



The influence of depression status on weekly exercise in children ages 6 to 17 years

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ABSTRACT

Exercise has been found to be an effective treatment for mild to moderate depression. The purpose of this study is to explore the relationship between depression status and weekly exercise in children ages 6 to 17 years stratifying by age and sex using a large nationally representative sample. The study data ($n = 65,059$) came from the 2011–12 National Survey of Children's Health. Depression categories were current, former, and no history of diagnosed depression. Exercise categories were exercising ≤ 6 days a week and 7 days a week. Multivariable regression stratified by age and by sex was conducted on the weighted survey data. Among children age 6 to 17, 95.2% were never depressed, 2.1% were formerly depressed, and 2.8% were currently depressed and 28.0% exercised daily. Currently depressed children had 0.75 (95% CI 0.56, 1.00) times and formerly depressed children had 1.09 (95% CI 0.76, 1.57) times the adjusted odds of exercising daily compared to never depressed children. Stratified separately by sex and by age, females and children age 12 to 17 with current depression had 0.63 (95% CI 0.42, 0.94) and 0.48 (95% CI 0.35, 0.66) times the adjusted odds of exercising daily compared to their counterparts with no depression. This study indicates a significant difference in daily exercise habits between currently depressed children age 12 to 17 and females compared to their never depressed counterparts. Healthcare workers should be aware of the possible heightened risk of physical inactivity for depressed female children and children age 12 to 17.

1. Introduction

Depression affects approximately 5% of individuals under the age of 17 (*Depression in Children and Teens*, 2018). Among children 12 to 17, 12.8% have received a diagnosis of depression in their life and up to 6.7% currently suffer from depression (*Perou et al.*, 2013). Depression in children under the age of 12 occurs but with a lower prevalence than those ages 12 to 17 (*Perou et al.*, 2013). Depression commonly manifests itself in children as frequent hopelessness, sadness, and boredom, low self-esteem and social isolation, and a lack of interest in previously enjoyed activities (*Depression in Children and Teens*, 2018). These symptoms can be devastating and negatively affect interpersonal relationships and educational achievements which can persist into adulthood (*Kapornai and Vetró*, 2008). Depression in children can also lead to an increased risk of substance abuse, self-harm, and suicide (*Kapornai and Vetró*, 2008; *Kelvin*, 2016).

While depression can be treated a variety of ways, it is most

commonly treated with psychotherapy, antidepressants, and cognitive behavioral therapy (*Larun et al.*, 2006). However, recent research has been looking at lifestyle changes that can aid in mitigating depressive symptoms. One such lifestyle change being considered is increasing one's physical activity regimen. Exercise has been found to be an effective treatment for depression in both children and adults (*Josefsson et al.*, 2014; *Korczak et al.*, 2017; *Mota-Pereira et al.*, 2011; *Rethorst et al.*, 2009). One randomized control trial of older adults even found that after 12 weeks, patients assigned to exercise alone had equal improvement of their depressive symptoms compared to those assigned antidepressants alone (*Blumenthal et al.*, 1999). Exercise can potentially offer an alternative to medication when antidepressants are ineffective for treatment of mild to moderate depression (*Dunn et al.*, 2005; *Mather et al.*, 2002).

The studies listed above were conducted primarily in adult populations, leaving the relationship between exercise and depression in children relatively understudied. The few studies conducted on the

Abbreviations: NSCH, National Survey Children's Health; S.C., sampled child; CI, confidence interval; aOR, adjusted odds ratio

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relationship between exercise and depression in children indicated exercise can reduce depressive symptoms but the effect is small and the literature on the topic is not robust (Biddle and Asare, 2011; Jerstad et al., 2010; Newman and Motta, 2007). Many of the studies conducted on this topic are either focused on one sex, adolescents, or are conducted with a small sample size (Jerstad et al., 2010; Newman and Motta, 2007). The purpose of this study is to explore the effect of depression status on weekly exercise in US children ages 6 to 17 years using nationally representative data set.

