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Reducing Depression and Anxiety in Children and Adolescents Facing Food Insecurity: The Joint and Independent Contributions of Movement Behaviors

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ABSTRACT: Backgrounds: Youth living in food-insecure households show greater vulnerability to psychiatric symptoms, including anxiety and depression. Although physical activity and sedentary behavior are established correlates of youth mental health, their associations within the context of food insecurity households remain understudied. This study examines how physical activity and sedentary behavior relate to depression and anxiety risk among children residing in food-insecure households. **Methods:** We analyzed data from the 2021–2022 National Survey of Children’s Health (NSCH), focusing on youth aged 6–17 years ($n = 2118$) living in food insecurity households. Multivariate logistic regression models adjusted for age, sex, race, parental education, family income, and overweight status were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for the link between physical activity and sedentary time and the risks of depression and anxiety. **Results:** Meeting physical activity guideline (≥ 60 min MVPA/day) was significantly associated with lower odds of both depression (OR = 0.63, 95% CI: 0.44–0.89, $p = 0.009$) and anxiety (OR = 0.60, 95% CI: 0.45–0.78, $p < 0.001$). Meeting sedentary behavior guideline showed a significant association with reduced odds of depression (OR = 0.56, 95% CI: 0.43–0.74, $p < 0.001$) and anxiety (OR = 0.78, 95% CI: 0.64–0.97, $p = 0.025$). Most notably, children who met both physical activity and sedentary behavior guidelines exhibited a significant reduction in depression (OR = 0.56, 95% CI: 0.33–0.94, $p = 0.027$) and anxiety (OR = 0.61, 95% CI: 0.43–0.87, $p = 0.009$) risk. **Conclusions:** The findings of this study reveal associations between meeting physical activity and sedentary behavior guidelines independently and jointly reduced risks of depression and anxiety, respectively. Future longitudinal cohort study should examine the prospective association of physical activity, sedentary behavior, and mental health among youth living in food-insecure households.

KEYWORDS: Movement behaviors; mental disorders; food insecurity; National Survey of Children’s Health (NSCH)

1 Introduction

Mental health disorders among children and adolescents have become a growing global public health crisis, characterized by a continuous rise in prevalence, and profound long-term impacts on individual social integration and quality of life [1,2]. According to the Centers for Disease Control and Prevention (CDC), about 20% of 3–17 years old are affected by mental health disorders every year in United States, among which anxiety and depression are the most frequently reported [3]. These conditions exert substantial short-term effects on individuals and are prospectively associated with enduring psychosocial functional impairments,

suboptimal academic achievement, and increased risk of chronic disease burden in adulthood [4–6]. While biological and genetic factors contribute to mental health vulnerability, numerous evidence indicates that social determinants, especially socioeconomic disadvantage, significantly shape the development of mental health conditions among adolescents [7,8].

Food insecurity remains consistently linked to elevated risks of depression, anxiety, and other psychological issues in adolescents and is increasingly recognized as a structural social determinant affecting youth mental health [8,9]. Empirical evidence have shown that adolescents residing in food-insecure households exhibit significantly elevated rates of emotional and behavioral problems compared with adolescents from food-secure households [10,11]. Even after controlling for income variables, this association remains statistically significant, suggesting that multiple stress factors related to food insecurity, including caregivers' anxiety, irregular meal times and frequencies, and insufficient dietary diversity, may directly affect adolescents' emotional functioning by influencing neurobiological pathways related to emotion regulation and processing [12,13].

Meanwhile, the developmental trajectory of psychological health in children and adolescents is significantly influenced by two adjustable lifestyle factors (physical activity and sedentary behavior) [14–16]. Evidence from meta-analysis consistently indicates that regular moderate to vigorous physical activity (MVPA) is robustly linked to reduced depression and anxiety symptoms across developmental stages [17]. In contrast, prolonged screen-based sedentary behavior, is associated with an increased risk of internalizing problems [18,19]. For example, a cohort study showed that social media usage frequency was significantly correlated with the depressive symptoms in adolescents [20]. A systematic review of sedentary behavior study among adolescents shows that screen time was positively correlated with their risk of developing mental disorders [21].

Although the relevant literature is already quite abundant, existing studies rarely explore the relationships between physical activity and sedentary behavior and the mental health of youth in food insecurity households. This gap is particularly concerning given that food-insecure households often face structural barriers to engaging in physical activity, including unsafe neighborhoods, lack of recreational facilities, transportation limitations, and competing demands on family time, which may exacerbate mental health vulnerabilities [18,19]. Moreover, while the World Health Organization (WHO) Global Recommendations on Physical Activity clearly state that children and adolescents should accumulate at least 60 min of MVPA daily and limit screen time to no more than two hours a day [22], the actual compliance rate is generally low. This is particularly obvious among those from lower socioeconomic backgrounds [23]. Therefore, the present study aimed to explore the separate and combined relationships of physical activity, sedentary time with psychological distress (e.g., anxiety and depression) in adolescents living in food-insecure households, using nationally representative 2021–2022 National Survey of Children's Health (NSCH) data.

