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Associations of Physical Activity and Sedentary Behavior with Internalizing Problems among Youth with Chronic Pain

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ABSTRACT: Background: Taking actions to maintain a healthy lifestyle, including regular engagement in physical activity (PA) and reducing sedentary behavior (SB), may protect against the development of internalizing problems among healthy youth. However, it remains unclear whether such associations exist among youth with chronic pain who often report symptoms of depression and anxiety. To this end, we aimed to investigate the associations between independent and combined PA and/or SB patterns with indicators of internalizing problems in this vulnerable population. **Methods:** Data used in this cross-sectional study were retrieved from the U.S. National Survey of Children's Health for the years 2021–2022. Specifically, caregiver proxy reports on sociodemographic factors and lifestyle behaviors of 4735 U.S. children and adolescents (referring to youth) aged 6–17 years were collected. We examined independent and combined patterns of PA and SB as exposures, with internalizing problems serving as outcomes of interest. Logistic regressions were used to examine the independent and combined associations of PA and/or SB patterns with anxiety and depression symptoms among youth with chronic pain while adjusting for covariates including age, sex, ethnicity, primary caregivers' education level, overweight status, and household federal poverty level. **Results:** Overall, our results indicated that PA was negatively associated with anxiety and depressive symptoms. Specifically, youth with chronic pain who engaged in at least 60-minute PA for 1–3 days, 4–6 days, or every day reported significantly lower likelihood of experiencing symptoms of anxiety (OR = 0.71, 95% CI: 0.60–0.84; OR = 0.44, 95% CI: 0.36–0.53; OR = 0.50, 95% CI: 0.40–0.63, respectively; all p -value < 0.001) and depression (OR = 0.63, 95% CI: 0.53–0.75; OR = 0.38, 95% CI: 0.31–0.47; OR = 0.46, 95% CI: 0.36–0.59, respectively; all p -value < 0.001) symptoms compared to those with 0 days. Conversely, SB (operationalized via the proxy screen time) was positively associated with anxiety and depression symptoms. Youth with chronic pain who reported 4 or more hours of daily screen time had significantly higher odds of experiencing symptoms of anxiety (OR = 2.17, 95% CI: 1.52–3.09, p < 0.001) and depression (OR = 2.30, 95% CI: 1.48–3.59, p < 0.001). Furthermore, youth with chronic pain who engaged in higher PA levels and reported lower SB levels had a lower likelihood of experiencing symptoms of anxiety (OR = 0.68, 95% CI: 0.52–0.87, p = 0.003) and depression (OR = 0.49, 95% CI: 0.34–0.70, p < 0.001) symptoms compared to those with lower PA levels and higher SB levels. **Conclusions:** Higher PA levels and lower SB levels were associated with a reduced likelihood of developing anxiety and depression symptoms, which are indicative of internalizing problems, among youth with chronic pain. Future public health actions in this vulnerable population should prioritize intervention programs that promote PA engagement to reduce SB levels.



KEYWORDS: Physical activity; screen time; depression; anxiety; physical pain

1 Introduction

Chronic pain is defined as an ongoing unpleasant sensory and emotional experience lasting 3 months or more months, typically associated with or caused by muscle-related injuries [1,2]. Chronic pain such as back pain and headache, is a common health condition among various age groups, including but not limited to children and adolescents (referred to in the rest of this manuscript as “youth”) which affects physical, psychological, and social function [3–5]. It is estimated that worldwide ~21% of youth experience chronic pain, with headache and musculoskeletal (e.g., back or body) pain accounting for most cases [6]. Furthermore, accumulating evidence suggests that in youth anxiety and depressive symptoms (commonly referred to as internalizing problems), often occur concomitantly with chronic pain [7].

