Received: 1 June 2021 | Revised: 20 October 2021 | Accepted: 26 October 2021

DOI: 10.1002/ajim.23307

RESEARCH ARTICLE

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE WILEY

Cost of lost work hours associated with the COVID-19 pandemic—United States, March 2020 through February 2021

Abay Asfaw

Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH), Economic Research and Support Office (ERSO), Washington, District of Columbia, USA

Correspondence
Abay Asfaw, Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH), Economic Research and Support Office (ERSO), 395 E St, SW Washington, DC 20201, USA.
Email: AAsfaw@cdc.gov

Abstract

Introduction: Of the 22.8 million coronavirus disease 2019 (COVID-19) cases recorded in the United States as of March 21, 2021 with age information, three-fourths were in the workingage group, indicating the potentially high economic impact of the pandemic. This study estimates the cost of lost work hours associated with the COVID-19 pandemic between March 2020 through February 2021.

Method: I used a before-and-after analysis of data from the 2017–2021 Current Population Survey to estimate the costs of lost work hours due to economic, workers' own health, and other reasons, from the COVID-19 pandemic.

Results: Across March 2020 through February 2021 (a year since the start of the pandemic in the United States), the estimated cost of lost work hours associated with the COVID-19 pandemic among US full-time workers was $138 billion (95% confidence interval [CI]: $73.4 billion–$202.46 billion). Shares of the costs attributed to economic, workers' own health, and other reasons were 33.7%, 13.7%, and 52.6%, respectively.

Conclusion: The $138 billion cost of lost work hours associated with the COVID-19 pandemic during March 2020 through February 2021 highlights the economic consequences of the pandemic, as well as indicating the potential benefit of public health and safety interventions used to mitigate COVID-19 spread.

KEYWORDS
COVID-19, CPS, lost work hours

1 | INTRODUCTION

As of March 21, 2021, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), had claimed more than 539,000 lives and infected more than 29.6 million people in the United States.[1] Out of 22.8 million COVID-19 cases with age information, three-fourths were in the working age-group of 18–64 years.[2] Cutler estimated that the total economic cost of the COVID-19 pandemic in terms of lost gross domestic product, premature death, long-term health impairment, and mental health impairment in the United States through Fall 2021 would be $16 trillion, of which $7.6 trillion (47.5%) was due to lost economic output over 20 years.[3] Makridis and Hartley estimated that the economic cost of current mitigation measures in place to combat COVID-19 in the United States in the first 2 months would be $2.14 trillion.[4] Using the Current Population Survey (CPS), Groenewold et al. estimated trends in absenteeism during March and April 2020, a period of rapidly accelerating transmission of COVID-19, compared with 5-year baselines.[5] Their results showed that increased absenteeism was observed in personal care and service, health-care support, and production occupations during March and April 2020, compared with the baseline years.

Although the overall macroeconomic impact of the pandemic has been estimated by some researchers, little is known about the impact

of the pandemic on the number of work hours lost. This study complements ongoing research efforts to measure the economic burden of COVID-19 by estimating the cost of lost work hours associated with the pandemic for US full-time workers from March 2020 through February 2021—1 year since the start of the COVID-19 pandemic in the United States—with the use of nationally representative micro-level data. The study also breaks down the costs by economic, workers' own health, and other factors. The results of the study will highlight for employers and other decision-makers the economic benefit of public health interventions for dealing with the pandemic.

2 | STUDY DATA AND METHODS

2.1 | Data

For this study, I used CPS data from March 2017 through February 2021. The CPS is the primary source of labor force statistics for the civilian, noninstitutionalized population aged ≥16 years in the United States.[6–8] It is conducted by the US Census Bureau for the US Bureau of Labor Statistics (BLS) on a probability selected sample of about 60,000 households each month. The data are publicly available on the US Census Bureau website (https://www.census.gov/programs-surveys/cps.html). The survey collects information on employment, number of hours worked, reasons for being absent from work or working part-time, earnings, and other characteristics of the labor force. The earnings data are collected from one-fourth of the CPS total sample.[9] I picked March 2020 as a starting month of the epidemic because during this month community transmission of COVID-19 had become established throughout the United States, with cases being reported in all 50 states and the District of Columbia.[10] I also used the CPS data from March 2017 through February 2020—the three most recent years before the COVID-19 pandemic—as baseline years.

Using a standardized questionnaire, trained interviewers collect data on sample-household members from one person who is knowledgeable about all the household residents. During the COVID-19 pandemic months (March 2020 to present), CPS data collection continued with some modifications intended to ensure the safety of both interviewers and respondents.[11] The average monthly response rate during March 2020 through February 2021 was 72%, about 12 percentage points lower than the average response rate in the baseline years.

In this study, I considered only full-time workers aged ≥16 employed during the survey weeks because the US Census Bureau collects information from only full-time workers on the main reason for working fewer than 35 h during the reference week. As a result, part-time workers and unemployed people were not included in the study. Full-time workers were defined as employed or self-employed people aged ≥16 who reported usually working ≥35 h per week at their main and other job or jobs. Full-time workers who reported that their weekly hours varied (6.0% during March 2017–February 2020 in the baseline years and 5.6% during March 2020–February 2021) were not included in the analysis.