2. Methods

The data for this study came from the 2011–12 National Survey of Children's Health, NSCH (Child and Adolescent Health Measurement Initiative, 2011; Maternal and Child Health Bureau at the Health Resources and Services Administration, 2011). The NSCH is a national telephone survey sponsored by the United States Department of Health and Human Services and conducted by the Centers for Disease Control and Prevention. The survey was conducted from February 2011 to June 2012. Phone numbers were sampled through random-digit-dial of landline and cell-phone numbers and stratified by state and type of phone number. Participants were parents or guardians of children age 0 to 17 years old. Participants reported all information collected on their child and, if the participant had multiple children, one child was randomly selected to represent the children in the household. The survey collected 95,677 responses and was weighted to represent all non-institutionalized children 0 to 17 years old living in each state and in the US (National Center for Health Statistics and State and Local Area for Health Statistics, 2017). Of the 95,677 NSCH observations, 65,680 were age 6 to 17 years old. Of the observations age 6 to 17 years old, 621 or 0.9% had missing values or had a response of “do not know” or “refused to answer” for either the exposure or outcome of interest resulting in a final analytic sample of 65,059.

2.1. Assessment of depression status

Depression status was divided into three categories: no history of diagnosed depression, former history of diagnosed depression, and current diagnosed depression. A child's current depression status was ascertained by the parent or guardian's response to two survey questions about the sampled child (S.C.). A response of “no” to the first question, “Has a doctor or other health care provider ever told you that [S.C.] had depression?”, was categorized as no history of diagnosed depression (2011 National Survey of Children's Health Questionnaire (February 2012), 2012). A response of “yes” to the first question and a response of “no” to the second question, “Does [S.C.] currently have depression?”, was categorized as former history of diagnosed depression (2011 National Survey of Children's Health Questionnaire (February 2012), 2012). A response of “yes” to both the first and second question was categorized as current diagnosed depression.

2.2. Assessment of weekly exercise

The exercise routine of the child was measured by grouping the number of days of exercise, recorded as discrete variables, into two categories. A response of 0 to 6 days to the question, “During the past week, on how many days did [S.C.] exercise, play a sport, or participate in physical activity for at least 20 minutes that made [him/her] sweat and breathe hard?” was grouped into the category labeled “0 to 6 days” (2011 National Survey of Children's Health Questionnaire (February 2012), 2012). A response of 7 days to the latter question was grouped into the category labeled “7 days”. This categorizing was used due to the CDC's recommendation that children be physically active at least 60 min every day (How Much Physical Activity Do Children Need?, 2015).

2.3. Covariates and stratification variables

2.3.1. Age

Age was collected in years and categorized as 6 to 11 years or 12 to 17 years based on the CDC's approximated age range for adolescence (American Academy of Pediatrics, 2018). Research has found the prevalence of depression increases while exercise decreases during adolescence (Kahn et al., 2008; Perou et al., 2013).

2.3.2. Sex

The child's sex was determined by the parent or guardian's response to the question “Is [S.C.] male or female?” (2011 National Survey of Children's Health Questionnaire (February 2012), 2012). Depression in children under the age of 13 displays no gender differences in prevalence; however, among children age 13 to 17, girls have been found to have higher rates of depression than boys (Hyde et al., 2008; Perou et al., 2013). Physical activity in youth has also been shown to vary between sexes particularly in adolescence (Trost et al., 2002).

2.3.3. Poverty status

The child's poverty status was approximated using the percentage of the federal poverty line (FPL) in which the child was living, which was calculated from the household income and family size reported by the participant. The poverty status was categorized as: 0–99%, 100–199%, 200–399%, and 400% or higher. Children living below 100% of the federal poverty line were found to be more likely to be formerly or currently depressed than those above the 100% federal poverty line (Perou et al., 2013). Poverty has also been shown to decrease physical activity (Duncan et al., 2002).