Such comorbidities or co-existing health issues may be linked to an increased likelihood of functional limitations in daily life [8]. Previous studies have shown that youth with chronic pain are more susceptible to developing internalizing problems [9], and these issues may persist into adulthood if left untreated [10]. A recent seminal meta-analytical review containing 79 studies (pooled sample size = 12,614 youth with chronic pain) indicated that the overall prevalence of anxiety and depression had reached ~35% and ~12%, respectively [11]. Furthermore, youth with chronic pain were observed to be 3 times more likely to report anxiety and depressive symptoms relative to healthy controls [11]. Against this background, it is critical to deepen an understanding of the factors that influence internalizing problems in this vulnerable population, especially concerning the role of modifiable lifestyle factors such as physical activity (PA) and sedentary behaviors (SB) [12].

Regular engagement in PA may have the potential to protect against the development of anxiety and depressive symptoms in youth [13–17]. For example, a meta-analysis conducted by Schuch and colleagues including 49 prospective studies (N = 266,939) indicated that higher levels of PA can protect against the development of depression in youths (adjusted OR = 0.90) [18]. Furthermore, recent reviews also provide evidence that PA intervention programs as an alternative or adjunct treatment for anxiety and depressive symptoms can effectively alleviate internalizing problems in youths [16,19,20]. In contrast, SB is defined as any waking behaviors (e.g., sitting, reclining, or lying posture) with an energy expenditure that has reached at least 1.5 metabolic equivalents [21] and has attracted great attention from the research community due to its close relation to a variety of health outcomes including indicators of internalizing problems [22–26]. Previous studies in youth showed negative associations of SB (indicated by proxy via screen-based activities) with indicators of internalizing problems (e.g., increased risk of developing anxiety and depressive symptoms) [27–30]. Notably, the associations of PA and/or screen-based SB with indicators of internalizing problems have rarely been investigated among youth with chronic pain.

The findings of a previous study suggest that individuals with knee osteoarthritis (noted musculoskeletal disorder) were more likely to report catastrophizing thinking which increased the likelihood of physical inactivity and SB [31]. Thus, chronic pain, to some extent, seems to be more likely to limit PA engagement [32], and this may exacerbate anxiety and depressive symptoms in youth [33,34]. PA and SB are two independent but interrelated lifestyle behaviors [35]. However, there is limited evidence regarding how PA and SB jointly contribute to internalizing problems in youth with chronic pain. Such an outstanding research question may preclude researchers and health professionals from making nuanced and evidence-based recommendations for this vulnerable population concerning the potential benefits of PA for mental health. To address this research gap, it is essential to investigate the associations of PA and SB with indicators of internalizing problems among youth with chronic pain. Thus, this study aimed to investigate the associations of PA

and SB with depression and anxiety among youth with chronic pain. Given that accumulating evidence indicates the beneficial association of PA with depression and/or anxiety among youth with different health conditions [36], while its associations with SB are less clear due to mixed findings in previous studies, we investigated both associations between independent and combined PA and SB patterns with indicators of internalizing problems among youth with chronic pain.

2 Methods

2.1 Study Design and Participants

Similar to previous research [12], in this cross-sectional study, publicly accessible data from the 2021–2022 National Survey of Children’s Health (NSCH) (<https://www.childhealthdata.org/>) (accessed on 15 January 2025) was used. The original data was collected using web- or paper-based surveys querying parents or primary caregivers of children aged between 0–17 years who were randomly selected from households across all 50 U.S. states and the District of Columbia between 2021 and 2022. A total of 104,995 complete responses were received in the NSCH survey. Ethical approval for this survey was granted by the U.S. Department of Health and Human Services.

Considering that caregivers of children aged 0–5 years were not surveyed about school safety and related outcomes, this analysis focuses on children and adolescents aged 6–17 years who experience chronic pain. The eligibility of children and adolescents was determined via the following single-item question responded to by either a parent or primary caregiver: “Does this child have any repeated or chronic pain, including headaches or other back or body pain?”, with a binary response (Yes vs. No). Only children and adolescents for whom their parents or primary caregivers responded with “yes” were deemed eligible for inclusion in this study.

