

Impact of COVID-19 induced lockdown on physical activity and sedentary behavior among university students: A systematic review

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Abstract

Background

The COVID-19 pandemic has entailed a significant socio-economic impact on various layers of the population. In many countries, attempts to control viral dissemination involved lockdown measures that limited citizens' overall mobility and professional and leisure activities.

Objective

This systematic review investigates the impact of COVID-19-induced lockdowns on university student physical activity and sedentary behavior, as these relate to physical and mental well-being.

Methods

Data was collected through PubMed/MEDLINE, Embase, SCOPUS, and APA PsycInfo databases until January 2021.

Results

Seven studies conducted in five different countries (United States, Spain, Italy, China, and United Kingdom) were included in the final review. Overall, most studies reported a significant decrease in mild physical activity (i.e., walking) among undergraduate students but not among graduate students. Consistently, most studies reported a significant increase in sedentary time (i.e., sitting time on weekdays) in undergraduate students but not in graduate students. We observed that students who were more sedentary previous to lockdown, increased or did not change their

moderate and/or vigorous physical activity. In contrast, those who were less sedentary previous to lockdown decreased their moderate and/or vigorous physical activity.

Conclusions

COVID 19 induced lockdowns appear to have negatively affected walking and sedentary behavior among undergraduate students but not among graduate students. Our results highlight the importance of promoting the World Health Organization recommendations for physical activity and sedentary behavior among university students to improve health outcomes.

Main messages

- This systematic review investigates the changes in physical activity and sedentary behavior of undergraduate and graduate students during the lockdown measures in response to the COVID-19 pandemic.
- A systematic review exploring physical activity and sedentary behavior changes among university students assessing student pre-pandemic sedentary behavior has not been published before.
- Findings suggest a decrease in undergraduate student mild physical activity levels during lockdowns, while their sedentary behavior predictably seemed to rise. For graduate students, no statistically significant changes were reported in mild physical activity levels and sedentary behavior.
- Changes in moderate and/or vigorous physical activity varied according to student pre-lockdown sedentary behavior.
- Conclusions are based on a limited number of studies, with an overall high risk of bias, which is the main limitation of the current systematic review.

Introduction

The infection caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), commonly referred to as COVID-19, represents a serious global threat to public health. COVID-19 was first detected in December 2019 in Wuhan, China, and declared a global pandemic on 11 March 2020¹. As of 11 March 2021, over 118 million cases and 2.6 million deaths have been reported worldwide².

COVID-19 is a highly contagious virus that is mainly transmitted through close person-to-person contact. There are no effective treatments to date, so large-scale physical distancing measures and movement restrictions – often called lockdowns – have been imposed in different countries to slow COVID-19 transmission³. Lockdown measures often include closing schools, universities, fitness centers, and other public locations^{4,5}.

Staying-at-home orders can harm people's health behaviors, such as an overall decrease in physical activity and an increase in sedentary behavior, which can profoundly impact an individual's health, well-being, and quality of life. Evidence has shown that physical activity is associated with significantly lower risks of all-cause mortality, hypertension, cardiovascular disease, type-2 diabetes, and various cancers. Additionally, it has been tied to improved mental health, cognitive function, and sleep outcomes⁶.

Since lockdown measures can hinder physical activity, the World Health Organization (WHO) has reinforced recommendations on the amount of physical activity necessary to provide significant health benefits and mitigate risks^{7,8}. In general, the WHO recommends at least 150 minutes of moderate-intensity physical activity (e.g., carrying light loads, bicycling at a regular pace, or doubles tennis), or at least 75 minutes of vigorous-intensity physical activity (e.g., heavy lifting, digging, aerobics, or fast bicycling) a week for all adults⁶.

Previous research has suggested that university student's mental health is heavily affected by social distancing measures adopted due to the COVID-19 pandemic⁹⁻¹¹. Multiple studies in different countries indicate that physical activity presents a powerful means to reduce the impact of lockdown measures on the psychological well-being of this specific population¹²⁻¹⁸. Although one previous systematic review reported an overall decrease in physical activity levels due to social distancing measures among university students¹⁹, the data

regarding this claim remains inconclusive. For instance, a cross-sectional study in Italian undergraduates showed that about half of the sample decreased physical activity. However, the other half maintained or even increased their usual physical activity practice²⁰.

