

COVID-19 and health in children and adolescents in the US: A narrative systematic review

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Abstract

In the United States, the Coronavirus Disease 2019 (COVID-19) pandemic necessitated nationwide closures of kindergarten through twelfth grade (K-12) schools. Stay-at-home orders and social distancing mandates were also implemented to mitigate the spread of COVID-19. The purpose of this systematic review was to synthesize the existing literature on how COVID-19 impacted K-12 students' eating patterns, physical activity, and sleep in the United States. Utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a literature search was conducted between October and December 2021. Inclusion criteria were studies focused on COVID-19 and eating patterns, physical activity, and sleep in students enrolled in K-12 schools since March 2020. International studies were excluded. Mixed findings were observed for eating patterns whereby the consumption of unhealthful savory and sweet items and healthful snacks (e.g., fruit and vegetables) increased. Reductions in physical activity and disrupted sleep routines were also observed. Heterogeneity in methodological procedures may limit the generalizability of these findings. In the United States, preliminary data suggest that select health-promoting behaviors were negatively impacted by the COVID-19 pandemic. Given that prolonged unhealthful eating patterns, physical inactivity, and poor sleep contribute to chronic disease risk, initiatives that increase health-promoting behaviors are warranted.

KEYWORDS

adolescents, children, COVID-19 pandemic, eating patterns, K-12, physical activity, sleep, US population

1 | INTRODUCTION

On March 11, 2020, the World Health Organization declared a global pandemic resulting from a 13-fold increase in Coronavirus Disease 2019 (COVID-19) cases compared to the preceding 2 weeks (Cucinotta & Vanelli, 2020). In the United States, countermeasures at population and individual levels, including stay-at-home orders, social distancing, and mask requirements were implemented as defense strategies against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus responsible for COVID-19.

Additionally, nationwide closures of kindergarten through twelfth grade (K-12) schools were mandated to mitigate disease transmission. By March 25, 2020, all US public school buildings were closed (Education Week, 2020). It is estimated that school closures impacted the typical school day for nearly 60 million children and adolescents enrolled in K-12 schools (Zviedrite et al., 2021). Along with increased reliance on remote learning modalities, students experienced deviations in access to meal services such as the National School Breakfast and Lunch programs, opportunities to engage in physical activity, and access to health services as a result of mandated school closures. Collectively, these factors may have decreased nutrient intake and physical activity, and increased food insecurity within households (Kinsey et al., 2020).

Research to date indicates that school closures limit social contact among students and may reduce the spread of infectious diseases during outbreaks and pandemics (Viner et al., 2020). However, some researchers have questioned the long-term health ramifications of COVID-19-related school closures (Donohue & Miller, 2020), particularly since elongated disruptions (e.g., typical summer breaks) may worsen cardiovascular and metabolic risk factors in children and adolescents (Sharfstein & Morphew, 2020). Additionally, concerns about school closures during COVID-19 are warranted particularly since schools provide students with access to nutritious meals, a structured learning environment, extracurricular activities, and after-school programs that promote health behaviors, including increased physical activity and a routine that facilitates a regular sleep schedule. This systematic review synthesized the existing literature on how K-12 students' eating patterns, physical activity, and sleep were impacted during this unprecedented period.

2 | METHODS

2.1 | Literature search

A systematic search was conducted to identify literature focused on COVID-19 and eating patterns, physical activity, and sleep in children and adolescents attending K-12 schools in the United States. Between October and December 2021, PubMed and Scopus electronic databases were utilized to identify relevant articles with the following keyword combinations: COVID-19, K-12 students, health, COVID pandemic, nutrition, eating patterns, eating habits, physical activity, exercise, sleep, kindergarten, elementary, and/or adolescents. A list of keywords used to determine study inclusion is included (Appendix A).

2.2 | Inclusion and exclusion criteria

Inclusion criteria were quantitative and qualitative research, including randomized trials, cross-sectional, and case-control studies that reported on K-12 students' health behaviors in the United States. Exclusion criteria were

conference presentations, titles available as abstract only, studies conducted outside the United States, and articles not published in English. Each article's title and abstract were initially screened for eligibility based on one or more outcomes of interest (i.e., eating patterns, physical activity, and/or sleep) by two independent researchers (i.e., one research assistant and the first author). Following an initial screening, full-text articles were accessed and reviewed by the first author to verify eligibility.

2.3 | Data extraction

Data extraction followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1), an evidence-based standard for reporting in systematic reviews and meta-analyses (Moher et al., 2009). Full texts of eligible articles were reviewed for inclusion and exclusion criteria, and reference mining strategies were employed to identify additional relevant articles. Data extraction was completed by two independent reviewers (i.e., one research assistant and the first author), and the studies included in the review were agreed upon by all authors. A standardized template (Microsoft Word, Microsoft, 2021) was designed to extract and organize articles' author(s), study type, purpose, sample, and major findings.