2.3.4. Education

The highest educational attainment achieved by the parents of the child was grouped into three categories: less than a high school degree, a high school degree, and greater than a high school degree. Past research has indicated parental educational attainment can influence childhood risk of depression with higher educational attainment leading to increased risk of childhood depression (McLeod et al., 2007). Additionally, increases in parental education have been found to have a positive effect on physical activity in children (Li et al., 2016).

2.3.5. Race/ethnicity

The child's race and ethnicity were categorized into white only, black only, Hispanic, and other based on the parent or guardian's response to the questions “Is [S.C.] of Hispanic, Latino or Spanish origin?” and “Is [S.C.] White, Black or African American, American Indian, Alaska Native, Asian, or Native Hawaiian or other Pacific Islander?” with the option of choosing more than one of the races listed (2011 National Survey of Children's Health Questionnaire (February 2012), 2012). A response of only “white” and no to the Hispanic origin question was considered white only, a response of “black or African American” and no to the Hispanic origin question was considered black only, those who answered yes to the Hispanic origin question were considered Hispanic, and all other responses were categorized as other. Depression status and exercise habits have been shown to vary between races (Dowda et al., 2001; Perou et al., 2013).

2.4. Statistical analysis

First, the bivariate distribution of exercise, depression, and each covariate was assessed. Logistic regression was used to model daily physical activity for all children age 6–17. Finally, because of known differences in exercise and diagnosed depression by both age and gender, the model was stratified separately by age (6 to 11 and 12 to 17) and gender (female and male) (Hyde et al., 2008; Kahn et al., 2008; Perou et al., 2013; Trost et al., 2002). All statistical analyses were conducted using Stata software (StataCorp, 2017). Complex survey

Table 1
Sex-stratified characteristics of US children age 6–17 by depression status, NSCH 2011–2012 (n = 65,059).

	Child's depression status								
	Female				p value	Male			
	Never 95.5% (n = 29,836) Weighted % (n)	Former 1.9% (n = 640) Weighted % (n)	Current 2.6% (n = 812) Weighted % (n)			Never 94.8% (n = 31,971) Weighted % (n)	Former 2.2% (n = 800) Weighted % (n)	Current 3.0% (n = 914) Weighted % (n)	p value
Age				< 0.01				< 0.01	
6 to 11 years	51.0% (14795)	15.0% (100)	18.5% (142)		50.4% (15308)	28.3% (219)	33.4% (238)		
12 to 17 years	49.0% (15041)	85.0% (540)	81.5% (670)		49.6% (16663)	71.7% (581)	66.6% (676)		
Race/ethnicity ^a				0.82				0.55	
White, non-Hispanic	53.0% (19585)	58.5% (412)	57.9% (542)		54.4% (21111)	51.9% (533)	56.1% (623)		
Black	15.2% (2849)	12.5% (48)	13.2% (70)		13.4% (2965)	10.8% (65)	15.2% (89)		
Hispanic	21.7% (3569)	19.5% (93)	19.4% (100)		22.8% (3997)	29.1% (100)	18.6% (97)		
Other	10.1% (3151)	9.5% (77)	9.5% (84)		9.4% (3126)	8.2% (87)	10.1% (91)		
Poverty line				< 0.01				< 0.01	
< 100%	19.6% (3914)	33.5% (145)	28.3% (220)		20.1% (4248)	22.9% (143)	39.6% (267)		
100–199%	20.8% (5028)	22.9% (139)	26.5% (188)		21.7% (5522)	24.8% (178)	24.9% (229)		
200–399%	29.9% (9284)	21.2% (175)	31.6% (212)		28.3% (10023)	32.7% (248)	21.8% (226)		
≥ 400%	29.6% (11610)	22.3% (181)	13.6% (192)		29.9% (12178)	19.6% (231)	13.7% (192)		
Education ^b				0.56				0.25	
< High school	11.0% (1484)	13.6% (48)	13.4% (54)		11.6% (1651)	9.4% (34)	12.6% (72)		
= High school	19.2% (4060)	22% (101)	22.6% (165)		19.7% (4566)	23.3% (128)	27.2% (187)		
> High school	69.8% (22651)	64.3% (418)	64.0% (497)		68.7% (23996)	67.4% (558)	60.1% (549)		
Weekly exercise				< 0.01				0.074	
0 to 6 days	76.2% (22950)	83.8% (543)	85.2% (694)		67.5% (21635)	66.2% (593)	70.5% (678)		
7 days	23.8% (6886)	16.2% (97)	14.8% (118)		32.5% (10336)	33.8% (207)	29.5% (236)		

Note: Not all percentages add to 100% due to rounding.