2.2 | Measurement of variables

CPS collects information on the number of hours respondents usually worked and the actual number of hours worked during the reference week, at all jobs combined (Table 1). This information was used to measure the number of work hours reduced or missed during the reference week. The number of work hours missed was computed as the

TABLE 1 Questions used to measure the number of work hours reduced or missed during the reference week and the reasons for them

I. Questions[a]	Possible values
Last week, how many hours did you actually work at your job or main job?	0–99
Last week, how many hours did you actually work at your other job?	0–99
How many hours do you usually work at your job or main job?	0–99, Hours vary each week
How many hours do you usually work at your other job?	0–99, Hours vary each week
II. Reasons[b]	**Specific reasons**
1. Non-COVID-19 related	Vacation or personal days; holiday (religious or legal); labor dispute; weather affected job; school or training; civic or military duty; seasonal work; retired or social security limit on earnings; work week less than 35 h; other family or personal obligations
2. COVID-19 related	
2.1. Economic	Slack work or business condition and could find only part-time work
2.2. Own health	Own illness, injury, medical appointment, health or medical limitation
2.3. Childcare	Childcare problems
2.4. Other	Other reasons

Abbreviation: COVID-19, coronavirus disease 2019.

[a]Basic CPS Items Booklet: Labor Force Items. Available at https://www.census.gov/programs-surveys/cps/technical-documentation/questionnaires.html.

[b]Author's compilation from U.S. Census Bureau Current Population Survey (CPS) Questionnaire. Available at https://www.census.gov/programs-surveys/cps/technical-documentation/questionnaires.html. Since March 2020, the "Own health" category includes people who indicated they were under quarantine or self-isolating due to health concerns. Reduced work hours due to the COVID-19 pandemic were included in "slack work or business conditions." See reference 5. During post-COVID-19 months, "Other reasons" might include ones related to the pandemic (see, for instance, https://cps.ipums.org/cps/resources/other_docs/employment-situation-covid19-faq-march-2020.pdf).

difference between the usual work hours and the actual hours worked in the reference week at all jobs combined (jobs 1 and 2). Respondents who reported that their usual hours varied were excluded from the analysis. CPS collects information on individuals who had a job or jobs but were not at work for the entire survey reference week. This variable was used to measure the number of work hours respondents were absent from work during the reference week. Overall, the number of work hours lost was measured as the sum of the number of work hours missed and the number of absent hours during the reference week. The CPS questions refer to 1 week of each month. Therefore, the number of work hours lost within the survey week was intended to be representative of the remaining 3 weeks of the survey month.[5]

The CPS data include reasons for absence or reduction of work hours (Table 1). I divided these reasons into two broad categories: non-COVID-19 related and COVID-19 related. Changes in the number of work hours lost due to absence or reduction of work hours due to seasonal work, maternity/paternity leave, holiday, labor dispute, weather, other family or personal obligations, civic or military duty, retirement or social security limits on earnings, and a workweek of <35 h were considered non-COVID-19 related. Changes in the number of work hours lost due to economic reasons, workers' own health, and childcare problems were considered COVID-19 related. Economic reasons include slack work or business conditions, seasonal work, or a job that started or ended during the week. Own illness, injury, medical appointment, and health and medical limitations were considered own-health reasons. Since March 2020, reasons also included in this category were quarantine and self-isolation due to health concerns.

Because of the COVID-19 pandemic, most childcare providers closed temporarily or reduced their capacity to keep children and staff safe. Consequently, parents have experienced serious childcare problems. Therefore, absence due to childcare problems was considered a COVID-19-related reason.[12] Finally, although CPS respondents who described reasons as "other" were asked to specify the reasons, the publicly available CPS data do not include that information. New reasons for absence from work during COVID-19 are not included as responses in the CPS standard reasons. Therefore, "other" was considered a COVID-19-related reason.

2.3 | Methods

In the absence of a randomized, controlled trial, different quasi-experimental methods can be used to examine the effect of an intervention or event on outcomes.[13,14] Difference-in-differences, uncontrolled before-and-after, time series designs, and controlled before-and-after are the most used quasi-experimental methods.[13,15,16] Among those, I used the uncontrolled before-and-after method to examine the impact of the COVID-19 pandemic on the number of work hours lost, because the other methods require a control group that has not been affected by the intervention. The term *uncontrolled* indicates that the before-and-after comparison is not between intervention groups and control groups not affected by the intervention. The uncontrolled before-and-after method compares the number of work hours lost 1 year before the COVID-19 pandemic with the number of work hours lost within a year after the pandemic started.

Figure 1 presents the framework of the before-and-after analysis used in this study. To better approximate the number of work hours lost within 1 year before the pandemic, I used the average number of work hours lost during March 2017 through February 2020, the three prepandemic years (Figure 2).

If threats to internal validity are addressed, the uncontrolled before-and-after design provides more reliable results than other nonexperimental studies, especially if the outcome is measured over time across a whole population.[17,18] Several factors can affect the internal validity of such a design, including history threat, instrumentation or reporting threat, and dropout threat. History threat indicates that changes other than COVID-19 might affect the number of work hours lost between the two study periods. To test for history threat,[17] differences in the total number of work hours lost during the three baseline years (March 2017–February 2018, March 2018–February 2019, March 2019–February 2020) were tested. A nonstatistically-significant difference in the number of work hours lost during these pre-COVID-19 periods indicates the absence of a history threat. Instrumentation or reporting and dropout threats occur when variables of interest are measured in different ways in the before and after periods and the number of participants who drop out of the study is enough to possibly change the characteristics of the participants. It is highly unlikely that these issues have affected the analysis, because the US Census Bureau uses a standard questionnaire to collect information from randomly selected representative CPS participants in all before- and after-COVID-19 periods.

I used the following formula to compute the number of work hours lost:

$$\text{TNWHL per year}_t = \sum_{m=1}^{12} [(\text{TNUHW}_{tm} \text{ per week in jobs 1 \& 2} - \text{TNAHW}_{tm} \text{ per week in jobs 1 \& 2}) * 4],$$

where TNWHL = total number of work hours lost, TNUHW = total number of usual hours worked, TNAHW = total number of actual hours worked, t = years (March 2017 through February 2018, March 2018 through February 2019, March 2019 through February 2020, and March 2020 through February 2021), and m = months from March through February in each year.

