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Systematic Review Open Access

COVID-19 Pandemic and Youth Fitness: A Systematic Review

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Abstract

While in school, children and adolescents are often required to participate in physical activity as part of daily interactions or guided by the curriculum. Whether that be playing a game at recess, or participating in physical education classes, children and adolescents are up and moving more. However, the COVID-19 pandemic stripped youth of these examples of incidental physical activity. Being in lockdown for long periods and experiencing different degrees of supervision from teachers and parents, children increased their consumption of junk food, sedentary activity, and unhealthy habits. Thus, physical fitness is likely to have decreased among youth since 2019. However, studies and publications on youth fitness specific to the pandemic are scarce. In this systematic review, we provide readers with relevant case studies, statistics, and information that reflects the impact of the coronavirus pandemic on youth fitness. Although the impact of coronavirus on youth fitness is a newly developed topic that still requires extensive research, evidence and comparison between fitness performance, habits, and behaviors pre and post pandemic infer a negative correlation.

Keywords: COVID-19, Coronavirus, Fitness, Physical Activity, Youth, Children.

Introduction

In 2019, an outbreak of a deadly respiratory virus, Coronavirus, changed the normalcy of everyday life. Infecting the population at an incredibly rapid rate and resulting in millions of deaths, many governments globally ordered national lockdowns and quarantine laws.[1-7] Leaving one's home was not permitted except for essential requirements such as food or medical appointments.[8-10] Many companies chose to conduct business via online platforms. Furthermore, schools were closed and moved to online learning.[11-14] Initially, students may have been excited about the prospect of staying home and going to school in their pajamas. However, this dream quickly posed to be a challenge for many students and their families. Schools provide students with many opportunities other than education, for example, for many it is the focal point of their social life.[15,16] In addition, school provides free counseling, food, and promotes physical activity. With more time spent with students performing school tasks via a laptop, sedentary lifestyle increased significantly. Students no longer had designated time for physical education[17] and performing physical exercises at home was even more difficult with nationwide shutdowns of recreation centers and national parks.[14]

Being physically active and reducing inactivity are essential to maintain physical fitness levels.[18-20] Current evidence indicates that the coronavirus pandemic decreased fitness levels in the overall population.[21-23] However, studies and publications on youth fitness specific to the pandemic are scarce. There are variable factors contributing to limited data on this topic- for example, the relatively short time period since the reopening of schools leading to inadequate period of observation to analyze the long-term effects on youth fitness. Nevertheless, there are some short-term studies that have compared fitness levels among youth between current time periods and past data. The purpose of this report is to provide readers with relevant case studies, data and information that reflects the impact of the coronavirus pandemic on youth fitness.

Methods

The review was completed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[24,25]

Literature Search

A comprehensive literature search was conducted in electronic databases including PubMed, National Library of Medicine, Consumer Health Database, American Health Rankings, and Sportdiscus from January 2019 through December 2022. The following terms were used in the search approach: ("Youth Fitness" AND “COVID”) OR ("Fitness" AND "Youth" AND “COVID”) OR ("Youth") AND (“Health”). The terms used were computed based on the question: “What are the rates of youth fitness and or physical activity pre and post Coronavirus?”.

Eligibility Criteria

The incorporated published literature must follow specific criteria. The literature must have been from a reliable primary source, with the focus being on young individuals of school age, ranging from grades Kindergarten through to year 12, or the ages of five through 18 years. The literature referenced in this study was thoroughly reviewed by an external peer reviewer and contains data relevant to the time periods of 2018 through 2022. Focusing on the specific time periods will show data in relation to the period of peak Coronavirus lockdowns. The demographics from publications must have included data based on age (youth) and health (fitness grading). Investigations were excluded if they: (i) were published in a language other than English; (ii) had findings not related to youth fitness and or physical activity; (iii) were conducted on participants not in grades kindergarten through to year 12. Figure 1 outlines the steps in the selection of the included studies.

Study Selection and Data Extraction

The literature review was conducted in the following manner: identification, criteria evaluation, data analysis, and data extraction. In the identification phase, records were found through a database search using keyword identification tools. During the criteria evaluation stage, references were analyzed via examination of paper titles and abstracts. Studies were excluded based on the above mentioned eligibility criteria. In the data analysis phase, relevant full texts were scrutinized for eligibility and all relevant works were included in this systematic review. Finally, the data extraction phase sought to analyze demographic data, study design, objectives, interventions and outcomes, with relevance to the defined hypothesis of the COVID-19 pandemic impacting the levels of fitness of school aged children.