2 Methods

2.1 Study Sample

The data for this study were sourced from the NSCH (website: <https://www.childhealthdata.org/>) conducted from 2021 to 2022, which draws on a nationally representative cross-sectional design. The NSCH collected comprehensive data on children's physical and mental health, healthcare access, family functioning, and socioeconomic context via surveys completed by primary caregivers. In the original NSCH survey, it employed a stratified, multistage probability sampling design to ensure national representativeness. Data were collected via web- or paper-based questionnaires administered to caregivers of children aged

0–17 years, randomly selected from households across all 50 U.S. states and the District of Columbia. This data collection cycle included 104,995 usable survey responses. The survey protocol received review and approved from the U.S. Department of Health and Human Services, ensuring compliance with federal ethical standards for human research. Because the study used only publicly available, deidentified datasets, it was exempt from requiring Institutional Review Board (IRB) approval.

All children aged 0 to 17 who resided in the US during 2021–2022 were considered eligible for this study. Our analysis was restricted to children with complete data on depression and anxiety ($n = 1022$), movement behaviors ($n = 41,676$), and covariates of interest ($n = 1044$) following a complete case analysis protocol. Then, we excluded the children from food-secure households ($n = 59,135$). The final sample consisted of 2118 children aged 6–17 years living in food-insecure households. We included these variables to examine the associations of movement behaviors and mental health outcomes.

2.2 Food Insecurity

In this study, food insecurity was operationalized using a validated, single-item question adapted from the National Health and Nutrition Examination Survey and incorporated into the 2021–2022 NSCH [24]. The question assesses household-level economic access to food over the past 12 months: “Which of these statements best describes your household’s ability to afford the food you need during the past 12 months?” Responses were categorized as: (1) We could always afford to eat good, nutritious meals, (2) We could always afford enough to eat but not always the kinds of food we should eat, (3) Sometimes we could not afford enough to eat, and (4) Often we could not afford enough to eat. Food insecurity was defined based on households’ reports of sometimes or often being unable to afford enough food (response = 3 and 4) in this study [25].

2.3 Measurements

The following question is used to measure the physical activity level: “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?” Responses were grouped into four categories: 0 days, 1–3 days, 4–6 days, and 7 days. For regression analyses, we created a binary variable indicating whether the child met the WHO global guideline of at least 60-min of MVPA every day (Yes = 1, No = 0). Sedentary behavior was measured by daily recreational screen time and through the following standardized questionnaire items: “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?” Responses were grouped into five categories: <1 h/d, 1 h/d, 2 h/d, 3 h/d, and ≥ 4 h/d. For regression analyses, we created a binary variable indicating whether the child met the WHO recommendation of two-hour or less per day of recreational screen time (Yes = 1, No = 0). In addition, we assigned a value of 1 to children who met both guidelines and a value of 0 to those who did not [26,27].

2.4 Mental Health

In this study, mental health outcomes (depression and anxiety) were assessed through standardized, parent-reported screening items from the NSCH, consistent with methods used in previous epidemiological studies [2,3]. These measures relied on caregivers’ reports of formal healthcare provider diagnoses. Depression was evaluated through the question: “Has a doctor or other healthcare provider ever told you that your child has depression?” Responses were categorized on a 3-point scale: 1 = Do not have the condition, 2 = Ever told, but no current condition, and 3 = Currently have the condition. For the analysis,

depression was dichotomized into a binary outcome variable: 1 = Currently has depression (response = 3), and 0 = Does not currently have depression (responses = 1 or 2). Anxiety was assessed using an analogous question: “Has a doctor or other healthcare provider ever told you that your child has anxiety problems?” Response categories mirrored those for depression: 1 = Do not have the condition, 2 = Ever told, but no current condition, and 3 = Currently have the condition. For analytical purpose, anxiety was operationalized as a binary variable. A value of 1 was assigned to adolescents endorsing the anxiety (response = 3), and a value of 0 was assigned to those reporting the absence of current anxiety (responses = 1 or 2) [26,27].

2.5 Covariates

To ensure robust estimation of the associations between physical activity, sedentary time, and mental health outcomes, we controlled for a comprehensive set of sociodemographic and health-related covariates selected based on established evidence from prior studies [3,4], as these factors have shown to significantly influence youth mental health and movement behaviors. Age was categorized into two groups: a childhood cohort (6–13 years old) and an adolescent cohort (14–17 years old). Biological sex was classified into males and females categories. Race were self-reported using the following classifications: Hispanic, white, black, Asian, and other. Parental or primary caregiver educational attainment was grouped into four levels: less than high school, high school degree or GED, some college or technical training, and college graduate or above. Overweight status was operationalized as a binary variable (yes vs. no) based on parent reports. Family income classification was stratified according to federal poverty level (FPL): 0–199% FPL, 200–299% FPL, 300–399% FPL, and 400% FPL or greater [26,28].

2.6 Statistical Analysis

All analyses were conducted using Stata/SE 18.0 (StataCorp, College Station, TX, USA). Descriptive statistics were calculated for the full sample, including means (standard deviations) for continuous variables and frequencies (proportion) for categorical variables. Consistent with previous methods [29,30], a multivariate logistic regression model was employed to examine the influence of physical activity, sedentary time, as well as their interaction on the risk of depression and anxiety symptoms, while adjusting for all covariates. We reported odds ratios (ORs) and 95% confidence intervals (CIs), considering a two-tailed p -value < 0.05 to be statistically significant.

