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ORIGINAL ARTICLE

An empirical analysis of factors determining changes in physical exercise during the COVID-19 pandemic

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Abstract

Aim The main objective of the study was to report the changes that have taken place in the practice of physical exercise during confinement and to examine the factors that favor or detract from it.

Material and methods To determine the objective, a survey was carried out in the United States during the pandemic and a sample of 511 participants was obtained. A binary logit model was used to process the data, as well as several independence tests.

Results The main result of this study is the increase in the practice of physical activity of the individuals surveyed during the pandemic. Some of the elements that most influenced this increase were annual family income, education level, and eating habits, but these results are subject to change depending on the respondent's body mass index. On the other hand, the results also show changes in physical exercise habits during the pandemic, especially in the time of the week when it is performed, and these changes are highly correlated with the use of electronic devices, hours of sleep, and physical condition of the respondents before the pandemic.

Conclusion Determining the different factors that affect the practice of physical exercise during pandemic periods seems to be important to determine in which populations it is more important to act or what resources are necessary when implementing physical exercise programs in specific situations such as pandemics.

Keywords Confinement · Exercise practice · Health conditions · Social environment · Logistic regression

Introduction

In December of 2019, a series of unexplained cases of pneumonia and mild respiratory infections were reported in Wuhan City, the largest metropolitan area in China's Hubei province (Tang et al. 2020). On January 30, 2020, the World Health Organization (WHO) classified this epidemic as a public health emergency of international concern (Zhu et al. 2020). On February 11, 2020, it was reported that the disease had been caused by a new type of coronavirus (CoV), called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was responsible for the coronavirus disease in 2019 (COVID-19) (Zhu et al. 2020). In the following weeks, infections spread in China and other countries, and the COVID-19 epidemic became a global health threat (Maugeri et al. 2020). The contamination of COVID-19 occurs from person-to-person mainly through respiratory droplets generated by coughing, sneezing and talking, and other sources of contagion that include biological fluids and already contaminated surfaces (Van Doremalen et al. 2020; Guo et al. 2020).

The clinical manifestations of COVID-19 are nonspecific and range from asymptomatic infection to severe respiratory failure. In most cases, it appears as an acute respiratory illness that includes fever, cough, myalgia, fatigue, dyspnea,

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and sore throat (Guo et al. 2020; Li et al. 2020). In moderate to severe cases, the disease progresses to respiratory difficulties, respiratory distress, and extra-respiratory symptoms that include heart and kidney damage and, in some cases, even death (Tsai et al. 2021). Furthermore, as indicated by Mesquita (da Rosa Mesquita et al. 2021), the death rate increased dramatically in patients already affected by one or more pathologies, those with preexisting health conditions, for example, diabetes, obesity, and cardiovascular disease.

Faced with the COVID-19 pandemic, public health recommendations led the governments worldwide to impose strict confinement rules on their citizens (Zajenkowski et al. 2020). Despite intense public health and research efforts to identify effective therapeutic and vaccination strategies to contain the spread of the virus and avoid the collapse of the health system, implementation of physical isolation measures were inevitable to stop the spread of the disease (Hossain et al. 2020). Among these measures are social isolation, teleworking, wearing masks while in public and maintaining social distancing or closure of educational centers, shops or non-essential services (Ferran et al. 2020). Therefore, people could only leave their home to perform essential jobs (health and social care sectors, police and armed forces, firefighting, water and electricity supply) or carry out essential activities (health visits, purchase of medications or food) (Hossain et al. 2020). While these restrictions were necessary and helped reduce the rate of infection among the population (Perry et al. 2021), they were not without limitations or adverse effects. Limited participation in normal physical and daily activities, cancelation of unnecessary travel, and the alteration of social and recreational habits added sources of stress and anxiety (Brooks et al. 2020; Droit-Volet et al. 2020; Hossain et al. 2020; Vicario-Merino and Muñoz-Agustín 2020), which negatively impacted physical activity levels (Hoffman et al. 2022; Narici et al. 2020) and ultimately compromised both physical and mental health (Williams et al. 2020). Such restraints and limitations during confinement reduced physical activity to levels well below the daily recommendation of 7500–10,000 steps per day (Blair 2009; Booth et al. 2017). In addition, a study conducted in Spain by Castañeda-Babarro et al. (2020) showed that healthy adults had reduced their self-reported daily physical activity while increasing their sedentary time during COVID-19 confinement. Such low levels of physical activity are shown to be associated with increased screen time and poor dietary habits across all ages (Booth et al. 2017; Husain and Ashkanani 2020). A sedentary lifestyle (i.e., office work, watching television, or prolonged sitting) has been consistently associated with increased all-cause mortality and increased mortality from metabolic syndrome and cardiovascular disease (Van der Ploeg et al. 2012). Several studies to date have shown that decreased physical activity can negatively influence glycemic control and lipid profile and is associated with increased fat mass and decreased lean mass with greater impact in individuals with overweight and obesity (Breen et al. 2013; Marzetti et al. 2017). During the course of the COVID-19 pandemic, work from home (WFH) increased abruptly and persisted after the outbreak for some workers (Bick et al. 2020; Tønnessen et al. 2021). Although social distancing was found to be an effective measure to reduce the spread of the disease, the resulting work pattern also affected people's mental and emotional well-being that could also be a culprit for a more sedentary lifestyle (Tsamakis et al. 2021). In a study conducted with 869 participants who worked from home, an increase in the prevalence of health problems was identified, including weight gain and psychosocial problems (Ekpanyaskul and Padungtod 2021). These effects on health were shown to be associated with an increased number of working hours per day during this period, causing an interference with the biological and social rhythms for sleep, recovery, and social interactions (Arlinghaus and Nachreiner 2014).

