Movement and mental health: Behavioral correlates of anxiety and depression among children of 6–17 years old in the U.S.

Xihe Zhu[a,*], Justin A. Haegele[a], Seán Healy[b]

[a] Department of Human Movement Sciences, Old Dominion University, VA 23529, USA
[b] Department of Behavioral Health and Nutrition, University of Delaware, DE 19716, USA

ABSTRACT

Objectives: The purpose of this cross-sectional study was to examine associations between physical activity, screen-time, sleep duration, and their combinations based on 24-h movement guidelines with anxiety and depression among a nationally representative cohort aged 6–17 years in the US.

Methods: The 2016 National Survey of Children's Health (NSCH) data from a representative sample of children (n = 15,010) aged 6–11 years and adolescents (n = 20,708) aged 12–17 years were analyzed using logistic regression. This analysis examined parent-reported demographics, lifestyle-related behavioral variables, adverse childhood experiences, and history of anxiety and depression.

Results: Physical activity participation was associated with anxiety and depression. Children with 0 days/week of physical activity were about twice more likely to have anxiety (Odds ratio (OR) = 2.19), and adolescents were over twice as likely to have anxiety (OR = 2.25) and depression (OR = 2.18), than peers with daily physical activity ≥ 60 min. There was no significant difference in the ORs of anxiety or depression between the children with daily physical activity and those with physical activity ≥60 min on 1–3 days/week or 4–6 days/week. Extracurricular activity participation and sleep duration were also significantly associated with anxiety and depression along with demographic variables such as race and weight status.

Conclusion: Some physical activity or organized extracurricular activity participation are associated with decreased odds of experiencing anxiety among children and adolescents, and depression among adolescents. Meeting all three 24-h movement guidelines was associated with lower ORs for anxiety for children and adolescents and depression among adolescents.

1. Introduction

Mental health disorders are a public health concern due to their prevalence, early onset, and detrimental impact on children and their families (Ghandour et al., 2019). Anxiety, characterized by excessive fear or worry, and depression, characterized by persistent sad or irritable mood, are considered to be among the most commonly occurring mental health disorders that typically develop in childhood and adolescence (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003; Kessler et al., 2007; Merikangas et al., 2010). For example, Mojtabai, Olfson, and Han (2016), utilizing population-based data in the United States (US) from the National Survey on Drug Use and Health, reported that the 12-month prevalence of depression episodes has increased from 8.7% in 2005 to 11.3% in 2014 among adolescents aged 12–17 years. Similarly, Ghandour et al. (2019) recently reported that 7.1% and 3.2% of US children aged 3–17 years had current anxiety or depression

diagnoses, respectively. These figures are alarming given that anxiety and depression are commonly associated with a host of negative outcomes during childhood, including drug and alcohol abuse, suicide risk, poor academic performance, parenting aggravation, and physical health problems (Bisko et al., 2018; Birmaher et al., 1996; Werner-Seidler, Perry, Calaer, Newby, & Christensen, 2017). Furthermore, anxiety and depression during youth is strongly associated with an increased risk of mental health disorders in adulthood (Pine, Cohen, Cohen, & Brook, 1999).

Anxiety and depression have been studied through the instances and severity of episodes/symptoms and as medical diagnoses of mental health disorders. Volitional, lifestyle-related behavioral variables, such as physical activity, screen-time viewing, extracurricular activity, and sleep, have been associated with mental health disorders and anxiety/depression symptoms among children and adolescents (Gunnell et al., 2016; Kleppang, Hartz, Thurston, & Hagquist, 2018; Maras et al., 2015;