3 Results

Table 1 depicts the demographic characteristics of youth living in food insecurity households. A total of 2118 children with a mean age of 12.06 years (SD = 3.45) were included. The sample was evenly distributed by sex (51.56% males, 48.44% females) and mainly composed of White (48.77%) and Hispanic (23.47%) youth. Family income bracket was relatively low 38.72% of households fall within the 0–199% of the Federal Poverty Level (FPL) range, while an additional 37.02% fall within the 200–299% FPL range. The parents’ educational attainment showed a differentiated distribution, with 39.09% reporting some college or technical school and 22.00% holding a college degree or higher. Overweight status was reported in 15.82% of the sample. Mental health outcomes revealed that 17.47% of youth experienced depression and 28.80% experienced anxiety. In terms of movement behaviors, 43.34% of children sat for four hours or more each day, while only 20.21% engaged in physical activity every day. The comparison of demographic and health-related characteristics of participants is presented in Supplementary Table S1.

Table 1: Characteristics of children living in food insecurity households (n = 2118).

Variables	M ± SD/Frequency	%
Age group	12.06 ± 3.45	/
6–13	1268	59.87
14–17	850	40.13
Sex identity		
Males	1092	51.56
Females	1026	48.44
Race		
Hispanic	497	23.47
White	1033	48.77
Black	320	15.11
Asian	63	2.97
Other	205	9.68
Family income classification		
0–199% FPL	820	38.72
200–299% FPL	784	37.02
300–399% FPL	451	21.29
≥400% FPL	63	2.97
Parents Education Level		
Less than high school	153	7.23
High school or GED	671	31.68
Some college or technical training	828	39.09
College graduate or above	466	22.00
Weight condition		
Non-overweight	1783	84.18
Overweight	335	15.82
Depressive symptoms		
No	1748	82.53
Yes	370	17.47
Anxiety symptoms		
No	1508	71.20
Yes	610	28.80
Physical activity		
0 days	382	18.03
1–3 days	916	43.25
4–6 days	392	18.51
7 days	428	20.21
Sedentary behavior		
<1 h	90	4.25
1 h or more	202	9.54
2 h or more	447	21.10
3 h or more	461	21.77
≥4 h	918	43.34

Note: FPL, federal poverty level; GED, general educational development; M, mean; SD, standard deviation.

Table 2 provides the covariate-adjusted results from logistic regression analysis used to evaluate how adherence to physical activity guidelines relates to mental health indicators. The analysis indicated a protective effect of meeting the physical activity recommendations. Compared with individuals who did not engage in insufficient physical activity, guideline adherence was significantly associated with lower adjusted odds of depression (OR = 0.63, 95% CI: 0.44–0.89, $p = 0.009$) and anxiety (OR = 0.60, 95% CI: 0.45–0.78, $p < 0.001$).

Table 3 presents results from the adjusted logistic regression analysis that assessed how compliance with sedentary behavior guidelines relates to mental health indicators. The results showed that meeting sedentary behavior guidelines was inversely associated with lower odds of both depression (OR = 0.56,

95% CI: 0.43–0.74, $p < 0.001$) and anxiety (OR = 0.78, 95% CI: 0.64–0.97, $p = 0.025$), suggesting that limiting sedentary behavior may be beneficial for mood regulation.

Table 4 presents the covariate-adjusted results from logistic regression analysis that evaluated the association of meeting combined physical activity and sedentary behavior guidelines with mental health indicators. The results revealed that meeting both physical activity and sedentary behavior guidelines had a significantly protective effect on reducing odds of depression (OR = 0.56, 95% CI: 0.33–0.94, $p = 0.027$) and anxiety (OR = 0.61, 95% CI: 0.43–0.87, $p = 0.009$).

Table 2: Logistic regression models of the associations between physical activity, depression and anxiety.

Variables	OR	Depression 95%CI	<i>p</i>	OR	Anxiety 95%CI	<i>p</i>
Age group						
6–13			Reference			
14–17	2.88	2.26, 3.66	<0.001	1.59	1.30, 1.95	<0.001
Sex identity						
Males			Reference			
Females	1.77	1.39, 2.25	<0.001	1.37	1.13, 1.67	0.002
Race						
Hispanic			Reference			
White	1.31	0.97, 1.78	0.079	1.58	1.23, 2.04	<0.001
Black	0.58	0.37, 0.89	0.012	0.45	0.31, 0.65	<0.001
Asian	0.07	0.01, 0.53	0.010	0.33	0.15, 0.76	0.009
Other	1.29	0.82, 2.01	0.270	1.14	0.78, 1.66	0.506
Education Level						
Less than high school			Reference			
High school or GED	1.84	1.07, 3.15	0.028	1.80	1.13, 2.88	0.014
Some college or technical training	1.60	0.93, 2.76	0.089	2.18	1.36, 3.47	0.001
College graduate or above	2.04	1.15, 3.62	0.014	2.47	1.51, 4.04	<0.001
Income classification						
0–199% FPL			Reference			
200–299% FPL	0.93	0.71, 1.23	0.621	0.95	0.75, 1.19	0.644
300–399% FPL	0.72	0.51, 1.00	0.052	0.86	0.66, 1.13	0.285
≥400% FPL	0.90	0.45, 1.80	0.765	0.99	0.56, 1.77	0.967
Weight condition						
Non-overweight			Reference			
Overweight	2.35	1.76, 3.12	<0.001	1.89	1.47, 2.45	<0.001
Meeting the physical activity guidelines						
No	Reference			Reference		
Yes	0.63	0.44, 0.89	0.009	0.60	0.45, 0.78	<0.001

Note: CI, confidence interval; FPL, federal poverty level; GED, general educational development; OR, odds ratio.