To further assess this issue and combine insights gained through recently published work, we conducted a systematic review to investigate university student's changes in physical activity and sedentary behavior during lockdown measures followed by the COVID-19 pandemic. More specifically, we aimed to answer the following main research question: What changes in physical activity and sedentary behavior can be observed among undergraduate and graduate students during a lockdown period, compared to their habits before these restrictions were in place?

Methods

A systematic review of the literature was registered with the International Prospective Register of Systematic Reviews (PROSPERO) database (ID: CRD42021230459) and conducted following PRISMA recommendations (Preferred Reporting Items for Systematic reviews and Meta-Analyses; Appendix A)²¹.

Selection criteria and outcomes

We included cross-sectional or longitudinal studies whose main objective was to evaluate the levels of physical activity or sedentary behavior (expressed as quantitative data, e.g., min/week) among university students (undergraduate or graduate) before and during the lockdowns adopted to contain the COVID-19 pandemic. We also included studies that aimed to assess broader populations only if they included university students. Lockdown measures (complete or partial) had to include at least the cancellation of face-to-face classes. Studies with samples of less than 50 university students were excluded based on the suspicions of a lack of statistical power to support their conclusions²². Additionally, we excluded studies that did not use validated physical activity measurement tools and studies that did not report concrete values of physical activity levels (e.g., mean with/without standard deviation) before and during the COVID-19 induced lockdowns. The primary outcome of interest was physical activity, and the secondary outcome was sedentary behavior.

Search strategy

Four scientific databases were searched from inception to 5 January 2021: Medline, Embase, SCOPUS, and APA PsycInfo. The complete electronic search strategies are shown in Appendix B. No search filters were applied.

After searching the selected databases, all references retrieved were downloaded, combined, and prepared for the screening process. Mendeley reference management software was used to search and eliminate duplicates²³.

Study selection

Two reviewers independently screened the retrieved titles and abstracts for potential inclusion and reviewed the full texts of studies that were considered viable candidates. Any disagreements were resolved by discussion until consensus was reached. Article selection was performed through the Rayyan web-based application for systematic reviews²⁴.

Data extraction

Two reviewers independently extracted the data of the selected studies, and any discrepancies were resolved by discussion. The extracted data was collected in a Microsoft Excel Spreadsheet that included: general information, methods, exposure/intervention data (e.g., lockdown characteristics, timing), population and setting, participants, outcomes, analysis, and main results. The authors of the corresponding articles were contacted whenever additional clarification of the reported findings was deemed necessary.

Risk of bias of the included studies

The risk of bias of cross-sectional and longitudinal studies was assessed using the ROBINS-I tool for uncontrolled studies²⁵. This tool

evaluates the following seven domains: 1) confounding, 2) selection of participants, 3) classification of the interventions, 4) deviations from intended interventions, 5) missing data, 6) measurement of outcomes, 7) selection of the reported result. The categories for risk of bias judgments are “Low risk”, “Moderate risk”, “Serious risk”, and “Critical risk” of bias. Risk of bias assessment was performed in parallel with data extraction by the same two researchers, and a consensus approach was used to determine the domain-level and overall risk of bias for each study.