^a Variables have < 5% of data as missing, do not know, or refused values.

^b Variables have < 10% of data missing, do not know, or refused values.

design and weighted data were used in all analyses to obtain accurate population estimates and account for gaps in coverage and non-response.

3. Results

3.1. Characteristics

Among US children age 6–17, 95.2% were never depressed, 2.1% were formerly depressed, and 2.8% were currently depressed. Approximately a quarter (28%) of children age 6 to 17 exercised daily. Among females, 95.5% had no history of depression, 1.9% had a history of diagnosed depression but no current diagnosis, and 2.6% had current depression (Table 1). Among males, 94.8% had no history of depression, 2.2% had a former diagnosis of depression, and 3.0% currently had depression (Table 1). Of children age 6 to 11, 97.6% had never had a diagnosis of depression, 0.9% had a former diagnosis of depression, and 1.5% had a current diagnosis of depression (Table 2). Children age 12 to 17 had higher percentages of both former and current depression diagnoses than younger children (former: 3.2% vs. 0.9%; current: 4.0% vs. 1.5%, respectively (Table 2)).

Among male children with former depression, 33.8% exercised for at least 20 min each day of the week compared to 32.5% with no history of depression and 29.5% with current depression (Table 1). However, among females, 23.8% with no history of depression exercised every day of the week compared to 16.2% with a former history of depression, and 14.8% with current depression (Table 1). The percentage of children age 6 to 11 who exercised 7 days a week was higher among those with current or former depression (49.7% and 48.3%, respectively) and lower among those with no history of depression (35.3%) (Table 2). In contrast, the percentage of children age 12 to 17 who exercised 7 days a week progressively decreased by depression status (no history of depression: 20.9%; former depression: 19.5%; current depression: 13.1% (Table 2)).

3.2. Multivariable analysis

3.2.1. Full model

Compared to children with no depression, children with former depression or with current depression had 0.89 (95% CI 0.63, 1.25) and 0.75 (95% CI 0.57, 0.99) times the unadjusted odds of exercising every day of the week (Table 3). After adjusting for age, sex, race/ethnicity, poverty status, and education, children's depression status was no longer statistically associated with daily exercise (Table 3). Females had 0.62 (95% CI 0.57, 0.68) times the adjusted odds of exercising seven days a week compared to their male counterparts (Table 3). Children 12 to 17 years old had 0.46 (0.42, 0.50) times the odds of exercising seven days a week compared to children age 6 to 11 years old when adjusting for variables included in the model (Table 3).

3.2.2. Sex stratified model

When stratified by sex, currently depressed females were found to exercise significantly less than their never depressed counterparts (adjusted odds ratio [aOR] 0.63, 95% CI 0.42, 0.94) while there was no statistical difference for males (Table 4). In both the male and female models, children age 12 to 17 had significantly lower adjusted odds of exercising every day of the week compared to children 6 to 11 years old. In the female model children age 12 to 17 had 0.40 (95% CI 0.35, 0.46) times the adjusted odds and in the male model children age 12 to 17 had 0.51 (95% CI 0.45, 0.57) times the adjusted odds of exercising every day of the week compared to their younger same sex counterparts (Table 4).

3.2.3. Age stratified model

Currently depressed children age 12 to 17 were significantly less likely (aOR: 0.48, 95% CI 0.35, 0.66) to have exercised daily compared to same age children who had never been depressed (Table 4). Depression, either former or current, was not associated with daily exercise for children age 6 to 11. In both age stratified models, females had lower adjusted odds of exercising daily (age 6–11: aOR 0.69, 95% CI 0.62, 0.78; age 12–17: aOR 0.54, 95% CI 0.47, 0.61) compared to

Table 2
Age-stratified characteristics of US children age 6–17 by depression status, NSCH 2011–2012 (n = 65,059).