Table 3: Logistic regression models of the associations between sedentary behavior, depression and anxiety.

Variables	OR	Depression 95%CI	<i>p</i>	OR	Anxiety 95%CI	<i>p</i>
Age group						
6–13			Reference			
14–17	2.84	2.23, 3.62	<0.001	1.64	1.34, 2.00	<0.001
Sex identity						
Males			Reference			
Females	1.89	1.48, 2.40	<0.001	1.45	1.19, 1.76	<0.001

Table 3: Cont.

Variables	OR	Depression 95%CI	<i>p</i>	OR	Anxiety 95%CI	<i>p</i>
Race						
Hispanic			Reference			
White	1.30	0.96, 1.77	0.087	1.56	1.21, 2.00	0.001
Black	0.57	0.37, 0.87	0.010	0.45	0.31, 0.66	<0.001
Asian	0.07	0.01, 0.55	0.011	0.35	0.15, 0.79	0.012
Other	1.26	0.80, 1.97	0.317	1.14	0.78, 1.66	0.491
Education Level						
Less than high school			Reference			
High school or GED	1.83	1.06, 3.14	0.029	1.78	1.11, 2.84	0.016
Some college or technical training	1.57	0.91, 2.70	0.106	2.10	1.32, 3.36	0.002
College graduate or above	2.07	1.16, 3.67	0.013	2.47	1.51, 4.04	<0.001
Income classification						
0–199% FPL			Reference			
200–299% FPL	0.92	0.70, 1.21	0.542	0.94	0.75, 1.19	0.615
300–399% FPL	0.72	0.51, 1.00	0.053	0.87	0.66, 1.14	0.304
≥400% FPL	0.89	0.45, 1.79	0.751	1.00	0.56, 1.78	0.998
Weight condition						
Non-overweight			Reference			
Overweight	2.37	1.78, 3.15	<0.001	1.94	1.51, 2.51	<0.001
Meeting the sedentary behavior guidelines						
No			Reference			
Yes	0.56	0.43, 0.74	<0.001	0.78	0.64, 0.97	0.025

Note: CI, confidence interval; FPL, federal poverty level; GED, general educational development; OR, odds ratio.

Table 4: Logistic regression models of the associations between combined movement behaviors, depression and anxiety.

Variables	OR	Depression 95%CI	<i>p</i>	OR	Anxiety 95%CI	<i>p</i>
Age group						
6–13			Reference			
14–17	2.91	2.29, 3.70	<0.001	1.63	1.34, 1.99	<0.001
Sex identity						
Males			Reference			
Females	1.82	1.43, 2.31	<0.001	1.42	1.16, 1.72	0.001
Race						
Hispanic			Reference			
White	1.30	0.96, 1.76	0.089	1.56	1.21, 2.01	0.001
Black	0.58	0.37, 0.89	0.013	0.45	0.31, 0.66	<0.001
Asian	0.07	0.01, 0.53	0.010	0.34	0.15, 0.78	0.010
Other	1.28	0.82, 2.00	0.283	1.14	0.78, 1.65	0.506
Education Level						
Less than high school			Reference			
High school or GED	1.85	1.07, 3.17	0.026	1.81	1.13, 2.89	0.013
Some college or technical training	1.61	0.93, 2.77	0.087	2.16	1.36, 3.45	0.001
College graduate or above	2.07	1.17, 3.66	0.013	2.50	1.53, 4.09	<0.001
Income classification						
0–199% FPL			Reference			
200–299% FPL	0.92	0.70, 1.22	0.579	0.94	0.75, 1.18	0.594
300–399% FPL	0.72	0.51, 1.00	0.053	0.86	0.66, 1.13	0.284
≥400% FPL	0.90	0.45, 1.80	0.774	0.99	0.56, 1.76	0.972

Table 4: *Cont.*

Variables	OR	Depression 95%CI	<i>p</i>	OR	Anxiety 95%CI	<i>p</i>
Weight condition						
Non-overweight			Reference			
Overweight	2.38	1.79, 3.17	<0.001	1.94	1.50, 2.50	<0.001
Meeting both physical activity and sedentary time guidelines						
No			Reference			
Yes	0.56	0.33, 0.94	0.027	0.61	0.43, 0.87	0.009

Note: CI, confidence interval; FPL, federal poverty level; GED, general educational development; OR, odds ratio.

4 Discussion

To examine the links between movement behaviors (physical activity and sedentary time) and mental health, this analysis applied logistic regression models adjusted for covariates in a sample of children from households experiencing food insecurity. The results revealed that meeting the physical activity guideline (≥ 60 min MVPA/day) was significantly associated with lower odds of both depression and anxiety, while compliance with the sedentary behavior guideline (< 2 h/day) was significantly linked to decreased odds of depression and anxiety among youth living in food-insecure households. Moreover, youth who jointly met both physical activity and sedentary behavior guidelines exhibited a significantly lower odds of depression and anxiety.