Note that the CPS data are collected during one "reference week" out of the month. The difference between the total number of usual hours worked and the total number of actual hours worked in each week was multiplied by four to estimate the total number of work hours lost in each month. Appendix A presents how the total number of work hours lost within 1 year after the pandemic (March 2020 through February 2021) was computed for absence related to economic reasons. A similar method was used to compute the total number of workhours lost for the three prepandemic years and for the different reasons of absence mentioned above. Then, monthly values from March through February of each year were added to estimate the total number of work hours lost in each study year. Finally, the total number of work hours lost within 1 year after the COVID-19 pandemic

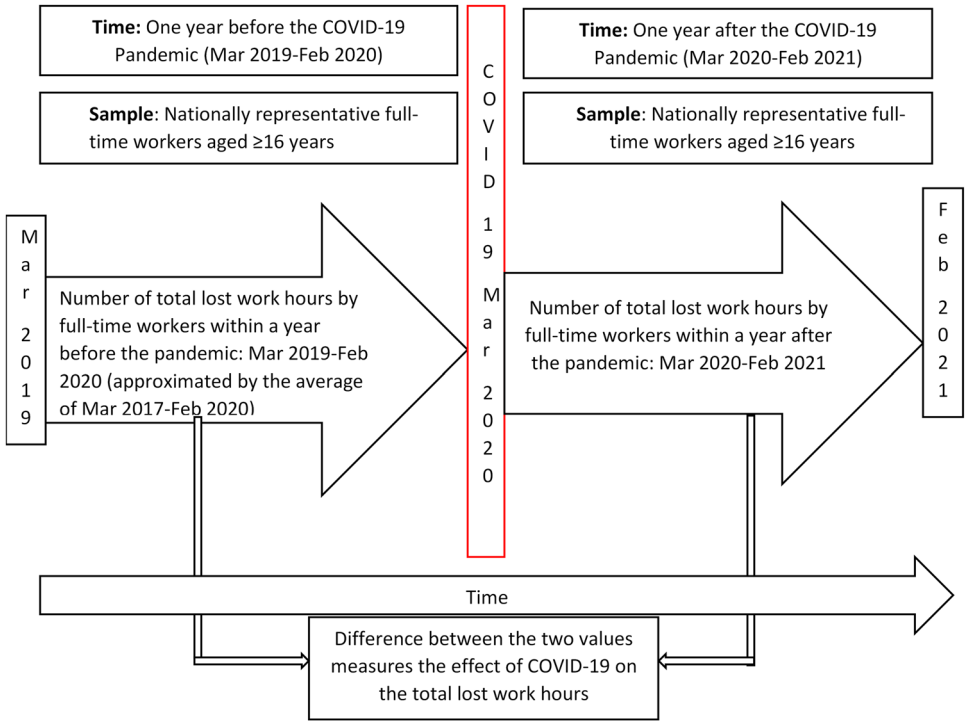

FIGURE 1 Framework for an uncontrolled before-and-after analysis

(March 2020 through February 2021) was compared with the average total number of work hours lost in the three pre-COVID-19 years (March 2017 through February 2020). Taking the average work hours lost in the three pre-COVID-19 years was expected to give more reliable results than taking 1-year pre-COVID-19 data (during March 2019 through February 2021). However, the results were very similar when the March 2019 through February 2020 values were used instead of the average value from the 3 pre-COVID-19 years. The difference between the total number of work hours lost within 1 year after the pandemic and the average total number of work hours lost within the 3 years before the pandemic measured the effect of COVID-19.[19] Differences were evaluated with two-tailed *t* tests on weighted data, and *p* values <0.05 were considered statistically significant. The impact of COVID-19 on the number of work hours lost was also computed for the four reasons assessed for lost hours.

Methods such as human capital approach (HCA), fraction cost, and multiplier are used in the literature to value productivity losses due to work hours lost.[20–23] The HCA measures individuals' contribution to society in terms of a stream of output (productivity) over their lifetime.[24] It uses gross wages to estimate productivity by assuming that employers equate marginal productivity of labor to its marginal cost.[25,26] The fraction cost method focuses on the time required to restore the productivity lost due to the absent worker.[26–28] It is argued that the fraction cost method better estimates lost productivity due to absenteeism than does the HCA method.[23,27] However, the fraction cost method is data-intensive, requiring detailed information on costs of replacing a worker, vacancy duration, and indirect cost during a fraction period and requiring more complex calculations[23,27] that are beyond the scope of this article.

The multiplier method assumes that the productivity loss of a worker should be evaluated in the context of its impact on coworkers and overall output. It is computed as the ratio of the total loss of team production and the individual gross wage of the absentee.[29–31] However, it is not easy to estimate the magnitude of the multiplier.[31]

In this study, the HCA was used to monetize the cost of work hours lost associated with COVID-19. Among different streams of outputs included in the HCA, lost workplace outputs due to absenteeism or reduced work hours were considered. In other words, lost outputs from home production and voluntary services were not included. As per HCA, I used the average gross hourly wage of workers who reported lost work hours during March 2020 through February 2021 ($22.96) to monetize lost hours. Of note, the average hourly wage of all workers during the same period was $28.33.

Data were weighted to produce nationally representative estimates from the CPS composite weight. More information about the sampling procedure and the weights are provided at https://cps.ipums.org/cps/sample_designs.shtml. In all cases, the sample weights were adjusted for the 12-month data in each period because 12 months of data were used for each year. Data were analyzed with Stata software (version 17; StataCorp 2020).