McMahon et al., 2017). For example, McMahon et al. (2017) examined the association between physical activity engagement and anxiety and depression symptoms among 11,110 adolescents from 10 European countries, and found more frequent physical activity to be associated with lower scores of anxiety and depression. Similarly, Maras et al. (2015) examined the relationship between screen-time viewing behaviors and symptoms of depression and anxiety in 2482 Canadian youth, and concluded that screen-time duration was positively associated with anxiety ($\beta = 0.07$) and depression ($\beta = 0.23$) scores. However, the relationship between physical activity, screen-time viewing, and extra-curricular activity (e.g., sport participation), and mental health disorders is complex and remains elusive. For instance, although some research has demonstrated that physical activity is negatively associated with anxiety and depression (Gunnell et al., 2016; Korczak, Madigan, & Colasanto, 2017), other findings show that only moderate-to-vigorous physical activity is negatively associated with depressive symptoms, and that after controlling for covariates, extracurricular activity, such as team sport participation, is not significantly associated with depression (Brunet et al., 2013). Studies have also linked sleep duration and disturbances to anxiety and depression among children and adolescents, suggesting that those who sleep less than the recommended hours are at higher risk for experiencing these mental health disorders (Alvaro, Roberts, & Harris, 2013). However, sleep duration/disturbance and its interaction with physical activity further complicates their relation to anxiety and depression (Feng, Du, Ye, & He, 2014). Specifically, the combined effects of physical activity and sleep quality was negatively associated with depression, but not with anxiety among college students (Feng, Du, Ye, & He, 2014). Thus far, only limited studies have examined these associations among children and adolescents (Alvaro et al., 2013; Chorney, Detweiler, Morris, & Kuhn, 2007).

Recently, researchers have used the Canadian 24-h movement guideline (Tremblay et al., 2016) to study the combined impact of meeting none, one, two, and three of the guidelines of physical activity, screen-time viewing, and sleep on cognition, physical and mental health (Janssen, Roberts, & Thompson, 2017; Walsh et al., 2018). Given that anxiety and depression are among the most commonly occurring mental health disorders in the US (Ghandour et al., 2019), and that lifestyle-related behavioral variables may have remediating effects (Gunnell et al., 2016; Maras et al., 2015; McMahon et al., 2017), further examination of the relationship between lifestyle-related behavioral variables such as physical activity, extracurricular activity, screen-time viewing, and sleep duration and anxiety and depression is warranted. Examining the association between these behavioral variables and anxiety and depression will help generate evidence to identify impactful behavioral elements for interventions. Thus, the purposes of this cross-sectional study was (a) to examine associations between extracurricular activity, physical activity, screen-time, and sleep duration, as discrete behaviors, with anxiety and depression; and (b) to examine the impacts of meeting none, one, two, and three of the 24-h movement guidelines on anxiety and depression among a nationally representative cohort aged 6–17 years in the US. When examining the existing literature, there is an apparent lack of population-based research examining these associations in the US. The NSCH is one of the national data sources for evaluating the presence of anxiety and depression, as well as the targeted lifestyle behaviors, on a regular basis in the US, thus providing an opportunity to examine these associations on a national level.

2. Method

2.1. Study design and data source

This cross-sectional analysis utilized nationally representative data from the 2016 National Survey of Children's Health (NSCH). The 2016 NSCH included a cross-sectional probability sample of non-institutionalized youth aged 0–17 years in the US. Data for this sample were collected between June 2016 and February 2017 via parent- or guardian-report using a two-phase, self-administered data collection process. One child from each household was identified as the focus of the household, and the adult with the most information about the child completed the survey. The weighted response rate was 40.7%. The data analysis plan adopted the NSCH's nonresponse adjusted weight to account for potential response bias (U.S. Census Bureau, 2017a). Further details about the 2016 NSCH can be found in the US Census Bureau's FAQ document (2017b).

2.2. Measures

Anxiety and depression. Children were identified as having anxiety and/or depression utilizing two questions in the NSCH. Participants were identified as having anxiety and/or depression when parents answered "currently have condition" to questions asking parents if they had ever been told by a health care professional that the child had the condition, and whether the child currently has the condition. Anxiety problems and depression were two of 27 health conditions that were listed within questions asking parents to report about potential health conditions that their child had or is currently experiencing.

Demographics. Demographic variables utilized in this analysis included parent reported age, race, sex, and weight status. In the NSCH, body mass index (BMI) is calculated based on parent-reported height and weight. Centers for Disease Control and Prevention (CDC) sex-specific BMI-for-age categories are provided in the NSCH data set, including: (a) underweight as less than 5th percentile, (b) normal weight as 5th percentile to less than 85th percentile, (c) overweight as 85th to < 95th percentile, and (d) obese as greater or equal to 95th percentile. For the purposes of this analysis, overweight and obese were aggregated into one category, 'overweight', as equal to or over 85th percentile.