2.2 Measures

2.2.1 Assessment of Movement Behaviors

Consistent with previous research [37], PA and SB were assessed via self-reports. More specifically, PA was assessed by querying the parents or primary caregivers with the following question: “During the past week, on how many days did this child exercise, play a sport, or participate in physical activity for at least 60 minute?” This single-item question was answered with 4 options (e.g., 0 days, 1–3 days, 4–6 days, or every day). SB was assessed using the following question: “On most weekdays, about how much time did this child usually spend in front of a TV, computer, cell phone, or other electronic device watching programs, playing video games, accessing the internet, or using social media, not including schoolwork?” Response options were less than 1 h a day, 1 h a day, 2 h a day, 3 h a day, and 4 or more hours a day.

As per PA and SB guidelines, only youth who were physically active every day of the week were classified as being “active” (being coded as 1 vs. 0 = failed to meet PA guidelines) [38]. Less than 1 h a day, 1 h a day and 2 h a day were considered “sedentary” (coded as 1 vs. 0 = failed to meet SB guidelines) [39]. Youth who met the combined PA + SB guidelines were coded as 1 (vs. 0 = failed to meet the combined guidelines) [38].

2.2.2 Assessment of Internalizing Problems

As in previous studies [39,40], depressive symptoms were assessed by the following question: “Has a doctor or other healthcare provider ever told you that your child has depression?” Answers included: 1 (do not have the condition), 2 (ever told, but no current condition), and 3 (currently have the condition). For our analysis, depression was coded as 1 when the parents or primary caregivers responded that their child “currently has the condition”. Anxiety was assessed by asking parents: “Has a doctor or other healthcare

provider ever told you that your child has anxiety problems?” Answers included: 1 (do not have the condition), 2 (ever told, but no current condition), and 3 (currently have the condition). Anxiety was coded as 1 when a response was “currently has the condition”. Higher scores reflect greater levels of anxiety and/or depression, respectively.

2.2.3 Covariates

Based on a previous study [40], we considered age (younger group = 6–13 years old *vs.* Older group = 14–17 years old), sex (male *vs.* female), ethnicity (Hispanic, white, black, Asian, and other/multi-racial), education level of primary caregivers (less than high school, high school degree or General Educational Development (GED), some college or technical school, and college degree or higher), overweight status (yes *vs.* no), and household federal poverty level (FPL) (0%–199% FPL, 200%–299% FPL, 300%–399% FPL, and 400% FPL or greater) as covariates.

2.3 Statistical Analysis

The statistical analysis was performed using Stata software (StataCorp (2017). Stata Statistical Software: Release 15. StataCorp LLC, 2017). Regarding descriptive statistics, categorical variables were provided as percentages, while continuous variables were provided as means with standard deviations (SDs). Logistic regression models were used to assess the relationships between movement behaviors (PA and/or SB) and internalizing problems (i.e., depression and anxiety), adjusting for age, sex, ethnicity, primary caregivers’ education level, overweight status, and household FPL. A *p*-value of less than 0.05 was considered statistically significant.

3 Results

Table 1 presents the descriptive characteristics of the sample. This study included 4735 youth who have chronic pain with a mean age of 13.31 (± 3.31) years. Among these participants, 42.96% were male. The majority of the sample were White (65.13%) and reported a household income level of 400% FPL or greater (32.44%). Additionally, more than half of the primary caregivers had a college degree or higher education level (52.52%). Around one-fifth (17.23%) of youth were categorized as overweight. In terms of mental health, 28.32% of youth reported symptoms of depression, and 44.29% were reported to have anxiety. PA levels varied with 18.51% of the sample did not engage in PA, whereas 13.56% engaged in PA every day. Screen time as a proxy of SB was high in this cohort, with 41.98% of participants spending four or more hours on screen time per day.