Consistent with prior studies [18,26,31], the current investigation shows that adolescents' adherence to physical activity guidelines is beneficially associated with diminished symptoms of depression and anxiety. In a recent meta-analysis synthesizing 30 studies, Wang et al. [32] reported that higher levels of MVPA correlate with lower depression and anxiety risk in the general pediatric population. Kjellenberg et al. [33] found that the longer duration of MVPA during daily leisure time, the lower the individual's depression and anxiety score in Swedish adolescents. A adolescent cross-sectional study also confirmed that people engaging in higher levels of MVPA had significantly reduced risk of depression and anxiety symptoms compared to those with lower physical activity levels [33]. Our findings further expanded existing knowledge, showing that physical activity may be associated with decreased mental health risks among youth from food-insecure backgrounds. One possible reason is that food insecurity, as a persistent and highly exposed family stressor, can significantly trigger heightened activation of the hypothalamic-pituitary-adrenal (HPA) axis. This increase in cortisol secretion is a key mechanism by which sleep quality compromised [34,35]. Relevant studies suggest that consistent engagement in physical activity can effectively regulate the HPA axis function, promoting its homeostatic recovery, thereby enhancing sleep efficiency and overall sleep quality [36,37]. Thereby, improved sleep can serve as a key mediating pathway, demonstrating that physical activity can alleviate the mental health risks among children in food-insecure households. From another perspective, children from food-insecure households have limited financial resources and find it difficult to afford alternative forms of activities such as indoor fitness, and thus mainly rely on public outdoor spaces like parks and sports fields for physical activities [38,39]. Moreover, unhealthy neighborhood characteristics (such as high crime, negative views of the community) not only prompt parents to restrict their children's outdoor activities for protective reasons, but also cause children to voluntarily avoid outdoor environments out of subjective fear [40,41]. This significantly reduces their daily physical activity levels. In this context, insufficient physical activity undermines its inherent capacity to alleviate stress and regulate mood among children, consequently reducing its positive protective effect on mental health [42].

Regarding the relationship between sedentary behavior and mental health, the existing literature has not reached a consistent conclusion [43,44]. Our findings indicate that there were significant association between meeting the sedentary behavior guideline and reduced risk of depression and anxiety in children and adolescents. Aligning with earlier research, the results further support the suggestion that limiting sedentary behavior may benefit mental health [45,46]. For example, Liu et al. [47] pointed out that among children under the age of 14, those who spend two hours or more in sedentary behavior, playing video games each day, have a significantly increased risk of developing depressive symptoms. However, some studies have even observed a weak negative trend between them [48,49]. This trend is particularly evident in sedentary activities that require high cognitive load, such as reading and academic tasks. As our study utilized the sedentary behavior measurement tool from the NSCH questionnaire, which focuses on screen-related sedentary time rather than overall sedentary duration or specific behavioral contexts. Given that clinical and epidemiological research has consistently shown a significant link between depressive and anxiety symptoms and social withdrawal and passive media use behaviors, this may explain why the significant associations between depressive and anxiety symptoms and sedentary behavior were observed in our study. Therefore, future research should adopt a typological distinction between passive sedentary behavior (e.g., screen-based entertainment) and cognitively engaged sedentary behavior (e.g., educational tasks), thereby enabling a more accurately analysis of their different impacts on the mental health of adolescents in food-insecure households.

Earlier studies have predominantly explored the relationship between mental health problems and either physical activity or sedentary time in isolation in children and adolescents [32,50]. Building on this, the present study further investigates the associations between combined physical activity and sedentary behavior and mental health. Our findings showed that youth who met both physical activity and sedentary behavior guidelines exhibited lower odds of depression and anxiety than their peers who met neither. These results align with prior evidence reported by Sampasa-Kanyinga et al. in children and adolescents [51], who found that meeting physical activity and sedentary behavior guidelines was associated with better mental health. Similarly, in the 6 to 17 age group, meeting the guidelines for physical activity and sedentary behavior was a significant protective factor. These children showed a lower risk of depression and anxiety compared to their peers who do not meet these standards [27]. Therefore, our findings indicate that future mental health intervention strategies for children from food-insecure households should ensure sufficient time for MVPA and control screen time within a reasonable range of 1 to 2 h per day.

The results obtained in this study have several practical significances. First, this study put forward suggestions for children's daily movement behaviors, for example, increasing the duration of MVPA every day and reducing the time spent on recreational screen use. It emphasizes the bidirectional regulation of physical activity and sedentary behavior, aiming to enhance the primary prevention effect on depressive and anxiety symptoms. Second, schools should give priority to taking the following measures to effectively guarantee the daily physical activity time of students from food-insecure families: moderately extend the break time between classes, implement trauma-informed physical education courses, and integrate organized physical activities into daily classroom teaching. Third, public health departments can encourage youth from food-insecure households to enhance their physical activity and decrease sedentary behavior by providing subsidies for their sports participation and enhancing public sports facilities in the community, thereby promoting the mental health of children.