3 | RESULTS

3.1 | Work hours lost due to economic reasons

Figure 1A presents the number of work hours lost by full-time workers during March 2017 through February 2021 and the impact

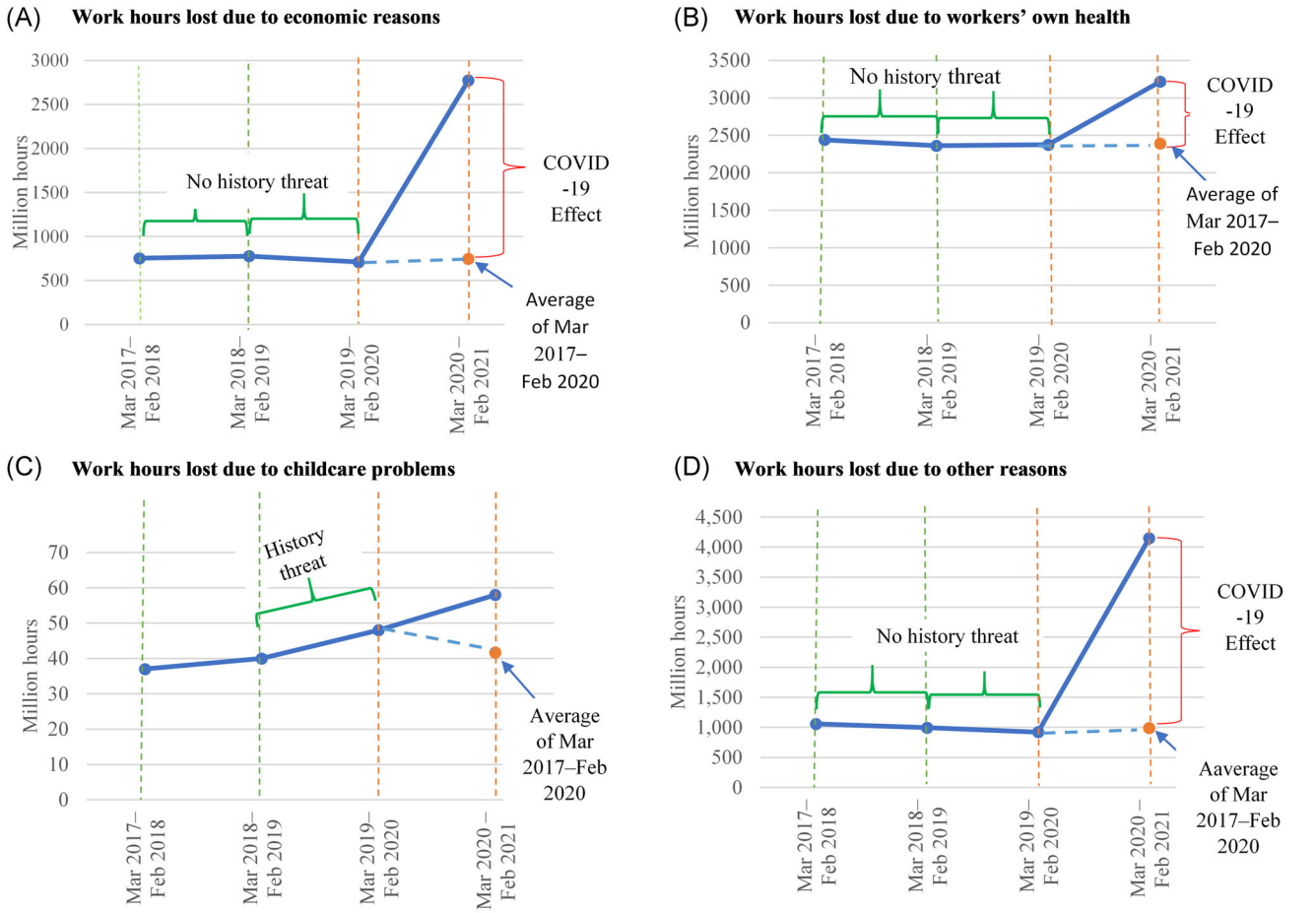

FIGURE 2 Estimated number of lost work hours by full-time workers during March 2017–February 2021 and impacts of the COVID-19 pandemic due to economic, workers' own health, childcare, and other reasons. COVID-19, coronavirus disease 2019

of the COVID-19 pandemic due to economic reasons during March 2020 through February 2021. The estimated number of work hours lost due to economic reasons during the March 2017 through February 2018 period was 752 million, which slightly increased to 776 million in March 2018 through February 2019. However, this 1.02% increase was not statistically significant (two-tailed t test = 0.354; $p = 0.72$). In the March 2019 through February 2020 period, this figure declined to 702 million, although the difference was not statistically significant (two-tailed t test = −1.02; $p = 0.32$). Overall, there were no statistically significant differences in the total estimated number of work hours lost during these pre-COVID-19 years due to economic reasons, indicating that there was no evidence of history threat (Table 2).

In the absence of COVID-19, the expected total number of work hours lost due to economic reasons during March 2020 through February 2021 (as proxied by the average for March 2017 through February 2020) would be 746 million. The estimated number of work hours lost due to economic reasons in that 1-year period was 2772 million (the Appendix A shows how this figure was computed), or 3.7 times higher than the expected value (two-tailed t test = 3.72; $p < 0.01$). The corresponding estimated cost of lost hours associated with the COVID-19 pandemic due to economic reasons was $46.54 billion (Table 3).