Social isolation alone is also a potent risk factor for compromised overall health at all stages of life (Hawkley and Capitanio 2015), with the worst consequences being represented in the elderly, the poor and minorities, some of them the fastest growing segments of the US population (Cacioppo and Hawkley 2003). Previous research has identified a wide range of indicators of social isolation that pose health risks, such as living alone, having a small social network, infrequent participation in social activities, and feelings of loneliness (Cornwell and Waite 2009). Evidence indicates that loneliness increases sensitivity to social threats and motivates renewal of social connections, but it can also affect executive functioning, sleep, and physical and mental well-being (Park et al. 2020). Together, these effects contribute to higher rates of morbidity and mortality in lonely older adults (Cacioppo and Cacioppo 2014). Not all individuals respond equally to confinement, with some developing more adaptive strategies to remain physically active (Alomari et al. 2020); therefore, reducing stress and anxiety and improving physical health (Joyner and Green 2009). Developing strategies for an active lifestyle under confinement is of utmost importance as it not only protects against physical complications (Narici et al. 2020) but also helps maintain good mental health (Paluska and Schwenk 2000).

Therefore, the objective of this study was to report the changes that have taken place in the practice of physical exercise during COVID-19 confinement and to examine the factors that favor or detract from it.

Methods

An online survey on Qualtrics, hosted at Southern Illinois University Edwardsville, was utilized to assess how adults were dealing with the COVID-19 confinement period. To participate in this study the inclusion criteria were as follows: being 18–89 years old and residing within the US. The survey was approved by the Institutional Review Board at Southern Illinois University (ID: 775) and launched online on April 7, 2020 and remained open until June 30, 2020. A snowball sampling method was used to recruit participants through social media and by email. All the participants read the information about the study and provided consent by clicking on the first page of the survey. Participants could withdraw at any given time by not proceeding or submitting the survey. The survey was set, so it was not possible to be taken twice utilizing the same device.

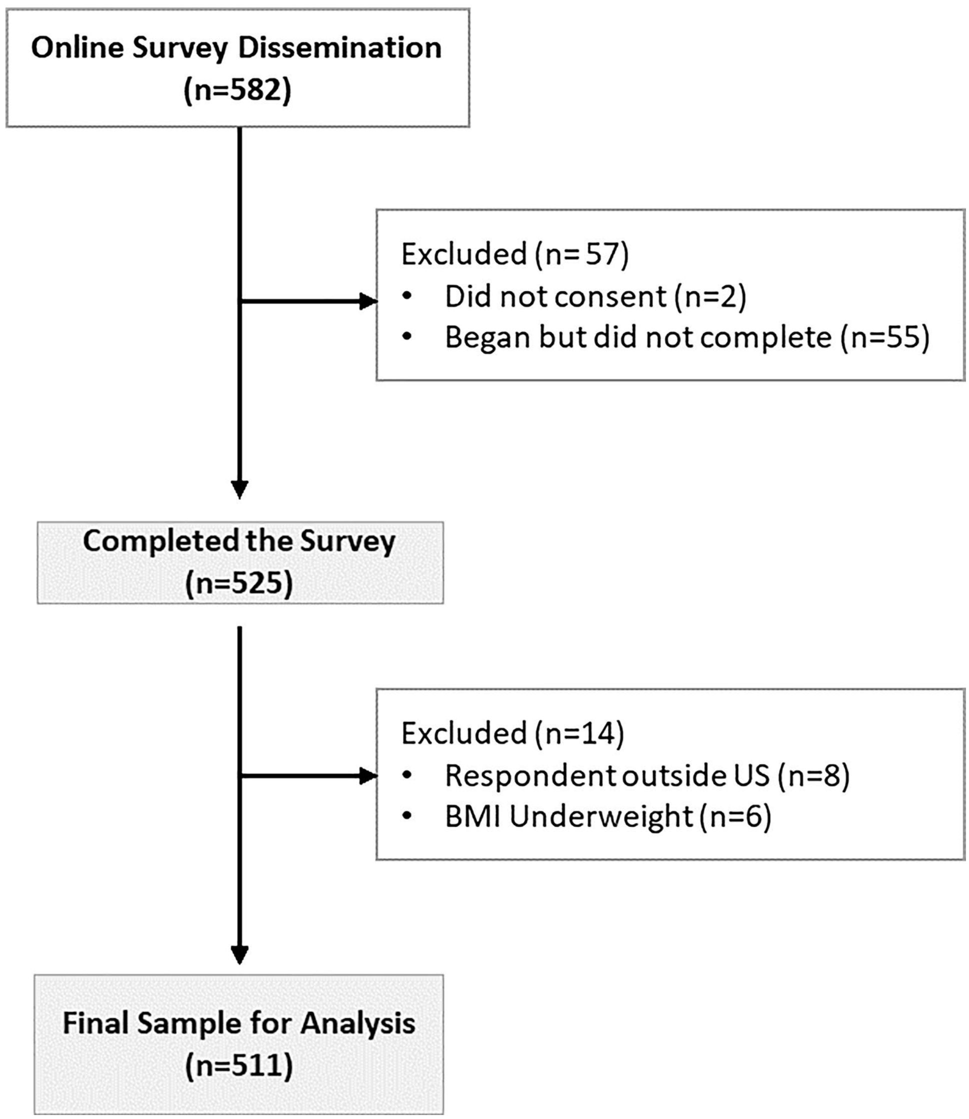
The initial data of this survey included all responses. The database was then cleaned for provided consent ($n = 2$), incomplete surveys ($n = 55$), and respondents outside the US ($n = 8$). Additionally, those respondents reporting a body mass index corresponding with underweight ($n = 6$) were removed to avoid skewed analysis. A total of 511 responses were analyzed in this study (see flow diagram, Fig. 1).