Extracurricular activity. Extracurricular activity participation was measured using three questions, including: (1) "During the past 12 months, did this child participate in a sport team or did he or she take sports lessons after school or on weekends?", (2) "During the past 12 months, did this child participate in any club or organizations after school or on weekends?", and (3) "During the past 12 months, did this child participate in any other organized activities or lessons, such as music, dance, language, or other arts?" Potential responses included "yes", "no", or "don't know." For the purposes of this analysis, responses to these three questions were dichotomized to either "no participation" or "participated in one or more activities."

Physical activity. Physical activity was assessed using one question in NSCH: "During the past week, on how many days did this child exercise, play a sport, or participate in physical activity for at least 60 min?" Potential responses, which were utilized to categorize physical activity behavior for this study, included "0 days", "1–3 days", "4–6 days", and "every day".

Screen-time viewing. Two questions were utilized to ascertain screen-time viewing scores for this analysis: (1) "On an average weekday, about how much time does this child usually spend in front of a TV watching TV programs, videos, or playing video games?" and (2) "On an average weekday, about how much time does this child usually spend with computers, cell phones, handheld video games, and other electronic devices doing things other than schoolwork?" Scores for the two questions were combined, and a dichotomous variable was created to "less than 2 h" or "2 h or more" of average weekday screen-time viewing, in alignment with screen-time guidelines from the American Academy of Pediatrics (2013).

Sleep. To assess sleep, parents were asked "During the past week, how many hours of sleep did this child get on an average weeknight?". Potential responses included "less than 6 h", "6 h", "7 h", "8 h", "9 h", "10 h", and "11 or more hours." Responses of 9 or more hours for children (aged 6 to 12) and 8 or more hours for adolescents (aged 13 to

17) were coded as "meeting sleep guidelines", and all other responses were coded as "not meeting sleep guidelines", in accordance with recommendations from American Academy of Sleep Medicine (Paruthi et al., 2016).

Covariates. Family income, parental education, and adverse childhood experiences were included as covariates for this analysis, as they are potentially related to anxiety and depression prevalence. Specifically, the combined pre-tax family income in the calendar year of 2015 for all members of the family was used as family income. Parent education was recorded as the highest grade or year of school completed by the parent. Parents reported on adverse childhood experiences, including whether the child has ever experienced the following: (1) parent/guardian divorce or separation, (2) Parent/guardian death, (3) serving time in jail, (4) physical fights in the home, and (5) whether the child was a victim/witness of violence, (6) lived with anyone who was mentally ill or (7) had problem with drugs, and (8) whether the child was ever unfairly treated/judged because of his/her racial background.

2.3. Data analysis

The data analyses contained two steps. First, a frequency table was created to present demographics of the participant, history of diagnosed anxiety, depression, the behavioral variables among the children, and the frequency of children meeting none, one, two or three 24-h movement guidelines, by age group (6-11 year-olds and 12-17 year-olds). Then, separate logistic regression analyses were conducted to estimate the adjusted odds ratio of anxiety problems and depression for both age groups. The logistic regression analyses were adjusted for parental education, family income, and the eight adverse childhood experiences listed earlier. To take into account the sampling plan of NSCH, the data analyses were conducted using the Complex Samples module of SPSS (Ver. 25, IBM; Armonk, NY), with an overall $p < 0.05$ for statistical significance tests.

3. Results

In total, this analysis included 15,010 children aged 6–11 years and 20,708 adolescents aged 12–17 years. Based on the 2016 NSCH data, 7.6% (95%CI: 6.6%–8.6%) of 6–11 year-old children had a diagnosis of anxiety, and 2.1% (95% CI: 1.7%–2.6%) had a diagnosis of depression. Among adolescents aged 12-17 years-old, 12.4% (95%CI: 11.5%–13.3%) had anxiety, and 8.2% (95%CI: 7.4%–9.0%) had depression. Overall, there were 20.9% of children aged 6–11 years old, and 24.9% of 12–17 years old meeting none of the three 24-h movement guidelines. There were 7.2% of children age 6–11 years old, and 2.0% of 12–17 years old meeting all three of the 24-h movement guidelines. The participants' demographic information, level of participation in extracurricular activities, physical activity, screen-time viewing, and weeknight sleep are detailed in Table 1. The detailed percentage of participants meeting 24-h guidelines are presented in Table 1 and Fig. 1 for both age groups.