Table 1: Characteristics of the sample (N = 4735)

Variable	Category	Mean/Frequency	Percentage (%)
Age		13.31 \pm 3.31	
	6–13 years old	2061	43.53
	14–17 years old	2674	56.47
Sex	Male	2034	42.96
	Female	2701	57.04
Ethnicity	Hispanic	767	16.20
	White	3084	65.13

(Continued)

Table 1 (continued)

Variable	Category	Mean/Frequency	Percentage (%)
Household income level	Black	325	6.86
	Asian	141	2.98
	Other/multi-racial	418	8.83
	0%–199% FPL	849	17.93
	200%–299% FPL	976	20.61
	300%–399% FPL	1374	29.02
	400% FPL or greater	1536	32.44
Education level of primary caregivers	Less than high school	171	3.61
	High school degree or GED	758	16.01
	Some college or technical school	1319	27.86
	College degree or higher	2487	52.52
Overweight status	No	3919	82.77
	Yes	816	17.23
Depression	No	3394	71.68
	Yes	1341	28.32
Anxiety	No	2638	55.71
	Yes	2097	44.29
Physical activity	0 days	868	18.51
	1–3 days	2044	43.58
	4–6 days	1142	24.35
	Every day	636	13.56
Screen time	Less than 1 h	169	3.62
	1 h	391	8.37
	2 h	1033	22.10
	3 h	1119	23.94
	4 or more hours	1962	41.98

Note: FPL, federal poverty level; GED, General Educational Development.

3.1 Associations between Physical Activity and Internalizing Problems

As shown in [Table 2](#), negative associations between PA and internalizing problems are observed (all $OR < 1$). Compared with youth who did not engage in PA, those who engaged in at least 60-minute PA for 1–3 days, 4–6 days, or every day had a significantly lower likelihood of experiencing symptoms of anxiety ($OR = 0.71$, 95% CI: 0.60–0.84; $OR = 0.44$, 95% CI: 0.36–0.53; $OR = 0.50$, 95% CI: 0.40–0.63, respectively; all p -value < 0.001). Additionally, youth who engaged in at least 60-minute PA on 1–3 days, 4–6 days, or every day

showed a significantly lower likelihood of reporting symptoms of depression (OR = 0.63, 95% CI: 0.53–0.75; OR = 0.38, 95% CI: 0.31–0.47; OR = 0.46, 95% CI: 0.36–0.59, respectively; all p -value < 0.001).

Table 2: Associations between physical activity (PA) and internalizing problems

	Anxiety		Depression	
	OR (95% CI)	p -value	OR (95% CI)	p -value
Age				
6–13 years old	1 (reference)		1 (reference)	
14–17 years old	1.60 (1.41, 1.80)	<0.001***	2.90 (2.50, 3.36)	<0.001***
Sex				
Male	1 (reference)		1 (reference)	
Female	1.37 (1.21, 1.54)	<0.001***	1.43 (1.25, 1.65)	<0.001***
Ethnicity				
Hispanic	1 (reference)		1 (reference)	
White	1.45 (1.22, 1.72)	<0.001***	1.18 (0.97, 1.43)	0.092
Black	0.51 (0.38, 0.69)	<0.001***	0.65 (0.47, 0.90)	0.009**
Asian	0.46 (0.30, 0.70)	<0.001***	0.48 (0.29, 0.79)	0.004**
Other/Multi-racial	1.33 (1.03, 1.71)	0.027*	1.43 (1.08, 1.89)	0.012*
Household income level				
0%–199% FPL	1 (reference)		1 (reference)	
200%–299% FPL	0.94 (0.77, 1.14)	0.516	0.83 (0.67, 1.03)	0.091
300%–399% FPL	0.85 (0.70, 1.02)	0.086	0.82 (0.66, 1.01)	0.059
400% FPL or greater	0.71 (0.58, 0.87)	<0.001**	0.63 (0.50, 0.78)	<0.001***
Education level of primary caregivers				
Less than high school	1 (reference)		1 (reference)	
High school degree or GED	1.38 (0.95, 2.01)	0.088	1.12 (0.75, 1.66)	0.577
Some college or technical school	1.74 (1.21, 2.50)	0.003**	1.25 (0.85, 1.84)	0.251
College degree or higher	1.92 (1.33, 2.77)	<0.001***	1.14 (0.77, 1.69)	0.501
Overweight status				
No	1 (reference)		1 (reference)	
Yes	1.34 (1.14, 1.57)	<0.001***	1.75 (1.48, 2.07)	<0.001***
Physical activity				
0 days	1 (reference)		1 (reference)	
1–3 days	0.71 (0.60, 0.84)	<0.001***	0.63 (0.53, 0.75)	<0.001***
4–6 days	0.44 (0.36, 0.53)	<0.001***	0.38 (0.31, 0.47)	<0.001***
Every day	0.50 (0.40, 0.63)	<0.001***	0.46 (0.36, 0.59)	<0.001***

