3346	42.2	
South	2787	15.4	8004	39.9	8482	44.7	
Midwest	1895	14.6	5354	39.5	5974	45.9	
West	2646	15.5	7913	42.1	8039	42.4	
Depression							<0.001
Yes	2593	23.3	3567	32.2	5012	44.6	
No Depression	5846	12.8	21,616	43.4	20,768	43.8	
Anxiety							<0.001
Yes	3442	22.6	5309	35.6	6432	41.8	
No Anxiety	5002	12.2	19,897	43.0	19,377	44.8	

Note: Based on 59,532 adult respondents aged 18 years or older, without missing data on COVID status and cognitive limitations. Adults with COVID infection in the past four weeks were excluded. Missing values of gender, poverty status, food sufficiency, lost employment income, marital status, depression, and anxiety are not presented in the table. Significant group differences were tested with Rao–Scott Chi-square tests. HS: high school; LT: less than; NHW: Non-Hispanic White; NHB: Non-Hispanic Black; NHA: Non-Hispanic Asian; Wt.: weighted.

Table 2 summarizes the prevalence of severe cognitive limitations among U.S. adults. Overall, 6.4% reported severe cognitive limitations. A higher percentage of adults with long COVID (13.1% vs. 6.2%) reported severe cognitive limitations compared to adults without COVID. The COVID-19 group had lower rates (4.1% vs. 6.2%) of severe cognitive limitations compared to the no-COVID group. In unadjusted logistic regression, adults with long COVID had higher odds of severe cognitive limitations (OR = 2.27 95% CI = 1.91, 2.69 $p < 0.001$) compared to those without any COVID (Table 3). However, those with COVID-19 had lower odds of severe cognitive limitations compared to those without any COVID (OR = 0.64, 95% CI = 0.54, 0.76, $p < 0.001$).

Table 2. Description of adults (age > 18 years) by severe cognitive limitation (Row%). Census Household Pulse Survey, 20 September 2023–2 October 2023.

	Severe Cognitive Limitation		No/Some Cognitive Limitation		
	N	**Wt.%**	**N**	**Wt.%**	
ALL	**3274**	**6.4**	**56,258**	**93.6**	
COVID Status					<0.001
Long COVID	1078	13.1	7375	86.9	
COVID-19	872	4.1	24,366	95.9	
No COVID	1324	6.2	24,517	93.8	
Gender					<0.001
Women	1980	6.8	29,853	93.2	
Men	1065	5.0	24,684	95.0	
Transgender	196	29.0	822	71.0	

Table 2. *Cont.*

	Severe Cognitive Limitation		No/Some Cognitive Limitation		
	N	**Wt.%**	**N**	**Wt.%**	
Age					<0.001
18–34 years	814	10.1	8333	89.9	
35–44 years	713	6.5	10,559	93.5	
45–54 years	644	6.0	9655	94.0	
55–64 years	601	5.4	11,204	94.6	
65–74 years	345	3.1	11,787	96.9	
75+ years	157	4.2	4720	95.8	
Race and Ethnicity					<0.001
NHW	2439	6.4	43,115	93.6	
NHW	199	5.2	3904	94.8	
Hispanic	359	7.3	4548	92.7	
NHA	88	4.2	2472	95.8	
Other	189	8.0	2219	92.0	
Education					<0.001
LTHS	122	7.9	1094	92.1	
HS	1520	7.8	18,562	92.2	
Associate degree	394	6.1	5933	93.9	
College	1238	4.2	30,669	95.8	
Poverty Status					<0.001
Poor	635	10.7	4728	89.3	
Low Income	756	8.8	7751	91.2	
Middle Income	917	6.1	15,495	93.9	
High Income	810	3.5	25,517	96.5	
Food Sufficiency					<0.001
Insufficiency	916	16.5	4097	83.5	
Sufficiency	2346	5.0	51,996	95.0	
Lost Employment Income					<0.001
Lost	537	12.1	4418	87.9	
No Loss	2733	5.7	51,748	94.3	
Health Insurance					<0.001
Insured	2963	6.0	53,197	94.0	
Not Insured	248	10.8	2297	89.2	
Marital Status					<0.001
Married	1365	4.6	32,579	95.4	
Widowed	180	7.2	3333	92.8	
Divorced/Separated	779	7.8	9511	92.2	
Never Married	944	9.5	10,689	90.5	
Region					0.0260
Northeast	432	5.1	8006	94.9	
South	1143	6.9	18,130	93.1	
Midwest	667	6.3	12,556	93.7	
West	1032	6.4	17,566	93.6	
Depression					<0.001
Yes	2080	18.6	9092	81.4	
No Depression	1191	2.9	47,039	97.1	