There are several limitations worth mentioning. First, this is a cross-sectional study, which can only understand the correlation between movement behavior and mental health, and thus cannot support the causal interpretations. Second, all variables in this study, including depression, anxiety, physical activity, and sedentary time, were reported by healthcare providers, which raises concerns regarding potential recall

inaccuracies and socially influenced response patterns. Third, due to the lack of data on intensity, duration, or context of physical activity and sedentary time in the NSCH database, we could not differentiate between beneficial and harmful forms of movement, for example, passive and positive sedentary behaviors. Finally, while the definition of food insecurity is mainly based on the household-level food availability, this indicator does not accurately reflect individual dietary quality or nutrient sufficiency.

Subsequent studies should use longitudinal designs to better determine causality and the directionality of associations between variables. At the same time, it is necessary to integrate objective measurement tools (e.g., accelerometers and wearable fitness tracking devices) to accurately quantify movement behaviors, and supplement with in-depth qualitative approaches, for example, open-ended interviews or organized group discussions to systematically explore the real experiences, coping strategies and underlying mechanisms of adolescents when facing the different challenges in food insecurity and mental health.

5 Conclusions

This study found that among children and adolescents growing up in food insecurity households, meeting physical activity and sedentary behavior guidelines was independently associated with a significantly lower risks of depressive and anxiety symptoms. However, further research should adopt objective movement measurement methods based on wearable devices, validated mental health assessment tools to conduct prospective longitudinal cohort studies, in order to rigorously examine the potential associations of increased physical activity, reduced sedentary time with mental health outcomes among children living in food-insecure households.

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Availability of Data and Materials: The data that support the findings of this study are openly available in National Survey of Children's Health (NSCH) survey at: <https://www.childhealthdata.org/>.

Ethics Approval: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

Supplementary Materials: The supplementary material is available online at <https://www.techscience.com/doi/10.32604/ijmh.2026.080191/s1>.

Abbreviations

The following abbreviations are used in this manuscript:

FPL	Federal Poverty Level
MVPA	Moderate to Vigorous Physical Activity
NSCH	National Survey of Children's Health

References

- Suppiej A, Longo I, Pettoello-Mantovani M. The pivotal role of mental health in child and adolescent development. *Glob Pediatr*. 2025;13:100277. [[CrossRef](#)].
- Tian J, Yan N, Hu X, Tian S, Wang Y, Mackay LE, et al. Global burden of mental disorders among adolescents and young adults, 1990–2021: A systematic analysis of the Global Burden of Diseases Study 2021. *Gen Psychiatry*. 2025;38(6):e102278. [[CrossRef](#)].
- Leeb RT, Danielson ML, Claussen AH, Robinson LR, Lebrun-Harris LA, Ghandour R, et al. Trends in mental, behavioral, and developmental disorders among children and adolescents in the US, 2016–2021. *Prev Chronic Dis*. 2024;21:240142. [[CrossRef](#)].
- Shiraly R, Roshanfekr A, Asadollahi A, Griffiths MD. Psychological distress, social media use, and academic performance of medical students: The mediating role of coping style. *BMC Med Educ*. 2024;24(1):999. [[CrossRef](#)].
- Zhang Y, Kuang J, Luo X, Zhao M, Liu X. Association between meeting 24-hour movement guidelines and psychological features of Chinese emerging adults. *Int J Ment Health Promot*. 2024;26(5):399–406. [[CrossRef](#)].
- Chu T, Liu X, Takayanagi S, Matsushita T, Kishimoto H. Association between mental health and academic performance among university undergraduates: The interacting role of lifestyle behaviors. *Int J Methods Psych Res*. 2023;32:e1938. [[CrossRef](#)].
- Mardini MT, Khalil GE, Bai C, DivaKaran AM, Ray JM. Identifying adolescent depression and anxiety through real-world data and social determinants of health: Machine learning model development and validation. *JMIR Ment Health*. 2025;12:e66665. [[CrossRef](#)].
- Kirkbride JB, Anglin DM, Colman I, Dykxhoorn J, Jones PB, Patalay P, et al. The social determinants of mental health and disorder: Evidence, prevention and recommendations. *World Psychiatry*. 2024;23(1):58–90. [[CrossRef](#)].
- Liang K, Chi X, Chen ST, Clark CCT, Zhang Y, Wang J. Food insecurity and bullying victimization among 170, 618 adolescents in 59 countries. *Front Psychiatry*. 2021;12:766804. [[CrossRef](#)].
- Cisneros-Vásquez E, Smith L, Yañez-Sepúlveda R, Olivares-Arancibia J, Gutiérrez-Espinoza H, Yon DK, et al. Beyond hunger: Uncovering the link between food insecurity and depression, anxiety, and stress in adolescents. *Curr Dev Nutr*. 2025;9(6):107453. [[CrossRef](#)].
- Folorunso OE, Ojo TO, Akinsulore A, Inyangudo G. Adolescent mental well-being and household food security: Insights from a cross-sectional study in Irewole local government area, Osun State, Nigeria. *BMC Public Health*. 2025;26(1):30. [[CrossRef](#)].
- Butler JL, Johnson CM, Hardison-Moody A, Bowen SK. Food insecurity associated with higher stress, depressive symptoms, and lower diet quality among women caregivers in north Carolina. *Nutrients*. 2024;16(15):2491. [[CrossRef](#)].
- Ejiohuo O, Onyeaka H, Unegbu KC, Chikezie OG, Odeyemi OA, Lawal A, et al. Nourishing the mind: How food security influences mental wellbeing. *Nutrients*. 2024;16(4):501. [[CrossRef](#)].
- Zhang Y, Chen S, Wang C, Zhang X, Zou L, Chi X, et al. Does more sedentary time associate with higher risks for sleep disorder among adolescents? a pooled analysis. *Front Pediatr*. 2021;9:603177. [[CrossRef](#)].
- Hinkley T, Timperio A, Watson A, Duckham RL, Okely AD, Cliff D, et al. Prospective associations with physiological, psychosocial and educational outcomes of meeting Australian 24-hour movement guidelines for the early years. *Int J Behav Nutr Phys Act*. 2020;17(1):36. [[CrossRef](#)].
- Lu C, Zou L, Becker B, Griffiths MD, Yu Q, Chen ST, et al. Comparative effectiveness of mind-body exercise versus cognitive behavioral therapy for college students with problematic smartphone use: A randomized controlled trial. *Int J Ment Health Promot*. 2020;22(4):271–82. [[CrossRef](#)].
- Hou J, Deng Q, Sha L, Zhu J, Xiang R, Zhao X, et al. Physical activity and risk of depression in adolescents: A systematic review and meta-analysis of prospective observational studies. *J Affect Disord*. 2025;371:279–88. [[CrossRef](#)].
- Kracht CL, Pochana SS, Staiano AE. Associations between moderate to vigorous physical activity, sedentary behavior, and depressive symptomatology in adolescents: A prospective observational cohort study. *J Phys Act Health*. 2023;20(3):250–7. [[CrossRef](#)].
- Perrino T, Brincks A, Lee TK, Quintana K, Prado G. Screen-based sedentary behaviors and internalizing symptoms across time among U.S. Hispanic adolescents. *J Adolesc*. 2019;72(1):91–100. [[CrossRef](#)].

