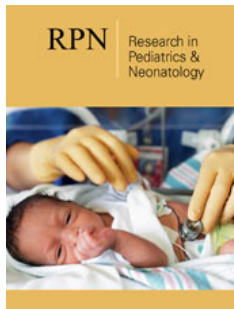



Physical Activity and Flourishing in Adolescents in a Nationally Representative Sample

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Abstract

Most adolescents do not meet the requirements outlined in the physical activity guidelines for Americans. A lack of physical activity not only increases the likelihood of negative health outcomes, but it is also linked to a decrease in positive health outcomes. One such outcome that physical activity has been shown to impact is flourishing. Using data from the national survey of child health, we explored flourishing in adolescents (12-17 years) who did and did not meet the national guideline of 60 minutes of daily moderate-to-vigorous physical activity. Only 15.9% of adolescents in the study met the guidelines. There was an association between flourishing and physical activity. Compared to adolescents who are physically active every day, those who do not participate in physical activity were 4.13 times less likely to flourish, and those who were physically active 1-3 days a week were 1.84 times less likely to flourish. There was no significant difference between those who were physically active 4-6 days a week and those who participated in physical activity daily. These findings underscore the urgent need to encourage adolescents to be more physically active and may have notable impacts on future research and policy related to physical activity.

Keywords: Physical activity; Children; Adolescents; Flourishing

Introduction

Physical activity and adolescent flourishing in a nationally representative sample

The current physical activity guidelines for Americans state that all children and adolescents aged between 6 and 17 years should be active for at least 60 minutes a day, seven days a week [1]. The type of physical activity an adolescent engages in should be of moderate-to-vigorous intensity with aerobic activities, muscle-strengthening activities, and bone-strengthening activities each being done at least three times per week. However, despite major public health campaigns that emphasize the importance of meeting these guidelines, it is estimated that only about a quarter of American adolescents reach this benchmark [2-4]. Moreover, there appears to be a sex-based discrepancy in meeting the guidelines, with adolescent females even less likely to meet these guidelines [4]. There are several well-documented reasons why so many adolescents fall short of the guidelines, including limited access to physical activity facilities, a lack of opportunities to participate in appropriate physical activity during school hours, and insufficient knowledge of the guidelines by the adolescents themselves as well as their parents or caretakers [5].

Physical activity and health outcomes

A lack of physical activity has been shown to have many short- and long-term negative effects on children and adolescents' health [6]. In the short term, physical inactivity is a major risk factor for the top chronic diseases that impact pediatric populations including diabetes, obesity, and mental illness [7]. Obesity, for example, has a childhood prevalence rate in the

United States of around 20%, with adolescents (aged between 12 to 19 years) more likely to be obese than younger children [8]. Numerous large studies, systematic reviews, and meta-analyses have identified physical inactivity as a risk factor for obesity, and physical activity as a protective factor against obesity [9,10]. It's important to note that physical activity is not only important for children and adolescents who are overweight and obese. Studies have also shown that a lack of physical activity can be just as detrimental to the health of a young person who has a BMI within normal limits [11].

Physical activity participation not only has an impact on physical health, but it has also been shown to play a big role in mental health. A 2019 systematic review and meta-analysis found a significant overall effect of physical activity on the mental health of children aged between 6 and 18 years [12]. Other meta-analyses have reported similar findings. For example, a 2011 study found that the overall effects of physical activity on children and adolescents' mental health were significant regardless of the characteristics of the participants or study methodology [13]. Specifically in adolescent populations physical activity has been shown to reduce the symptoms of the most common mental health disorders in this population, depression and anxiety [14].

In the long term, physical inactivity in childhood has been linked to many of the major chronic illnesses and the World Health Organization [15] has named insufficient physical activity as the fourth leading risk factor for mortality in adolescents and adults [4]. It is widely reported that physical activity reduces with age and that physical activity levels during childhood and adolescence are predictive of physical activity throughout adulthood [16]. Therefore, the importance of establishing healthy physical activity habits in childhood and adolescence should not be underestimated as studies have shown that there is a biological carry-over effect from childhood physical activity and adult health outcomes [17].

