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Research Article

COVID-19 Pandemic Impact on Trajectories in Cardiometabolic Health, Physical Activity, and Functioning Among Adults from the 2006–2020 Health and Retirement Study

Hind A. Beydoun, PhD, MPH,[1,*] May A. Beydoun, PhD, MPH,[2] Rana S. Gautam, PhD,[3] Brook T. Alemu, PhD,[4] Jordan Weiss, PhD,[5] Sharmin Hossain, PhD,[2] and Alan B. Zonderman, PhD[2]

[1]Department of Research Programs, Fort Belvoir Community Hospital, Fort Belvoir, Virginia, USA. [2]Laboratory of Epidemiology and Population Sciences, National Institute on Aging, NIA/NIH/IRP, Baltimore, Maryland, USA. [3]Department of Sociology and Human Services, University of North Georgia, Dahlonega, Georgia, USA. [4]Health Sciences Program, School of Health Sciences, Western Carolina University, Cullowhee, North Carolina, USA. [5]Department of Demography, UC Berkeley, Berkeley, California, USA.

*Address correspondence to: Hind A. Beydoun, PhD, MPH, Department of Research Programs, Fort Belvoir Community Hospital, 9300 DeWitt Loop, Fort Belvoir, VA 22060, USA. E-mail: Hind.a.Baydoun.civ@mail.mil

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Abstract

Background: The aim of this study was to evaluate the impact of the COVID-19 pandemic on trajectories in cardiometabolic health, physical activity, and functioning among U.S. older adults, overall and according to selected baseline sociodemographic characteristics.

Methods: We performed secondary analyses using longitudinal data on 1,372 participants from the 2006–2020 Health and Retirement Study. Pre-post COVID-19 pandemic onset was examined in relation to body mass index (BMI), number of cardiometabolic risk factors and/or chronic conditions, physical activity, Activities of Daily Living (ADL), and Instrumental Activities of Daily Living (IADL) using mixed-effects regression models and group-based trajectory models.

Results: The COVID-19 pandemic was associated with significantly increased BMI (β = 1.39, 95% confidence interval [CI]: 0.74, 2.03). Furthermore, the odds of having at least one cardiometabolic risk factor and/or chronic disease increased pre-post COVID-19 onset (odds ratio 1.16, 95% CI: 1.00, 1.36), whereas physical functioning worsened pre-post COVID-19 onset (ADL: β = 1.11, 95% CI: 0.94, 1.28; IADL: β = 0.59, 95% CI: 0.46, 0.73). The pre-post COVID-19 period (2018–2020) showed a stable group of trajectories, with low, medium and high levels of the selected health indicators. Health disparities according to sex, race/ethnicity, educational level, work status, and total wealth are highlighted.

Conclusions: The COVID-19 pandemic onset appears to worsen cardiometabolic health and physical functioning among U.S. older adults, with clusters of individuals defined by selected sociodemographic characteristics experiencing distinct trajectories pre-post COVID-19 pandemic onset.

Keywords: Activities of daily living, Coronavirus, Lifestyle, Obesity, Statistical models

The severe acute respiratory syndrome (SARS-CoV-2) emerged as a new flu-like illness with atypical pneumonia in the city of Wuhan, China, on December 2, 2019; since then, this viral infection has spread worldwide and the World Health Organization declared it as the cause of the coronavirus-19 disease (COVID-19) pandemic on March 11, 2020 (1). Nearly 131 million confirmed COVID-19 cases and 2.85 million COVID-19 fatalities have been reported globally, with 30.8 million confirmed COVID-19 cases and 555 000

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COVID-19 fatalities in the United States alone as of April 2021 (1–3). COVID-19 can exhibit a wide spectrum of clinical manifestations and severity that range from asymptomatic to mild upper respiratory symptoms, severe bilateral pneumonia, acute respiratory distress syndrome, septic shock, multiorgan failure, and death (4,5).