Note: OR = odds ratios; CI = confidence interval. * p < 0.05, ** p < 0.01, *** p < 0.001.

3.2 Associations between Sedentary Behavior and Internalizing Problems

Positive associations between SB and internalizing problems were observed (see Table 3). Youth who spend four or more hours on screen time per day had a significantly higher likelihood of experiencing anxiety (OR = 2.17, 95% CI: 1.52–3.09, p < 0.001) and depressive symptoms (OR = 2.30, 95% CI: 1.48–3.59, p < 0.001).

compared to those with less than one hour of screen time. Additionally, youth who spend three hours on screen time had a higher likelihood of reporting anxiety (OR = 1.62, 95% CI: 1.13–2.32, $p = 0.009$).

Table 3: Associations between sedentary behavior (SB) and internalizing problems

	Anxiety		Depression	
	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
Age				
6–13 years old	1 (reference)		1 (reference)	
14–17 years old	1.54 (1.36, 1.75)	<0.001***	2.72 (2.35, 3.16)	<0.001***
Sex				
Male	1 (reference)		1 (reference)	
Female	1.48 (1.31, 1.67)	<0.001***	1.55 (1.34, 1.78)	<0.001***
Ethnicity				
Hispanic	1 (reference)		1 (reference)	
White	1.43 (1.21, 1.70)	<0.001***	1.16 (0.96, 1.41)	0.129
Black	0.52 (0.39, 0.69)	<0.001***	0.62 (0.45, 0.86)	0.004**
Asian	0.46 (0.30, 0.70)	<0.001***	0.46 (0.28, 0.77)	0.003**
Other/Multi-racial	1.29 (1.00, 1.66)	0.047*	1.36 (1.03, 1.79)	0.029*
Household income level				
0%–199% FPL	1 (reference)		1 (reference)	
200%–299% FPL	0.95 (0.78, 1.16)	0.611	0.86 (0.69, 1.06)	0.157
300%–399% FPL	0.84 (0.70, 1.02)	0.076	0.80 (0.65, 0.99)	0.038*
400% FPL or greater	0.69 (0.56, 0.84)	<0.001***	0.59 (0.48, 0.74)	<0.001***
Education level of primary caregivers				
Less than high school	1 (reference)		1 (reference)	
High school degree or GED	1.26 (0.87, 1.83)	0.218	1.03 (0.69, 1.53)	0.876
Some college or technical school	1.58 (1.10, 2.28)	0.013*	1.16 (0.79, 1.71)	0.453
College degree or higher	1.79 (1.24, 2.58)	0.002**	1.08 (0.73, 1.60)	0.698
Overweight status				
No	1 (reference)		1 (reference)	
Yes	1.40 (1.19, 1.64)	<0.001***	1.81 (1.52, 2.14)	<0.001***
Sedentary behavior				
<1 h	1 (reference)		1 (reference)	
1 h	1.25 (0.84, 1.87)	0.270	0.87 (0.52, 1.46)	0.593
2 h	1.32 (0.92, 1.90)	0.132	1.23 (0.77, 1.94)	0.386
3 h	1.62 (1.13, 2.32)	0.009**	1.43 (0.91, 2.25)	0.126
4 or more hours	2.17 (1.52, 3.09)	<0.001***	2.30 (1.48, 3.59)	<0.001***