The importance of physical activity has not only been shown through the risk associated with physical inactivity, participation in physical activity has also been shown to facilitate several positive health outcomes for adolescents. For example, one 2018 study reported a positive relationship between physical activity and health-related quality of life for adolescents living with a chronic disease [18]. A systematic review of studies on the relationship between physical activity and health status in adolescents found that in a majority of studies (81%), physical activity improved self-reported health status [19]. Moreover, multiple studies found that this relationship persisted over time with improved self-reported health status reported into adulthood. This systematic review also highlighted that some physical activity, even when it does not meet the recommended guidelines, significantly improved self-reported health status.

Physical activity guidelines

The physical activity guidelines are created and maintained by the U.S. Department of Health and Human Services [1] and are informed by a series of systematic reviews of the latest scientific literature on physical activity and health outcomes. The primary

goals of the guidelines are to inform the public about the importance of physical activity and to provide concrete guidance as to the type and frequency of physical activity necessary for positive health outcomes [1]. The primary audience for the guidelines is health professionals and policymakers who are tasked with disseminating the information to parents, teachers, and other caretakers, as well as the pediatric population to which they apply.

Flourishing and physical activity

A vast majority of the literature on physical activity in childhood and adolescence focuses on the need to engage in physical activity to avoid negative outcomes and there is substantially less literature that focuses on positive health indicators [20]. One positive health indicator that has been linked to physical activity participation is flourishing. There is no single definition of flourishing, instead, it is a broad term that refers to the reduction in negative functioning and an increase in positive functioning [21]. Essentially, flourishing is a combination of increased emotional, psychological, and social well-being, and a reduction in negative outcomes.

A small number of studies have linked flourishing and physical activity. One 2020 study found that 20 minutes of vigorous physical activity per day significantly predicted flourishing in a sample of American adolescents [22]. Another recent study looked at flourishing in adolescents with obesity and found that adolescents who participated in any amount of physical activity weekly, even below the amount recommended by the guidelines, were significantly more likely to flourish compared to their peers who did not participate in any physical activity [23]. A 2018 study looked at the factors associated with parent-perceived flourishing and found that physical activity and access to neighborhood amenities like parks, sidewalks, and recreation centers were significantly associated with flourishing [24]. Finally, a 2022 narrative review found that physical activity during adolescence may improve resilience and self-regulation and reduce the risk of mental health conditions [20].

Aim and Objective

In light of the small number of studies on physical activity participation and positive health indicators, this study aimed to use a large, nationally representative sample to examine whether adolescents who did not meet the recommended amount of weekly physical activity participation were less likely to flourish than their peers who did meet the recommendation. The overall framework that guided this study was developmental systems theory, with development being considered a result of dynamic, bidirectional interactions between genes and environments across a number of systems [25]. We hypothesized that adolescents who met the guidelines (60 minutes of moderate-to-vigorous activity, seven days a week) would be more likely to flourish than those who did not meet the guidelines.

Methods

Data: Data was taken from the cross-sectional, nationally representative 2018-2019 National Survey of Children's Health (NSCH). The survey was funded by the United States Health

Resources and Services Administration (HRSA) and run by the United States Census Bureau. Data was collected via online and mailed surveys from randomly sampled households across the United States with at least one child between 0 and 17 years [26]. Data is publicly available online free of charge.

Participants: This study was limited to 12 -17-year-olds (N = 24,554) with the sample being made up of 12,525 males (52.2%) and 11,457 females (47.8%). Sociodemographic factors of the selected sample included the child's sex, race/ethnicity, poverty level, and access to neighborhood amenities.

Variables and measures

Physical activity status groups: Physical activity participation was determined based on parent response to the 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 minutes?" Responses to this question were coded as both a four-level item (1 - "0 days", 2 - "1-3 days", 3 - "4-6 days", and 4 - "Every day") and a two-level item (1 - "0- 6 days" and 2 - "Every day"). The two-level item is representative of those who met the physical activity guidelines of 60 minutes of daily exercise and those who did not.