2.4 | Quality appraisal

Tailored assessment tools developed by the National Heart, Lung, and Blood Institute were utilized to evaluate the quality of included studies. Included articles were rated "good," "fair," or "poor" based on the Quality Assessment Tool for Observational Cohort and Cross-sectional Studies tool or the Quality Assessment of Case-Control Studies tool (Table 1). The Quality Assessment Tool for Observational Cohort and Cross-sectional Studies tool consists of 14 items, and the Quality Assessment of Case-Control Studies tool consists of 12 items, which are designed to evaluate the methodological soundness of a study's design, including internal validity as well as potential flaws in study implementation.

2.5 | Appraisal of risk of bias

The potential risk of bias was assessed using the Risk of Bias Instrument for Cross-Sectional Surveys of Attitudes and Practices tool, the Tool to Assess Risk of Bias in Longitudinal Symptom Research Studies Aimed at the General Population, and the Tool to Assess Risk of Bias in Case-Control Studies provided by the CLARITY Group at McMaster University. Included articles were graded on a continuum of "definitely yes" (i.e., low risk of bias) to "definitely no" (i.e., high risk of bias) based on five domains for cross-sectional studies, prospective longitudinal studies, quasi-experimental interrupted time series, and case-control studies (Table 1).

2.6 | Study selection

The literature search resulted in 1419 articles. An initial screening of article titles and abstracts, after removing duplicates, identified 1346 studies that did not meet the inclusion criteria. Of the remaining studies, 10 additional studies were excluded. Thirteen studies met the inclusion criteria and are included herein (Figure 1).

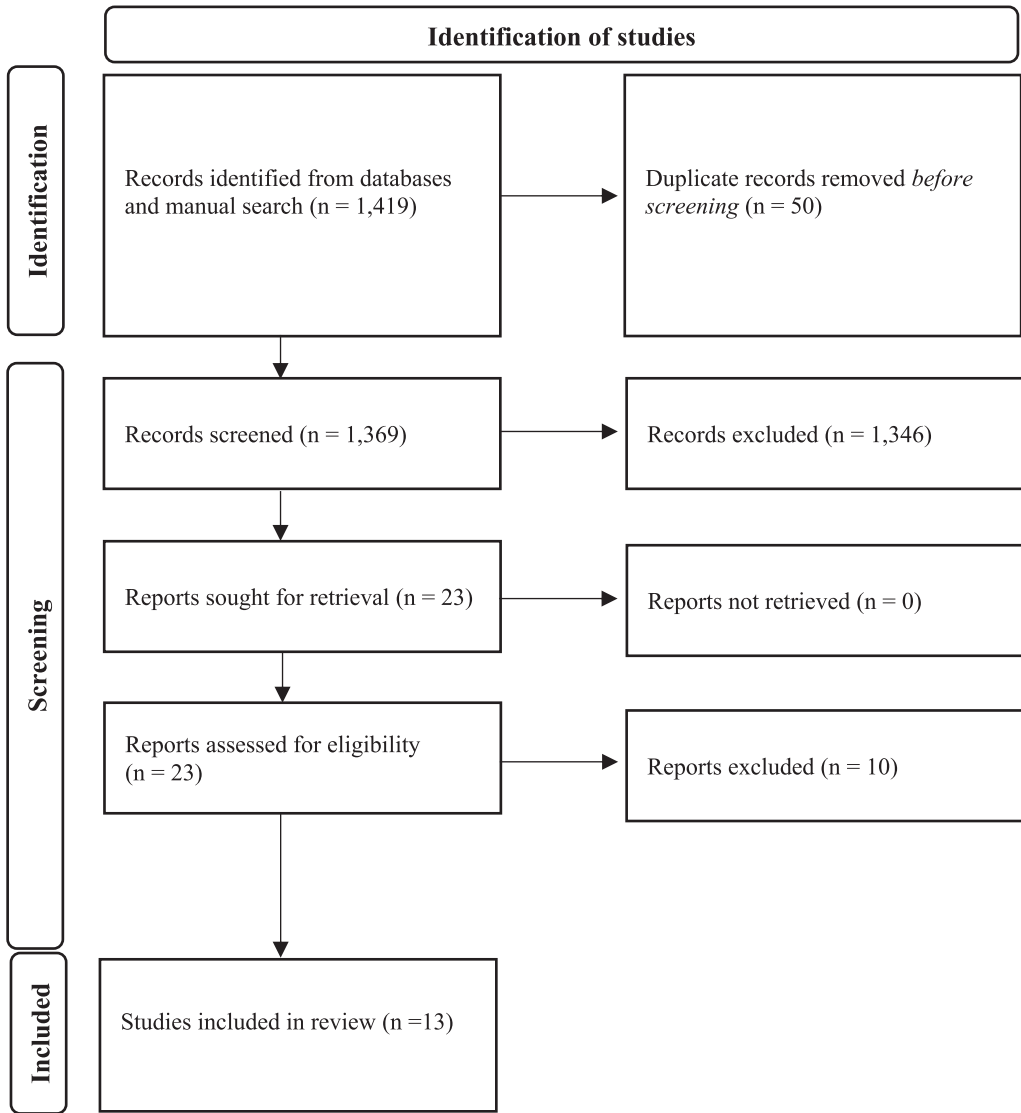


FIGURE 1 : Study selection flow diagram.