The survey had a total of 60 questions and took approximately 10 min to complete. The survey comprised four different sections: (1) demographics, (2) health history, (3) daily habits (i.e., dietary and sleep habits, and screen time), and (4) exercise (i.e., habits, facilities, technology, equipment, barriers/facilitators) (see Supplementary Table S1).

Statistical analysis

Descriptive and frequency analysis were used for the initial characterization of the sample divided by demographics (age, gender, race, civil status, annual family income, education level, regular dwelling, working conditions, employment status), healthy history (medical conditions, BMI group, smoking), daily habits (dietary, screen habits, and sleep) and exercise (physical

Fig. 1 Flow diagram



fitness and exercise before and during COVID-19 confinement, company, and workout location). A quantitative analysis was carried out using a logistic regression model with two dichotomous dependent variables: "participants who increased their level of exercise during the confinement" (FIT) and "participants who decreased their level of exercise during the confinement" (NEGFIT). This statistical analysis was performed to answer the following questions: "Which factors are associated with an increased level of fitness during the COVID-19 pandemic?" and "Which factors are associated with a decreased level of fitness during the COVID-19 pandemic?". Regression analyses were carried out with dichotomous dependent variables (FIT and NEGFIT), and several variables were used as regressors (gender, race, education level, annual family income, dietary habits, weekday, pre outdoors, working conditions, BMI group, exercise before and pre work). The p-value determined whether these variables were determinant in explaining the changes in the practice of physical exercise. The models estimated for each of the variables (FIT and NEGFIT) are not homogeneous since both the variables and their significance are different in each case. Based on the dependence of the change in exercise behavior and the BMI, the 511 participants were filtered into four groups (extremely healthy, normal, optimal, and unhealthy) and analyzed. When a variable was considered significant, the relative influence of the categories of that same qualitative variable was analyzed in more detail. Finally, in a complementary manner and considering the results of the previous regressions, independence contrasts were carried out between the most relevant variables when it comes to a person doing physical exercise. All the logistic regression calculations were carried out in PROC GLIMMIX (SAS, version 9.4) and Chi-Square Tests of Independence (PROC FREQ, SAS version 9.4). To determine the relevance of the variables in the estimated models, significance levels of 10%, 5%, and 1% were used.

Results

Descriptive statistics

First, we will describe the main characteristics of the complete sample (511 participants), as well as the results only for those who reported having performed physical exercise during the confinement (450 participants).

Complete sample

Demographics

The survey respondents of this study resided in 32 states of the US, with the majority located in Illinois, Missouri, and Texas (see Fig. 2 in Appendix). Table 1 shows demographic characteristics of the participants. Approximately, 70% of the respondents were between 30–59 years of age while the remaining ~30% were almost equally distributed between the age groups of 18–29 and 60–89 years. In terms of gender, the majority of respondents (76.9%) were female and 86.3% reported to be white. The marital status of respondents was reported as 66.5% married and 22.5% never married. Regarding annual household income, the most frequent family income ranges are above $60,000 per year (76.1%) and those who reported incomes between $51,000 and $60,000 (6,9%). Respondents' education level showed 61.6% holding a graduate degree, followed by bachelor's degree (28.8%) and some college but no degree (4.7%). About working conditions, 71.8% did not work remotely, 56% worked more than 40 h per week before the pandemic, 35.6% worked between 1 and 39 h per week, and 3.5% were unemployed. This contrasts with working conditions during the pandemic, in which the percentage of employees working more than 40 h per week decreased by 12 points to 43.8% while there was an increase in the number of participants working between 1 and 39 h (43.4%) as well as the unemployed, which more than double compared to before the pandemic (8%) (see Supplementary Table 2).

Health history

More than half of the respondents reported eating the same amount of food during the pandemic (50.5%) and 35.8% increased their daily intake during that period. The same is true for sleep habits: 47.7% reported that they slept the same hours and 35.2% that their sleep hours had increased. In addition, screen hours increased during the confinement (59.7%).

Exercise habits and workout location

There was a great variety in the physical fitness of the respondents prior to the pandemic, with a predominance of those who declared having a normal physical fitness (52.6%) and improved physical fitness during the confinement (31.7%) that showed to be higher by more than 6 points compared to those who had worsened (25.6%). Interestingly, data reflected an 8 percentage point increase in the practice of physical exercise during the pandemic (88.1%). On the other hand, the respondents' favorite place for physical exercise before the pandemic was the gym (40.9%), followed by home (34.1%) and outdoors (22.7%).