Flourishing categories: Overall flourishing, as determined by parent report, was the outcome variable of the study. Responses to three separate items (shows interest and curiosity in learning new things, works to finish tasks they start, and can stay calm and in control when faced with a challenge) were used together to measure overall flourishing. Each item was coded as 1- "Always", 2- "Usually", 3- "Sometimes", and 4- "Never." Overall flourishing was coded as both a three-level item (1- "Always/usually response to 0-1 items", 2- "Always/usually response to 2 items", and 3- "Always/usually response to all 3 items.") and two-level item (1- "Always/usually response to 0-2 items", 2- "Always/usually response to all 3 items."). The two-level version of overall flourishing was used for logistic regression.

Predictors: Demographic variables used in the study included sex (male/female), and race/ethnicity (White/Non-Hispanic, Hispanic, Black/Non-Hispanic, Other/Multi-racial, non-Hispanic). One family-based demographic variable, family-based poverty level (0-99% Federal Poverty Level [FPL], 100-199% FPL, 200-399% FPL, >400% FPL), was included. One environmental variable, neighborhood amenities, was included. Neighborhood amenities comprised of parks, recreation centers, and sidewalks and was coded as a four-level item (1 - "Neighborhood does not contain any amenities", 2 - "Neighborhoods contains 1 amenity", 3 - "Neighborhood contains 2 amenities", 4 - "Neighborhood contains 3 amenities."). All variables were treated as categorical except poverty level which was treated as ordinal.

Statistical analysis

The analysis was conducted using IBM SPSS 27 [27]. The prevalence in the sample of those who met the physical activity guidelines and those who did not was calculated. We conducted tests of the association of physical activity participation and flourishing using chi-square for categorical variables and Kendall's

tau-b for ordinal variables. A hierarchical binary logistic regression was used for the primary analysis to determine whether physical activity status significantly predicted flourishing over and above demographic covariates (sex, race, poverty level, and neighborhood amenities).

Result

The first research question asked about the proportion of American adolescents aged 12-17 years that met the physical activity guidelines for Americans for daily activity. The estimated proportion who met the guidelines was 15.9%, with 84.1% not meeting the guidelines. Breaking down the portion of the sample who did not meet the guidelines, 12% met the guidelines 0 days a week, 41.4% met the guidelines 1-3 days a week, and 30.6% met the guidelines 4-6 days a week.

The second question asked whether there was an association between physical activity participation status (met guidelines, did not meet guidelines) and overall flourishing in adolescents. The hypothesis was that there would be a significant association between physical activity participation status and flourishing. Figure 1 shows flourishing among adolescents who did and did not meet the physical activity guidelines. There was a significant weak association between two-level physical activity participation status and three-level overall flourishing, $\tau_b(24488) = .071$, $p < 0.001$, which indicates that this association is likely in the population.

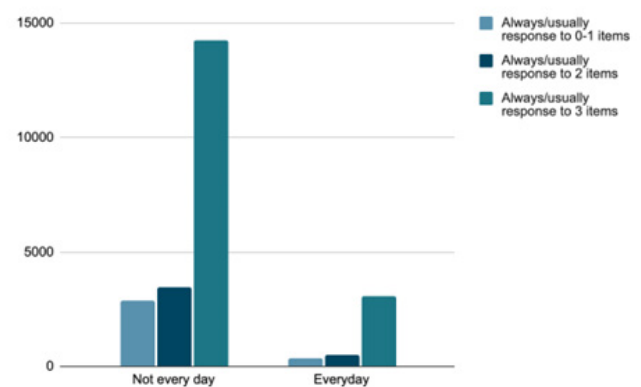


Figure 1: Flourishing in adolescents who did and did not meet the physical activity guidelines.

The association of physical activity participation status and each item that made up overall flourishing was significant in the expected direction: Shows interest and curiosity in learning new things, $\tau_b(24453) = -.107$, $p < 0.001$, a weak association; works to finish the tasks they start, $\tau_b(24453) = -.098$, $p < 0.001$, a weak association; and stays calm and in control when faced with a challenge, $\tau_b(24412) = -.087$, $p < 0.001$, a weak association.