Strategy for data synthesis

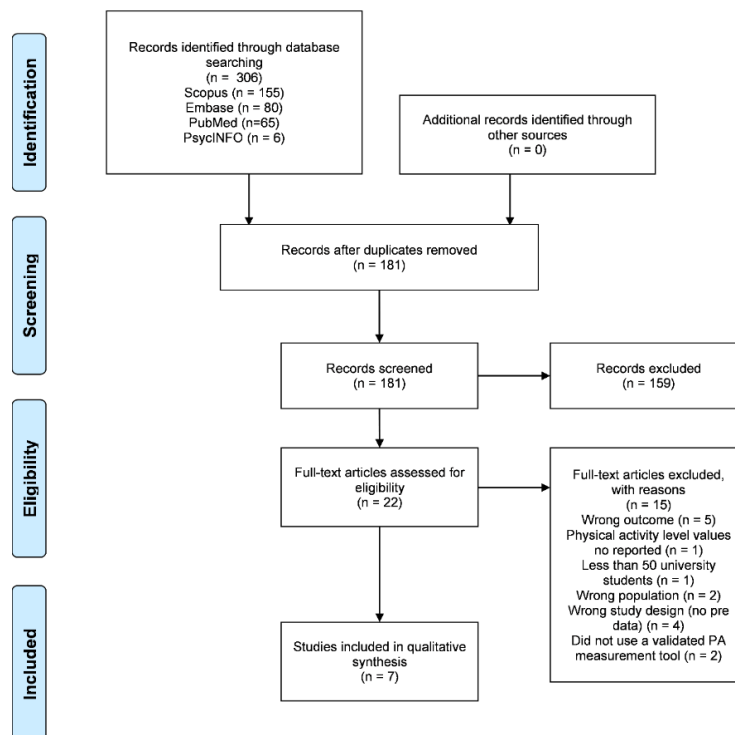
The extracted data were presented in a narrative synthesis. The extracted information was compiled and organized in tables to summarize each included study. The interpretation of the results was performed by the three authors contributing to this systematic review.

Results

Selection of studies

In total, 306 records were initially retrieved, and 181 records remained after removing duplicates. Based on title and abstract screening, 159 articles were excluded, so 22 articles were retrieved and thoroughly assessed for eligibility. Of these, 15 were excluded for: not being the outcome of interest, not using a validated physical activity measurement tool, not reporting specific physical activity level values, having less than 50 university students, having the wrong population, or having the wrong study design. More detailed information on these papers, with reasons for their exclusion from our analysis, can be found in Appendix C. The remaining seven articles were included in this review (Figure 1).

Figure 1. PRISMA flow diagram of study inclusion.



Source: Prepared by the authors of this study.

Study characteristics

The characteristics of the included studies are shown in Table 1. Studies were conducted in the following countries: United States^{15,26}, Spain²⁷, Italy^{28,29}, China³⁰, and the United Kingdom³¹. Four out of seven studies were cross-sectional, and the remaining three were longitudinal (uncontrolled pre-post studies). All studies reported a higher proportion of women in their sample sizes, except one that did not describe university student's female/male ratio²⁶. The studied populations ranged in size from 84 students (a group of graduate students)²⁶ to 7024 students (a group of undergraduate students)³⁰, and in age from 20.0 years³¹ to 29.9 years (a group of graduate students)²⁶. All studies used validated questionnaires to evaluate the changes in physical activity and/or sedentary behavior, most commonly through the International Physical Activity Questionnaire (IPAQ).

Table 1. Characteristics of included studies.

Author, year	Country	Setting	Study design	Population	Sample size (included in the analysis)	Age (mean ± SD or median (range or IQR) (years)	Females (%)	Recruitment	Measures	Date of survey	Date of lockdown order
Barkley, 2020 ²⁶	United States	A public university in the Midwestern United States.	Cross-sectional with one cut-off point	University (undergraduate and graduate) students and employees.	100 undergraduate students; 84 graduate students	Undergraduate students = 26.9 ± 8.9; graduate students = 29.9 ± 9.7	Not reported	E-mail	Godin physical activity questionnaire. IPAQ.	Between 18 May and 3 June 2020.	20 March 2020
Luciano, 2020 ²⁸	Italy	Not reported	Cross-sectional with two cut-off points	6th-year Italian medicine students (undergraduate students).	First survey = 714; Second survey = 394	First survey = 25.0 ± 2.0; Second survey = 25.0 ± 2.0	First survey = 62.0; Second Survey = 73.0	Student representatives invited all the students in their class to fill in the online questionnaire (convenience sampling)	IPAQ.	First cut-off point: between October and November 2019; Second cut-off point: between 9 March and 3 May 2020.	9 March 2020
Galle, 2020 ²⁹	Italy	The Sapienza University of Rome, the Parthenope University of Naples, and the Aldo Moro University of Bari.	Cross-sectional with one cut-off point	Undergraduate students attending three Italian universities.	1430	22.9 ± 3.5	65.5	Students attending web courses were invited to voluntarily participate in the study by filling in the web-based questionnaire.	IPAQ	The last three weeks of May 2020.	March 2020
Yang, 2020 ³⁰	China	National survey	Cross-sectional with one cut-off point	Undergraduate and graduate students.	7024 undergraduate students; 234 graduate students	Undergraduate students = 20.6 ± 1.8; graduate students = 24.6 ± 3.5	Undergraduate students = 70.0; graduate students = 70.9	Social media platforms (snowball sampling)	IPAQ	May 2020	24 January 2020
Romero-Blanco, 2020 ²⁷	Spain	Not reported	Longitudinal (uncontrolled pre-post study)	First- to fourth-year health sciences students (undergraduate students).	213	20.5 ± 4.6	80.8	The study was carried out within the context of another study. No further details.	IPAQ	Pre measurement: between 15 and 30 January 2020; Post measurement: between 1 and 15 April 2020.	March 2020
Savage, 2020 ³¹	United Kingdom	East Midlands UK University	Longitudinal (uncontrolled pre-post study)	Undergraduate students.	214	20.0 (mean)	72.0	Online survey	Exercise Vital Sign questionnaire	Pre measurement: October 14, 2019; Post measurement: April 27, 2020	20 March 2020
Maher, 2021 ¹⁵	United States	Institution in the southeast United States	Longitudinal (uncontrolled pre-post study)	Kinesiology undergraduate students	107	21.7 ± 2.6	Approximately two-thirds of the sample	Online questionnaire	IPAQ	Pre measurement: between 21 January and 11 March 2020; Post measurement: between 17 April and 5 May 2020	30 March 2020