Epidemiologic evidence has identified key characteristics that may have an impact on COVID-19 morbidity and mortality risks, including advanced age (1,3,5,6), male sex (1,3–5), minority race and ethnicity (4,5,7,8), obesity (2–6,9), elevated inflammatory markers (1,2,5,6,9,10), preexisting chronic conditions (1,3–5,9), including hypertension (1,4,5,9), diabetes (3–6,9), coronary artery disease (1,3,6,9), cerebrovascular disease (1,3,6,9), arrhythmias (11), heart failure (1,3,6,9), chronic kidney disease (4,7,9), chronic respiratory disease (7,9) and cancer (7,9) as well as multimorbidities (4,7). In a recent study, Lopez-Bueno et al. analyzed data on 51 514 SHARE COVID-19 survey participants (50 years and older) from 27 European countries and Israel, whereby chronic conditions diagnosed within 3 years, especially lung disease, heart disease, and cancer as well as multimorbidities, were strongly associated with COVID-19 hospitalization (12). Systematic reviews and meta-analyses of observational studies have suggested that obesity as well as its associated cardiometabolic risk factors and chronic conditions may be over-represented among COVID-19 patients and could potentially affect outcomes of COVID-19 including level of severity, hospitalization, intensive care unit admission, and death (1). Whereas the causal relationship between cardiometabolic health characteristics and COVID-19 outcome requires further elucidation, multiple biological mechanisms have been suggested including immunosenescence (11), estrogen pathway activity (5), vitamin D status (5), overexpression of angiotensin-converting enzyme 2 (2,3,6)—the receptor for SARS-CoV-2 S protein—and excessive inflammatory response (2) by the adipose tissue.

Obesity remains an issue of public health significance because it is a modifiable risk factor for the development of several chronic conditions, including the 2 leading causes of death—cardiovascular disease and cancer—in the United States and worldwide (9). Genetic, environmental, behavioral, and metabolic risk factors may promote the development of obesity and its associated cardiometabolic diseases, which are highly prevalent chronic conditions linked to increased morbidity and mortality risks (7,9). Besides its potential for exacerbating health risks associated with COVID-19, a high prevalence of obesity, cardiometabolic risk factors, and/or chronic conditions at the population level poses a challenge in the context of the COVID-19 pandemic, which has upended global economies and placed a substantial burden on health care systems (2,13). Although access to inpatient, outpatient, and other health care services may be limited during the COVID-19 pandemic, efforts aimed at reducing health care needs have become a high priority to avoid saturating or overwhelming health care systems (14). Public health strategies have become commonplace in an effort to reduce person-to-person viral transmission, and these include intermittent lockdowns, policies for quarantine and isolation, social distancing, closures of schools, universities, restaurants, and nonessential businesses, as well as behavioral recommendations focused on hand-washing and the wearing of face masks (15,16). From a cardiometabolic perspective, these same public health strategies may have been beneficial to certain groups who had the opportunity to adopt healthier lifestyles and harmful to others for whom the COVID-19 pandemic may have negatively impacted their ability to sustain a healthy lifestyle and to access health care services necessary for chronic disease prevention and management (6,7).

Recently conducted surveys indicated that health behaviors—including diet, physical activity, and sleep—which are known to directly affect cardiometabolic health and to indirectly affect COVID-19 morbidity and mortality risks, could have been adversely affected by COVID-19 restrictions that are imposed at the population level as part of these public health strategies (4,15). For instance, a web-based survey involving 726 adolescents from European (Italy and Spain) and Latin American (Brazil, Chile, and Colombia) countries was conducted by Ruiz-Roso et al. revealing a high prevalence of ultra-processed food consumption and physical inactivity during the COVID-19 pandemic (15). The potentially negative effect of the COVID-19 pandemic on dietary intake, physical activity, sedentary behaviors, and sleep was reviewed by Parekh et al. who proposed community-level interventions and policy changes including nutrition assistance programs, designated areas for recreation and active transportation with an emphasis on health disparities and vulnerable populations to address the long-lasting impact of the COVID-19 pandemic on these health behaviors (17). Similarly, King et al. described how lockdown and social distancing policies could influence diet, physical activity, sleep, daylight exposure, circadian rhythm, and cardiometabolic health (18).

Researchers have referred to the coexistence of obesity and COVID-19 that tend to reinforce each other in terms of their detrimental effects on health as a "syndemic" (19). Although adults, 50 years and older, represent a high-risk population for COVID-19, limited but growing evidence exists for the impact of the COVID-19 pandemic on specific health indicators (cardiometabolic health, physical activity, and functioning) that may be negatively affected by the COVID-19 pandemic in this age group, with the potential for health disparities according to demographic and socioeconomic characteristics (20–39). A primary aim of this longitudinal study is to evaluate the impact of the COVID-19 pandemic on trajectories in cardiometabolic health among adults ≥50 years who participated in the 2006–2020 Health and Retirement Study (HRS). A secondary aim of this longitudinal study is to evaluate the impact of the COVID-19 pandemic on trajectories in physical activity and functioning among adults ≥50 years who participated in the 2006–2020 HRS. Specifically, we applied distinct methodologies to examine trajectories in various health indicators and assessed whether these trajectories varied pre-post COVID-19 pandemic onset and according to selected sociodemographic characteristics at baseline.