Table 2. *Cont.*

	Severe Cognitive Limitation		No/Some Cognitive Limitation		
	N	**Wt.%**	**N**	**Wt.%**	
Anxiety					<0.001
Yes	2367	16.4	12,816	83.6	
No Anxiety	905	2.4	43,371	97.6	
COVID-19 Vaccination					<0.001
Vaccinated	2693	5.9	49,394	94.1	
Not Vaccinated	576	8.6	6753	91.4	

Note: Based on 59,532 adult respondents aged 18 years or older, without missing data on COVID status and cognitive limitations. Adults with COVID infection in the past four weeks were excluded. Missing values of gender, poverty status, food sufficiency, lost employment income, marital status, depression, anxiety, and COVID-19 vaccination are not presented in the table. Significant group differences were tested with Rao–Scott Chi-square tests. HS: high school; LT: less than; NHW: Non-Hispanic White; NHB: Non-Hispanic Black; NHA: Non-Hispanic Asian; Wt.: weighted.

Table 3. Unadjusted and adjusted odds ratios and 95% confidence intervals (CI) of COVID status from logistic regressions on severe cognitive limitation. Adults (age $\geq$ 18 years). Census Household Pulse Survey, 20 September 2023–2 October 2023.

Model 1: Unadjusted			
	uOR	**95%CI**	**Prob**
COVID-19 Status			
Long COVID	2.27	[1.91, 2.69]	<0.001
COVID-19	0.64	[0.54, 0.76]	<0.001
No COVID (Ref)			
Model 2: Adjusted for gender, age, race, and ethnicity			
	aOR	**95%CI**	**Prob**
COVID Status			
Long COVID	1.87	[1.56, 2.23]	<0.001
COVID-19	0.58	[0.49, 0.70]	<0.001
No COVID (Ref)			
Model 3: Adjusted for gender, age, race, and ethnicity and SDOH			
COVID Status			
Long COVID	1.93	[1.61, 2.31]	<0.001
COVID-19	0.72	[0.61, 0.85]	<0.001
No COVID (Ref)			
Model 4: Adjusted for gender, age, race, and ethnicity, SDOH, depression, and anxiety			
COVID Status			
Long COVID	1.65	[1.38, 1.96]	<0.001
COVID-19	0.75	[0.63, 0.89]	<0.01
No COVID (Ref)			
Model 5: Adjusted for gender, age, race, and ethnicity, SDOH, depression, anxiety, and COVID-19 Vaccination			
COVID Status			
Long COVID	1.65	[1.39, 1.97]	<0.001
COVID-19	0.75	[0.63, 0.89]	<0.01
No COVID (Ref)			

Note: Based on 59,532 adult respondents aged 18 years or older, without missing data on COVID status and cognitive limitations. Adults with COVID infection in the past four weeks were excluded. SDOH included education, poverty status, lost income, food sufficiency, health insurance, marital status, and region. Ref: aOR: adjusted odds ratio; Ref: reference group, SDOH: social determinants of health, uOR: unadjusted odds ratio.

In a fully adjusted analysis (Table 3), those with long COVID compared to no COVID had higher odds of cognitive limitations (aOR = 1.65, 95% CI = 1.39, 1.97). The relationship between COVID-19 vaccination status and severe cognitive limitations was found to be insignificant (aOR = 0.94, 95% CI = 0.77, 1.13; p = 0.4854). NHB adults (aOR = 0.62, 95% CI = 0.47, 0.82; p = <0.01) had lower odds of severe cognitive limitations compared to NHW. With respect to age groups, compared to the reference of 18–34 years old, all age groups except 75 years or older had lower odds of severe cognitive impairment.