	Child's depression status									
	6 to 11 years old				p value	12 to 17 years old				
	Never 97.6% (n = 30,151) Weighted % (n)	Former 0.9% (n = 320) Weighted % (n)	Current 1.5% (n = 380) Weighted % (n)			Never 92.8% (n = 31,740) Weighted % (n)	Former 3.2% (n = 1122) Weighted % (n)	Current 4.0% (n = 1346) Weighted % (n)	p value	
Sex ^a					< 0.01					0.87
Female	49.3% (14795)	30.2% (100)	31.6% (142)			48.7% (15041)	49.2% (540)	50.4% (670)		
Male	50.7% (15308)	69.8% (219)	68.4% (238)			51.3% (16663)	50.8% (581)	49.6% (676)		
Race/ethnicity ^a					0.33					0.54
White, non-Hispanic	51.4% (18941)	60.6% (192)	46.8% (232)			56.2% (21813)	53.2% (755)	60.5% (933)		
Black	14.0% (2874)	7.1% (28)	21.1% (45)			14.5% (2940)	12.9% (85)	11.8% (114)		
Hispanic	24.3% (4151)	24.6% (52)	22.4% (46)			20.2% (3419)	24.8% (141)	17.7% (151)		
Other	10.4% (3366)	7.7% (43)	9.7% (48)			9.1% (2921)	9.1% (121)	9.9% (127)		
Poverty line					< 0.01					< 0.01
< 100%	21.4% (4403)	25.5% (77)	43.5% (138)			18.2% (3765)	28.3% (211)	31.2% (349)		
100–199%	22.2% (5406)	32.9% (71)	25.1% (114)			20.3% (5155)	21.4% (246)	25.8% (303)		
200–399%	29.0% (9416)	24.5% (98)	26.5% (89)			29.1% (9922)	28.4% (326)	26.1% (349)		
≤ 400%	27.4% (10926)	17.1% (74)	4.8% (39)			32.3% (12898)	21.9% (339)	16.9% (345)		
Education ^b					0.22					0.44
< High school	11.7% (1675)	11.1% (19)	14.7% (33)			10.8% (1462)	11.3% (63)	12.4% (93)		
= High school	19.5% (4029)	20.4% (47)	29.6% (85)			19.5% (4606)	23.4% (183)	23.5% (267)		
> High school	68.7% (22714)	68.5% (213)	55.8% (217)			69.7% (23996)	65.3% (764)	64.1% (829)		
Weekly exercise					< 0.01					0.02
0 to 6 days	64.7% (19492)	51.7% (214)	50.3% (239)			79.1% (25154)	80.5% (923)	86.9% (1133)		
7 days	35.3% (10659)	48.3% (106)	49.7% (141)			20.9% (6586)	19.5% (199)	13.1% (213)		

Note: Not all percentages add to 100% due to rounding.
^a Variables have < 5% of data as missing, do not know, or refused values.
^b Variables have < 10% of data missing, do not know, or refused values.

Table 3
Unadjusted and adjusted odds ratios of regular exercise (7 days) among children 6–17, NSCH 2011–2012.