Method

Data Source

Initiated in 1992, the HRS is an ongoing, nationally representative longitudinal study of community-dwelling U.S. adults over the age of 50 and their spouses of any age designed to study economic well-being, labor force participation, health, and family composition through biennial surveys administered by telephone or face-to-face interviews. Multistage probability sampling of U.S. households within geographical strata was performed whereby African Americans, Hispanics, and residents of Florida were oversampled, and response rates at baseline and follow-up waves were >80% for all HRS interviews. All HRS participants provided written informed consent and the University of Michigan's Institutional Review Board approved study protocols. Details of the HRS sponsored by the National Institute on Aging and the Social Security Administration are reported elsewhere (40,41).

Study Participants

The original HRS study consists of participants from whom data were collected in 1992, 1994, and 1996, and the Study of Asset and Health Dynamics of the Oldest Old (AHEAD) consists of those from whom data were collected in 1993 and 1995. After the 2 studies were merged, 2 new cohorts—the Children of the Depression (born 1924–1930) and the War Babies (1942–1947)—were added in 1998. Subsequently, the Early Baby Boomers (1948–1953) cohort was added in 2004, the Mid Baby Boomers (1954–1959) cohort was added in 2010, and the Late Baby Boomers (1960—1965) cohort was added in 2016. Starting in 2006, HRS began collecting data on psychosocial factors, whereby half of the sample completed detailed face-to-face interviews that included physical, biological, and psychosocial measures, and the other half completed a core interview by telephone. To reduce study-related costs and burden on participants, enhanced interviewing alternated between half-samples at each subsequent wave. Our sample was restricted to HRS participants for whom data were collected during the 2006, 2008, 2010, 2012, 2014, 2016, and/or 2018 (before COVID-19) waves as well as the 2020 (COVID-19) wave whereby an enhanced interviewing (EFTF) half-sample was interviewed by telephone due to social distancing restrictions. EFTF half-sample release to fieldwork occurred sequentially on June 11, 2020 (EFTF1) and September 24, 2020 (EFTF2). To achieve our study goals, we linked the latest release of the 2020 HRS COVID-19 project, which became publicly available for 3 266 EFTF respondents in February 2021, to the 1992–2018 HRS longitudinal file developed by the RAND Center for the Study of Aging.

Study Variables

Trajectories in body mass index (BMI), number of cardiometabolic risk factors, and/or chronic conditions as well as physical activity and functioning measured using Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scores were evaluated at 7 HRS waves pre-COVID-19 onset and 1 wave post-COVID-19 onset and baseline sociodemographic characteristics were examined in relation to their pre-post COVID-19 onset trajectories.

Sociodemographic characteristics

Baseline HRS data were queried for sex (male, female), age (continuous; 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80+ years), race (White/Caucasian, Black/African American, Other), ethnicity (Hispanic, non-Hispanic), education (no degree, GED, high school graduate, some college, college degree or higher), work status (working, not working), and total wealth (in U.S. dollars; <25 000, 25 000–124 999, ≥125 000) (42). These variables were selected for the purpose of evaluating disparities in cardiometabolic health, physical activity, and functioning profile pre-post COVID-19 onset.

Cardiometabolic health

The 2006-2020 HRS data were extracted on self-reported BMI, defined as weight (in kilograms) divided by height (in meters) squared. The presence of cardiometabolic risk factors and chronic conditions was determined using a series of questions pertaining to physician-diagnosed hypertension, diabetes, heart disease (heart attack, coronary heart disease, angina, congestive heart failure, other heart problems), and/or stroke. We further defined the total number of cardiometabolic risk factors and/or chronic conditions as "0," "1," "2," "3," or "4" (41,43).

Physical activity and functioning

The 2006–2020 HRS data were extracted on self-reported frequency of moderate and vigorous exercise (never, 1–4 times per month, or >1 times per week), 5 ADL items (walking across the room, dressing, bathing, eating, getting in/out of bed) and 5 IADL items (using a telephone, taking medication, managing money, shopping for groceries, preparing meals), which were recoded as "yes" or "no" dummy variables that indicate "any difficulty" for comparability with a 1995 publication by Wallace and Herzog (44). The range of values for total ADL and IADL scores was 0–5.