Individuals performing physical exercise

Results exercise during the pandemic

The results of the 450 participants who reported having exercised during the pandemic are shown in Table 1. Sociodemographic characteristics and healthy and daily habits of this subsample showed similar proportions among the different categories of the study variables (gender, race, age, income,

Table 1 Demographic characteristics of individuals performing physical exercise ($n = 450$)

	Demographics (%)						
Age	18–20	21–29	30–39	40–49	50–59	60–89	
	0.44	15.78	22.44	26.67	21.11	13.56	
Gender	**Male**	**Female**	**Other**				
	22.67	77.33	0				
Race	**American Indian o Alaskan Native**	**Asian**	**Black or African American**	**From multiple races**	**Hispanic or Latino**	**Native Hawaiian or other Pacific Islander**	**White**
	0.44	1.56	2.89	2.67	5.56	0.22	86.67
Annual family income	**Less than $20,000**	**$20.000 to $ 30,000**	**$31.000 to $40,000**	**$41.000 to $50,000**	**$51.000 to $60,000**	**Above $60,000**	
	3.11	2.67	4.89	6.44	6.44	76.44	
Working conditions	**No Remote**	**Remote**					
	72.67	27.33					
Employment Status during Covid-19	**Disable, not able to work**	**Employ working 1–39 h per week**	**Employ working 40 h or more per week**	**Not employ**	**Retired**		
	0	42	45.78	8	4.22		
	Health history (%)						
BMI group	**Healthy**	**Obese**	**Overweight**				
	42.44	25.78	31.78				
Dietary habits	**Eat Less**	**Eat More**	**Eat Same**				
	13.33	33.11	53.56				
Screen habits	**Decrease**	**Increase**	**Same**				
	4.22	58.67	37.11				
Sleep	**Same**	**Sleep Less**	**Sleep More**				
	47.11	16.22	36.67				
	Exercise habits (%)						
Physical fitness before	**Extremely Healthy**	**Optimal**	**Normal**	**Unhealthy**			
	13.11	28	50.44	8.44			
Physical fitness during	**Improved**	**No diference**	**Worsened**				
	35.11	43.11	21.78				
Exercise before	**Yes**	**No**					
	85.56	14.44					
Total days/week before	**1–2 days**	**3–4 days**	**+4 days**	**None**			
	8.67	31.11	45.78	14.44			
Total days/week during	**1–2 days**	**2–3 days**	**3–4 days**	**+4 days**			
	9.33	1.33	31.11	58.22			
Hours/week before	**0 h**	**Less than 1 h**	**1–2 h**	**3–4 h**	**+4 h**		
	14.44	0.65	12.89	29.11	42.89		
Hours/week during	**1–2 h**	**2–3 h**	**3–4 h**	**+4 h**			
	14.22	2.67	31.78	51.33			
Weekend	**Longer**	**No Change**	**Shorter**				
	27.56	57.68	14.67				
Weekday	**Longer**	**No Change**	**Shorter**				
	48.44	30.22	21.33				

Table 1 (continued)

Schedule change	**Yes**	**No**			
	75.11	24.89			
Intense before	**Easy**	**Hard**	**Max**	**Medium**	**None**
	6.44	29.56	1.11	48.44	14.44
Intense during	**Easy**	**Hard**	**Max**	**Medium**	
	15.56	6.67	19.78	58	
New activities	**Yes**	**No**			
	43.78	56.22			
	Exercise workout location (%)				
Pre outdoors	**Yes**	**No**			
	25.56	74.44			
Pre community	**Yes**	**No**			
	43.11	56.89			
Pre work	**Yes**	**No**			
	13.78	86.22			
Pre home	**Yes**	**No**			
	37.33	62.67			

marital status, etc.) to the full sample, which includes the respondents who did not exercise.

Change in exercise habits during confinement

In those respondents who did exercise, changes in physical exercise habits were observed during the pandemic. Of the 450 participants who exercised during the confinement, 14.4% reported that they did not exercise before the pandemic.

Fitness during the pandemic improved for 35.1% of the respondents and worsened for 21.8%. With respect to the frequency of physical exercise, participants who exercised more than four days a week increased from 45.8% to 58.2%, as did the number of hours per week of physical exercise, which increased by almost 9 percentage points. There were also changes in the days of the week on which physical exercise is practiced; 27.6% of respondents reported an increase in exercise during weekends versus 14.7% who indicated a decrease during those days of the week. On weekdays, there were also changes, with 48.4% of respondents stating an increase in physical exercise on these days and 21.3% reporting a decrease.

Taking into account the intensity of exercise, light exercise increased almost threefold, from 6.4% to 15.6%. Other relevant changes can be seen in moderate-intensity exercise, which went from 48.4% before the pandemic to 58% during the pandemic. Vigorous-intensity exercise decreased from 29.6% to 6.7%, and very-vigorous exercise increased from 1.1% to 19.8%. Finally, 43.8% reported having practiced new activities, and the location for the practice of physical exercise was similar to that reported in the full sample.