Level of evidence of the selected papers

The level of evidence of each selected publication was individually assessed by analyzing the methodological quality of each source. The sources include: report card indicator reviews, nationally representative data, qualitative data on implementation of evidence-based policy and practice by State Mental Health Authorities (SMHA), Virginia Department of Health testing results and statistics, Behavioral Risk Factor Survey Analysis, peer reviewed publications, and statistics from Americans Health Ranking Annual report years 2019-2022.

Methodological quality and risk of bias

The methodological quality of the selected studies was determined by the PEDro scale (http://www.pedro.org.au/english/downloads/pedro-scale/) which consists of eleven items. The selected articles with a score of seven or greater in the PEDro scale were considered of ‘high’ methodological quality, those with a score of five to six of ‘fair’ quality and with a score of four or below of ‘poor’ quality.[26] The Cochrane Collaboration’s tool was utilized to assess the risk of bias of the included articles.[27]

Results

A total of 108 studies were identified in the database search and, after the removal of 2 duplicates, 106 studies remained for screening. During the screening process, 64 publications were excluded as they were not related to the research question. Consequently, the full text of 19 studies were reviewed in detail. After careful analysis, 12 studies were excluded for not meeting inclusion criteria. Finally, 7 studies were included in the systematic review. The selection process is summarized in Figure 1.

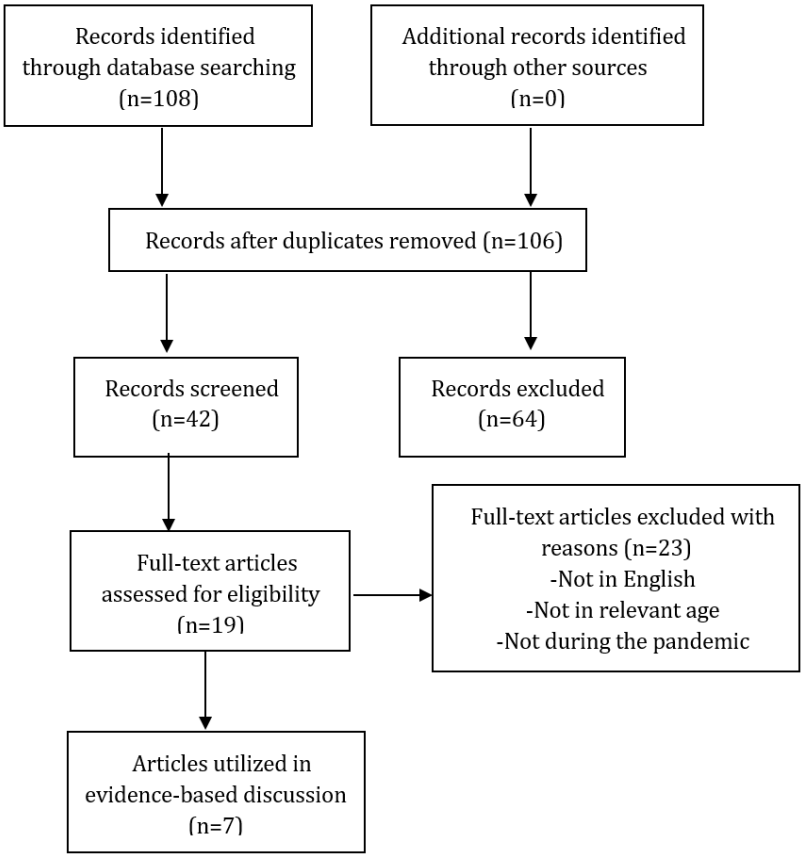

Figure 1. Study selection process

Table-1. Methodological quality assessment of the included studies with the PEDro scale.

Source	1	2	3	4	5	6	7	8	9	10	11	Score
Pavlovic et al. 2021 [28]	■	■	■		■	■	■		■			4/10
Wahl-Alexander & Camic, 2021 [29]		■			■	■	■					7/10
Dunton et al. 2021 [30]	■	■	■		■	■	■				■	4/10
Chaffee et al. 2021 [31]		■	■		■	■	■		■		■	4/10
Tulchin-Francis et al. 2021 [32]		■	■		■	■			■			5/10
Watrous et al. 2021 [33]	■		■		■	■	■	■	■			4/10
Appelhans et al. 2021 [34]		■	■		■	■	■		■			5/10

1) Eligibility criteria has been specified; 2) Subjects were randomly allocated to groups; 3) Allocation was concealed; 4) The groups were similar at baseline regarding the most important prognostic indicators; 5) There was blinding of all subjects; 6) There was blinding of all therapists who administered the therapy; 7) There was blinding of all assessors who measured at least one key outcome; 8) Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; 9) All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by "intention to treat"; 10) The results of between-group statistical comparisons are reported for at least one key outcome; 11) The study provides both point measures and measures of variability for at least one key outcome. White = satisfied and Black = unsatisfied.