Statistical Analysis

Complete subject analyses were conducted using Stata release 16 (StataCorp19. Stata Statistical Software; Release 16, StataCorp LLC, College Station, TX) while taking into account complex sampling design and using the preliminary weight variable *CVWGTR*. After describing the sociodemographic characteristics of the study sample at baseline, we summarized indicators of cardiometabolic health, physical activity, and functioning at each of the 8 HRS waves. Whereas categorical data were summarized using frequencies and percentages, continuous data were summarized by calculating measures of central tendency (mean, median) and dispersion (standard error (SEM), interquartile range), as appropriate. We also evaluated variation in health indicators across HRS waves using design-based *F* tests. Subsequently, we constructed age-adjusted mixed-effects linear and logistic regression models to evaluate the impact of the COVID-19 pandemic on BMI (continuous), number of cardiometabolic risk factors, and/or chronic conditions (1+ vs 0), physical activity (≥ 1 time per month vs < 1 time per month), ADL (Continuous), and IADL (Continuous) scores with and without 2-way interaction terms for pre-post COVID-19 pandemic onset with each of sex, race, ethnicity, education, work status, and total wealth. Finally, we identified distinct trajectories for BMI, number of cardiometabolic risk factors, and/or chronic conditions, physical activity, ADL and IADL scores over the 2006–2020, 2006–2018, and 2018–2020 HRS time periods. Using a Stata plugin (traj and trajplot) adapted from a well-established SAS procedure (SAS Institute, Cary, NC) (45,46), we performed group-based trajectory modeling—a specialized form of finite mixture modeling—to identify groups of adults with similar developmental trajectories over time. This group-based approach utilizes a multinomial modeling strategy and maximum likelihood to estimate model parameters, with maximization achieved by the quasi-Newton procedure. We specified a Tobit (*cnorm*), zero-inflated Poisson (*zip*), or logit (*logit*) distribution and a sampling *weight* for the selected outcomes, with intercept (0), linear (1), quadratic (2), or cubic (3) orders for each group trajectory, as appropriate, and displayed group-based trajectories over time with 95% confidence intervals (CI). For consistency and ease of interpretation, we defined up to 3 groups per outcome and dropped higher-order polynomials found not to be statistically significant within the group-based model. We reported the Akaike information criterion for each group-based trajectory model as a goodness-of-fit measure. Furthermore, we constructed multinomial logistic regression models to evaluate the association of baseline sociodemographic characteristics with distinct trajectories of the selected health indicators between the 2018 and 2020 waves of HRS data. Two-sided statistical tests were performed assuming an alpha level of .05.

Results

As shown in Figure 1, 17 132 of 42 233 HRS participants were ≥50 years of age at the 2006, 2008, 2010, 2012, 2014, 2016, or

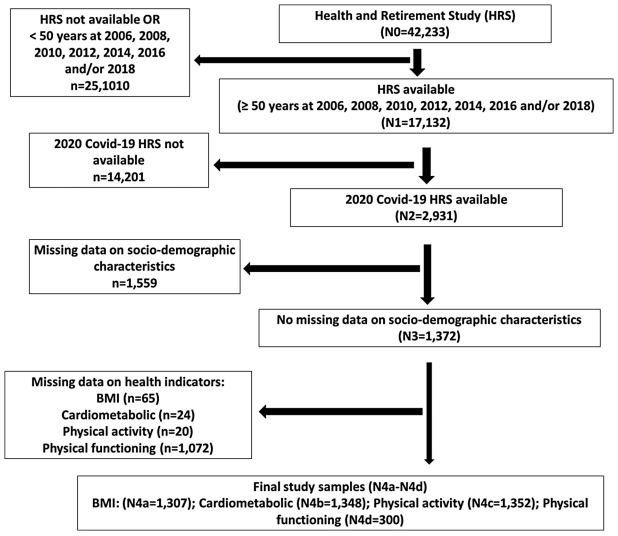

Figure 1. Study flowchart—2006–2020 Health and Retirement Study.

2018 waves of data. Of those, 2 931 HRS participants took part in the 2020 COVID-19 project. Of 1 372 HRS participants with no missing data on baseline sociodemographic characteristics, 1 307 had complete data on BMI, 1 348 had complete data on number of cardiometabolic risk factors and/or chronic conditions, 1 352 had complete data on physical activity, and 300 had complete data on ADL and IADL scores.

Table 1 presents baseline sociodemographic characteristics using data from 1 372 HRS participants (58.6% female; mean [± SEM] age: 60.7 ± 0.26 years). Whereas 6.6% of these participants were of Hispanic ethnicity, 88.1% were White/Caucasian, 7.3% were Black/African American, and 4.6% were of other race. Furthermore, 30.6% had a college degree or higher, 59.6% were working, and 63.1% reported a total wealth ranging between $25 000 and $124 999 at baseline.