Logit model

To determine the factors influencing the practice of physical exercise (FIT variable), several logit models were estimated, in which the most relevant/influencing variables

Table 2 Fixed effects test FIT and NEGFIT

FIT				
	Model (1)	Model (2)	Model (3)	Model (4)
Gender		0.997		
Race		0.7116		
Education level	0.0698*			
Annual family income	0.0577*			
Dietary habits	0.0079***			
Weekday				0.0001***
Pre outdoors			0.0635*	
NEGFIT				
	Model (1)	Model (2)	Model (3)	
Annual family income	0.0336**			
Working conditions	0.0362**			
BMI group	0.0008***			
Dietary habits				
Exercise before	0.1448			
Weekday		< 0.0001***		
Pre work	0.3622		0.4624	

The models indicate the different specifications to explain the behavior of the FIT and NEGFIT variables and the coefficients of the least squares means estimates. Significance levels at *10%; **5%; ***1%

were education level, annual family income, dietary habits, outdoor practice before the pandemic, and physical exercise practice during the week. The results are shown in Table 2.

With respect to education level, only being a student ($p < 0.05$) or having a university degree ($p < 0.01$) has a significant impact on physical exercise behaviors. In relation to annual family income, the most influential levels in the practice of physical exercise are incomes below \$20,000 ($p < 0.05$) or above \$60,000 ($p < 0.05$) and the relation with physical exercise practice is inverse. In addition, those with family income between 41,000 and 50,000 dollars are also significant. Finally, among eating habits, those who reported eating more ($p < 0.01$) or the same ($p < 0.01$) during the pandemic are relevant, and its relation with physical exercise practice is also inverse. The above results are shown in Table 3.

In contrast, the most important factors for not practicing physical exercise (NEGFIT) are family income, working conditions, BMI group, and the practice of exercise during the week. The results are also shown in Table 3. All income levels are significant in the lack of practice of physical exercise with the exception of those who reported annual incomes between 41,000 and 50,000 dollars. Working conditions are also relevant, both for those who performed face-to-face ($p < 0.01$) and remote ($p < 0.01$) work. With respect to the BMI group, the three categories (healthy, overweight, and obese) are significant in explaining the non-practice of physical exercise ($p > 0.01$). Changes in physical exercise during the week are relevant, with a significance level of 1%, in not practicing physical exercise. Finally, performing or not performing physical exercise at work is a determinant for not performing physical exercise ($p < 0.01$) (see Table 4).

BMI group

Estimations of the logit model performed on four subsamples (extremely healthy, normal, optimal, and unhealthy) for each of the BMI group categories, with the dependent variable FIT and the regressors (education level, annual family income, working conditions, and diet) (Table 5). The only significant results were reported in the normal BMI group, in which working conditions were relevant in determining the practice of physical exercise ($p < 0.1$) and in the optimal group, in which diet was the key factor ($p < 0.05$). In the rest of the estimations, no significant differences were found.

Contrasts of independence

Finally, considering the results of the previous section, several independence tests were carried out between the most

Table 3 Logit estimates FIT

FIT								
		Estimate	Standard error	DF	t value	Pr > |t|	Mean	Standard error mean
Education level	High school degree or eq	–0.498	0.805	499	–0.62	0.5364	0.378	0.189
	Some college but no degree	–1.282	0.498	499	–2.58	0.0103**	0.217	0.085
	Associate degree	–0.639	0.550	499	–1.16	0.246	0.346	0.124
	Bachelor degree	–0.452	0.252	499	–1.8	0.0732*	0.389	0.060
	Graduate degree	–1.048	0.232	499	–4.52	< .0001***	0.260	0.045
Annual family income	Less than \$20,000	–1.822	0.790	499	–2.31	0.0215**	0.139	0.095
	\$20,000 to \$30,000	0.397	0.600	499	0.66	0.5085	0.598	0.144
	\$31,000 to \$40,000	–0.575	0.480	499	–1.2	0.2315	0.360	0.111
	\$41,000 to \$50,000	–1.770	0.567	499	–3.12	0.0019***	0.146	0.071
	\$51,000 to \$60,000	–0.413	0.416	499	–0.99	0.3215	0.398	0.100
	Above \$60,000	–0.521	0.224	499	–2.33	0.0203**	0.373	0.052
Dietary habits	Same	–0.882	0.298	499	–2.96	0.0033***	0.293	0.062
	More	–1.215	0.318	499	–3.82	0.0001***	0.229	0.056
	Less	–0.255	0.351	499	–0.73	0.4675	0.437	0.086
Pre outdoors	Yes	–0.456	0.191	509	–2.39	0.0171**	0.388	0.045
	No	–0.865	0.110	509	–7.85	< .0001***	0.296	0.023
Weekday	0	–2.657	0.517	507	–5.14	< .0001***	0.066	0.032
	Shorter	–3.136	0.511	507	–6.14	< .0001***	0.042	0.020
	No change	–1.179	0.202	507	–5.83	< .0001***	0.235	0.036
	Longer	0.240	0.136	507	1.76	0.0796*	0.560	0.034

The table shows the estimates for each of the logit models. Significance levels at *10%; **5%; ***1%