SD: standard deviation.

IQR : interquartile range (Q3-Q1).

IPAQ: International Physical Activity Questionnaire.

Source: Prepared by the authors of this study.

Risk of bias of the included studies

The risk of bias of the included studies is shown in Table 2. According to the ROBINS-I tool, all ten studies were at critical risk of bias due to confound related to the uncontrolled study design. Moreover,

participants selection bias was unclear in five studies because they did not report the response rate, and serious in two studies due to low response rates: Galle et al. reported a response rate of 0.9%²⁹ while Savage et al. mention a response rate of 2.3%³¹.

Table 2. Risk of bias of uncontrolled studies using the ROBINS-I tool²⁵.

Author, year	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall
Barkley, 2020	Critical risk of bias	No information	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Critical risk of bias
Luciano, 2020	Critical risk of bias	No information	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Critical risk of bias
Galle, 2020	Critical risk of bias	Serious risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Critical risk of bias
Yang, 2020	Critical risk of bias	No information	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Critical risk of bias
Romero-Blanco, 2020	Critical risk of bias	No information	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Critical risk of bias
Savage, 2020	Critical risk of bias	Serious risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Critical risk of bias
Maher, 2021	Critical risk of bias	No information	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Low risk of bias	Critical risk of bias

Source: Prepared by the authors of this study.

Changes in physical activity

Changes in physical activity were evaluated in seven studies^{15,26-31}. The specific types of activity assessed were mild intensity (i.e., walking), moderate-intensity, and vigorous-intensity activities. Physical activity levels were reported as separate scores for each activity level and/or as a combined score for total moderate and vigorous physical activity levels. Five studies reported results for undergraduate students only^{15,27-29,31}, and two reported separate results for undergraduate and graduate students^{26,30}.

Units of measurement for physical activity varied across studies. Four studies expressed physical activity levels in minutes per week^{15,27,29,31}, one study in hours per day³⁰. Two studies used specific instrument scores: Godin score/week in one study²⁶ and MET-minutes/week in another (a MET is a ratio of working metabolic rate relative to resting metabolic rate)²⁸. Five studies reported means with or without standard deviations^{15,26,27,29,31}, and two studies reported medians and interquartile ranges^{28,30}. The main findings of all included studies are shown in Table 3.

Table 3. Summary of findings of included studies.