3.2 | Work hours lost due to workers' own health reasons

The estimated numbers of work hours lost due to workers' own health reasons during the periods of March 2017 through February 2018, March 2018 through February 2019, and March 2019 through February 2020 were 2440 million, 2362 million, and 2375 million, respectively. There was no statistically significant difference in the estimated number of work hours lost during these pre-COVID-19 years due to workers' own health reasons, indicating that there was no evidence of history threat. See Figure 1B and Table 2 for the details. The estimated number of work hours lost due to workers' own health reasons during March 2020 through February 2021 was 3216 million (95% confidence interval [CI]: 2918 million–3516 million), or 1.3 times higher than the average value for 3 pre-COVID-19

TABLE 2 Estimated number of total lost work hours by full-time workers, by year and reason: Current Population Survey, United States, March through February 2017–2021

	Weighted total, millions: March through February (95% confidence interval)				History threat test: Two-sample two-tailed *t*-test		
Reasons for work hours lost	Mar 2017–Feb 2018 (*N* = 555,000)	Mar 2018–Feb 2019 (*N* = 542,885)	Mar 2019–Feb 2020 (*N* = 527,568)	Mar 2020–Feb 2021 (*N* = 440,158)	Mar 2018–Feb 2019 versus Mar 2017–Feb 2018	Mar 2019–Feb 2020 versus Mar 2018–Feb 2019	Mar 2019–Feb 2020 versus Mar 2017–Feb 2018
Economic	752 (655–848)	776 (678–874)	709 (625–793)	2772 (1715–3830)	0.354	−1.020	−0.651
Workers' own health	2,440 (2163–2717)	2362 (2185–2539)	2375 (2178–2571)	3216 (2918–3516)	−0.466	0.094	−0.378
Childcare problems	37 (31–44)	40 (31–49)	48 (41–55)	59 (48–69)	0.422	1.375*	2.150**
Other	1056 (809–1302)	993 (804–1181)	921 (699–1143)	4147 (2117–6117)	−0.397	−0.622	−0.797
Total (excluding childcare problems)	4247 (3906–4590)	4131 (3862–4400)	4005 (3711–4299)	10,135 (7039–13,232)	−0.525	−0.534	−1.056

Note: Only full-time workers were considered in the study. A full-time worker was defined as an employed or self-employed person aged ≥16 who reported usually working ≥35 h per week at their main and other job or jobs. Full-time workers who reported that their weekly hours varied were not included in the analysis. Weighted *N* = 118,680,074 (Mar 2017–Feb 2018); 121,272,862 (Mar 2018–Feb 2019); 123,010,719 (Mar 2019–Feb 2020); 115,321,236 (Mar 2020 –Feb 2021). History threat indicates that changes other than COVID-19 might affect the number of work hours lost between the two periods. Total work hours lost due to childcare problems were excluded from the total column because the variable did not satisfy the "no history threat" assumption. The *t* test results are from two-sample tests, and *p* values are from two-tailed tests.

*$p < 0.1$; **$p < 0.05$.

Source: Author's analysis of data from the Current Population Survey (CPS), March 2017 through February 2021 data.

TABLE 3 Estimated cost of work hours lost associated with COVID-19: Current Population Survey, United States, March 2017 through February 2021

Reasons for lost work hours	Weighted total, millions (95% confidence interval)		Two-sample two-tailed *t*-test: After versus before	Cost of COVID-19 associated with work hours lost, $ billions (95% confidence interval)	Cost of COVID-19 associated with work hours lost, by reason, %
	One year before the COVID-19 pandemic (Mar 2019–Feb 2020)	One year after the COVID-19 pandemic (Mar 2020–Feb 2021)			
Economic reasons	709 (625–793)	2772 (1715–3830)	3.814***	$47 ($25–$70)	33.66
Workers' own health	2375 (2178–2571)	3216 (2918–3516)	4.616***	$19($17–$22)	13.72
Other reasons	921 (699–1143)	4147 (2117–6117)	3.096***	$74 ($33–$114)	52.63
Total	4005 (3842–4414)	10,135 (7039–13,232)	3.863***	$141($73–$202)	100.00

Note: Sample sizes are reported in Table 2. The costs of COVID-19 associated with work hours were computed by multiplying the difference between the work hours lost one year after the pandemic (Mar 2020 through Feb 2021) and the work hours before the pandemic (Mar 2019 through Feb 2020) by the average hourly wage rate of workers who reported lost work hours in March 2020 through February 2021 ($22.96). The *t*-test results are from two-sample tests, and *p* values are from two-tailed tests.

Abbreviation: COVID-19, coronavirus disease 2019.

***$p < 0.01$.

Source: Author's analysis of data from the CPS March 2017 through February 2021 data.

years of 2392 million (95% CI: 2184 million–2601 million), and the difference was statistically significant (two-tailed t test = 5.89; $p < 0.01$). This indicates that the estimated cost of lost hours associated with the COVID-19 pandemic due to workers' own health reasons was $18.92 billion (95% CI: $12.08 billion–21.01 billion) (Table 3).

3.3 | Work hours lost due to childcare reasons

In the case of work hours lost due to childcare problems, the hypothesis that there was no evidence of history threat could not be rejected. See Figure 1C and Table 2. The estimated number of work hours lost due to childcare problems during March 2017 through February 2018 was 37 million; during March 2018 through February 2019 and March 2019 through February 2020, it increased to 40 million and 48 million, respectively. The difference in the number of work hours lost due to childcare problems between the periods of March 2019 through February 2020 and March 2017 through February 2018 was statistically significant (two-tailed t test = 2.15; $p < 0.05$), violating the "no history threat" assumption. Therefore, work hours lost due to childcare problems were not included in the final analysis.

