

Early and current physical activity: cross-sectional associations with overweight among adults

D.H.C. COLEDAM

Federal Institute of Education, Science and Technology of São Paulo, Boituva, São Paulo, Brazil

Keywords

Adolescence • Body Mass Index • Child • Health • Motor activity

Summary

Introduction. The health benefits of physical activity in all ages are widely known, however the effects of early physical activity on future health are not yet fully understood. The aim of this study was to analyze the cross-sectional associations between previous and current physical activity with overweight among adults.

Methods. A probabilistic sample of 534 teachers was included in the study. Independent variables were physical activity in childhood, adolescence, and current, and clustering of the variables, all analyzed using a self-report questionnaire. The dependent variable was overweight, estimated by the body mass index, assessed using self-report measures of weight and height. Covariates were sex, age, skin color, income, sedentary behavior, medication use for weight control, and nutritionist counseling. Poisson regression

was adopted to estimate Prevalence Ratios (PR) in the multivariate analysis.

Results. Physical activity at ages 6-10 (PR = 1.03 to 1.13), 12-14 (PR = 0.96 to 0.98), and 15-17 (PR = 0.76 to 0.90) years was not associated with overweight. Participants who do not meet the recommendation of current physical activity have a higher likelihood of being overweight (PR = 1.55 to 2.17) and the magnitude of the association increased when analyzing those who were not physically active through all periods analyzed (PR = 3.69 to 4.69).

Conclusion. Performing physical activity only in early life does not seem to promote health benefits in the sample analyzed. Although current physical activity is associated with the outcome, the promotion of both early and current physical activity seems to be a better strategy to prevent overweight among adults.

Introduction

Overweight and obesity is a worldwide epidemic and the prevalence is approximately 40%, although this varies according to the region of the world [1]. The health consequences are widely known and include cardiovascular, metabolic, and musculoskeletal diseases, some types of cancer, depression, anxiety, body dissatisfaction, low self-esteem, a negative self-concept, and poor quality of life [2]. The etiology of overweight is complex and multifactorial and involves environmental, behavioral, biological, and contextual factors that result in a positive energy balance [1-3].

Among behavioral factors, physical activity is an important aspect in the emergence of overweight, independent of age [4-6]. Observational data demonstrated that physical activity is associated with a lower prevalence of overweight and obesity among adults [7, 8]. Results of experimental studies corroborate observational data and indicate that an increase in physical activity reduces weight, the body mass index, and body fat among adults [9]. Any amount of physical activity is encouraged, however, it is recommended that adults perform at least 150 min a week of aerobic physical activity at moderate to vigorous intensity to receive health benefits [4, 5], whereas a higher amount of physical activity \approx 300 min provides additional benefits. In addition to aerobic activity, two or more sessions of muscle-strength-

ening activities of moderate or higher intensity involving major muscle groups are recommended [4, 5].

Although physical activity is recommended to prevent overweight and obesity through life, the effects of physical activity during childhood and adolescence on weight status in adulthood are not yet well understood. Physical activity guidelines do not describe any effects of physical activity in childhood and adolescence on subsequent ages [4, 6, 10]. Information is available describing that early physical activity promotes a lower prevalence of chronic diseases [11-13], carotid intima-media thickness [14], a better metabolic profile [15], and bone health [16-18]. One study showed that extracurricular physical activities reduce the risk of being overweight in adulthood [19]; however data were not adjusted for current physical activity in adult age. Another study showed a negative association between sports practice early in life and body fat [15], but the sample was not classified according to weight status. Besides the information available, the role of physical activity in childhood and adolescence on overweight in adulthood is unclear, as well as whether continuity of physical activity can provide better effects when compared to physical activity in only one period of life.

Investigation of the long-term effect of physical activity during early age on subsequent overweight is relevant since it is a priority in health promotion, and the prevalence has increased over the years independently of age,

sex, or socioeconomic status [20]. Furthermore, overweight is determinant in the etiology of non-communicable diseases as well as some other health disorders [2]. Considering the scarcity of information related to this topic, the aim of this study was to analyze the cross-sectional associations between physical activity during childhood, adolescence, and current, as well as the clustering of these variables with overweight among adults.