Author, year	Group	Physical activity								Sedentary behavior			
		Measurement unit	Mild		Moderate		Vigorous		Total moderate + vigorous		Measurement unit	Pre-lock-down	Lock-down
			Pre-lock-down	Lock-down	Pre-lock-down	Lock-down	Pre-lock-down	Lock-down	Pre-lock-down	Lock-down			
Barkley, 2020 ²⁶	Under-graduates	Godin score/week; mean ± SD	16.3 ± 22.6	10.8 ± 12.9*	15.0 ± 15.7	12.9 ± 12.4	16.0 ± 22.1	14.0 ± 17.9	-	-	Min/week; mean ± SD	3089.2 ± 1455.4	3681.0 ± 1600.3
	Graduates		12.0 ± 22.4	11.2 ± 11.7	17.1 ± 36.9	16.6 ± 19.7	19.1 ± 32.9	21.0 ± 33.7	-	-	Min/week; mean ± SD	3129.1 ± 1329.7	3696.4 ± 1566.5
Romero-Blanco, 2020 ²⁷	Under-graduates	Min/week; mean ± SD	-	-	-	-	-	-	223.3 ± 305.5	383.2 ± 438.9*	Min/day; mean ± SD	418.6 ± 201.6	525.4 ± 194.6*
Luciano, 2020 ²⁸	Under-graduates	MET-min/week; median [Q1 – Q3]	693 [359 – 1386]	99 [0 – 347]*	0 [0 – 240]	80 [0 – 400]*	360 [0 – 1440]	480 [0 – 1440]	-	-	Hours/day; median [Q1 – Q3]	8 [6 – 10]	10 [8 – 12]*
Galle, 2020 ²⁹	Under-graduates	Min/week; mean	480	114.5*	199.3	148.1*	138.6	108.3*	-	-	Min/day; median ± IQR	240 ± 240	480 ± 300*
Yang, 2020 ³⁰	Under-graduates	Hours/day; median [Q1 – Q3]	1.0 [0.5 – 1.5]	1.0 [0.5 – 1.2]*	-	-	-	-	1.2 [0.8 – 2.0]	1.0 [0.7 – 2.2]*	Hours/day; median [Q1 – Q3]	4.0 [2.0 – 6.0]	5.0 [2.5 – 8.0]*
	Graduates		1.0 [0.5-1.0]	1.0 [0.5-1.0]	-	-	-	-	1.0 [0.7-1.5]	1.0 [0.6-1.4]	Hours/day; median [Q1 – Q3]	6.0 [4.0-8.0]	6.0 [4.0-8.0]
Savage, 2020 ³¹	Under-graduates	Min/week; mean ± SD	-	-	-	-	-	-	249.2 ± 239.6	221.4 ± 220.6	Hours/week; mean ± SD	55.2 ± 25.1	78.1 ± 32.1*
Maher, 2021 ¹⁵	Under-graduates	Min/week; mean ± SD	-	-	-	-	-	-	424.6 ± 372.0	324.7 ± 316.6*	-	-	-

SD: standard deviation;

Q1: first quartile.

Q3: third quartile.

IQR: interquartile range (Q3-Q1).

*Post value significantly different from corresponding pre value (p <0.05).

Decrease

Increase

Source: Prepared by the authors of this study.

Undergraduate students

All four studies reporting mild physical activity levels^{26,28-30} found statistically significant reductions in physical activity. Regarding moderate physical activity levels, one study found no significant change²⁶, one reported a statistically significant increase²⁸, and one reported a statistically significant decrease in physical activity²⁹. Of the three studies that assessed vigorous physical activity levels, two reported no significant changes in physical activity^{26,28}, and one reported a statistically significant decrease in physical activity²⁹. Concerning studies reporting results for total moderate and vigorous physical activity levels, we found that two reported a statistically significant reduction in physical activity^{15,30}, one reported no significant change³¹, and one reported a statistically significant increase²⁷.

Graduate students

Neither of the two studies reporting physical activity outcomes in graduate students^{26,30} found statistically significant changes in physical activity levels (mild, moderate and/or vigorous physical activity levels).

Changes in sedentary behavior

Changes in sedentary behavior (i.e., sitting time during weekdays) were evaluated in six studies. Four of them reported results for undergraduate students only^{27-29,31}, and two reported separate results

for undergraduate and graduate students^{26,30}. Units of measurement for sedentary behavior varied across studies, as two of them expressed sedentary behavior in minutes per day^{27,29}, two studies in hours per day^{28,30}, one in minutes per week²⁶, and another in hours per week³¹. Three studies reported mean and standard deviations^{26,27,31}, and three studies reported medians and interquartile ranges²⁸⁻³⁰. The main findings of all included studies are shown in Table 3.