3.4 | Work hours lost due to other reasons

During the March 2017 through February 2018 period, 1056 million work hours were lost due to other reasons; the number slightly declined to 993 million and 921 million during the periods of March 2018 through February 2019 and March 2019 through February 2020, respectively (Figure 1D). There were no statistically significant differences in the estimated number of work hours lost due to other reasons during these pre-COVID-19 periods, indicating that there was no evidence of history threat (Table 2). In the absence of COVID-19, the average total number of work hours lost due to other reasons during the 3 pre-COVID-19 years was 990 million (95% CI: 780 million–1200 million). The total estimated number of work hours lost due to other reasons during March 2020 through February 2021 was 4147 million (95% CI: 2117 million–6117 million), or 4.2 times higher than the expected value. The corresponding estimated cost of lost hours associated with the COVID-19 pandemic due to other reasons was $74.48 billion (95% CI: $32.56 billion–$114.20 billion). See Table 3 for the details.

4 | DISCUSSION

The overall economic impact of the COVID-19 pandemic is enormous. Using macro level data, studies estimated the economic burden of the pandemic in the United States to be $2.14 trillion within 2 months of the pandemic and $16 trillion through Fall 2021.[3,4] Using the March and April 2020 CPS data, Groenewold et al. estimated that health-related workplace absenteeism due to COVID-19 rose in personal care and service, health-care support, and production occupations.[5] This study complements existing research by estimating the impact of the COVID-19 pandemic on the number of work hours lost among US full-time workers in the first year of the pandemic. The results of the study indicate that the COVID-19 pandemic significantly increased the number of work hours lost, in comparison with the average number of work hours lost in the previous 3 pre-COVID-19 years. During March 2017 through February 2020 (the 3 pre-COVID-19 years considered in the study), the average total number of work hours lost per year due to economic, workers' own health, and other reasons was 4128 million (95% CI: 3842 million–4414 million). The total estimated number of work

hours lost due to economic, workers' own health, and other reasons during that 1-year period (March 2020 through February 2021) was 10,135 million (95% CI: 3842 million–4414 million), or 2.5 times higher than the expected value.

Overall, the estimated cost of lost work hours associated with the COVID-19 pandemic among US full-time workers due to economic, workers' own health, and other reasons within 1 year was $138 billion (95% CI: $73 billion–$202 billion). See Table 3 for the details. The Congressional Budget Office (CBO) estimated the cost of the pandemic in lost output during the next decade to be $7.6 trillion ($760 billion per year).[3] The estimate presented in this study is lower than the $760 billion cost estimate because the CBO cost estimate included lost output among unemployed workers, among part-time workers, and due to a decline in overall demand for goods and services.

The estimated costs of lost work hours associated with the COVID-19 pandemic among US full-time workers due to economic and workers' own health reasons were $47 billion (95% CI: $24 billion–$69 billion) and $19 billion (95% CI: $12 billion–$21 billion), respectively. Overall, the estimated cost of lost work hours associated with the COVID-19 pandemic due to economic factors and workers' own health reasons made up nearly half of the cost. The estimated cost of lost work hours associated with the pandemic among US full-time workers due to other reasons was $74 billion (95% CI: $31 billion–$113 billion).

Although the high impact of COVID-19 on the number of work hours lost due to economic and health reasons is understandable, it is less clear why the number of work hours lost due to other reasons increased more than fourfold. In the CPS, respondents who answered "other" were asked to specify their reasons; however, the publicly available CPS data do not include information on the specific reasons. New reasons for absence from work during COVID-19—such as workplace closure for cleaning and disinfecting, disruption of work for installing plexiglass cubbies and other protections, supply disruptions, and travel restrictions—are not included as possible responses in the CPS standard reasons for absence. However, these COVID-19-specific responses may be included as "other" in open-ended responses. The average percentage of workers who reported "other" reasons was between 0.5% and 0.6% during the three pre-COVID-19 baseline years; it increased to 2.2% during the period of March 2020 through February 2021. The BLS also reported that during March and April 2020, those who were not at work due to efforts to contain the spread of the coronavirus were included in the "other" reasons category instead of being classified as "unemployed on temporary layoff."[19]

The findings in this report are subject to at least seven limitations. First, the study did not include respondents who were in the labor force but unemployed (unemployed on layoff and unemployed looking for a job). The average share of these people from the total labor force was 3.9% during the pre-COVID-19 baseline years (March 2017 through February 2020), and it increased to 8.9% during the post-COVID-19 period (March 2020 through February 2021). The study also excludes part-time workers, because the US Census Bureau collects information from only full-time workers on the main reason for working fewer than 35 h during the reference week. Full-time workers who reported that their weekly hours varied (6.0% during the baseline years and 5.6% during the post-COVID-19 year) also were not included in the analysis. These exclusions could significantly underestimate the impact of COVID-19 on the number of work hours lost. A study conducted in Canada based on all individuals in the labor force aged 20–64 showed that COVID-19 decreased the total weekly work hours by 32%.[32] Second, also excluded were costs associated with presenteeism, lost home production, reduced productivity of coworkers, and lost outputs due to premature mortality.