Table 2 summarized the estimated ORs for anxiety problems. For children, controlling for parental education, family income, and adverse childhood experiences, physical activity participation and race were significantly associated with anxiety. Children who had 0 days/week of physical activity had an OR of 2.19 (95% CI: 0.97–4.96) for anxiety problems, compared to their peers who had daily physical activity of 60 min or more. No significant difference was found between the ORs for anxiety problems for children who had at least 60 min of daily physical activity and those with 60 min of physical activity on 1–3 days/week or 4–6 days/week. Among the racial/ethnic groups, Asian and Black children had significantly lower ORs of anxiety problems than Hispanic, White, and other ethnics groups. For adolescents, physical activity participation, extracurricular activity participation, and race/ethnicity were associate with anxiety. Adolescents who had 0

Table 1
Demographic characteristics of 2016 national survey of Children's health for 6–17 years old.

|	6–11 years old	12–17 years old
Sample size, no.	15,010	20,708
Anxiety (%, 95%CI)		
Diagnosed having anxiety	7.6% (6.6–8.6%)	12.4% (11.5–13.3%)
No history	92.4% (91.4–93.4%)	87.6% (86.7–88.5%)
Depression (%, 95%CI)		
Diagnosed having depression	2.1% (1.7–2.6%)	8.2% (7.4–9.0%)
No history	97.9% (97.4–98.3%)	91.8% (91.0–92.6%)
Age (y), mean (SD)	8.50 (1.70)	14.51 (1.70)
Sex: Girls (%, 95%CI)	49.0% (47.2–50.8%)	48.9% (47.4–50.5%)
Ethnicity (%, 95%CI)		
Asian	4.2% (2.9–5.9%)	4.1% (3.4–4.8%)
Black	11.4% (9.4–13.8%)	12.6% (11.4–13.9%)
Hispanic	26.1% (22.7–29.8%)	23.1% (21.2–25.0%)
White, non-Hispanic	52.4% (49.1–55.6%)	54.8% (53.1–56.5%)
Others/multiracial	5.9% (4.9–7.2%)	5.5% (4.9–6.1%)
Weight status (%, 95%CI)		
Underweight	8.6% (6.9–10.6%)	5.4% (4.8–6.2%)
Healthy weight	56.4% (53.1–59.7%)	64.4% (62.7–66.1%)
Overweight/obese	35.0% (31.7–38.3%)	30.2% (28.6–31.8%)
Extracurricular activity (%, 95%CI)		
One or more activities	83.6% (80.7–86.2%)	83.1% (81.7–84.5%)
No participation	16.4% (13.8–19.3%)	16.9% (15.5–18.3%)
Physical activity ≥ 60 min/day (%, 95%CI)		
0 day/week	5.3% (3.9–7.1%)	12.7% (11.6–13.9%)
1–3 days/week	39.2% (36.1–42.5%)	40.7% (39.0–42.4%)
4–6 days/week	31.0% (28.2–34.0%)	28.4% (27.0–29.9%)
Every day (meet guideline)	24.5% (21.8–27.3%)	18.2% (16.8–19.6%)
Average weeknight sleep (%, 95%CI)		
Meet age-appropriate hours	61.7% (58.6–64.7%)	66.5% (64.8–68.1%)
Below age-appropriate hours	38.3% (35.3–41.4%)	33.5% (31.9–35.2%)
Weekday screen-time viewing (%, 95%CI)		
2 h or more/day	77.6% (74.6–80.4%)	88.9% (87.8–89.9%)
Less than 2 h/day (meet guideline)	22.4% (19.6–25.4%)	11.1% (10.1–12.2%)
24-h movement guideline (%, 95%CI)		
Meet none of the guidelines	20.9% (19.4–22.5%)	24.9% (23.6–26.3%)
Meet 1 of the guidelines	42.7% (40.9–44.6%)	56.3% (54.7–57.8%)
Meet 2 of the guidelines	29.2% (27.5–30.8%)	16.8% (15.7–18.0%)
Meet all 3 of the guidelines	7.2% (6.4–8.1%)	2.0% (1.6–2.3%)