Notably, when looking at the four-level version of physical activity, a similar significant weak association between physical activity participation status and three-level flourishing was found, $\tau_b(24488) = .175$, $p < 0.001$. Figure 2 shows flourishing among adolescents who participated in 60 minutes of moderate-to-vigorous physical activity 0 days a week, 1-3 days a week, 4-6 days a week, and every day.

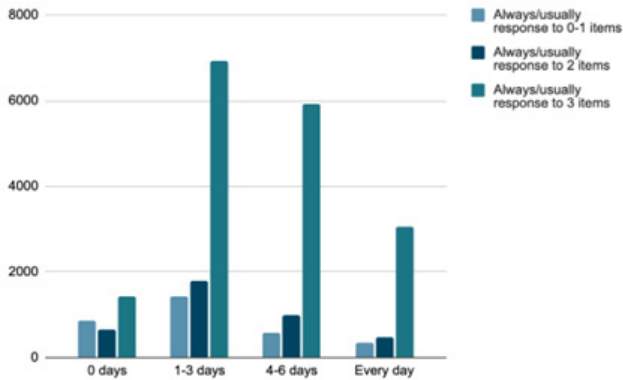


Figure 2: Flourishing in adolescents who did and did not meet the physical activity guidelines (four-level version).

The third research question was whether physical activity participation status would add significant incremental predictive utility in the prediction of flourishing over and above a block of demographic predictors. The hypothesis was that physical activity participation status would provide significant incremental predictive utility over and above a block of demographic predictors. Hierarchical binary logistic regression with two blocks of predictors was used to evaluate a model for predicting flourishing. The first block of predictors consisted of sex, race/ethnicity, poverty level, and neighborhood amenities. Physical activity participation status (using the four-level version of the variable) constituted the second block of predictors.

Initial assumptions of logistic regression (independence of observations, categories of outcome variable and categorical predictor variables mutually exclusive and exhaustive, sufficient ratio of cases per predictor variable [here > 3000:1]) were met.

Table 1: Results of Logistic Regression (full model) reference category.

Variable	b	SE	Wald	p	OR	95% CI	
						Lower	Upper
Constant	1.181	0.065	331.47	<.001	3.256		
Sex (Female)a	-0.406	0.03	182.55	<.001	0.667	0.629	0.707
Race/Ethnicity (White)			21.73	<.001			
Hispanic	-0.106	0.047	5.18	0.023	0.899	0.821	0.985
Black	-0.115	0.059	3.77	0.052	0.891	0.793	1.001
Other/Multi-racial, Non-Hispanic	0.151	0.048	9.79	0.002	1.163	1.058	1.279
Poverty (0-99% FPL)			321.83	<.001			
100-199% FPL	0.212	0.055	15.07	<.001	1.236	1.11	1.375
200-399% FPL	0.469	0.05	88.233	<.001	1.599	1.45	1.764
400% FPL or greater	0.779	0.05	246.293	<.001	2.179	1.977	2.402
Neighborhood Amenities (3 amenities)			32.24	<.001			
0 amenities	-0.198	0.043	21.42	<.001	0.821	0.755	0.892
1 amenity	-0.203	0.044	21.72	<.001	0.816	0.75	0.889
2 amenities	-0.099	0.037	7.11	0.008	0.906	0.843	0.974
Days Engaging in 60 Minutes of Physical Activity (Every Day)			972.71	<.001			

To assess multicollinearity among the predictors, all of which are categorical, the predictor variables were dummy coded, and multiple linear regression was run with these dummy variables to generate VIF and tolerance values. Dummy variables associated with some categories of the poverty level (tolerance = .23, VIF = 4.39) and working poor families (tolerance = .28, VIF = 3.53) variables indicated that these two variables had a potentially problematic degree of multicollinearity. For all other predictor variables, tolerance was > .2 and VIF was < 1.6, indicating an absence of significant multicollinearity. After removing the working poor variable, tolerance was > .6 and VIF was < 1.7 for all predictor variables. Thus, the logistic regression analysis was repeated after excluding the working poor variable. As to the absence of outliers, leverage points, or highly influential points, 285 of 30280/30893 cases (0.92%) had a standardized residual value > 2.5, with 4 of those cases having a standardized residual value > 3.0. This was deemed a negligible portion of the sample; thus, the assumption was met.