Characteristics	7 days of exercise	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Depression status		
Current depression	0.75 (0.57, 0.99)	0.75 (0.56, 1.00)
Former depression	0.89 (0.63, 1.25)	1.09 (0.76, 1.57)
Never depression	1.00 (ref)	1.00 (ref)
Age		
6 to 11 years	1.00 (ref)	1.00 (ref)
12 to 17 years	0.47 (0.43, 0.51)	0.46 (0.42, 0.50)
Sex		
Female	0.64 (0.59, 0.69)	0.62 (0.57, 0.68)
Male	1.00 (ref)	1.00 (ref)
Race/ethnicity		
White, non-Hispanic	1.00 (ref)	1.00 (ref)
Black	0.95 (0.85, 1.07)	0.92 (0.81, 1.05)
Hispanic	0.69 (0.61, 0.79)	0.64 (0.55, 0.75)
Other	0.91 (0.80, 1.03)	0.86 (0.75, 0.98)
Poverty line		
< 100%	1.18 (1.06, 1.32)	1.45 (1.26, 1.66)
100–199%	1.15 (1.03, 1.29)	1.24 (1.10, 1.40)
200–399%	1.11 (1.00, 1.22)	1.10 (0.99, 1.22)
≤ 400%	1.00 (ref)	1.00 (ref)
Education		
< High school	0.71 (0.60, 0.84)	0.70 (0.58, 0.85)
= High school	1.09 (0.98, 1.21)	1.02 (0.91, 1.14)
> High school	1.00 (ref)	1.00 (ref)

their male counterparts (Table 4).

4. Discussion

This study explored the relationship between depression status and weekly exercise habits in children ages 6 to 17 using a nationally representative sample. The results of the study indicate that children age

12 to 17 and females are at heightened risk of physical inactivity when currently depressed compared to never-depressed younger children and males. The results of each of the four models supported these findings; both age-stratified models found females had lower odds of exercising daily compared to males and both sex-stratified models found that children age 12 to 17 were at decreased odds of exercising every day compared to younger children. These results are of concern as females and adolescents are already at-risk for inadequate exercise, which appears to be further exacerbated by depression (Breslin et al., 2012; Colley et al., 2011; Eaton et al., 2012; Wilk et al., 2018).

Published results have been mixed on whether depression is a predictor of physical activity levels in children (Adamo et al., 2009; Da Silva et al., 2012; Fulkerson et al., 2004; Gunnell et al., 2016; Jerstad et al., 2010; Neumark-Sztainer et al., 2003; Roshanaei-Moghaddam et al., 2009; Wichstrøm et al., 2013; Zahl et al., 2017). These diverse results could be due to varying classifications and measures of physical activity levels and depression status. The majority of research reporting on the relationship between depression and exercise were longitudinal studies (Da Silva et al., 2012; Gunnell et al., 2016; Jerstad et al., 2010; Neumark-Sztainer et al., 2003; Roshanaei-Moghaddam et al., 2009; Wichstrøm et al., 2013; Zahl et al., 2017), whereas the current study utilized cross-sectional data. The results of this study were similar to multiple longitudinal studies that found a negative association between depression and physical activity with depression as the predictor variable (Gunnell et al., 2016; Jerstad et al., 2010; Roshanaei-Moghaddam et al., 2009; Wichstrøm et al., 2013). However, a portion of the published data on this topic found only a modest relationship for females and adolescents (Gunnell et al., 2016; Jerstad et al., 2010; Wichstrøm et al., 2013). Additionally, none of the published research appears to have looked at the effects of former depression on physical activity, instead focusing on current depression or varying degrees of depressive symptoms (Adamo et al., 2009; Da Silva et al., 2012; Fulkerson et al., 2004; Gunnell et al., 2016; Jerstad et al., 2010; Neumark-Sztainer et al., 2003; Roshanaei-Moghaddam et al., 2009; Wichstrøm et al., 2013; Zahl et al., 2017).

Table 4
Adjusted odds ratios of regular exercise (7 days) among children 6–17 stratified separately by age and sex, NSCH 2011–2012.