Undergraduate students

Of the six studies reporting sedentary behavior outcomes in undergraduate students, five reported statistically significant increases in sedentary time²⁷⁻³⁰, and one reported no significant change²⁶.

Graduate students

Both studies that reported sedentary behavior outcomes among graduate students^{26,30} found no statistically significant change in sedentary time during COVID-19 induced lockdowns.

Changes in moderate and/or vigorous physical activity levels in relation to pre-lockdown sedentary behavior

Undergraduate students

Four studies found an increase or no change in moderate and/or vigorous physical activity in undergraduate students with high pre-

lockdown sedentary times (7.0 to 8.0 hours per day)^{26-28,31}. In contrast, two studies reported a decrease in moderate and/or vigorous physical activity in undergraduate students with low pre-lockdown sedentary times (4.0 hours per day both)^{29,30}.

Graduate students

Two studies found no changes in moderate and/or vigorous physical activity in graduate students with high pre-lockdown sedentary times (6.0 to 7.5 hours per day)^{26,30}.

Regardless of changes in moderate and/or vigorous physical activity, those who complied with the current WHO recommendations (150 min/week of moderate physical activity or 75 min/week of vigorous physical activity) before the lockdown measures also did so during the lockdowns^{15,27,29-31}. In contrast, students who did not comply with the WHO recommendations before the pandemic did not do so during the lockdowns^{26,28}.

Discussion

This systematic review aimed to investigate the changes in physical activity and sedentary behavior of university students during the lockdown measures implemented in many countries to control the COVID-19 pandemic. Overall, most studies reported a significant decrease in mild physical activity (i.e., walking) among undergraduate students, but no changes in this type of physical activity among graduate students. Consistently, most studies reported significant increases in sedentary time (i.e., sitting time on weekdays) in undergraduate students but not in graduate students. We observed that students that were more sedentary pre-lockdown increased or did not change moderate and/or vigorous physical activity. In contrast, those who were less sedentary pre-lockdown decreased moderate and/or vigorous physical activity.

Our findings have differences and similarities with a previous systematic review conducted by López-Valenciano et al.¹⁹, who evaluated the impact of COVID-19 induced-lockdown on physical activity in university students. This review reported an overall decrease in physical activity during lockdowns based on numerical and not statistical changes. In contrast, we reported statistically significant changes among this population. We found that moderate and/or vigorous physical activity changes were inconsistent between studies, some reporting significant increases, others significant decreases, and others no significant changes. In this review, we also explore the reasons that may explain these differences and found that they were associated with the respondent's pre-pandemic sedentary behavior, which was our second outcome of interest.

In contrast to López-Valenciano et al.¹⁹, we got additional data from graduate students, who seem to have maintained their health behavior during lockdowns. However, we agree with López-Valenciano et al.¹⁹ that overall, walking during lockdowns decreased significantly among undergraduate students, consistent with the overall increases observed in sedentary time. Furthermore, we agree with the latter colleagues that regardless of the changes, those students who met the WHO moderate and/or vigorous physical activity recommendations before lockdowns also met the recommendations during the lockdowns. These findings remained true even though we included two additional studies in our review that were published after the last literature search conducted by López-Valenciano et al.¹⁹.

Regarding changes in moderate and/or vigorous physical activity, our findings are consistent with a primary study conducted by Meyer et al. among university students and employees (mixed population)³². This study reported that cancellation of face-to-face classes due to the COVID-19 pandemic decreased moderate and/or vigorous physical activity in participants that were more active pre-cancellation and did not lead to changes in participants who were less active pre-cancellation. However, we also found that cancellation of face-to-face classes led to significant increases in physical activity in participants who were less active pre-cancellation.

All in all, we believe that the observed decrease in mild physical activity (i.e., walking) among undergraduate students can be explained by the forced closures of university campuses and the shift to online teaching methods. These factors eliminate the need to physically go to classes, move within university facilities, and in turn, increase computer time, resulting in more sedentary behavior. Moreover, the absence of changes in walking time among graduate students could be explained by a predisposition to sedentary behavior due to a high workload (work demands seem to have been maintained during the pandemic), their greater experience and self-motivation, and their ability to organize their lives better.