20. Xu J, Duan H, Qin K, Liu B. Association between screen time and depressive and anxiety symptoms among Chinese adolescents. *Front Psychiatry*. 2025;16:1428885. [[CrossRef](#)].
21. Santos RMS, Mendes CG, Sen Bressani GY, de Alcantara Ventura S, de Almeida Nogueira YJ, de Miranda DM, et al. The associations between screen time and mental health in adolescents: A systematic review. *BMC Psychol*. 2023;11(1):127. [[CrossRef](#)].
22. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med*. 2020;54(24):1451–62. [[CrossRef](#)].
23. Rawal LB, Smith BJ, Quach H, Renzaho AMN. Physical activity among adults with low socioeconomic status living in industrialized countries: A meta-ethnographic approach to understanding socioecological complexities. *J Environ Public Health*. 2020;2020:4283027. [[CrossRef](#)].
24. Alaimo K, Briefel RR, Frongillo EA Jr, Olson CM. Food insufficiency exists in the United States: Results from the third National Health and Nutrition Examination Survey (NHANES III). *Am J Public Health*. 1998;88(3):419–26. [[CrossRef](#)].
25. Branley CE, Lee MR, Person S, Hager K, Lemon SC. Association between parent-perceived neighborhood support on food insufficiency and public benefit participation among US children. *Prev Med Rep*. 2025;57:103174. [[CrossRef](#)].
26. Liu X, Drenowatz C, Chen S, Chen S, Ma Y, Zhang Y. Exploring the impact of adherence to 24-h movement guidelines on psychological health and academic engagement in children and adolescents with speech/language impairment. *J Sci Sport Exerc*. 2025:1–12. [[CrossRef](#)].
27. Zhu X, Haegele JA, Healy S. Movement and mental health: Behavioral correlates of anxiety and depression among children of 6–17 years old in the U.S. *Ment Health Phys Act*. 2019;16:60–5. [[CrossRef](#)].
28. Taylor A, Kong C, Zhang Z, Herold F, Ludyga S, Healy S, et al. Associations of meeting 24-h movement behavior guidelines with cognitive difficulty and social relationships in children and adolescents with attention deficit/hyperactive disorder. *Child Adolesc Psychiatry Ment Health*. 2023;17(1):42. [[CrossRef](#)].
29. McCoy SM, Rupp K. Physical activity and bullying in adolescents with overweight and obesity. *Int J Bullying Prev*. 2024:1–10. [[CrossRef](#)].
30. DeLuca ZW, Rupp K. Physical activity, sports participation, and psychosocial health in adolescents with hearing loss. *J Adolesc Health*. 2022;71(5):635–41. [[CrossRef](#)].
31. Velazquez B, Petresco S, Pereira R, Buchweitz C, Manfro PH, Caye A, et al. Physical activity and depressive symptoms among adolescents in a school-based sample. *Braz J Psychiatry*. 2022;44(3):313–6. [[CrossRef](#)].
32. Wang L, Barker AR, Metcalf B, Liu Y, Hillsdon M, Price L. The association between accelerometer-measured physical activity and symptoms of depression and anxiety in children and adolescents: A systematic review and meta-analysis. *BMC Pediatr*. 2025;26(1):96. [[CrossRef](#)].
33. Kjellenberg K, Ekblom O, Ahlen J, Helgadóttir B, Nyberg G. Cross-sectional associations between physical activity pattern, sports participation, screen time and mental health in Swedish adolescents. *BMJ Open*. 2022;12(8):e061929. [[CrossRef](#)].
34. Mazloomi SN, Talebi S, Kazemi M, Ghoreishy SM, Moosavian SP, Amirian P, et al. Food insecurity is associated with the sleep quality and quantity in adults: A systematic review and meta-analysis. *Public Health Nutr*. 2023;26(4):792–802. [[CrossRef](#)].
35. Pourmotabbed A, Moradi S, Babaei A, Ghavami A, Mohammadi H, Jalili C, et al. Food insecurity and mental health: A systematic review and meta-analysis. *Public Health Nutr*. 2020;23(10):1778–90. [[CrossRef](#)].
36. Wang B, Zhou H. Physical activity and adolescent depression: The moderating effects of self-esteem, sleep quality and social support in mental health interventions. *Int J Ment Health Nurs*. 2025;34(4):e70126. [[CrossRef](#)].
37. Liu Y, Lu Y, Wang H, Tian E, Su X, Su S, et al. The influence of physical exercise on adolescents' negative emotions: The chain mediating role of academic stress and sleep quality. *BMC Pediatr*. 2025;25(1):442. [[CrossRef](#)].
38. To QG, Frongillo EA, Gallegos D, Moore JB. Household food insecurity is associated with less physical activity among children and adults in the U.S. population. *J Nutr*. 2014;144(11):1797–802. [[CrossRef](#)].
39. Odoms-Young A, Brown AGM, Agurs-Collins T, Glanz K. Food insecurity, neighborhood food environment, and health disparities: State of the science, research gaps and opportunities. *Am J Clin Nutr*. 2024;119(3):850–61. [[CrossRef](#)].