Third, the average hourly wage was estimated solely on the basis of the wage that respondents reported and did not include benefits. During March 2020 through February 2021, the average hourly wage was $28.33. However, to better estimate lost outputs due to lost work hours, the average hourly wage was computed from the wages of workers who reported lost work hours ($22.96). Consequently, the estimates presented in this report may underestimate the actual impact. Wages might also underestimate the value of lost outputs because an absent worker might be replaced by a less experienced worker, and this might decrease the overall productivity. Wages also do not include recruiting and training costs for new workers.[28]

Fourth, the response rate during March 2020 through February 2021 was 12% lower than the average response rate during the baseline years, mainly because of the COVID-19 pandemic. As a result, the sample size during March 2020 through February 2021 declined by 21% from the average sample size during the baseline years. However, the decline in the response rate did not affect the accuracy and reliability of the estimates.[33,34] Fifth, because the CPS data on all eligible members of a household are collected from one respondent, who must recall a week-long period, these data might be subject to proxy-respondent and recall-period biases. I assumed that the CPS data collected during one reference week out of the month—usually a 7-day calendar week (Sunday–Saturday) that includes the 12th of the month—are representative of all weeks of the month. Sixth, the study did not account for any population increase, which might underestimate the estimated cost of lost work hours associated with the pandemic.[32] Finally, because workday absence due to childcare problems was subject to historical bias, it was not included in the total computed costs.

5 | CONCLUSION

This study estimated the cost of lost work hours associated with the COVID-19 pandemic during March 2020 through February 2021. The results showed that the estimated lost work hours associated with the COVID-19 pandemic due to economic, workers' own health, and other reasons among US full-time workers were 2026 million (95% CI: 1058 million–2995 million), 824 million (95% CI: 734 million–915 million), and 3157 million (95% CI: 1337 million–4917 million), respectively. Overall, the total number of work hours lost associated with the pandemic due to economic, workers' own health, and other reasons

was $138 billion (95% CI: $73 billion–$202 billion) within the year since community transmission of COVID-19 had become established throughout the United States in March 2020. The estimated costs of lost work hours associated with COVID-19 presented in this study alone highlight the economic benefit of public health interventions and other measures such as vaccination to help reduce the spread of the virus. This study also provides preliminary data for potential studies to analyze any disproportionate burdens of the cost of lost work hours on specific occupational or demographic groups.

ACKNOWLEDGMENTS

The author thanks Matthew Groenewold, Regina Pana-Cryan, Brian Quay, Tim Bushnell, and Toni Alterman, all of CDC, for their valuable comments and suggestions on an earlier draft of the paper, and Ms. Seleen Collins for her excellent editorial assistance.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Paul A. Landsbergis declares that he has no conflict of interest in the review and publication decision regarding this article.

AUTHOR CONTRIBUTIONS

Abay Asfaw designed and conceptualized the study, conducted the empirical analysis, drafted the work, and interpreted the results.

DATA AVAILABILITY STATEMENT

The data used for the analyses, Current Population Survey (2017-2021), are publicly available at https://www.census.gov/programs-surveys/cps.html

ORCID

Abay Asfaw http://orcid.org/0000-0002-4729-7302

REFERENCES

1. Centers for Disease Control and Prevention. COVID Data Tracker. 2021. Accessed March 21, 2021. https://covid.cdc.gov/covid-data-tracker/#datatracker-home
2. Centers for Disease Control and Prevention. COVID Data Tracker: Demographic Trends of COVID-19 cases and deaths in the US reported to CDC. 2021. Accessed March 21, 2021. https://covid.cdc.gov/covid-data-tracker/#demographics
3. Cutler DM, Summers LH. The COVID-19 pandemic and the $16 trillion virus. *JAMA*. 2020;324(15):1495-1496.
4. Makridis C, Hartley J. The cost of COVID-19: a rough estimate of the 2020 US GDP impact. Mercatus Center, George Mason University. Published online April 6, 2020. Accessed March 21, 2020. https://www.mercatus.org/system/files/makridis-cost-covid-19-mercatus-v1.pdf
5. Groenewold MR, Burrer SL, Ahmed F, Uzicanin A, Free H, Luckhaupt SE. Increases in health-related workplace absenteeism among workers in essential critical infrastructure occupations during the covid-19 pandemic—United States, March–April 2020. *Morb Mortal Wkly Rep*. 2020;69(27):853-858.
6. Burkhauser RV, Feng S, Jenkins SP. Using the P90/P10 index to measure US inequality trends with Current Population Survey data: a view from inside the Census Bureau vaults. *Rev Income Wealth*. 2009;55(1):166-185.
7. Flood S, King M, Rodgers R, Ruggles S, Warren JR. *Integrated Public Use Microdata Series, Current Population Survey*. 8 ed. IPUMS; 2021.
8. Dixon J. Sensitivity Analysis of Nonresponse Bias in the Current Population Survey. Office of Survey Methods, Bureau of Labor Statistics, www bls gov/osmr/abstract/st/st080160 htm. 2008.
9. U.S. Bureau of Labor Statistics Labor Force Statistics from the Current Population Survey. 2018. Accessed March 21, 2021.
10. Schuchat A, Covid C, Team R. Public health response to the initiation and spread of pandemic COVID-19 in the United States, February 24–April 21, 2020. *Morb Mortal Wkly Rep*. 2020;69(18):551-556.
11. CPS and COVID-19 IPUMS: CPS. 2020. Accessed March 18, 2021. https://cps.ipums.org/cps/covid19.shtml
12. U.S. Chamber of Commerce Foundation. COVID-19 impact on childcare. 2021. Accessed March 18, 2021. https://www.uschamberfoundation.org/reports/covid-19-impact-childcare
13. Ho A, Phelan R, Mizubuti GB, et al. Bias in before–after studies: narrative overview for anesthesiologists. *Anesth Analg*. 2018;126(5):1755-1762.
14. White H, Sabarwal S. Quasi-experimental design and methods. *Methodol Briefs Impact Eval*. 2014;8:1-16.
15. Sedgwick P. Before and after study designs. *BMJ*. 2014;349:349.
16. Grimshaw J, Campbell M, Eccles M, Steen N. Experimental and quasi-experimental designs for evaluating guideline implementation strategies. *Fam Pract*. 2000;17(suppl_1):S11-S16.
17. Robson LS, Shannon HS, Goldenhar LM, Hale AR. Guide to evaluating the effectiveness of strategies for preventing work injuries: how to show whether a safety intervention really works. Cincinnati, Ohio: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2001. Accessed March 12, 2021. https://www.alnap.org/system/files/content/resource/files/main/evaluation-guide-2001b-%281%29.pdf
18. Goodacre S. *Uncontrolled Before-After Studies: Discouraged by Cochrane and the EMJ*. BMJ Publishing Group Ltd and the British Association for Accident; 2015.
19. U.S. Bureau of Labor Statistics. Frequently asked questions: the impact of the coronavirus (COVID-19) pandemic on the Employment Situation for April 2020. 2020. Accessed March 19, 2021. https://www.bls.gov/covid19/employment-situation-covid19-faq-april-2020.htm
20. Kigozi J, Jowett S, Lewis M, Barton P, Coast J. Estimating productivity costs using the friction cost approach in practice: a systematic review. *Eur J Health Econ*. 2016;17(1):31-44.
21. Van den Hout W. The value of productivity: human-capital versus friction-cost method. *Ann Rheum Dis*. 2010;69(Suppl 1):i89-i91.
22. Pike J, Grosse SD. Friction cost estimates of productivity costs in cost-of-illness studies in comparison with human capital estimates: a review. *Appl Health Econ Health Policy*. 2018;16(6):765-778.
23. Lensberg BR, Drummond MF, Danchenko N, Despiégel N, François C. Challenges in measuring and valuing productivity costs, and their relevance in mood disorders. *Clinicoecon Outcomes Res*. 2013;5:565.
24. Tranmer JE, Guerriere DN, Ungar WJ, Coyte PC. Valuing patient and caregiver time. *Pharmacoeconomics*. 2005;23(5):449-459.
25. Liljas B. How to calculate indirect costs in economic evaluations. *Pharmacoeconomics*. 1998;13(1):1-7.
26. Birnbaum H. Friction-cost method as an alternative to the human-capital approach in calculating indirect costs. *Pharmacoeconomics*. 2005;23(2):103-105.