2.7 | Study characteristics

Study characteristics and major findings are summarized (Tables 2–4). Among the 13 included studies, 76% ($n = 10$) were cross-sectional, 8% ($n = 1$) utilized a quasi-experimental interrupted time-series design, 8% ($n = 1$) employed a retrospective case-control design, and 8% ($n = 1$) were a prospective longitudinal study. The mean sample among the included studies was 1444 participants. Socioeconomic status was reported in one study; of which, 60.4% of students attended low-income schools, as defined by a *Title 1* distinction. Schools are eligible to receive *Title 1* funding from the federal government to support academic achievement distinction if 40% of the student population is from low-income households (U.S. Department of Education, 2018). Further, one study reported on education status household food insecurity. For this review, studies were grouped according to the following

TABLE 1 Appraisal of quality and risk of bias

First author and year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Quality rating	Bias risk
Beck (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	N	N	NA	N	Fair	Intermediate-High
Becker (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	Y	N	Good	Intermediate-Low
Burkart (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	Y	N	Good	Intermediate-Low
Dayton (2021)	Y	Y	N	Y	Y	N	N	N	Y	Y	N	Y	NA	NA	Fair	Intermediate-Low
Dunton (2020)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	NA	N	Good	Intermediate-Low
Eyler (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	NA	N	Good	Intermediate-Low
Garcia (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	NA	N	Good	Intermediate-Low
Jansen (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	NA	Y	Good	Intermediate-Low
McGuine (2021)	Y	Y	CD	Y	N	Y	Y	NA	Y	NA	Y	N	NA	N	Fair	Intermediate-Low
Neshteruk (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	N	N	NA	N	Fair	Intermediate-High
Pavlovic (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	NA	N	Good	Intermediate-Low
Tulchin-Francis (2021)	Y	Y	Y	Y	N	Y	Y	NA	Y	NA	Y	N	NA	N	Good	Intermediate-Low
Weingart (2021)	Y	Y	CD	Y	N	Y	Y	NA	Y	NA	Y	N	NA	N	Fair	Intermediate-Low

TABLE 2 Characteristics for studies on eating patterns

Authors	Study type	Purpose	Sample	Major findings
Beck et al.	Cross-sectional	Examined the impact of the COVID-19 pandemic on health behaviors in children (4–12 years) with overweight or obesity	Parents/guardians (N = 145)	<ul style="list-style-type: none"> No significant difference in dietary behaviors during the COVID-19 pandemic
Burkart et al.	Quasi-experimental interrupted time-series	Compared obesogenic behaviors in children (7–12 years) during 2018–2019 and the COVID-19 pandemic	Children (N = 231); physical activity and sleep data Parents/guardians (N = 74); reported children's screen time and dietary intake	<ul style="list-style-type: none"> Dietary intake increased: +0.3 healthful foods and +1.2 unhealthful foods
Jansen et al.	Cross-sectional	Examined parental stress during the COVID-19 pandemic, pre-COVID-19 stress, financial stress, food parenting practices, and child (2–12 years) snack intake frequency	Parents/guardians (N = 318)	<ul style="list-style-type: none"> COVID-19 stress was positively associated with snacking of savory and sweet items in children COVID-19 stress was positively associated emotion-based snacking (e.g., higher frequency of ice-cream consumption) in children
Neshteruk et al.	Cross-sectional	Described diet, physical activity, sleep, and screen time of children with obesity during the COVID-19 pandemic	Parents/guardians (N = 51)	<ul style="list-style-type: none"> Increased snacking and more meals prepared at home Some families attempted to offer more healthful snack options, including fruits and vegetables whereas others relied on items that were higher in calories and carbohydrates