Characteristics	7 days of exercise			
	Age model		Sex model	
	Age 6–11	Age 12–17	Female	Male
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Depression status				
Current depression	1.47 (0.88, 2.46)	0.48 (0.35, 0.66)	0.63 (0.42, 0.94)	0.85 (0.58, 1.25)
Former depression	1.64 (0.94, 2.86)	0.91 (0.56, 1.48)	0.88 (0.56, 1.38)	1.24 (0.75, 2.05)
Never depression	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Age				
6 to 11 years			1.00 (ref)	1.00 (ref)
12 to 17 years			0.40 (0.35, 0.46)	0.51 (0.45, 0.57)
Sex				
Female	0.69 (0.62, 0.78)	0.54 (0.47, 0.61)		
Male	1.00 (ref)	1.00 (ref)		
Race/ethnicity				
White, non-Hispanic	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Black	0.94 (0.79, 1.12)	0.88 (0.73, 1.07)	1.02 (0.83, 1.25)	0.83 (0.71, 0.98)
Hispanic	0.65 (0.53, 0.78)	0.64 (0.51, 0.80)	0.64 (0.51, 0.79)	0.65 (0.53, 0.79)
Other	0.87 (0.74, 1.03)	0.84 (0.67, 1.06)	0.82 (0.68, 0.99)	0.89 (0.74, 1.08)
Poverty line				
< 100%	1.44 (1.20, 1.74)	1.43 (1.16, 1.77)	1.63 (1.33, 2.01)	1.32 (1.09, 1.59)
100–199%	1.30 (1.10, 1.52)	1.17 (0.96, 1.41)	1.29 (1.07, 1.55)	1.21 (1.03, 1.42)
200–399%	1.10 (0.96, 1.27)	1.10 (0.94, 1.28)	1.18 (1.01, 1.38)	1.05 (0.91, 1.20)
≤ 400%	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Education				
< High school	0.64 (0.50, 0.81)	0.81 (0.60, 1.11)	0.63 (0.48, 0.83)	0.75 (0.58, 0.98)
= High school	1.07 (0.91, 1.26)	0.95 (0.81, 1.12)	1.04 (0.87, 1.24)	1.00 (0.87, 1.16)
> High school	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)

Some limitations of the current study include parent-reported data, inability to establish temporality, exposure distribution, and missing data. The exposure, outcome, and all confounders were reported by the parents of the children and not through an objective measure. Parent-reported data may have led to misclassification of both exposure and outcome due to parents not wishing to disclose that their child has depression or exercises infrequently. Parent-reported physical activity measures have been shown to overestimate children's actual physical activity levels roughly 72% of the time (Schmitz et al., 2002). However, an overestimation by parents on the reported number of days a child exercised would artificially bias the results toward the null and the results were significant even with this possible bias. Regarding temporality, due to the cross-sectional nature of the study, the temporal relationship between regular exercise and depression status was unable to be determined. However, the exercise variable data was collected on exercise habits in the week prior to the survey in which it is unlikely a child's depression status changed. Another possible limitation was the study population may not have reflected the general population of 12 to 17 year-olds as the percentage of adolescents with a current or lifetime diagnosis of depression was on the lower-end of the range reported in the literature (Mojtabai et al., 2016; Perou et al., 2013). Estimates for the lifetime prevalence of depression for adolescents ranged between 7 and 12% (Mojtabai et al., 2016; Perou et al., 2013). An explanation for why this study's estimate is on the lower end of the range could be due to the estimates being derived from parent-reported data. Studies that used self-report or directly tested adolescents for depression tended to have a higher prevalence of depression due to either children not telling parents about their depression or cases of depression not captured in clinician offices (Mojtabai et al., 2016; Perou et al., 2013). This hypothesis is supported by the fact that the estimates from this study are similar to the estimates from the 2007 NSCH of 7.1% and 3.5% of adolescents having any diagnosis of depression and having a current diagnosis of depression (Perou et al., 2013).

4.1. Conclusion

Future research should determine effective interventions to increase physical activity in depressed females and adolescents. Interventions do exist for children with depression to increase their physical activity however, there is a need for more high-quality studies on these interventions (Brown et al., 2013). In the meantime, healthcare workers should educate currently-depressed female and adolescent children and their parents of the increased risk for inadequate exercise. Interventions tailored to female children and adolescents, including school-based interventions, should be implemented or maintained to mitigate depressive symptoms and keep depressed children physically active until interventions tailored to the currently depressed among this population can be developed.

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Conflicts of interest

None.

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