Furthermore, we hypothesize that lockdown measures induced by the COVID-19 pandemic (e.g., the closure of fitness centers and gyms) may have created barriers that negatively affected the moderate and/or vigorous physical activity levels of university students who were most active before the pandemic. However, lockdowns may have offered opportunities – such as gaining extra time by eliminating daily commutes to exercise at home – to increase moderate and/or vigorous physical activity levels among university students who were less active before the pandemic.

We acknowledge that since this review is based on uncontrolled studies, there may also be many confounding factors that may explain the changes observed in physical activity, such as the participant's psychological status and well-being before and during the pandemic. These health-related factors may have influenced the health behaviors of university students during the pandemic. High exposure to social media and television and the sense of more leisure time related to online learning may have also impacted student's activity levels.

Overall, most of the studies included in this systematic review reported a significant increase in sedentary times, suggesting that sedentary behavior is an important health issue that should be addressed during the pandemic. A previous systematic review has shown that prolonged sedentary behaviors between one to 16 years are independently associated with deleterious health outcomes (all-cause mortality, cardiovascular disease, cancer, and/or type 2 diabetes) regardless of moderate and/or vigorous physical activity. However, it should be noted that outcomes were more pronounced at lower levels of physical activity³³. The findings mentioned above suggest that, without adequate attention for the potential increases in sedentary behavior, lockdown measures may have serious long-term effects on the health of university students. Although no statistical changes in sedentary behavior were reported among graduate students, special attention should be paid to this group of students. They were reported to have relatively long sedentary times before the pandemic and thus are inherently more at risk for the potential negative consequences of sedentary behavior.

WHO recommends that adults replace sedentary time with physical activity of any intensity (including walking) and ideally aim to increase moderate or vigorous physical activity to reduce the detrimental effects of high levels of sedentary behavior⁶. Strategies to promote physical activity and reduce sedentary behavior during lockdowns may include: free and regular online sessions delivered by universities well-being services, short breaks during and/or in between e-lectures, allowing students to stretch their legs, and the virtual physical activity resources – including tutorial videos and social media platforms to promote interaction and increase motivation to engage in physical activity.

This systematic review has several limitations. First, the conclusions are based on a limited number of studies, judged to be at critical risk of bias, mainly due to the uncontrolled study designs: cross-sectional or pre-post study designs. Such study designs do not determine whether the reported changes are due to the COVID-19 induced-lockdowns rather than other confounding factors. Second, it was not possible to perform a meta-analysis to assess changes in physical activity objectively. This is because some studies reported medians rather than means, indicating a skewed distribution of the data. Since means and medians can be very different when the data are skewed, imputation of missing mean values and meta-analysis was considered inappropriate. Third, the studies included in this review were all conducted in high-income countries, limiting extrapolating the results to low-income countries. Fourth, the physical activity and sedentary behavior data assessed in the included studies were self-reported, leading to inaccurate answers due to recall bias or other confounding factors typically observed in such questionnaires.

Despite these limitations, this study contributes to a better understanding of changes in physical activity and sedentary behavior in university students due to the lockdown measures implemented in some countries to control the spread of COVID-19. It also highlights the importance of promoting the WHO recommendations for physical activity and sedentary behavior among university students to improve health outcomes.

Conclusion

This systematic review summarizes the existing evidence on the impact of the COVID-19 induced lockdowns on physical activity and sedentary behavior among university students. These findings suggest that lockdown measures caused an overall decrease in walking and increased sedentary behavior among undergraduate students. However, no evident changes were reported among graduate students. Furthermore, changes in moderate and/or vigorous physical activity varied according to the pre-lockdown sedentary behavior. Our findings should inspire universities and policymakers to increase their efforts to actively promote physical activity among student populations during lockdown periods to manage the adverse health outcomes of such restrictive measures.

Notes

Contributor roles

PAR: Conceptualization, methodology, formal analysis, investigation; writing – original draft, project administration. BLN: Conceptualization, writing – review, editing. FF: Investigation, writing – review, editing.

Competing interests

The authors declare no competing financial interests or personal relationships that could have influenced this work.

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Ethics

This is a systematic review based on published literature; therefore, ethics approval was not required.

Supplementary files

<https://osf.io/gt567>

Language of submission

English.

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