CI: confidence interval; SD: Standard deviation.
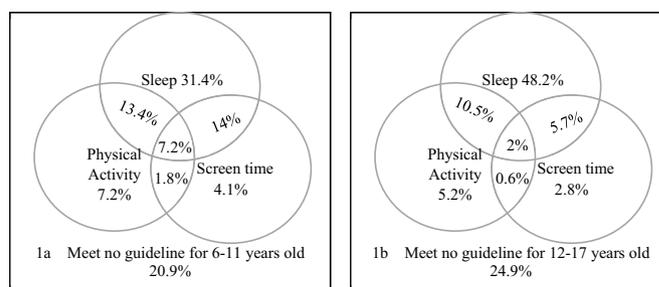
Fig. 1. Percentage of participants meeting 24-hour movement guidelines.

days/week of physical activity had an OR of 2.25 (95%CI: 1.53–3.33) for anxiety problems, compared to their peers who had daily physical activity of 60 min or more. Among adolescents, those who had no extracurricular activity had a higher OR for anxiety problems than those participating in one or more extracurricular activity (OR = 1.69, 95%CI: 1.33–2.16). White participants had the highest OR for anxiety problems among adolescents (OR = 1.51, 95%CI: 1.09–2.08). In general, meeting all three 24-h guidelines was associated with lower OR for anxiety; however, the ORs were significantly higher among those meeting no guideline for adolescents (OR = 2.12, 95%CI: 1.15–3.92), and meeting physical activity and screen time guidelines for children (OR = 4.36, 95%CI: 0.99–19.26).

Table 2
Estimates of anxiety from 2016 national survey of Children's health for 6–17 years old.

	Adjusted Odds Ratio (95% CI)	
Anxiety	6–11 years old	12–17 years old
Sex		
Boys	1.28 (0.88–1.87)	0.73 (0.61–0.88)
Girls	1 (referent)	1 (referent)
Ethnicity		
Asian	0.11 (0.03–0.43)*	0.39 (0.22–0.69)*
Black	0.41 (0.16–1.07)	0.52 (0.33–0.81)*
Hispanic	1 (referent)	1 (referent)
White, non-Hispanic	0.93 (0.50–1.72)	1.51 (1.09–2.08)*
Others/multiracial	0.90 (0.39–2.09)	0.93 (0.60–1.43)
Weight status		
Underweight	0.75 (0.41–1.37)	0.87 (0.52–1.46)
Healthy weight	1 (referent)	1 (referent)
Overweight/obese	1.27 (0.81–1.98)	1.24 (0.99–1.53)
Extracurricular activity		
One or more activities	1 (referent)	1 (referent)
No participation	0.90 (0.48–1.67)	1.69 (1.33–2.16)*
Physical activity ≥ 60 min/day		
0 day/week	2.19 (0.97–4.96)	2.25 (1.53–3.33)*
1–3 days/week	1.46 (0.88–2.43)	1.24 (0.89–1.74)
4–6 days/week	0.64 (0.38–1.06)	0.94 (0.65–1.35)
Everyday	1 (referent)	1 (referent)
Average weeknight sleep		
Meet age-appropriate hours	1 (referent)	1 (referent)
Below age-appropriate hours	0.98 (0.58–1.64)	1.26 (1.03–1.53)
Weekday screen-time viewing		
Less than 2 h/day	1 (referent)	1 (referent)
2 h or more/day	0.98 (0.58–1.64)	1.20 (0.86–1.67)
24-h movement guideline		
Meet none of the guidelines	1.79 (0.72–4.47)	2.12 (1.15–3.92)*
Meet screen time guideline alone	0.82 (0.28–2.38)	1.29 (0.57–2.93)
Meet sleep guideline alone	1.44 (0.59–3.55)	1.71 (0.94–3.13)
Meet screen time, sleep guidelines	1.53 (0.50–4.73)	1.34 (0.65–2.75)
Meet physical activity guideline alone	1.75 (0.54–5.69)	1.77 (0.78–4.02)
Meet physical activity, screen time guidelines	4.36 (0.99–19.26)*	3.92 (0.88–17.56)
Meet physical activity, sleep guidelines	0.99 (0.36–2.74)	1.20 (0.59–2.46)
Meet all three guidelines	1 (referent)	1 (referent)

*Odds ratio was statistically significant different from the referent adjusted for parental education, family income, and adverse childhood experience (*p* < 0.05).