TABLE 3 Characteristics for studies on physical activity

Authors	Study type	Purpose	Sample	Major findings
Beck et al.	Cross-sectional	Examined the impact of the COVID-19 pandemic on health behaviors in children (4–12 years) with overweight or obesity	Parents/guardians (N = 145)	<ul style="list-style-type: none"> Daily physical activity was lower during the COVID-19 pandemic (i.e., 1.0 vs. 1.8 h; $p < .001$) Nonacademic screen time increased during the pandemic (3.8 vs. 1.6 h; $p < .001$) 28% of participants did not participate in outdoor physical activity and 45% had no access to outdoor play while at home
Burkart et al.	Quasi-experimental interrupted time series	Compared obesogenic behaviors in children (7–12 years) during 2018–2019 and the COVID-19 pandemic	Children (N = 231); physical activity and sleep data Parents/guardians (N = 74); reported children's screen time and dietary intake	<ul style="list-style-type: none"> Daily light physical activity decreased by 69 min during the COVID-19 pandemic Daily moderate to vigorous physical activity decreased by 8 min during the COVID-19 pandemic Daily sedentary behavior increased by 79 min during the COVID-19 pandemic
Dayton et al.	Retrospective case-control	Compared cardiovascular fitness in children (11–18 years) before and during the COVID-19 pandemic school shutdown	Children (N = 20)	<ul style="list-style-type: none"> Maximal oxygen uptake lower in post COVID-19 cohort compared to pre COVID-19 cohort (39.1 vs. 44.7, respectively; $p = .031$) Percentile of predicted maximal oxygen uptake was lower in the post COVID-19 cohort (95% vs. 105%; $p = .042$)
Dunton et al.	Cross-sectional	Examined physical activity and sedentary behaviors in children (5–13 years) during the COVID-19 pandemic	Parents/guardians (N = 211)	<ul style="list-style-type: none"> 90 min of school-related sitting and 8 h of leisure-time sitting per day Parents perceived that children (9–13 years) had a greater decrease in physical activity and a greater increase in sedentary behaviors compared to children (5–8 years)

(Continues)

TABLE 3 (Continued)

Authors	Study type	Purpose	Sample	Major findings
Eyler et al.	Cross-sectional	Examined parents/guardians' perceptions of changes in children's (5–12 years) physical activity before and during the COVID-19 pandemic stay-at-home orders	Parents/guardians (N = 245)	<ul style="list-style-type: none"> ▪ 63.7% of parents reported a decrease in children's physical activity during stay-at-home orders ▪ Parents were more likely to report a reduction in children's physical activity if the child did not have access to a playmate or adult supervision (social barriers) compared to not having access to neighborhood play spaces (environmental barriers)
García et al.	Cross-sectional	Examined the impact of the COVID-19 pandemic on physical activity, screen time, and sleep duration in adolescents (14–19 years) with autism spectrum disorder	Adolescents with autism spectrum disorder (N = 9)	<ul style="list-style-type: none"> ▪ Decrease in physical activity during compared to before the COVID-19 pandemic (2.27 vs. 4.17 days) ▪ Increase in weekday (6.25 vs. 3.69 h) and weekend (7.39 vs. 5.94 h) screen-time compared to before the COVID-19 pandemic
McGuine et al.	Cross-sectional	Described adolescent athletes (15–17 years) health during the COVID-19 pandemic school closures and cancellations of sports	Adolescent athletes (N = 13,002)	<ul style="list-style-type: none"> ▪ Physical activity level was better for athletes in the ninth compared to the eleventh grade (14.5 vs. 10.9 based on the Pediatric Functional Activity Brief Scale)

TABLE 3 (Continued)

Authors	Study type	Purpose	Sample	Major findings
Pavlovic et al.	Cross-sectional	Examined physical education and physical activity maintenance in children and adolescents (5–18) during the COVID-19 pandemic distance learning	Teachers, school nurses, and school district administrators (N = 2440)	<ul style="list-style-type: none"> ▪ 79% reported "significantly less" or "somewhat less" physical activity during school closure ▪ For closed schools, barriers to physical activity included "student access to online learning," and "teacher/student communication" were challenges to physical activity ▪ For opened schools, "social distancing," "access to gymnasium/equipment," and "concern for personal health and wellbeing" were challenges to physical activity
Tulchin-Francis et al.	Cross-sectional	Examined the impact of the COVID-19 pandemic on children's (3–18 years) physical activity and play behavior	Parents/guardians (N = 1310)	<ul style="list-style-type: none"> ▪ Physical activity score decreased from 56.6 to 44.6 ($p < .001$) based on the Godin Leisure-Time Exercise Questionnaire ▪ Moderate to vigorous physical activity decreased from 46.7 to 34.7 ($p < .001$) based on Godin Leisure-Time Exercise Questionnaire

TABLE 4 Characteristics for studies on sleep

Authors	Study type	Purpose	Sample	Major findings
Beck et al.	Cross-sectional	Examined the impact of the COVID-19 pandemic on health behaviors in children (4–12 years) with overweight or obesity	Parents/guardians (N = 145)	<ul style="list-style-type: none"> Bedtime was 1.6 h later during the COVID-19 pandemic
Becker et al.	Prospective	Examined changes in sleep patterns, duration, delayed sleep/wake behaviors, and daytime sleepiness in adolescents (15–17 years) with or without Attention-deficit/Hyperactivity Disorder before and during the COVID-19 pandemic	Adolescents (N = 122 reported health behaviors Parents/guardian reported adolescents' sleep	<ul style="list-style-type: none"> More difficulties initiating and maintaining sleep during the COVID-19 pandemic Shifts to later bedtimes and waketimes during the COVID-19 pandemic Adolescents with ADHD did not experience a longer duration of sleep during school nights and were less likely to obtain the recommended amount of sleep during the COVID-19 pandemic
Burkart et al.	Quasi-experimental interrupted time-series	Compared obesogenic behaviors in children (7–12 years) during 2018–2019 and the COVID-19 pandemic	Children (N = 231); physical activity and sleep data Parents/guardians (N = 74); reported children's screen time and dietary intake	<ul style="list-style-type: none"> Bedtimes were delayed by 2.07 h during the COVID-19 pandemic
Garcia et al.	Cross-sectional	Examined the impact of the COVID-19 pandemic on physical activity, screen time, and sleep duration in adolescents (14–19 years) with autism spectrum disorder	Adolescents (N = 9)	<ul style="list-style-type: none"> No changes in sleep duration during the COVID-19 pandemic
Weingart et al.	Cross-sectional	Examined sleep parameters and predictors during the COVID-19 pandemic school closures in adolescents (11–18 years)	Adolescents (N = 590)	<ul style="list-style-type: none"> Waketimes were 2.1–2.9 h later during the COVID-19 pandemic school closures Sleep recommendations were achieved by later waketimes Later start times for classes resulted in greater odds of increased sleep duration and more delays in waketimes