In contrast, adults with unfavorable SDOH had higher odds of cognitive limitations compared to their counterparts. These groups were high school (aOR = 1.16, 95% CI = 1.02, 1.32) versus college educated, poor (aOR = 1.41, 95% CI = 1.12, 1.79) and near poor (aOR = 1.30, 95% CI = 1.06, 1.58) compared to high income, lost employment income (aOR = 1.26, 95% CI = 1.02, 1.56) versus no lost employment income, food insufficiency (aOR = 1.53, 95% CI = 1.30, 1.82) versus no food insufficiency, widowed (aOR = 1.47, 95% CI = 1.08, 2.01) compared to married, southern region (aOR = 1.25, 95% CI = 1.03, 1.52) compared to northeast, and transgender (aOR = 3.32, 95% CI = 2.35, 4.69) compared to males.

4. Discussion

In this nationally representative study of U.S. adults, we found that 15.1% of adults reported experiencing long COVID, representing approximately 29.4 million adults. This estimate is higher than prior reports. For example, a 2022 report using the National Health Interview Survey (NHIS) found that approximately 6.9% of U.S. adults had ever experienced long COVID, with 3.4% reporting current symptoms at the time of the survey [22]. Data from the Medical Expenditure Panel Survey (MEPS) in early 2023 estimated a long COVID prevalence of around 7% [19]. The differences between our estimates and prior studies may be attributable to variations in survey methodology, time, population demographics, and definitions of long COVID. While the census pulse survey was administered between 20 September 2023 and 2 October 2023, other surveys were from earlier time periods [22,23]. Furthermore, the wording of the HPS survey question includes a broad range of symptoms (e.g., brain fog, fatigue, dizziness, and menstrual changes) [24], which may differ from stricter long COVID definitions used in other studies. These factors highlight the complexity of defining and measuring long COVID prevalence across different populations and methodologies.

We also found that 6.4% of U.S. adults reported severe cognitive limitations. This finding is lower than with prior research, though estimates of cognitive impairment vary based on population age and assessment tools. For instance, a 2018 CDC report found that 11.2% of adults aged ≥45 years reported subjective cognitive decline, with prevalence increasing with age [25]. Another study reported that the prevalence of moderate to severe cognitive impairment among adults aged 70 and older was 9.5% [26]. The lower estimate in our study is likely due to differences in age distribution, as our study included adults aged 18 and older, whereas cognitive limitation studies are typically conducted in older populations. Additionally, the reliance on self-reported cognitive limitations rather than clinically diagnosed impairment may have influenced our findings.

Importantly, we observed that adults with long COVID were significantly more likely to report severe cognitive limitations (13.1%) compared to those without COVID (6.2%, $p < 0.001$). This aligns with prior studies linking long COVID to cognitive impairment. Zhao et al. (2024) found that individuals with chronic symptoms persisting three months post-COVID exhibited significant cognitive slowing in reaction time and vigilance tests, with 19.4% of patients experiencing severe impairment compared to 4% in the no-COVID group [16]. Similarly, in a community sample of adults in England, individuals with unre-

solved persistent symptoms following COVID-19 demonstrated notable cognitive deficits compared to those without a history of infection [17]. A surprising finding in our study was that adults with an acute COVID-19 infection reported lower rates of severe cognitive limitations compared to those with no COVID history. This finding is somewhat unexpected, as one might anticipate that any history of COVID-19 could be associated with increased cognitive challenges. The reasons for this observation are not entirely clear and warrant further investigation to understand the mechanisms underlying cognitive outcomes in individuals with varying durations of COVID-19 symptoms. One possible explanation is that older adults who experienced more severe acute COVID-19 infections may have higher mortality rates or long-term institutionalization, potentially leading to the underrepresentation of cognitively impaired older adults in survey-based studies. As a result, the older individuals included in our dataset may be those who had milder infections and were overall healthier at baseline, contributing to a lower observed prevalence of cognitive impairment post-COVID [27]. Additionally, differential reporting and adaptation mechanisms may contribute to this pattern. Older adults are more likely to attribute cognitive changes to normal aging rather than COVID-19, leading to the underreporting of symptoms in surveys [28]. Our study also found that adults aged 18–34 years had a higher likelihood of reporting severe cognitive limitations compared to some older age groups. While cognitive impairment is generally more prevalent in aging populations, several factors may explain this unexpected finding. Research suggests that younger adults with long COVID frequently report persistent cognitive symptoms, including brain fog, difficulty concentrating, and memory problems, even if they experienced mild acute COVID-19 illness [29]. This may indicate post-viral neurological effects rather than neurodegenerative causes. In addition, differences in digital literacy may contribute to reporting biases. Younger adults who are more engaged with digital health resources [30] may be more aware of and likely to report cognitive difficulties, whereas older populations may underreport symptoms [31]. These findings highlight the need for targeted cognitive assessments and mental health screenings in younger adults experiencing long COVID.