Table 2 summarizes cardiometabolic health, physical activity, and functioning indicators using data from 1 372 2006–2020 HRS subsamples. Design-based *F*-tests suggested significant heterogeneity in the distribution of health indicators according to HRS wave. Whereas mean BMI did not vary considerably over time, there was a consistently declining trend in the proportion of individuals with no cardiometabolic risk factors and/or chronic conditions and a consistently increasing trend in mean ADL/IADL scores over time indicating worsening physical functioning. Since 2012, there was a consistently increasing proportion of individuals performing physical activity less than once per month.

Table 3 displays age-adjusted mixed effects linear and logistic regression models for COVID-19 pandemic as a predictor of cardiometabolic health, physical activity, and functioning. The COVID-19 pandemic was associated with significantly increased BMI (β = 1.39, 95% CI: 0.74, 2.03). Furthermore, the odds of having at least 1 cardiometabolic risk factor and/or chronic disease increased pre-post COVID-19 onset (odds ratio = 1.16, 95% CI: 1.00, 1.36). Similarly, physical functioning worsened pre-post COVID-19 onset (ADL: β = 1.11, 95% CI: 0.94, 1.28; IADL: β = 0.59, 95% CI: 0.46, 0.73). Further analyses suggested that the impact of pre-post COVID-19 onset on health indicators varied according to the selected sociodemographic characteristics. Specifically, significant

Table 1. Baseline Sociodemographic Characteristics of Study Sample—2006–2020 Health and Retirement Study (*n* = 1 372)

	% or Mean ± *SEM*
Sex	
Male	41.4
Female	58.6
Age (y)	
Mean ± *SEM*	60.7 ± 0.26
50–54	22.5
55–59	28.4
60–64	19.7
65–69	14.4
70–74	8.9
75–79	4.2
≥ 80	1.8
Race	
White/Caucasian	88.1
Black/African American	7.3
Other	4.6
Ethnicity	
Hispanic	6.6
Non-Hispanic	93.3
Education	
No degree	11.4
GED	4.3
High-school graduate	29.4
Some college	24.3
College degree or higher	30.6
Work status	
Working	59.6
Not working	40.3
Total wealth ($)	
<25 000	16.7
25 000–124 999	63.1
≥125 000	20.2

Note: GED = general educational development test.

interaction terms were observed for sex (BMI), race (BMI), Hispanic ethnicity (IADL), education (cardiometabolic risk factors and/or chronic conditions), work status (ADL, IADL), and total wealth (ADL). The impact of the COVID-19 pandemic on BMI was more pronounced for women and less pronounced for individuals of other race. In contrast, increasing level of education appears to dampen the impact of the COVID-19 pandemic on having any cardiometabolic risk factor and/or chronic condition. Finally, the decline in physical functioning was less pronounced in the context of participants who worked at baseline (see Supplementary Table 1).

Supplementary Table 2 displays group-based trajectory models for cardiometabolic health, physical activity, and functioning for 2006–2020, 2006–2018, and 2018–2020. We constructed Tobit models whereby intercepts ± linear slopes were significant regression terms for each health indicator with no quadratic or cubic terms. Whereas the pre-post COVID-19 period (2018–2020) showed a stable group of trajectories, with low, medium, and high levels for each health indicator, the overall 2006–2020 time period showed an increasing trend for all trajectories of cardiometabolic risk factors and/or chronic conditions, a decreasing trend for all trajectories of physical activity and an increasing trend for ADL/IADL trajectories, with low and medium (but not high) scores at baseline (see Figure 2).

Table 2. Cardiometabolic Health, Physical Activity, and Functioning Pre-Post COVID-19 Onset—2006–2020 Health and Retirement Study (n = 1 372)