Methods

A cross-sectional study with a probabilistic sample of elementary teachers from public schools from Londrina, Paraná, Brazil was carried out in 2014. Information about the characteristics of the city can be found elsewhere [21]. The present study is part of a larger project aiming to investigate the sociodemographic, work condition, and health risk predictors of health service use, medication consumption, absenteeism, and presenteeism. A study was conducted with a representative sample of teachers from 63 schools according to each region of the city (north, south, east, west, and center). All measures were self-reported and assessed using a standardized questionnaire. The study was approved by the Ethics Committee for Research involving human beings of the State University of Londrina, process 118/2014. The guidelines of Resolution N° 466/2012 of the Brazilian National Health Council were followed.

The minimum sample size was estimated using the following parameters: $N = 2.500$, a 50% outcome prevalence, 5% sample error, confidence interval of 95%, and design effect of 1.5, using the software OpenEpi 3.0. A minimum of 500 teachers was required to compose the sample of the study. All schools from the urban region ($N = 74$) were invited to participate in the study and 63 agreed. The proportion of participating schools in relation to the total was 85%. The following eligibility criteria were adopted: a) having been a teacher in municipal schools for at least 1 year and be working in an elementary school; b) not being retired or on medical leave during data collection; c) not having been work relocated (i.e., teacher working as a secretary or in administration). These eligibility criteria were applied as they are derived from the main project described above.

PROCEDURES

Before data collection all participants signed an informed written consent containing the objectives, procedures, risks, and benefits of the study, as well as the researchers' contact details. The project was authorized by the Municipal Education Department who provided permission to conduct the study. All schools that agreed to participate in the study were visited to present the study proposal and obtain authorization from the principals. The purpose and procedures of the study were presented to teachers and data collection was scheduled randomly in the schools where the teachers were enrolled. The participants completed the self-report questionnaire and for those who were absent on the scheduled date, another

data collection was performed. All the procedures were carried out in the school where each teacher worked and performed by the coordinator of the project.

VARIABLES

The dependent variable was overweight and the independent variables were physical activity between 6-10, 11-14, and 15-17 years old, as well as current, and the clustering of physical activity in all ages analyzed. Sex, age, skin color, income, sedentary behavior, medication use for weight control, and nutritionist counseling were the covariates.

Overweight was assessed by the body mass index (weight/height²). Weight and height were self-reported and the cut-off adopted for overweight classification was $\geq 25\text{kg/m}^2$ [22]. The validity of self-report measures of weight and height in adults for classification purposes in epidemiological studies has been described elsewhere [23, 24]. In addition, we conducted a pilot study to analyze the validity of measures (self-report and measured weight and height) with 50 teachers. There was high agreement between data for overweight (Kappa index = 0.864), with relative agreement in 93.5% of cases. The difference in overweight prevalence between predicted and observed values was 2.2%, with a mean difference of 0.16 (-0.32 to 0.64) kg for weight and 0.02 (-0.27 to 0.12) m for height, and there were no statistical differences ($P > 0.05$) between self-report and measured values. Intraclass correlation coefficients were as follows: Weight = 0.98 (0.97-0.99), height = 0.91 (0.83-0.94), body mass index = 0.96 (0.93-0.98).

Current physical activity was assessed with the Brazilian version of the International Physical Activity Questionnaire, details of which can be found elsewhere [25]. The procedures described by Hallal et al. [26] were followed. The domains recreation, sports, exercise, and leisure-time physical activity were used for aerobic activity and the assessment of strength exercise practice was performed through the question: "How many days a week do you perform muscle strengthening exercises?" with response options "0, 1, 2, 3, and ≥ 4 ". The current recommendation of 150 minutes/week of moderate to vigorous physical activity and muscle-strengthening activities on 2 or more days a week was adopted [4, 5]. Physical activity in childhood and adolescence was assessed using the question: "When you were between 6 and 10 years old, how many days a week did you practice physical activity outside of school (supervised or not)" with answer options "none; 1-2 days; 3-4 days; > 5 days". The same question was performed for 11-14 and 15-17 years of age. Participants that reported "3-4 days" or "> 5 days" were considered active. Any type of physical activity commonly performed by children and adolescents in leisure time was considered, such as sports practice, physical exercises, gymnastics, dance, running, walking, swimming, riding a bike, active games, and outdoor play.