Other noteworthy findings were the relationships of SDOH with severe cognitive limitations. In the fully adjusted analysis, unfavorable SDOH were associated with severe cognitive limitations. Adults experiencing food insufficiency had higher odds of severe cognitive limitations, consistent with studies linking low socioeconomic status to increased dementia risk. For example, Marden et al. reported that a stable socioeconomic status in early and adult life predicted better memory function and slower decline [32]. Additionally, individuals who lost employment income, had lower income levels, or possessed lower educational attainment exhibited higher odds of severe cognitive limitations. These findings are in line with research suggesting that lower socioeconomic status exacerbates the risk of cognitive decline [32].

Our study had some notable strengths. Firstly, we used the HPS survey. The survey allowed for a large and diverse population pool while gathering information in real time. Additionally, our study asked whether the participant "tested positive or a doctor or provider told you that you have COVID". This way, COVID data could be captured for those who may have done home testing and did not actually get a formal diagnosis from the doctor, further allowing us to more accurately assess the association between cognitive impairment and COVID diagnosis. Other studies may have just relied on ICD-10 codes or formal diagnosis. Also, our research findings may lead to further research and closer monitoring of cognitive function after patients have been diagnosed with COVID. After a patient is diagnosed with COVID, healthcare professionals may provide screening tools to monitor cognitive function.

Our study has several limitations. Firstly, it included all adults with a recent COVID-19 infection. It did not exclude adults with cognitive impairment prior to diagnosis. This inclusion may have led to an overestimation of the association between long COVID and cognitive impairment. Future studies could consider excluding individuals with known cognitive disorders to establish a more direct link. Secondly, this was a cross-sectional study in which adults self-reported their symptoms and diagnosis. Therefore, this study was susceptible to recall bias. Additionally, the absence of standardized neurocognitive assessments limits our ability to distinguish between actual cognitive deficits and perceived difficulties, which may be influenced by factors such as anxiety or depression. Thirdly, the HPS survey is an online survey that is only available to those with at least one email address or cell phone number. This adds selection bias to the study, as only subjects with internet access were included. Furthermore, we lack detailed information regarding respondents' COVID-19 diagnoses and health conditions, including hospitalization history or the development of other conditions requiring care. Consequently, we cannot determine whether cognitive impairments are attributable to the infection itself or to complications arising from hospitalization. Lastly, we did not have access to respondents' medication histories; some individuals may have been taking medications that affect cognitive function, potentially confounding our findings. In addition, the HPS dataset did not include detailed information on lifestyle factors and health behaviors, such as physical activity and diet, which could also have influenced our results.

Long COVID remains an evolving public health concern. Our findings highlight the importance of monitoring cognitive function in individuals with persistent post-COVID symptoms. Given that cognitive limitations often progress to severe cognitive impairment and dementia—a condition that affects nearly 50 million people globally [33] and is expected to rise as the population ages—addressing cognitive symptoms early is critical. Dementia imposes substantial humanistic, clinical, and economic burdens, including increased healthcare costs, caregiver strain, and loss of productivity [34]. Future research should aim to clarify the mechanisms underlying cognitive limitations associated with long COVID and explore interventions, such as cognitive rehabilitation programs, to mitigate these effects and reduce the long-term burden on individuals and healthcare systems.

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