outcomes: eating patterns, physical activity, and sleep. Overlap in outcomes was observed in three studies, and almost 50% of studies relied on feedback from parents/guardians.

3 | RESULTS

3.1 | Major findings

3.1.1 | Eating patterns

This narrative review synthesized data from 13 studies. Of these, 31% ($n = 4$) described how COVID-19 impacted eating patterns (Table 1). Two of these studies utilized a quantitative cross-sectional design, one was a quasi-experimental interrupted time-series study, and the fourth relied on qualitative, semistructured interviews. Of the studies included, mixed findings were reported for eating patterns. While some researchers reported an increase in energy-dense foods and snacks, others indicated no changes in eating patterns or an increase in fruit and vegetable consumption. Specifically, responses from parent/guardian semistructured interviews revealed that while some families relied on calorically dense items higher in carbohydrates, other families attempted to provide more healthful snack options, including fruits and vegetables (Neshteruk et al., 2021).

Similar findings were also observed by Burkart et al. (2022) who reported an increase in healthful (e.g., fruits, vegetables, and unsweetened dairy) and unhealthy foods (e.g., sweets and dessert items, convenience foods, savory snacks, and sugar-sweetened beverages) during the COVID-19 pandemic. Interestingly, one study reported no significant differences in eating patterns during the COVID-19 pandemic (Beck et al., 2021), while another reported a positive association between COVID-19-related stress and intake of savory and sweet snacks such as regular potato chips, tortilla chips, ice-cream, and other frozen desserts (Jansen et al., 2021).

3.1.2 | Physical activity

Physical activity was among the outcomes measured in 69% ($n = 9$) of studies (Table 2). Of these studies, one study addressed sleep outcomes along with physical activity, while two studies examined sleep, eating patterns, and physical activity. The majority of studies were cross-sectional (67%) with quasi-experimental, retrospective case-control, and prospective representing the remaining 33% of studies. Five researchers relied on parents/guardians for data collection, one study was conducted exclusively with children (Dayton et al., 2021), two were focused on adolescents (Garcia et al., 2021) or adolescent athletes (McGuine et al., 2021), and one was conducted with elementary, middle school, and physical education teachers, district administrators, and school nurses (Pavlovic et al., 2021). Collectively, these studies suggest that K-12 students experienced reductions in daily physical activity during the COVID-19 pandemic.

According to Beck et al. (2021), daily physical activity was reduced from 1.8 to 1.0 h per day in children 4–12 years with overweight and obesity, and 45% of participants reported not having access to outdoor play during the pandemic. Next, when examining children's (7–12 years) behaviors during spring and summer of the pandemic compared to data from the previous 2 years (i.e., spring 2018 and 2019), Burkart et al. (2022) reported that moderate to vigorous physical activity decreased by 10 min while sedentary behavior increased by 79 min per day. In the retrospective case-control study that examined the effects of COVID-19 school closures on cardiovascular fitness, maximal oxygen uptake, an indicator of physical fitness, was significantly lower in the post-COVID cohort compared to the pre-COVID cohort (39.1 vs. 44.7, respectively; Dayton et al., 2021).

According to Dunton et al. (2020) and Tulchin-Francis et al. (2021), older children (9–18 years) had a greater decrease in physical activity and a greater increase in sedentary behaviors compared to younger children (3–8

years). Interestingly, almost 64% of parents/guardians reported that social barriers (e.g., lack of access to playmates or adult supervision) compared to environmental barriers (e.g., a lack of access to neighborhood recreation spaces) were responsible for the reduction in physical activity engagement (Eyler et al., 2021).