	2006	2008	2010	2012	2014	2016	2018	2020
Body mass index (kg/m^2) (n = 1 307)	p < .0001[a]							
Mean ± *SEM*	28.0 ± 0.2	28.6 ± 0.2	28.3 ± 0.2	28.6 ± 0.2	28.4 ± 0.2	28.6 ± 0.2	28.3 ± 0.2	28.0 ± 0.2
Cardiometabolic risk factors and chronic conditions (n = 1 348)	p < .0001[a]							
0	48.8%	42.8%	37.3%	34.0%	30.2%	25.5%	23.9%	23.4%
1	35.8%	37.8%	38.7%	37.6%	36.9%	37.5%	35.9%	36.0%
2	12.6%	15.5%	18.4%	21.6%	25.1%	26.6%	28.2%	27.9%
3	2.7%	3.5%	5.2%	6.0%	6.9%	9.2%	10.3%	10.7%
4	0.2%	0.3%	0.3%	0.8%	0.9%	0.1%	1.7%	0.2%
Physical activity (moderate or vigorous) (n = 1 352)	p < .0001[a]							
Never	9.3%	8.4%	13.4%	13.3%	13.8%	16.2%	19.6%	20.0%
1-4 times per month	21.6%	23.1%	27.0%	26.7%	27.0%	25.6%	23.2%	21.9%
>1 times per week	69.2%	68.5%	59.5%	59.9%	59.1%	58.2%	57.2%	57.8%
Physical functioning (n = 300)								
ADL	p < .0001[a]							
Mean ± *SEM*	0.42 ± 0.08	0.40 ± 0.08	0.55 ± 0.09	0.56 ± 0.08	0.66 ± 0.08	0.82 ± 0.09	0.89 ± 0.11	1.52 ± 0.11
IADL	p < .0001[a]							
Mean ± *SEM*	0.28 ± 0.05	0.25 ± 0.05	0.35 ± 0.06	0.31 ± 0.05	0.66 ± 0.08	0.54 ± 0.07	0.72 ± 0.09	0.79 ± 0.08

Notes: ADL = Activities of Daily Living; IADL = Instrumental Activities of Daily Living.
[a]*P*-values were generated using design-based *F* tests.

Supplementary Table 3 presents multinomial logistic regression models for baseline sociodemographic characteristics as predictors of trajectories in cardiometabolic health, physical activity, and functioning pre-post COVID-19 pandemic (2018–2020). Women were more likely to cluster in the "Medium" trajectory for number of cardiometabolic risk factors and/or chronic conditions, whereas Black/African American participants were more likely to cluster in the "High" trajectories of number of cardiometabolic risk factors and/or chronic conditions. The "Medium" and "High" trajectories of ADL scores were more frequent among other races and less frequent among those of Hispanic ethnicity. Whereas increasing wealth was associated with greater likelihood of "High" physical activity and lower likelihood of "High" IADL, individuals with college degree or higher were more likely to cluster in the "High" physical activity group and less likely to cluster in the "High" cardiometabolic risk factors and/or chronic conditions group.

Discussion

In this longitudinal study, we performed secondary analyses of 2006–2020 HRS data on U.S. adults ≥50 years at baseline whereby we examined pre-post COVID-19 onset in relation to cardiometabolic health, physical activity, and functioning. Specifically, we applied 2 distinct methodologies, namely mixed-effects regression and group-based trajectory models, while evaluating health disparities according to selected sociodemographic characteristics. Whereas the COVID-19 pandemic had no significant impact on physical activity, HRS participants' BMI, number of cardiometabolic risk factors, and/or chronic diseases and physical functioning worsened pre-post COVID-19 onset. Between 2018 and 2020, "Low," "Medium," and "High" levels of health indicators were identified with no increasing or decreasing trends over time. In general, the impact of the COVID-19 pandemic on these health indicators varied according to sex, race, ethnicity, level of education, work status, and total wealth in the context of mixed-effects regression and/or group-based trajectory models, with traditionally underserved populations experiencing worse outcomes.

A growing body of research has examined the impact of the COVID-19 pandemic on a wide range of behavioral, physical, and mental health outcomes among children (47,48), adolescents (48), and adults (26,39). To date, most studies have focused on deleterious health effects of COVID-19 lockdown policies (21,27) on a wide range of health outcomes such as weight gain (49), diabetes (50), diet (51), physical activity (52), sleep (53), substance use (30), anxiety (54), and depression (54). Bakaloudi et al. conducted a systematic review and meta-analysis of 36 (35 cross-sectional and 1 cohort) observational studies and reported weight gain among 11.1%–72.4% of individuals and weight loss among 7.2%–51.4% of individuals after the first lockdown period (March–May 2020) with a weighted mean between-group difference in body weight of 1.57 (95% CI: 1.01–2.14) kg and BMI of 0.31 (95% CI: 0.17–0.45) kg/m^2 in the post-lockdown period compared with the pre-lockdown period, with one study reporting significant weight loss as a result of malnutrition among individuals > 60 years (21). Similarly, Freiberg et al. performed a rapid review involving 32 population-based epidemiological studies to evaluate whether COVID-19 lockdown may have influenced modifiable cardiovascular risk factors (diet, physical activity, sedentary behavior, smoking, alcohol use, obesity, dyslipidemia, and hypertension), suggesting that physical activity decreased and sedentary behavior increased in all age groups during the COVID-19 lockdown, with