27. Koopmanschap MA, Rutten FF, van Ineveld BM, Van, Roijen L. The friction cost method for measuring indirect costs of disease. *J Health Econ*. 1995;14(2):171-189.
28. Goeree R, O'Brien BJ, Blackhouse G, Agro K, Goering P. The valuation of productivity costs due to premature mortality: a comparison of the human-capital and friction-cost methods for schizophrenia. *Can J Psychiatry*. 1999;44(5):455-463.
29. Nicholson S, Pauly MV, Polsky D, Sharda C, Szrek H, Berger ML. Measuring the effects of work loss on productivity with team production. *Health Econ*. 2006;15(2):111-123.
30. Pauly MV, Nicholson S, Polsky D, Berger ML, Sharda C. Valuing reductions in on-the-job illness:'presenteeism'from managerial and economic perspectives. *Health Econ*. 2008;17(4):469-485.
31. Hassink W, van den Berg B. Methods and instruments for the estimation of production changes in economic evaluationsIn: *Mental Health Economics*. Razzouk D, Cham: Springer; 2017:431-441.
32. Lemieux T, Milligan K, Schirle T, Skuterud M. Initial impacts of the COVID-19 pandemic on the Canadian labour market. *Can Public Policy*. 2020;46(S1):S55-S65.
33. Ward JM, Edwards KA. Statistics in the time of coronavirus: COVID-19-related nonresponse in the CPS household survey. 2020. Accessed March 18, 2021. https://ssrn.com/abstract=3692799
34. US Bureau of Labor Statistics. Frequently asked questions: the impact of the coronavirus (COVID-19) pandemic on The Employment Situation for April 2020. 2020. Accessed March 18, 2021. https://www.bls.gov/cps/employment-situation-covid19-faq-may-2020.pdf

How to cite this article: Asfaw A. Cost of lost work hours associated with the COVID-19 pandemic—United States, March 2020 through February 2021. *Am J Ind Med*. 2022;65:20-29. doi:10.1002/ajim.23307

APPENDIX A

TABLE A1 An example of how total number of work hours lost due to economic reasons[a] was computed for 1 year after the start of the COVID-19 pandemic (March 2020 through February 2021)

Months after start of COVID-19 pandemic	$NUHW_{pw}$ (millions): Total number of usual hours worked per week in jobs 1 & 2	$TNAHW_{pw}$ (millions): Total number of actual hours worked per week in jobs 1 & 2	TNWHL = NUHW – TNAHW: Total number of work hours lost per week	Total number of work hours lost per month (millions)
Mar 2020	75.0	42.4	32.6	130.4
Apr 2020	68.0	38.6	29.4	117.6
May 2020	83.4	47.4	36.0	144.0
Jun 2020	287.0	144.0	143.0	572.0
Jul 2020	253.0	133.0	120.0	480.0
Aug 2020	179.0	94.4	84.6	338.4
Sep 2020	148.0	78.3	69.7	278.8
Oct 2020	118.0	64.6	53.4	213.6
Nov 2020	76.0	42.0	34.0	136.0
Dec 2020	67.3	38.5	28.8	115.2
Jan 2021	69.0	40.6	28.4	113.6
Feb 2021	72.2	39.0	33.2	132.8
Total within 1 year after start of the pandemic				2772.4

Abbreviations: COVID-19, coronavirus disease 2019; NUHW, number of usual hours worked; TNAHW, total number of actual hours worked; TNWHL, total number of work hours lost.

[a]Economic reasons include slack work or business conditions and being able to find only part-time work.