Note: OR = odds ratios; CI = confidence interval. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.3 Associations of Combined Movement Behaviors and Internalizing Problems

Results for the associations between meeting PA + SB guidelines and internalizing problems are presented in Table 4. Youth who met the combined PA + SB guidelines had significantly lower odds of experiencing anxiety and depressive symptoms relative to those youth who did not meet the combined

guidelines. Specifically, youth who met the PA + SB guidelines had 32% lower likelihood of reporting anxiety (OR = 0.68, 95% CI: 0.52–0.87, $p = 0.003$) and a 51% lower likelihood of reporting depressive symptoms (OR = 0.49, 95% CI: 0.34–0.70, $p < 0.001$) as compared to those who did not meet the combined recommendations on PA and SB.

Table 4: Associations of combined movement behaviors and internalizing problems

	Anxiety		Depression	
	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
Age				
6–13 years old	1 (reference)		1 (reference)	
14–17 years old	1.68 (1.48, 1.90)		3.00 (2.59, 3.47)	<0.001***
Sex				
Male	1 (reference)		1 (reference)	
Female	1.43 (1.27, 1.62)	<0.001***	1.50 (1.31, 1.73)	<0.001***
Ethnicity				
Hispanic	1 (reference)		1 (reference)	
White	1.39 (1.17, 1.65)	<0.001***	1.13 (0.93, 1.37)	0.222
Black	0.53 (0.40, 0.71)	<0.001***	0.65 (0.47, 0.90)	0.009**
Asian	0.45 (0.29, 0.69)	<0.001***	0.48 (0.29, 0.80)	0.005**
Other/Multi-racial	1.28 (0.99, 1.64)	0.056	1.35 (1.02, 1.78)	0.033*
Household income level				
0%–199% FPL	1 (reference)		1 (reference)	
200%–299% FPL	0.93 (0.76, 1.13)	0.449	0.83 (0.67, 1.03)	0.093
300%–399% FPL	0.84 (0.69, 1.01)	0.063	0.81 (0.66, 1.00)	0.048*
400% FPL or greater	0.68 (0.55, 0.83)	<0.001***	0.59 (0.47, 0.74)	<0.001***
Education level of primary caregivers				
Less than high school	1 (reference)		1 (reference)	
High school degree or GED	1.31 (0.90, 1.90)	0.158	1.06 (0.71, 1.58)	0.764
Some college or technical school	1.62 (1.13, 2.33)	0.009**	1.18 (0.80, 1.74)	0.399
College degree or higher	1.80 (1.25, 2.59)	0.002**	1.08 (0.73, 1.60)	0.689
Overweight status				
No	1 (reference)		1 (reference)	
Yes	1.43 (1.22, 1.67)	<0.001***	1.88 (1.59, 2.23)	<0.001***
PA + SB				
No	1 (reference)		1 (reference)	
Yes	0.68 (0.52, 0.87)	0.003**	0.49 (0.34, 0.70)	<0.001***

Note: PA, physical activity; SB, sedentary behavior; OR, odds ratios; CI, confidence interval. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4 Discussion

The present study investigated the independent and combined associations of PA and/or SB with internalizing problems (i.e., depressive symptoms and anxiety) among youth with chronic pain. Our findings

provide evidence that both more time spent on PA and less time spent on SB are associated with a lower likelihood of reporting symptoms of depression and anxiety in this vulnerable population.