Most of the sources utilized survey methodology due to pandemic restrictions. With surveys, subjects are almost always aware of the study and its purpose (to meet informed consent criteria). Because of this, the majority of sources used did not meet the satisfactory components of categories 2, 5, and 6. In contrast, the majority of studies contained statistical analysis between cohorts. Comparison between different cohorts allows examiners to analyze the efficacy of interventions.

The number of participants in included studies ranged from 130 to over 1,000 participants. The individuals that participated were either children aged 3-17 years old or the parents relaying information about their children that fell into the same age category. Pavlovic et al.,[28] collected

environmental physical activity inhibitors of 1,789 schools during the coronavirus lockdown. The respondents reported 80% of children being less physically active based on several parameters including: presence of regulated fitness classes, closure policies, location of the school, and socioeconomic status. Wahl-Alexander & Camic[29] compared pre-pandemic fitness test scores to post-pandemic fitness test scores of 264 students in grades three through to eight [133 males and 131 females]. The scores of the testing conducted by Wahl-Alexander & Camic reflect an average of 0.478 times drop in fitness related performance.[29] Dunton et al.,[30] extracted data from parents and guardians regarding the behavior of their children aged between 5 and 13. This data summarized that children engaged in an average of 8 hours of sedentary activity daily during the pandemic lockdowns. Similarly, Chaffee et al.,[31] compared pre and post pandemic activity levels of 1,006 year 9 and 10 students. One cohort was composed of students from the pre-pandemic period of spring 2019 (March, April, and May) and the other, the mid-pandemic period of fall of 2019 (September, October, November). The authors found that the percent of physically active teens dropped from 54.0% to 38.1% in the pandemic affected cohort.[31] Tulchins-Francis et al.,[32] surveyed parents of youth aged 3-18 years. Over 1,300 completed surveys were analyzed to conclude that physical activity level scores of children decreased significantly during the pandemic from 56.6% to 46.6%. Watrous et al.,[33] compared BMI scores of cohorts pre and post pandemic. The subjects included 154 children aged 8 to 11 years old, and it concluded that the pre-pandemic cohort had an average of 15% higher fitness levels while the post-pandemic cohort had lower scores and more visceral body fat measured. In a newly developed case study, Appelhans et al.,[34] obtained data from 1,364 families about unhealthy habits and behaviors pre and post pandemic. The study found that 87% of participants had negative changes and behaviors during the coronavirus pandemic.

On further analysis of the included studies, it was found that there are multiple factors affecting physical activity levels of youth during the coronavirus pandemic. Factors of note include: socioeconomic status, access to facilities or parks and individual habits or impulse behavior. The effects of the Coronavirus lockdown had adverse impacts on [already decreasing] youth fitness levels as shown by measurable data extracted in papers from Watrous,[33] Chaffee[31], and Wahl-Alexander & Camic[29] in particular. These papers concluded that: BMI and visceral adipose tissue increased after the pandemic, fitness scores decreased by a measurable mean of 0.478, and physical activity or sports recreational involvement decreased by 16%. Other included papers with qualitative methods such as surveys yielded similar results- for example: significant increases in sedentary behavior, decrease in overall movement, and increase in negative impulsive behaviors such as skipping workouts or unhealthy eating habits, and decrease in baseline physical activity. Included case studies highlight that youth and adolescents have been negatively impacted by COVID-19 closures of schools (Table 1). An increase in sedentary activity has decreased fitness performance thus posing plausible risks on youth health.

Discussion

The current review aimed to investigate the effects of Coronavirus-related lockdowns and school closures on youth fitness. The methodological quality of the included studies was deemed as fair and poor. The results showed that the proposed pre-pandemic trends of already decreasing worsened during closures for a variety of reasons including: accessibility, habits, parental monitoring, and increases in sedentary activities.