Table 3
Estimates of depression from 2016 national survey of Children's health for 6–17 years old.

	Adjusted Odds Ratio (95% CI)	
Depression	6–11 years old	12–17 years old
Sex		
Boys	1.23 (0.62–2.44)	0.65 (0.51–0.83)*
Girls	1 (referent)	1 (referent)
Ethnicity		
Asian	0.03 (0.00–0.24)*	0.46 (0.23–0.93)*
Black	1.23 (0.38–4.04)	0.81 (0.48–1.38)
Hispanic	1 (referent)	1 (referent)
White, non-Hispanic	1.51 (0.58–3.93)	1.46 (0.97–2.20)
Others/multiracial	3.95 (1.42–10.96)*	1.18 (0.68–2.05)
Weight status		
Underweight	0.61 (0.23–1.64)	1.17 (0.58–2.35)
Healthy weight	1 (referent)	1 (referent)
Overweight/obese	2.43 (1.25–4.75)*	1.32 (1.01–1.72)*
Extracurricular activity		
One or more activities	1 (referent)	1 (referent)
No participation	0.75 (0.35–1.46)	2.10 (1.58–2.80)*
Physical activity ≥ 60 min/day		
0 day/week	0.65 (0.23–1.88)	2.18 (1.30–3.64)*
1–3 days/week	0.93 (0.43–2.02)	1.08 (0.69–1.70)
4–6 days/week	0.49 (0.22–1.11)	0.79 (0.49–1.28)
Everyday	1 (referent)	1 (referent)
Average weeknight sleep		
Meet age-appropriate hours	1 (referent)	1 (referent)
Below age-appropriate hours	1.98 (1.05–3.75)*	1.32 (1.03–1.69)*
Weekday screen-time viewing		
Less than 2 h/day	1 (referent)	1 (referent)
2 h or more/day	0.97 (0.50–1.90)	1.19 (0.75–1.89)
24-h movement guideline		
Meet none of the guidelines	0.66 (0.17–2.53)	9.86 (3.09–31.51)*
Meet screen time guideline alone	0.13 (0.02–0.73)*	7.31 (2.06–25.90)*
Meet sleep guideline alone	0.37 (0.10–1.37)	7.97 (2.53–25.09)*
Meet screen time, sleep guidelines	0.14 (0.03–0.64)*	5.70 (1.62–20.10)*
Meet physical activity guideline alone	0.78 (0.17–3.47)	8.91 (2.42–32.85)*
Meet physical activity, screen time guidelines	2.80 (0.46–16.96)	37.14 (6.02–229.00)*
Meet physical activity, sleep guidelines	0.11 (0.02–0.76)*	6.43 (1.80–23.01)*
Meet all three guidelines	1 (referent)	1 (referent)

*Odds ratio was statistically significant different from the referent adjusted for parental education, family income, and adverse childhood experience (*p* < 0.05).

The estimated ORs for depression are presented in Table 3, adjusting for participants' parent education, family income, and adverse childhood experiences. Participants who reported average weeknight sleep below age-appropriate hours had higher ORs for depression than those meeting age-appropriate hours, among both children (OR = 1.98, 95%CI: 1.05–3.75), and adolescents (OR = 1.32, 95%CI: 1.03–1.69). Overweight/obese participants were more likely to have depression than those who were normal weight and underweight for both children (OR = 2.43, 95%CI: 1.25–4.75) and adolescents (OR = 1.32, 95%CI: 1.01–1.72). For adolescents, those with no extracurricular (OR = 2.10, 95%CI: 1.58–2.80) or physical activity participation (OR = 2.18, 95%CI: 1.30–3.64) had significantly higher ORs for depression than those who had at least one extracurricular activity and those who had at least one day or more of 60 min physical activity per week. Boys had a lower depression OR estimate (OR = 0.65, 95%CI: 0.51–0.83) than girls among adolescents. Meeting all three 24-h guideline was associated with significantly lower OR for depression among adolescents than meeting none, one, or a combination of two guidelines among adolescents. For children, however, meeting screen-time viewing alone, and a combination of screen time and sleep, as well as a combination of physical activity and sleep guidelines, was associated with significantly lower ORs for depression than meeting none or all three guidelines (Table 3).