Table 4 Logit estimates NEGFIT

NEGFIT								
		Estimate	Standard error	DF	t value	Pr>|t|	Mean	Sd(mean)
Annual family income	Less than $20,000	–1.366	0.615	498	–2.220	0.0267**	0.203	0.100
	$20,000 to $30,000	–2.626	1.070	498	–2.450	0.0144**	0.067	0.067
	$31,000 to $40,000	–1.030	0.473	498	–2.180	0.0298**	0.263	0.092
	$41,000 to $50,000	–0.390	0.402	498	–0.970	0.3319	0.404	0.097
	$51,000 to $60,000	–1.833	0.475	498	–3.860	0.0001***	0.138	0.056
	Above $60,000	–1.551	0.224	498	–6.910	<.0001***	0.175	0.032
Working conditions	Remote	–1.204	0.281	498	–4.290	<.0001***	0.231	0.050
	No remote	–1.728	0.351	498	–4.920	<.0001***	0.151	0.045
BMI group	Healthy	–2.018	0.331	498	–6.100	<.0001***	0.117	0.034
	Overweight	–1.065	0.332	498	–3.200	0.0014***	0.256	0.063
	Obese	–1.315	0.337	498	–3.900	0.0001***	0.212	0.056
Weekday	0	0.164	0.257	507	0.640	0.5228	0.541	0.064
	Shorter	0.938	0.227	507	4.130	<.0001***	0.719	0.046
	No change	–2.015	0.266	507	–7.570	<.0001***	0.118	0.028
	Longer	–2.758	0.286	507	–9.640	<.0001***	0.060	0.016

The table shows the estimates for each of the logit models. Significance levels at *10%; **5%; ***1%

Table 5 Fixed effects BMI group

BMI group				
	Extremely healthy	Normal	Optimal	Unhealthy
Education level	0.136	0.193	0.984	0.918
Annual family income	0.862	0.160	0.641	0.824
Working conditions	0.262	0.095*	0.387	0.235
Dietary habits	0.442	0.523	0.011**	0.156

The models indicate the different specifications to explain the behavior of the FIT variable, for each sub-sample considering the fitness of each participant, and the coefficients of the least squares means estimates. Significance levels at *10%; **5%; ***1%

Table 6 Independence test BMI group

	BMI group		
		Chi-square	P-value
Exercise workout location	Pre work	70.604	0.022**
	Pre home	13.700	0.001***
	Pre community	7.903	0.019**
	Pre outdoors	0.612	0.737

Chi-square statistics for the independence test. Significance levels at *10%; **5%; ***1%

relevant variables of the Logit analysis (p-value), which are the BMI group and changes in physical exercise practice during the week. The first independence tests (for the whole sample) associate the BMI group with the place of physical exercise prior to the pandemic. The results show that there is a dependence relationship between BMI and having performed physical exercise at work ($p<0.05$), at home ($p<0.01$), and in community places ($p<0.05$). However, the same dependence relationship is not shown for the variables BMI and outdoor exercise (see Table 6).

Independence contrasts between changes in physical exercise practice during the week and demographic variables, on medical history, daily habits, and exercise practice was performed for those participants who exercised during the pandemic. As can be seen in Table 7, there is a relationship between changes in physical exercise practice during the week and age ($p<0.1$), gender ($p<0.05$), race ($p<0.05$), and annual family income ($p<0.05$). There is also a dependency relationship with daily habits, hours of sleep ($p<0.05$), and screen time ($p<0.05$). Finally, there is a strong relationship between the weekday variable and physical exercise habits; specifically, having done physical exercise before the pandemic ($p<0.01$) and choosing community locations ($p<0.01$).

Discussion

The scope of this study is to report the changes that have taken place in the practice of physical exercise during the confinement and to examine the factors that favor or detract from it. One of the relevant results is the increase of 8 percentage points in the practice of physical exercise during the pandemic, which raises to 88% the percentage of participants

Table 7 Independence test weekday

	Weekday		
		Chi-square	P-value
Demographics	Age	17.511	0.064*
	Gender	8.672	0.013**
	Race	22.876	0.029**
	Education level	12.391	0.135
	Annual family income	19.475	0.035**
	Employment status during Covid-19	4.776	0.573
	Working conditions	3.252	0.197
Health history	BMI Group	4.032	0.402
	Sleep	12.302	0.015**
	Screen habits	11.463	0.022**
	Dietary habits	3.301	0.509
Exercise habits	Physical fitness before	22.985	0.001***
Exercise workout location	Pre work	0.311	0.856
	Pre community	36.120	< .0001***
	Pre home	3.554	0.169
	Pre outdoors	2.171	0.338

Chi-Square statistics for the independence test. Significance levels at *10%; **5%; ***1%

who report performing physical exercise. These results coincide with those observed in a study by Constand et al. (2020) who stated that the increase in the practice of physical exercise during the pandemic was almost one third in very active people and almost two thirds in inactive people.