Results of the hierarchical logistic regression are provided in Table 1. As expected, both the initial model, which consisted of the first block of predictors (sex, race/ethnicity, poverty level, and neighborhood amenities), $\chi^2(10) = 654.45, p < 0.001$, and the full model, which consisted of the first and second block of predictors (physical activity participation status), $\chi^2(13) = 1645.73, p < 0.001$, significantly outperformed the null model. The Hosmer and Lemeshow test indicated that both the initial, $\chi^2(8) = 12.81, p = .12$, and full model, $\chi^2(8) = 10.22, p = .25$, fit the data appropriately. In addition, a pseudo R^2 measure, used in logistic regression to determine the goodness of fit of a model, yielded Nagelkerke pseudo $R^2 = .038$ for the initial model and Nagelkerke pseudo $R^2 = .095$ for the full model, indicating the full model better predicted flourishing than the initial model.

0 days	-1.419	0.056	648.5	<.001	0.242	0.217	0.27
1-3 days	-0.608	0.046	176.49	<.001	0.544	0.497	0.595
4-6 days	-0.056	0.049	1.29	0.257	0.946	0.858	1.042

As expected, sex, race/ethnicity, poverty level, and neighborhood amenities were all significant predictors of flourishing in the full model. Looking at the odds ratios for pairwise comparisons for sociodemographic and environmental predictors in the full model, almost all were significant with only one exception. For the race/ethnicity variable, comparisons between White and Black ($p = .052$) were not significant.

As expected, the second block of predictors (number of days engaging in 60 minutes of physical activity) provided significant incremental utility in predicting flourishing, $\chi^2(3) = 991.27$, $p < 0.001$. In other words, adding physical activity participation status to the initial model increased the ability of the full model to predict flourishing over and above the other predictors. Classification statistics for initial and full models are shown in Table 1. The addition of physical activity participation marginally increased classification accuracy over the initial model from 70.7% to 71.6%.

Overall, physical activity participation status significantly predicted flourishing, Wald $\chi^2(3) = 972.71$, $p < 0.001$. Using the reciprocal of the odds ratios from Table 1, the odds of not flourishing for adolescents who do not participate in any physical activity is 4.13 times greater than for those who participate in 60 minutes of physical activity every day (OR = 4.13, 95% CI, 3.70 to 4.61). The odds of not flourishing for adolescents who participate in 1-3 days of physical activity a week is 1.84 times greater than for those who participate in 60 minutes of physical activity every day (OR = 1.84, 95% CI, 1.68 to 2.01). Notably, the odds of not flourishing for adolescents who participate in 4-6 days of physical activity a week were almost equal to their peers who participated in daily physical activity and not significant (OR = 1.06, 95% CI, .96 to 1.17).

Discussion

Using secondary data analysis of a nationally representative sample of American adolescents between 12 and 17 years, we found that a lack of physical activity was associated with reduced flourishing. Specifically, adolescents who did not participate in daily physical activity were 4.13 times less likely to flourish than peers who meet the recommended 60 minutes a day of physical activity. Moreover, those adolescents who were only physically active 1-3 days a week, were also significantly less likely to flourish. These findings were not only consistent with our hypothesis that adolescents who met the guidelines for physical activity would be more likely to flourish than those who did not meet the guidelines, but they were also consistent with existing literature which has linked reduced physical activity with reduced flourishing [22,24].

Within the nationally representative dataset used for this study, only 15.9% of adolescents met the guidelines for physical activity (60 minutes of moderate to vigorous activity every day). Looking more closely at the 84.1% who did not meet the guidelines, 12% did not participate in any physical activity, 41.4% participated 1-3

days a week, and 30.6% participated 4-6 days a week. The overall proportion of children who met the physical activity guidelines was slightly lower than the number published by the United States office of disease prevention and health promotion OASH [28], which reported that 20% of adolescents meet the guidelines between 2008-2018 [29]. However, the results of this study are in line with the information in OASH's healthy people 2030 report, in which they classified adolescent physical activity as "getting worse" over the last 5 years and proposed a target of 30% of adolescents meeting the guidelines by 2030 [28].