40. Chaparro MP, Bilfield A, Theall KP. Exposure to neighborhood crime is associated with lower levels of physical activity and higher obesity risk among adolescent girls, but not boys. *Child Obes.* 2019;15(2):87–92. [[CrossRef](#)].
41. MacIntyre S. Deprivation amplification revisited; or, is it always true that poorer places have poorer access to resources for healthy diets and physical activity? *Int J Behav Nutr Phys Act.* 2007;4(1):32. [[CrossRef](#)].
42. Wu J, Zhao X, Shao Y, Zang W, Jun H, Yu W. The impact of physical exercise on internalizing and externalizing problem behaviors among middle school students: Correlation and regression prediction analysis. *Child Adolesc Psychiatry Ment Health.* 2025;19(1):45. [[CrossRef](#)].
43. da Costa BGG, Van Rooij AJ, Tuijnman A, Saunders TJ, Chaput JP. Associations between type and timing of physical activity and sedentary behavior with mental health in adolescents and young adults. *J Phys Act Health.* 2023;20(7):655–63. [[CrossRef](#)].
44. Zhang J, Yang SX, Wang L, Han LH, Wu XY. The influence of sedentary behaviour on mental health among children and adolescents: A systematic review and meta-analysis of longitudinal studies. *J Affect Disord.* 2022;306:90–114. [[CrossRef](#)].
45. Gilchrist JD, Battista K, Patte KA, Faulkner G, Carson V, Leatherdale ST. Effects of reallocating physical activity, sedentary behaviors, and sleep on mental health in adolescents. *Ment Health Phys Act.* 2021;20:100380. [[CrossRef](#)].
46. Rodriguez-Ayllon M, Cadenas-Sánchez C, Estévez-López F, Muñoz NE, Mora-Gonzalez J, Migueles JH, et al. Role of physical activity and sedentary behavior in the mental health of preschoolers, children and adolescents: A systematic review and meta-analysis. *Phys Med.* 2019;49(9):1383–410. [[CrossRef](#)].
47. Liu M, Wu L, Yao S. Dose–response association of screen time-based sedentary behaviour in children and adolescents and depression: A meta-analysis of observational studies. *Br J Sports Med.* 2016;50(20):1252–8. [[CrossRef](#)].
48. Khouja JN, Munafò MR, Tilling K, Wiles NJ, Joinson C, Etchells PJ, et al. Is screen time associated with anxiety or depression in young people? Results from a UK birth cohort. *BMC Public Health.* 2019;19(1):82. [[CrossRef](#)].
49. Werneck AO, Hallgren M, Stubbs B. Prospective association of sedentary behavior with psychological distress among adolescents. *J Adolesc Health.* 2025;76(3):408–14. [[CrossRef](#)].
50. Wen X, Zhu F, Yuan Z, Mao Z. Relationship between physical activity, screen-related sedentary behaviors and anxiety among adolescents in less developed areas of China. *Medicine.* 2022;101(39):e30848. [[CrossRef](#)].
51. Sampasa-Kanyinga H, Lien A, Hamilton HA, Chaput JP. The Canadian 24-hour movement guidelines and self-rated physical and mental health among adolescents. *Can J Public Health.* 2022;113(2):312–21. [[CrossRef](#)].