To address which factors are relevant in the decision to practice or not to practice physical exercise, we can first introduce those that affect the sociodemographic characteristics of the respondent. First, from the information collected, it seems that those participants with a higher level of education are more likely to practice physical exercise; specifically, those who either have an academic degree or are in the process of obtaining one. This positive relationship between the practice of physical exercise during the pandemic and education level is consistent with the results obtained in different studies over the years. A study by Wildbur (2003b) reported that Latina women living in the United States who had less than a high school education performed less physical exercise compared to those with a higher level of education. In another, conducted by the same author, but with a sample of African-American women, those who completed high school were four times more likely to be active than those that did not. Moreover, women with a university degree were still two to three times more likely to be active than those with a lower level of education (Wilbur et al. 2003a). Along the same lines, MacDougall et al. (1997) also showed that people with no education or primary education were more likely to have a low level of activity than those with higher education. Regarding the relationship between income and physical exercise, in our study, there is a contrast between those earning less than $20,000 per year and those earning between $41,000–50,000 and more than $60,000 per year. As with data obtained in other studies, earnings above $41,000 are associated with higher physical exercise (Bauman et al. 2012; Chatton and Kayser 2013). Income level is a key contributing factor to the education level and practice of physical exercise in addition to other factors. In this sense, it is not surprising the negative relationship between the low-income group (< $20,000) and with a reduced participation in sports and exercise at younger ages as they tend to have lower income (Wolla and Sullivan n.d.). Finally, working conditions are among the factors that have an impact on the decrease in physical exercise, being significant both for those who work remotely and those who do not. During the COVID-19 pandemic, in jobs where telecommuting was possible, a considerable number of employees worldwide were allowed to work from home (Mitchell 2021); however, in places where this was not a feasible solution, they were forced to suspend operations with consequent pay suppression (Harangi-Rákos et al. 2022). It seems that both factors may have a negative impact on the practice of physical exercise, either from the economic problems due to salary suppression (Roberts 2017) or the increase in the proportion of sedentary time derived from teleworking (Ráthonyi et al. 2021). In this regard, in a study by Hernandez et al. (2021), one of their objectives was to analyze the degree of physical activity during the COVID-19 pandemic in remote workers, and it was shown that more than 70% of the workers surveyed reported increased sedentary behaviors.

In terms of factors relevant to the practice or not of physical exercise during the COVID-19 pandemic (daily habits, specifically, diet) our data revealed that the practice of physical exercise is related to eating habits. As is well known, periods of confinement, related to negative psychological effects (Brooks et al. 2020), imply changes in the daily routine of the population (Sánchez-Sánchez et al. 2020), and may lead to inappropriate behaviors such as physical inactivity or the consumption of unhealthy food and beverages (López-Bueno et al. 2020) and the consequent increase in the development of certain diseases such as obesity or diabetes (Vergara Castañeda et al. 2020). In this sense, following a balanced and healthy diet, while maintaining minimum levels of physical exercise takes on special importance in relation to its health benefits during confinement (Reyes-Olavarría et al. 2020). These results are in line with those obtained in the review by Bennet et al. (2021) where six of the included studies showed an increase of both quantity and frequency of their meals during quarantine. Consequently, when considering the increase in physical activity in our sample and taking into account that food consumption (whether equal or higher) also positively influences physical activity, it is evident that the confinement period due to COVID-19 generated both beneficial and detrimental effects. However, it should also be noted that our study did not consider the type of food that increased in consumption, as other studies have also reported an increase in the consumption of fresh produce (Di Renzo et al. 2020) and home cooking (Pietrobelli et al. 2020) during the confinement period.

Related to physical exercise habits, the most significant factor affecting exercise during confinement was not exercising outdoors before the pandemic. This result may suggest that people who exercised in other places, such as their own home or workplace, may be more likely to continue exercising in their own home during the pandemic. The results obtained in our study are in agreement with those obtained by Dunton et al. (2020) who showed that physical activity at home was associated with fewer declines in physical activity during the pandemic, which may imply that the barriers of confinement affect outdoor and low-cost exercise. Another study, by Yang and Koenigstorfer (2020) suggests that users of digital exercise aids were less likely to experience a reduction in their physical activity levels, which could be related to the fact that such tools are more likely to be used by people who do not exercise outdoors. Another factor, also associated with the practice of physical exercise (both positively and negatively) during the pandemic for all its variables (no physical exercise during the week, more or fewer days, or more days per week), is that referring to changes in the days of the week for the practice of exercise (more, less, or the same). It could be affirmed that these patterns are to be expected, since, as is well known, the state of confinement changed the daily life of the workers, altering their lifestyle behaviors, including those related to the practice of physical exercise (Loef et al. 2022).

The factors with the greatest influence on changes in physical exercise habits during the week in the confinement period were, on the one hand, sleep habits and the use of electronic devices and, on the other hand, physical fitness prior to the pandemic and the practice of physical activity in groups. In relation to sleep habits and the practice of exercise, there is great evidence that physical exercise practiced regularly has a positive impact on total sleep time (Kredlow et al. 2015), being of great importance since the quality of sleep has a fundamental role in health promotion and risk of suffering chronic diseases and depression (Irwin 2015). Also, it appears that factors influencing exercise changes during the week, such as pre-pandemic fitness and group physical activity, could be connected. During confinement, there was a significant increase in screen time (Jia et al. 2020), being also higher for young adults (Qin et al. 2020). In this sense, studies show both a positive and negative association in the use of digital media and physical activity. For example, the use of smartphones and video games is associated with a lower likelihood of exercising (Grimaldi-Puyana et al. 2020) and the use of social networks (especially those with sports content) may favor this practice (Shimoga et al. 2019). Therefore, although some people increased their dependence on social networks as a form of entertainment, others used social networks as a means to perform physical activity and break the daily routine derived from confinement (Areiza-Padilla et al. 2021).