Data relating to the association between flourishing and the four-level version of the physical activity variable provides a key takeaway from this study. While there was a significant difference in flourishing between those adolescents who participate in physical activity daily and those who do not participate at all or those who participate only 1-3 days, there was not a significant difference between those who participate every day and those who participate most days (4-6 days a week). This is consistent with previous literature which suggests that participating in at least some physical activity can still have positive and meaningful benefits for adolescents [19]. Essentially, our results suggest that those who exercise four or more days a week have a comparable likelihood of flourishing and therefore, the recommendation of seven days a week of exercise may not be necessary to enhance flourishing.

Developmental systems theory guided this study, with the relationship between physical activity and flourishing being acknowledged as complex and multidimensional [25]. The hierarchical logistic regression analysis results showed that all the sociodemographic variables included in the first model (sex, race/ethnicity, poverty level, and access to neighborhood amenities) were significantly associated with flourishing. When physical activity was added, it provided significant incremental utility in predicting flourishing over and above sociodemographic predictors. All the sociodemographic variables included in the model have been shown to be predictors of flourishing in previous literature and therefore it is particularly noteworthy that physical activity was able to significantly increase the classification accuracy of the model [16] (Lounassalo et al., 2019).

Implication-1

The results of this study underscore the need to examine the lack of physical activity among adolescents in the United States. Specifically, the results support the CDC and OASH's findings that physical activity rates are declining, and that urgent action needs to be taken to reduce the risk of negative health outcomes. However, the results of this study are unique in highlighting the need for research to go beyond negative health outcomes or the absence of disease to explore how the decline in physical activity in adolescents is impacting positive health outcomes like flourishing.

Moreover, from a public health perspective, it is important that the impact a lack of physical activity can have on positive health outcomes for adolescents also be communicated effectively to adolescents, parents and guardians, and others involved in the care of those aged 12 to 17 years.

The results also illustrate the need for policymakers to potentially revisit guidelines to consider whether a more flexible approach to physical activity may facilitate equal, or ideally greater, results. This is particularly pertinent given that the last update to the guidelines was made in 2018 and since then, there has been a sharp decline in adolescents who meet the physical activity guidelines [28]. The results of this study found there was a significant difference between those who participated in physical activity daily and those who participated 0-3 days per week. However, there was no significant difference for those who participated 4-6 days per week. Therefore, with the support of additional research on other health outcomes related to physical activity, it may be possible to consider a gentler approach to the guidelines. Additionally, looking to the adult guidelines as an example, guidelines could also be adapted to have a total goal time for physical activity over the course of a week, rather than a daily component to provide a more attainable and sustainable benchmark for adolescents [30].

Limitation-2

The results of this study should be considered with the following limitations. Firstly, since this study utilized a cross-sectional study design, it is limited in its ability to infer a causal pathway between physical activity and flourishing. It is entirely possible that the relationship between these two variables is bi-directional and that a lack of flourishing may result in decreased physical activity participation. Additionally, physical activity and flourishing were based on parent responses to four questions. The question on physical activity specifically only asked parents about physical activity in the last week. There are several factors that could contribute to the response a parent gave to that question, and future research should consider a more controlled and long-term way of evaluating adolescent physical activity.

Conclusion

Ultimately, the findings of this study suggest that meeting the requirements of the physical activity guidelines for Americans can facilitate greater flourishing in adolescents. Those adolescents who do not meet these guidelines, particularly those who participate in three or fewer days of physical activity per week are at increased risk of not flourishing compared to peers that participate in four or more days of physical activity. Therefore, there is a need to promote the importance of physical activity in the promotion of positive health outcomes as well as conduct comparable research on both positive and negative health outcomes to potentially inform changes to the guidelines.

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