A description of included case studies and interpretation of their findings is provided below. A research study by Pavlovic et al.,[28] was conducted in March 2020 with the purpose of examining the maintenance of physical education and physical activity during distance learning periods, as well as determining the resources educators were utilizing to deliver PE curricula. Surveys were sent to 1,789 schools, 62 district administrators, 64 nurses, and three miscellaneous institutions. 69.7% of respondents were located in a city or suburb that had low socioeconomic status and 97.8% of campuses in the studied population were closed because of COVID-19. Most of the institutions had physical education requirements, however about 2.8 percent did not. During

the pandemic, institutions that did not enforce physical education requirements increased to 21 percent. In schools that remained open, 60 percent did not maintain physical education requirements during the same period. The results reflected that almost 80% of respondents reported children being significantly less active.

In another case study by Wahl-Alexander & Camic[29], researchers analyzed how COVID-19 affected fitness of school aged males and females. A specific formula to compare fitness before and after COVID-19 closures of schools was utilized. The population was composed of 264 Year 3 through to year 8 students, (n=131 males, n=133 females). The authors reported that both males and females gained significant weight and decreased in their performance of push-ups, curl ups, and aerobic exercises (see Table 2).

Table 1. Studies that evaluated youth fitness and or physical activity pre and post Coronavirus.

Study and Year	Population	Purpose	Results
Pavlovic et al. 2021 [28]	Teachers, administrators and nurses	Analyze the maintenance of physical education and physical activity during the time of distance learning	80% of responders reported children being significantly less active
Wahl-Alexander & Camic,2021 [29]	School aged males and females	Analyze how COVID-19 affected fitness of school aged males and females using a specific formula	Both males and females gained significant weight and decreased in their performance of push-ups, curl-ups, and aerobic exercises.
Dunton et al. 2020 [30]	Legal parents and guardians	Evaluate child's habits	Children engaged in approximately 8 hours of sedentary behavior each day
Chaffee et al. 2021 [31]	Two cohorts of 9th and 10th graders	Analyze physical activity	Teens enrolled during peak lockdowns suffered a greater decrease in physical activity
Tulchin-Francis et al. 2021 [32]	Parents of youth aged 3-18 years	Analyze the effects of the coronavirus pandemic on play and physical activity of youth	Physical activity level scores of children decreased significantly during the pandemic from 56.6% to 46.6%
Watrous et al, 2021 [33]	Children aged 8-11 years	Observation of fitness level differences between pre and post pandemic cohorts	The pre-pandemic cohort had an average of 15% higher fitness levels compared to the post-lockdown cohort.
Appelhans et al, 2021 [34]	Children and their families (N = 1364)	Measurement of pre and post pandemic behaviors and habits	87% of participants had negative changes and behaviors during the coronavirus pandemic

Table 2. Adolescent fitness performance pre vs post COVID-19 reported by Wahl-Alexander and Camic, 2021 (29).

Fitness Component	COVID-19 effect
Push-ups	−35.6%, $\eta 2 = 0.371$. Statistically significant decrease post COVID-19
Sit-ups	−19.4%, $\eta 2 = 0.420$. Statistically significant decrease post COVID-19
Aerobic Endurance Run test	−26.7%, $\eta 2 = 0.644$. Statistically significant decrease post COVID-19

Similar case studies have gathered information about children's behavior from legal guardians to evaluate their habits. In a case study conducted by Dunton et al.,[30] online surveys were completed in relation to children aged 5-13 years, comparing pre and post COVID-19 closures and categorized children's habits based on activity level. The survey concluded that children engaged in about 8 hours of sedentary behavior (sitting) each day.[30]

Chaffee et al.,[31] analyzed 1,006 students in two cohorts of high school aged children in 9th and 10th grade. 521 were enrolled in spring (March, April, and May) 2019 and 485 who were enrolled in fall (October, November, December) 2019. The results concluded that the early 2019 cohort saw a statistically insignificant change in physical activity levels from 53.7% to 52.9%. In contrast, the percent of physically active teens dropped from 54.0% to 38.1% in the

mid-pandemic cohort of late 2019.[31]