Finally, our study showed that body mass index related variables (healthy, overweight, or obese) were determinants of not performing physical exercise. Interestingly, these variables were strongly related to the location where the participants performed physical exercise (outdoors, at the workplace, at home or in a group) before the pandemic: body mass index (all groups) and exercising at home or in a group and, very strongly, with the practice of physical exercise at home. This relationship shows that lifestyle components, such as physical inactivity, are one of the main factors that influence the maintenance of the body mass index, contributing to the incidence of obesity and overweight (Missiriya Jalal et al. 2021).

Strengths and limitations

It is necessary to extend the study in those variants that are relevant to our results, specifying in more detail some key variables. To achieve this, it is essential to use a more diverse and heterogeneous sample, given that the setting in which the data were collected was mostly composed of college graduates. In addition, it would be beneficial to extend the study to other geographic areas and to carry out comparisons between different states.

Future research

For future research, it is crucial to consider several areas of study and proposals based on our results. For example, we could explore the implementation of specific programs targeting groups with different body mass indexes (BMI) or programs that encourage physical activity both at home and outdoors, examine the possibility of providing resources to users based on their income, and/or develop a public health protocol that takes into account the income levels of the population in situations such as pandemics. This protocol could include programs designed to serve specific groups of people, whether special populations or those with chronic pathologies. We could also consider creating specific resources for people who are accustomed to exercising outside the home, as they appear to have experienced more difficulties during confinement.

Given the observed increase in the practice of physical exercise during confinement, it would be interesting to conduct a long-term follow-up of these individuals to determine if they have maintained their improved habits or if they have returned to their pre-confinement routines. This would allow us to better understand trends and factors influencing exercise adherence.

This would provide us with valuable information on the impact of exercise on people's overall health and well-being.

Conclusions

- During confinement, there was an increase in the practice of physical exercise.
- Among all the variables analyzed, the elements that most favor/distort the practice of physical exercise are dietary habits, annual family income, and education level. These factors also affect physical exercise differently according to body mass index.
- Other significant results are the changes in the days of the week used for physical exercise due to the circumstances derived from confinement, which are also closely related to the use of electronic devices and screens, the hours of sleep, and the physical state prior to the pandemic.

Appendix

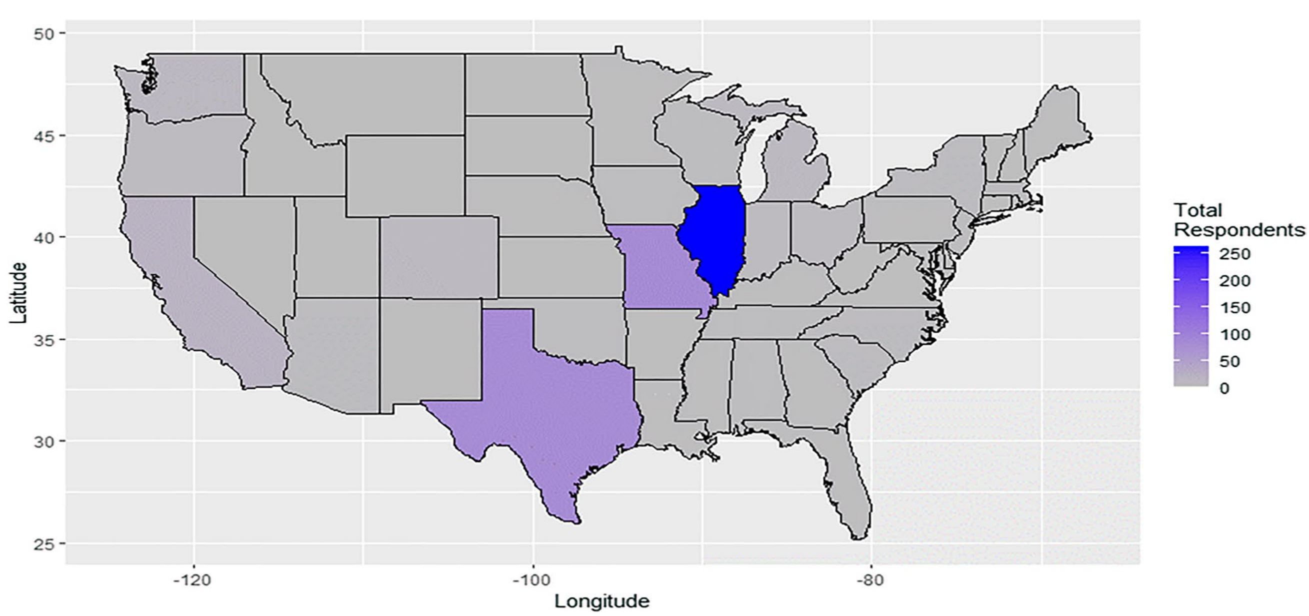


Fig. 2 Number of respondents by state

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Availability of data and material Data are available upon request from the corresponding author.

Declarations

Ethical approval This study was approved by the Kuali Amendment Justification. All authors state their compliance with the Code of Ethics of the World Medical Association (the 1964 Declaration of Helsinki and its later amendments).

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication All participants were properly instructed that data gained in the present study will be used for publication in an anonymous form and gave online their informed consent for publication.

Conflicts of interest The authors declare no conflicts of interest.

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