In particular, our findings indicate that higher PA levels are associated with a reduced likelihood of reporting anxiety and depressive symptoms among youth with chronic pain. These findings align with previous research on children and adolescents suggesting that PA has a positive effect on internalizing problems [30,41]. More specifically, comparable to our study, PA was associated with a lower likelihood of developing symptoms of depression and anxiety, with stronger associations observed with higher PA [42]. These findings suggest a dose-response relationship in which higher PA may yield a greater mental health benefits. The positive effects of PA on mental health are likely to be mediated by complex neurobiological mechanisms [43] including but not limited to exercise-induced changes in endorphin release [44], the human dopaminergic system [45], peripheral brain-derived neurotrophic factor (BDNF) concentrations [46], and structural changes to brain regions associated with depression such as the hippocampus, and the prefrontal and anterior cingulate cortices [47]. Undertaking PA also offers opportunities for social interaction [48], which may serve as a protective factor against these mental health issues [48,49], especially in children and adolescents who are at a critical stage of social development [50,51]. Concerning SB, our results showing that more screen time (proxy of SB) is associated with a higher risk of developing symptoms of depression and anxiety. These findings align with those of previous studies that have reported prolonged screen time as a risk factor for internalizing problems in youth [13,52] potentially driven by mechanisms related to higher rates of inflammation [53] and a reduction in social interaction [54].

From an integrated perspective, youth with chronic pain who met the recommendations on PA + SB had a lower risk of experiencing depression and anxiety, suggesting an synergistic and positive effect. This aligns with findings from a previous study on youth with chronic pain, indicating that adherence to the combined (PA and SB) guidelines is associated with reduced severity of depressive symptoms [12]. Furthermore, our findings are partially supported by a previous meta-analysis [28] indicating that engaging in PA and reducing the time spent on SB may be beneficial for youth mental health. Collectively, our findings highlight the importance of addressing both movement behaviors in interventions aimed at improving mental health among youth with chronic pain. In particular, such interventions should not only target the PA promotion but also the reduction of time spent sedentary, particularly of screen-based SB which is prevalent in youth. Parents, caregivers, and schools can promote enjoyable (supportive) and convenient types of PA that accommodate the pain-related limitations of this vulnerable population. These strategies, in turn, may be effective in promoting overall mental health for youth with chronic pain.

Although the findings of this study add to the growing body of evidence documenting the positive influence of specific lifestyle patterns (i.e., high PA levels and low SB levels) on mental health in youth with chronic pain, it is important to acknowledge several limitations. Firstly, the cross-sectional design prevents testing whether the observed associations between these variables are causal. Thus, prospective and intervention studies are warranted to elucidate the underlying causal mechanisms of our observations. Second, the assessment of movement behaviors (e.g., PA and SB) relies on self-reported measures which could be influenced by recall bias and social desirability bias [55,56]. Thus, future studies should utilize objective assessment methods (e.g., accelerometers) to obtain more accurate data on PA and SB, thereby enhancing the reliability and robustness of the findings. Third, the survey did not consider the PA intensity that is differentially linked to mental health outcomes [57,58]. To address this limitation, future research should investigate whether the associations between PA and mental health among youth with chronic pain vary as a function of the PA intensity [59]. Fourth, although the NSCH survey question about chronic pain was specific to recurrent and chronic pain, the chronicity of pain was not evaluated, which requires further investigation with a longitudinal design. Fifth, the severity of symptoms of depression and anxiety was not

assessed, which has precluded us from concluding whether youth with a specific severity level are more responsive to the influence of lifestyle behaviors (e.g., PA and SB), especially whether youth with higher levels of depression and anxiety benefit to a greater extent from a healthier lifestyle (e.g., more PA and less SB) [60,61].

5 Conclusion

Our findings suggest that higher PA levels and lower SB levels are protective factors against the development of anxiety and depressive symptoms (i.e., indicators of internalizing problems) among youth with chronic physical pain. However, future interventional studies are required to investigate whether increasing regular PA levels and reducing SB levels can reduce the prevalence of depressive symptoms and anxiety among this vulnerable population.

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