More recent studies have been conducted and suggest that the impact of coronavirus, and the 2019 pandemic, may have long term adverse-effects on youth fitness. Studies conducted after pandemic restrictions were lifted provide insight on post-pandemic fitness protocols and education in schools, such as the survey conducted out of Texas by Tulchin-Francis et al in late 2020 of 1,300 3 to 18 year olds.[32] This paper used local anonymised feedback from parents as well as national data for a socioecological framework modeling of questions, to analyze the effects of the coronavirus pandemic on play and physical activity of youth. Positively, 82.7% of collected surveys were fully completed and included in the study, however limitations included that the majority of participants were considered to be moderate to highly educated families, with at least four or more years of college education. Only a small representation were from low income families (6.5%). It found that most neighborhoods scored a low "environmental neighborhood" score based on lack of cycling/pedestrian path use. Furthermore, 58% of recreational facilities and 78.9% of organized sports were inaccessible during the pandemic. The physical activity level scores of children decreased significantly during the pandemic from 56.6 to 46.6. More specifically, moderate to vigorous physical activity decreased while light physical activity remained consistent. Finally, Tulchin-Francis et al.,[32] emphasized and used their own data to make local recommendations based off the US guideline recommendations of youth obtaining at least one hour of physical activity [moderate to vigorous] on a daily basis. These included: acknowledgement from public officials the impact of the pandemic on physical activity, encourage families and parents to continue to encourage physical activity, and schools ensure that all individuals receive physical education via in-person or online instruction.[32]

A study conducted by Watrous et al, from Northeastern University, US analyzed performance differences between different cohorts to form conclusions on pandemic-related inhibitors of youth fitness.[33] A sample of 154 children, aged 8-11 years, performed VO2 max, aerobic capacity, and BMI testing before and after the pandemic. The pre-pandemic cohort had an average of 15% higher fitness levels while the post-pandemic cohort had lower scores and increase in visceral adipose tissue.

In another study, conducted by Appelhans et al.,[34] executive function impairment changes were observed. Executive functions were defined as "a set of cognitive processes that support goal-directed behavior, including inhibitory control, working memory, cognitive flexibility, and other second-order processes (e.g. planning and problem-solving)". This is significant, as if an individual exhibits executive function deficits, it is harder for them to adhere to a healthy diet, participate in exercise, or moderate substance abuse including alcohol. More specifically, the coronavirus pandemic has been hypothesized to negatively impact executive functions. This study drew samples from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development, a prospective birth cohort of children and their families (N = 1364) recruited in 1991.[34] The assessments captured trajectories of health and development throughout childhood and adolescence. Data was taken before and after the pandemic and measured behaviors and habits, summarized in table 1. Individuals were asked about their emotional wellbeing, healthy eating habits, BMI, and physical activity adherence. Conclusions were drawn and found that approximately 87% of participants had negative changes and behaviors during the coronavirus pandemic [i.e.: motivation, self-restraint and emotional regulation]. The study found that individuals with preexisting low executive function scores were more likely to be vulnerable to negative impacts of the pandemic.[34] Although the study did not primarily focus on children, it is useful in drawing inferences about factors that influence unhealthy behaviors that may decrease physical activity. More specifically, many of the participants have children and may easily negatively influence their behavior or habits. This study is the only known study to analyze the psychological factors of physical activity adherence.

Limitations

While there are some scholarly articles that analyze the effect of coronavirus-related closures on youth fitness, it is a newly developed topic that has yet to be developed by

exercise scientists and other researchers. Due to its recent impact, there are few numerical values in data that have been recorded in studies. The majority of research conducted has been via observational data collection i.e surveys, therefore response bias is likely to be present. Furthermore, because the studies were conducted in a survey manner, the results are more subjective. In addition, this makes it difficult to obtain a control group for reference in comparison.

Recommendations for Future Research

In the future, it may be beneficial to conduct group comparisons with at least three trials. For example, measuring objective data such as performances such as VO_2 max, flexibility scores, aerobic capacity, or muscular strength at least six months apart to compare results. Additionally, it will highly benefit researchers to analyze a larger number of participants to reduce the possibility of extreme bias. Another factor to consider are external variables such as geographic location, household income, accessibility to recreational facilities and school attendance. These factors, while not a direct effect on coronavirus and fitness, greatly impact how youth may or may not participate in exercise

Conclusions

Although the impact of coronavirus on youth fitness is a newly developed topic that still requires extensive research, previous evidence and comparison between fitness performance, habits, and behaviors pre and post pandemic infer a negative correlation.

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None.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

Coronavirus disease 2019: COVID-19.

Authors' contributions

BT and AW: Study conceptualization and drafting of the manuscript.

BT, AA and AW: Interpreting the available data

BT, AA and AW: Revision of the paper.

BT, AA and AW: Final minor edits

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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None.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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