Additionally, 79% of a sample ($n = 2440$) of elementary, middle school, and physical education teachers, school administrators, and school nurses reported significantly less or somewhat less physical activity during COVID-19 school closures (Pavlovic et al., 2021). In the two studies focused on adolescents, one was conducted with participants diagnosed with autism spectrum disorder while the other was conducted with adolescent athletes. In the study conducted with adolescents with autism spectrum disorder, participants spent fewer days engaged in physical activity during the COVID-19 pandemic compared to before the pandemic (2.27 vs. 4.17 days, respectively) (Garcia et al., 2021). Finally, activity levels appeared more favorable for ninth graders compared to older grades, and female athletes reported a higher likelihood of moderate to severe anxiety symptoms as a result of school closures and cancellation of sporting events (McGuine et al., 2021).

3.1.3 | Sleep

Sleep outcomes were addressed in 38% ($n = 5$) of studies (Table 3). Three of these studies employed a cross-sectional design, one was a prospective longitudinal study, and one utilized a quasi-experimental interrupted time-series design. Four of the five studies reported adverse changes in sleep behaviors during COVID-19. Specifically, children 4–12 years with overweight and obesity went to bed 1.6 h later compared to before the pandemic (Beck et al., 2021). Burkart et al. (2022) also reported a delay in sleep time by 124 min in children 7–12 years during the COVID-19 pandemic compared to early 2018 and 2019. Next, among adolescents (15–17 years) with or without attention-deficit/hyperactivity disorder (ADHD), initiating and maintaining sleep was more difficult during the pandemic, and worries/fears related to COVID-19 were associated with delayed bedtimes and waketimes (Becker et al., 2021).

For adolescents without ADHD, later bedtimes and waketimes, longer sleep duration, and less daytime sleepiness were reported during school nights. Interestingly, longer sleep duration was not observed in adolescents with ADHD who were less likely to obtain the recommended amount of sleep during the pandemic (Becker et al., 2021). In another study examining sleep parameters in adolescents 11–18 years, sleep recommendations were achieved as a result of later waketimes that carried into typical school hours (Weingart et al., 2021). Additionally, when compared to middle school students, high school students had later bedtimes and waketimes but spent less overall time sleeping. Further, students with later class start times also elected later bedtimes and waketimes. According to one research group, the mean waketime was 8:58 a.m. compared to 6:20 a.m. before the pandemic. Finally, no changes in sleep duration were observed in adolescents diagnosed with autism spectrum disorder (Garcia et al., 2021).

4 | DISCUSSION

To the authors' knowledge, this narrative review is the first to synthesize the extant literature on the COVID-19 pandemic and eating patterns, physical activity, and sleep in K-12 students in the United States. Given the small number of existing studies, the present review adopted an inclusive approach in terms of study designs and study population to address the outcomes of interest. Collectively, the included studies provide some preliminary evidence that the COVID-19 pandemic may have adversely impacted select health-promoting behaviors in children and adolescents, namely physical activity and sleep. Of note, mixed findings were observed for eating patterns with reports of increased consumption of both unhealthful and healthful foods and snacks.

4.1 | Eating patterns

Fruits, vegetables, and whole grains contribute to a healthful eating pattern, and components present in these foods, including vitamins, minerals, antioxidants, and dietary fiber are linked to a reduction in chronic disease risk and early mortality (del Río-Celestino & Font, 2020; Slavin & Lloyd, 2012; Yahia et al., 2019). Results from the studies included in the present review suggest inconclusive findings for students' eating patterns. While one study reported no significant changes in eating patterns during the COVID-19 pandemic, the three remaining studies indicated an increase in unhealthful snacks (e.g., sweet and savory items higher in calories and carbohydrates) and healthful snacks (e.g., fruits and vegetables). Although the present review focused on research conducted exclusively in children and adolescents in the United States and incorporated studies with various study designs, two additional systematic reviews focused on national and international samples been published previously (Campbell & Wood, 2021; González-Monroy et al., 2021).

According to Campbell and Wood (2021), who examined the eating patterns of children and adults using national and international samples ($n = 38$ studies), there was inconclusive evidence that COVID-19 adversely impacted eating patterns in children (Campbell & Wood, 2021). As with the present undertaking, methodological differences among study designs, population, and outcomes of interest were cited as potential explanations for the overall findings (Campbell & Wood, 2021). Interestingly, psychosocial changes were reported during the COVID-19 pandemic which may have adversely impacted eating patterns (Campbell & Wood, 2021). In a systematic review by González-Monroy et al. (2021), emphasis was placed on prospective longitudinal studies using national and international samples ($n = 23$ studies) with children and adults. The authors reported an increase in snacking frequency with a preference for ultraprocessed foods and sweets (e.g., potato chips, cereals, and sugar-sweetened beverages) and a reduction in fresh foods, including fruits and vegetables (González-Monroy et al., 2021). It is also important to mention that several of the studies included in the present review disproportionately focused on households with higher socioeconomic status which may limit the generalizability of findings.