4. Discussion

The purpose of this cross-sectional study was to examine associations between lifestyle-related behavioral variables including physical activity, screen-time viewing, and sleep duration with anxiety and depression among a nationally representative cohort of children (aged 6–11) and adolescents (aged 12–17) years in the US. Overall, among children and adolescents in the current study, rates of anxiety (7.6% and 12.4%, respectively) and depression (2.1% and 8.2%, respectively) appear higher than those reported by Ghandour et al. (2019) who identified that 7.1% of US youth (aged 3 to 17) had a current diagnosis of anxiety and 3.2% had a diagnosis of depression using NSCH data. These differences may be partially explained by the utilization of a different analysis technique, in that Ghandour et al. (2019) analyzed participants as one large group (3–17 years old) while we analyzed two age groups (6–11 and 12–17 years old) separately. Our prevalence estimates for depression are in alignment with Mojtabai et al.'s (2016) report for adolescents (8.7–11.3%), which used a dataset from National Survey on Drug Use and Health.

In this analysis, engagement in physical activity and extracurricular activities appeared to be significant behavioral correlates of anxiety and depression. Notably, children and adolescents who engaged in no days

of physical activity had significantly greater odds of having an anxiety diagnosis than those who met the physical activity guideline of daily engagement in physical activity. Likewise, a lack of participation in any physical activity or extracurricular activities was associated with a greater likelihood of depression for adolescents, compared to those who engaged daily in these behaviors. These findings reflect previous research that highlights the importance of frequent physical activity engagement and sport participation for decreasing the odds of experiencing anxiety and depression symptoms (Kleppang et al., 2018; Korczak et al., 2017; McMahon et al., 2017). A unique finding regarding physical activity is the assertion that even some physical activity engagement, that is less than meeting typically daily physical activity guidelines, can decrease the likelihood of anxiety and depression. Thus, while meeting daily physical activity guidelines are commonly associated with health-related and psychological well-being indices (Carson, Chaput, Janssen, & Tremblay, 2017), engaging in even occasional physical activity might be important to reduce the likelihood of anxiety and depression for adolescents. In other words, some physical activity, although not daily or longer than 60 min, is better than none for mental health outcomes in this population.

Conversely, screen-time engagement was not significantly associated with higher odds of anxiety or depression among this sample. This finding conflicts with some previous research conducted on large samples in other countries, such as Canada (Maras et al., 2015), which found that screen-time duration was associated with anxiety ($\beta = 0.07$) and depression ($\beta = 0.23$) scores. However, the relationship between screen-time and anxiety and depression remains ambiguous as some studies separated different types of screen-time viewing behaviors (Maras et al., 2015), and others did not (Gunnell et al., 2016). Specifically, when the screen-time viewing was separated into computer usage, TV viewing, and video game playing, research found that video game playing was associated with anxiety and depressive symptoms but TV viewing was not (Maras et al., 2015). Results were also mixed regarding sleep duration in this study; whereas no significant associations were found between sleep and anxiety, significant negative associations were found between sleep duration and the likelihood of having a diagnosis of depression, for children and adolescents. This finding was generally consistent with previous reports for adolescents where its interaction with physical activity behavior has been reported as well (Ogawa et al., 2018).