Table 3. Age-Adjusted Mixed-Effects Linear and Logistic Regression Models for COVID-19 Pandemic Onset as a Predictor of Cardiometabolic Health, Physical Activity, and Functioning—2006–2020 Health and Retirement Study (n = 1 372)

	Mixed-Effects Models	
	β (95% CI)	OR (95% CI)
Body mass index (kg/m^2) (n = 1 307)		
Continuous	1.39 (0.74, 2.03)	—
Cardiometabolic risk factors and chronic conditions (n = 1 348)		
1+ vs 0	—	1.16 (1.00, 1.36)
Physical activity (moderate or vigorous) (n = 1 352)		
≥1 time per month vs < 1 time per month	—	0.87 (0.74, 1.02)
Physical functioning (n = 300)		
ADL (continuous)	1.11 (0.94, 1.28)	—
IADL (continuous)	0.59 (0.46, 0.73)	—

Notes: β = slope; ADL = Activities of Daily Living; CI = confidence interval; IADL = Instrumental Activities of Daily Living; OR = odds ratio.

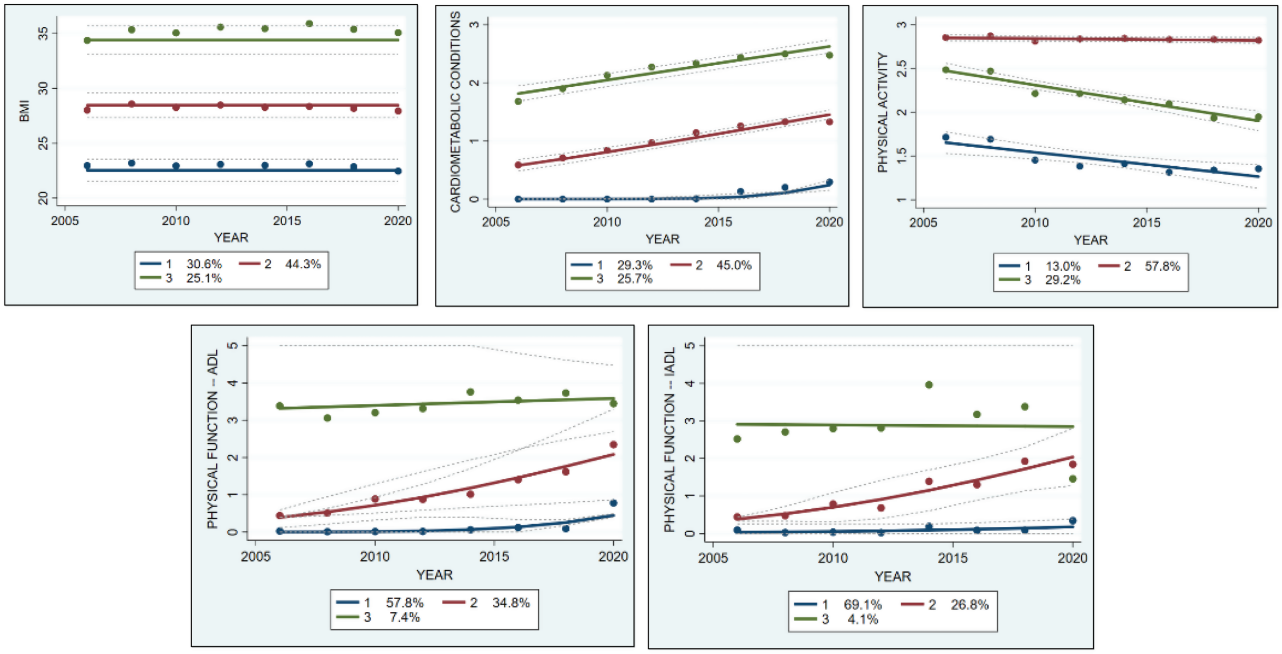

Figure 2. Group-based trajectories for health indicators—2006–2020 Health and Retirement Study. *Note:* For all outcomes, except physical activity, trajectory 1 represents the lowest level, trajectory 2 represents the intermediate level and trajectory 3 represents the highest level. For physical activity, trajectory 1 represents the lowest level, trajectory 3 represents the intermediate level and trajectory 2 represents the highest level. Full color version is available within the online issue.

increased food and alcohol consumption and worsened dietary quality among adults (25).