Considering that higher socioeconomic status is associated with more psychosocial resources, including access to health-promoting services and resources that facilitate nutrition knowledge and cooking skills (Hagger et al., 2013; Monteiro et al., 2013), households with lower socioeconomic status may experience more disruptions in food access and changes in eating patterns during a global pandemic. Additionally, in a retrospective cohort study by Little et al. (2021) on the impact of socioeconomic status on clinical outcomes of COVID-19 ($n = 3528$), patients with COVID-19 who resided in high poverty areas were significantly younger, more likely to be female or a racial minority, or had a higher prevalence of comorbidities compared to individuals who resided in low poverty areas (Little et al., 2021). Next, lower socioeconomic status has been linked to an increased risk of mortality from cardiovascular disease, and COVID-19 appears to adversely affect individuals with a lower socioeconomic status more than those with higher socioeconomic status (Naylor-Wardle et al., 2021). These findings suggest inequalities based on socioeconomic status, and highlight the importance of including socioeconomic status in studies focused on health behaviors.

4.2 | Physical activity

Physical activity is a key contributor to improved quality of life, chronic disease amelioration, and a reduction in all-cause mortality (Gill et al., 2013; Janssen & LeBlanc, 2010; Kraus et al., 2019; Warburton & Bredin, 2017). Yet, many children and adolescents do not meet the recommendations for physical activity (Gomes et al., 2017; Hallal et al., 2012). In the United States, mandated school closures, stay-at-home orders, and cancellation of sporting events during the COVID-19 pandemic appeared to have exacerbated this problem in children and adolescents. In 100% of the studies included in the present review, a decline in physical activity and/or an increase in sedentary behaviors was observed in children and adolescents during the COVID-19 pandemic.

Similar changes in physical activity and sedentary behaviors were reported in children and adults in systematic reviews conducted with national and international samples (López-Valenciano et al., 2021; Stockwell et al., 2021). Additionally, in the present review, one retrospective case-control study reported a decline in cardiorespiratory fitness during the pandemic. Cardiorespiratory fitness, a measure of the circulatory and respiratory systems' capacity to supply oxygen to the skeletal muscle for the production of energy (Caspersen et al., 1985), is an important consideration in overall health, and is an independent predictor of premature cardiovascular disease (Högström et al., 2014), cardiometabolic health (Lang et al., 2018), and academic achievement (Santana et al., 2017) in children and adolescents. According to a recent Scientific Statement from the American Heart Association, cardiorespiratory fitness has declined over the past six decades (Raghuveer et al., 2020; Tomkinson & Olds, 2007; Tomkinson et al., 2019), and less than half of US adolescents (12–15 years) (Gahche, 2014) are believed to have adequate cardiorespiratory fitness. Given that many children and adolescents engaged in less than the recommended amount of physical activity before the COVID-19 pandemic, and that cardiorespiratory fitness is generally lacking in younger populations, the current evidence highlights the importance of incorporating sustainable strategies to increase physical activity now that mandates for school closures have been lifted.

4.3 | Sleep

Prolonged inadequate and/or disrupted sleep and extended wakefulness may result in deleterious systems-level changes in the human body (Vyazovskiy, 2015). In the present review, changes in sleep routines were observed in all but one study with reports of later bedtimes and waketimes, and difficulties initiating and maintaining sleep in various populations (e.g., children with overweight or obesity, and adolescents with or without ADHD). Sleep recommendations were achieved in one study; however, later nightly bedtimes and waketimes were credited for this occurrence. Along with adverse systems-level outcomes of inadequate sleep, sleep disturbances have also been a subject of interest in the research literature. Indeed, common consequences associated with disrupted sleep are reduced daytime alertness and sleepiness during daytime hours (Fallone et al., 2002). Changes in mood, behavior, temperament, and attentiveness may also result from sleep disruptions (Sadeh, 2007; Tomaso et al., 2021).

In a study examining the impact of sleep on education delivered in schools, favorable changes in sleep were associated with academic and cognitive improvements in children ($n = 130$; 8–9 years) (Rey et al., 2020). Next, in a recent cross-sectional study conducted with a sample of Brazilian adolescents ($n = 876$; 16.4 ± 1.2 years), almost 50% experienced excessive sleepiness during daytime hours (Malheiros et al., 2021). Additionally, the authors reported that engagement in physical activity may reduce daytime sleepiness, while consumption of processed foods and each additional hour of social media use was associated with an increase in daytime sleepiness. Finally, inadequate nighttime sleep, irregular evening meals, and excessive screen time have been associated with a 40% increase in obesity prevalence in children (Anderson & Whitaker, 2010). With increased remote learning and leisure-specific screen time, stay-at-home orders, and mandated school closures created an ideal setting to promote adverse changes in sleep during the COVID-19 pandemic. Despite the return to in-person instruction, it will be important to continue to monitor how sleep patterns adapted during the pandemic shift over time.

4.4 | Strengths and limitations

This review contributes to the existing body of literature regarding associations between COVID-19 and health-promoting behaviors. To the authors' knowledge, no previous systematic reviews have focused exclusively on

COVID-19 and children and adolescents' eating patterns, physical activity, and sleep in the United States, representing a key strength of the present work. Additional strengths include current reports of children and adolescents' health-promoting behaviors during the COVID-19 pandemic, and the inclusion of behaviors of concern that need to be addressed in strategies to improve the health and wellbeing of children and adolescents.