When the data were examined using the 24-h movement guidelines, the findings showed that for anxiety for children and adolescents, and for depression among adolescents, meeting all three guidelines was associated with lower ORs. For 12–17 years old adolescents, while meeting all three 24-h guidelines was associated with lower ORs for anxiety and depression, we did not find a dose-response pattern between the number of guidelines met and ORs for anxiety or depression. This finding conflicts with a recent report among a similar aged population in Canada (Janssen et al., 2017), where a dose-response pattern was reported. Two possible reasons are noted. First, the mental health variables were operationalized differently, as Janssen et al. (2017) used emotional problems as a proxy for mental health while this study looked at two specific mental health disorders. Additionally, the eight combinations of meeting 24-h guidelines broke the data into a larger number of groups of small size, thus increased the estimation error and widened the confidence intervals, decreasing the statistical power to detect statistical significance in our analyses. For 6–11 years old children, meeting physical activity and sleep guidelines was associated with a significantly higher OR for anxiety than those meeting all three, which was inconsistent with the literature (Feng et al., 2014; Janssen et al., 2017; Walsh et al., 2018) where the findings of meeting those two guidelines were generally positive or non-negative for mental health. Similarly, for this age group, children meeting one (e.g., screen time) or a certain combination of two guidelines (e.g., screen time and physical activity) was associated with lower ORs for depression than those meeting all three, different from the existing findings (Feng et al., 2014; Janssen et al., 2017). More research is needed to further examine

the relationship among these variables in this age group.

When examining the relationships between targeted health-enhancing behaviors and anxiety and depression, it is important to consider the possibility of relationships being bi-directional. As noted by Gunnell et al. (2016), while increasing health-enhancing behaviors may alleviate or prevent symptoms of mental health disorders, mental health disorders may also lead to disengagement in health-enhancing behaviors. For example, when analyzing data from 1160 Canadian adolescents, Gunnell et al. (2016) noted that although screen-time engagement did not predict future anxiety or depression, higher initial symptoms of both anxiety and depression independently predicted future increases in screen-time viewing. Thus, it is feasible to suggest that although screen-time viewing behaviors and sleep findings were mixed in this analysis, bi-directional relationships where anxiety and depression influence health-enhancing behaviors may exist. The cross-sectional nature of this study could not afford us the opportunity to explore the possible relationships bi-directionally.

Findings should be interpreted considering certain limitations. First, anxiety and depression variables included in this analysis were reliant on parent-reports of being told by a health care provider that their child had the specified condition. This data may be prone to recall bias, whereby the parent may have inaccurately remembered the child receiving a diagnosis, or the frequency at which they engage in a certain behavior (Bitsko et al., 2018). Additionally, the cross-sectional nature of study and relatively low response rate are limitations of the study. The lack of validity and reliability information for measures of physical activity, sleep, and screen time viewing in NSCH should also be noted as a limitation. Furthermore, social desirability bias may influence the results, whereby parents may be hesitant to report levels of lifestyle-related behaviors or mental health diagnoses that may appear unfavorable (Weden et al., 2013). However, the effects of social desirability may be reduced due to the large number of questions being asked during data collection. Parents were also asked about "anxiety problems" rather than "anxiety disorder", which may inflate figures, whereas the requirement that parents heard this from a health care provider may reduce figures (Bitsko et al., 2018).

Mental health disorders, such as anxiety and depression, are a major public health concern among children and adolescents (Ghandour et al., 2019). Fortunately, and consistent with previous research (Gunnell et al., 2016; Kleppang et al., 2018), adherence to guidelines for physical activity and sleep are consistently associated with anxiety and depression in this study. More specifically, engaging in no days of physical activity or no organized extracurricular activities significantly increased the likelihood of experiencing anxiety among children and adolescents, and depression among adolescents. Likewise, meeting sleep recommendations was associated with lower odds of depression diagnoses among both children and adolescents. Meeting screen-time viewing recommendations was not associated with either anxiety of depression diagnoses among participants in this analysis. While in most cases meeting all three 24-h movement guideline was desirable, it was not the case for depression among 6–11 years old children. In line with previous research examining health-related and psychosocial benefits of these volitional, lifestyle-related health behaviors, it appears that children and adolescents in the US can experience benefits related to anxiety and depression from targeted interventions aimed at increasing physical activity, organized extracurricular activity, and enhancing sleep duration.

Conflict of interest statement

The authors declare no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.mhpa.2019.04.002.

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