Despite using distinct methodologies, our study is consistent with the overall body of research highlighting the deleterious effects of the COVID-19 pandemic in the context of aging, with similarly observed health disparities (21,26). For instance, Garcia-Esquinas et al. analyzed interview data collected from 4 cohorts of community-dwelling individuals aged ≥65 years in Spain (n = 3 041) before the COVID-19 pandemic and within 7–15 weeks after COVID-19 lockdown (26). Although COVID-19 lockdown was not associated with a deterioration in smoking, alcohol intake, diet or weight, it was associated with a reversible reduction in physical activity (26). By contrast, worsening of chronic pain and decline in mental health were not reversed after restrictions were lifted (26). The impact of COVID-19 lockdown on lifestyle and mental health was stronger in the context of men, individuals with chronic conditions, and those experiencing social isolation or feelings of loneliness (26).

A growing number of studies have focused on the impact of the COVID-19 pandemic on physical functioning among adults, including large-sample studies focused on mental health and social interactions among disabled adults (≥52 years) in England (55) as well as nutrition and physical activity among adults (62–98 years) living independently in the Netherlands (38). A public health concern is how the COVID-19 pandemic may have modified health behaviors such as moderate-to-vigorous physical activity, ADL activities (eg, walking) and IADL (eg, grocery shopping) among adults. In fact, any change in physical activity and functioning can also affect cardiometabolic health directly and COVID-19 morbidity and mortality risks indirectly, with potentially adverse consequences on psychological well-being (38,55).

A strength of this study is that it uses nationally representative longitudinal data to examine trajectories in health indicators pre-post COVID-19 among U.S. adults ≥50 years at baseline. Study findings should however be interpreted with caution and

in light of several limitations. First, linkage of the 2006–2018 HRS with the 2020 HRS COVID-19 project and missing information on key variables over the course of eight HRS waves yielded analytic samples that were much smaller than the full HRS sample potentially leading to selection bias. For instance, a substantial number of study participants had missing data on ADL and IADL when selecting items that were available throughout the study period (2006–2020) (44). Second, the majority of HRS data were collected using retrospective self-report potentially leading to nondifferential misclassification and estimated measures of association that are biased towards the null value. Third, floor and ceiling effects are limitations of several health indicators (eg, physical activity, ADL, IADL) precluding our ability to detect meaningful changes over time as well as pre-post COVID-19 pandemic. In particular, we did not use standard Katz or Lawton Brody ADL/IADL measures (56,57), but rather relied on 5-item ADL and IADL scores developed for the HRS (44). On the other hand, specific IADL items such as telephone use and grocery shopping may carry different meanings besides physical functioning in the context of the COVID-19 pandemic. Fourth, we relied on existing data from the HRS and, as such, were unable to evaluate the impact of COVID-19 pandemic on dietary patterns, sleep behaviors or depressive symptoms assessed during the 2006-2018 HRS waves but not in the context of the 2020 COVID-19 project. Furthermore, it is plausible that changes in cardiometabolic health, physical activity and functioning after onset of the COVID-19 pandemic may be attributed to COVID-19 infection at the individual level. Whereas the HRS COVID-19 questionnaire did not include results of COVID-19 screening tests, it included self-reported COVID-19 infection. After restricting the study population to subjects with no evidence of self-reported COVID-19 infection, mixed effects regression models yielded similar results to the overall study population (Supplementary Table 4). Fifth, the observational nature of HRS increases the likelihood of residual confounding when examining various associations between sociodemographic characteristics and health outcomes. Finally, the pre-COVID-19 time period comprised 7 waves of data collection whereas the post-COVID-19 time period comprised one wave of data collection. In addition, the 2020 HRS project covers the initial COVID-19 wave preceding the availability of safe and efficacious vaccines. Therefore, study findings cannot be extrapolated into later waves of the COVID-19 pandemic. Unlike previously conducted studies, changes in health indicators could not be attributed to a COVID-19 lockdown event but rather to the COVID-19 pandemic as a whole.

In conclusion, the COVID-19 pandemic appears to worsen cardiometabolic health and physical functioning among U.S. adults ≥50 years at baseline, with clusters of individuals defined by selected sociodemographic characteristics experiencing distinct trajectories pre-post COVID-19 pandemic. Additional studies are needed that extend data collection into later COVID-19 waves to examine how the availability of safe and efficacious vaccines might influence levels and trends in various health indicators. Future studies should also focus on elucidating individual-, household-, and community-level characteristics that could mediate the disparate impact of the COVID-19 pandemic according to demographic and socioeconomic characteristics.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None declared.

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