Despite these preliminary findings, the following limitations should be noted. First, the majority of included studies relied on cross-sectional study designs which cannot infer causation. Next, several studies, particularly those focused on younger participants, relied on parent/guardian self-reports which may have been subjected to social desirability bias and/or difficulties recalling children's prepandemic health behaviors. It should also be mentioned that while this review was focused on K-12 students, three studies included data on children 2–4 years along with children who met the K-12 criteria. It may be difficult to disentangle data collected on children 2–4 years old compared to data from older children as key developmental differences exist between younger and older age groups. Additionally, many of these studies received a “good” quality rating using the National Heart, Lung, and Blood Institute's quality assessment tool.

Next, the heterogeneity in methodological procedures (e.g., use of various survey assessment tools and reliance on convenience sampling that resulted in a bias toward middle- to upper-class households with Internet access), and various populations of interest (e.g., participants with overweight and obesity, autism spectrum disorder, and athletes), may partially account for the differences in findings among the included studies. As such, caution should be taken when interpreting these results. With the pandemic ongoing, future studies are warranted to fully elucidate the continued impact of the COVID-19 pandemic on eating patterns, physical activity, and sleep in children and adolescents in the United States.

5 | CONCLUSION

Preliminary changes in eating patterns, physical activity, and sleep were observed in children and adolescents in the United States during the COVID-19 pandemic. While some changes (i.e., an increase in fruit and vegetable consumption) may contribute to positive health outcomes, others (i.e., a reduction in physical activity and an increase in sedentary behaviors) have the potential to negatively impact long-term health. Given recent reports of increases in COVID-19 cases across the nation and concerns about emerging variants of SARS-CoV-2, future research must continue to investigate the long-term effects of COVID-19 on K-12 students. Next, considering the importance of health-promoting behaviors, educators, school psychologists, and policymakers are well-positioned to collaborate on programs, curricula, and policies to promote healthful eating patterns, physical activity, and sleep now that students have transitioned back to in-person school.

Additionally, schools should provide credible resources to help families and students build resilience and reduce anxiety regarding COVID-19, and provide opportunities to support educators during the transition back to in-person instruction. Further, school psychologists should empower parents/guardians to create predictable routines (e.g., structured mealtimes with the family), discuss developmental and behavioral concerns, and provide social and emotional support for students as they navigate the return to in-person school. Finally, emphasis should be placed on mitigating negative pandemic-related behaviors by creating sustainable strategies and programs to facilitate health-promoting behaviors in children and adolescents in the United States while also accounting for inequality in socioeconomic status among students.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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APPENDIX A: KEYWORD SEARCH LIST UTILIZED TO DETERMINE STUDY INCLUSION

COVID-19 + K-12 students; COVID-19 + K-12 students + health; COVID-19 + K-12 students + nutrition; COVID-19 + K-12 students + eating patterns; COVID-19 + K-12 students + physical activity; COVID-19 + K-12 students + exercise; COVID-19 + K-12 students + sleep; COVID-19 + kindergarten + health; COVID-19 + kindergarten + nutrition; COVID-19 + kindergarten + eating patterns; COVID-19 + kindergarten + physical activity; COVID-19 + kindergarten + exercise; COVID-19 + kindergarten + sleep; COVID-19 + elementary + health; COVID-19 + elementary + nutrition; COVID-19 + elementary + eating patterns; COVID-19 + elementary + physical activity; COVID-19 + elementary + exercise; COVID-19 + elementary + sleep; COVID-19 + adolescents + health; COVID-19 + adolescents + nutrition; COVID-19 + adolescents + eating patterns; COVID-19 + adolescents + physical activity; COVID-19 + adolescents + exercise; COVID-19 + adolescents + sleep; COVID pandemic + K-12 students; COVID pandemic + K-12 students + health; COVID pandemic + K-12 students + nutrition; COVID pandemic + K-12 students + eating patterns; COVID pandemic + K-12 students + physical activity; COVID pandemic + K-12 students + exercise; COVID pandemic + K-12 students + sleep; COVID pandemic + kindergarten + health; COVID pandemic + kindergarten + nutrition; COVID pandemic + kindergarten + eating patterns; COVID pandemic + kindergarten + physical activity; COVID pandemic + kindergarten + exercise; COVID pandemic + kindergarten + sleep; COVID pandemic + elementary + health; COVID pandemic + elementary + nutrition; COVID pandemic + elementary + eating patterns; COVID pandemic + elementary + physical activity; COVID pandemic + elementary + exercise; COVID pandemic + elementary + sleep; COVID pandemic + adolescents + health; COVID pandemic + adolescents + nutrition; COVID pandemic + adolescents + eating patterns; COVID pandemic + adolescents + physical activity; COVID pandemic + adolescents + exercise; COVID pandemic + adolescents + sleep.