Age and skin color were assessed by an open question. Similarly, sedentary behavior was estimated by hours spent watching TV and using a PC: "On a normal day

during leisure time, how much time do you watch TV”, and the same question was asked for PC. Income was estimated according to the values proposed by the questionnaire of the Brazilian Association of Polling Companies [27]. Medication use for weight control was estimated by the question: “Do you regularly use (continuously) any type of medication? Indicate only medicines used under medical prescription during the last six months.” A list of categories of medicine was displayed, including weight control. The response options were “Yes or No”. The question “How many times in the last 12 months have you attended consultations with a nutritionist” was used to assess nutritionist counseling.

Due to the lack of instruments, some variables were assessed by questions that were developed to achieve the aims of the present study (previous physical activity, muscle strength exercise, medication use for weight control, and nutritionist counseling). Some steps were adopted for the development of questions: Proposal of the questions, assessment of the content validity by a panel of experts, and modification of the questions according to suggestions from the experts. Furthermore, a pilot study with 50 elementary teachers was conducted to assess comprehension and the reproducibility of the questions within seven days test-retest. The cut-off for the inclusion of variables in this study were (one-way intraclass coefficient > 0.5 for continuous variables and kappa index > 0.40 for categorical variables).

Descriptive statistics are presented as mean, confidence interval of 95%, and absolute and relative frequency. The comparison of self-report versus measured weight and height was performed by the T-test for independent samples and the Kappa statistic was used to test the agreement between overweight classifications. Reproducibility of measures was performed by the Intraclass Correlation Coefficient for continuous variables and Kappa statistic for categorical variables. The bivariate association between independent variables with overweight was performed by the Chi-Squared test and variables that presented $P < 0.20$ were inserted in multivariate models. Multivariate analysis was conducted using Poisson Regression to estimate Prevalence Ratios (PR) and confidence intervals of 95% (CI95%) considering strata, weight, and primary sample units using the package “survey” of the software STATA 13.0. Statistical significance was set at $P < 0.05$.

Results

Of the 595 participants, 61 teachers were excluded from the study due to incomplete information on the questionnaire. The final sample was composed of 534 teachers, stratified according to region of the city. The respective proportion of teachers in the population and sample were similar according to regions of the city: north (32.8 and 30.8%), south (20.0 and 17.9%), east (20.3 and 18.3%), west (22.1 and 28.0%), and center (4.8 and 4.9%).

The sample was composed of a higher proportion of female teachers, between 30 and 49 years old, middle

and high income, white color, with sedentary behavior for less than 2h, not users of medication for weight control, with no nutritionist counseling, and not physically active in adolescence; not currently active or active in childhood, adolescence, and adulthood physical activity were clustered. The prevalence of overweight was 40.4% (Tab. I).

Table II describes the bivariate association between physical activity at 6-10, 12-14, and 15-17 years old, as well as current physical activity, and the clustering

Tab. I. Characteristics of the sample (n = 534).

Sample characteristics	n (%)
Sex	
Male	25 (4.7)
Female	509 (95.3)
Age	
22 - 29	70 (13.1)
30 - 39	169 (31.6)
40 - 49	210 (39.3)
> 50	85 (15.9)
Income	
Low	83 (15.5)
Middle	235 (44.0)
High	216 (40.4)
Skin color	
White	424 (79.4)
Other	110 (20.6)
Sedentary behavior	
< 2 h	304 (56.9)
≥ 2 h	230 (43.1)
Overweight	
No	318 (59.6)
Yes	216 (40.4)
Medication use for weight control	
No	519 (97.2)
Yes	15 (2.8)
Nutritionist counseling	
No	461 (86.3)
Yes	73 (13.7)
Physically active between 6-10 years old	
No	268 (50.2)
Yes	266 (49.8)
Physically active between 12-14 years old	
No	291 (54.5)
Yes	243 (45.5)
Physically active between 15-17 years old	
No	373 (69.9)
Yes	161 (30.1)
Current Physical activity *	
No	439 (82.2)
Yes	95 (17.8)
Physically active between 6-17 years old and currently active	
No	482 (90.3)
Yes	52 (9.7)

* 150 min of moderate to vigorous aerobic physical activity plus strength activities two times/week.

Tab. II. Association between previous and current physical activity and overweight among elementary teachers.

Variables	Overweight	
	% (CI 95%)	Crude PR (CI 95%)
Physically active between 6-10 years old	P = 0.181	
Yes	46.2 (40.1-52.4)	Reference
No	40.4 (34.6-46.3)	0.86 (0.66-1.12)
Physically active between 12-14 years old	P = 0.069	
Yes	47.6 (41.2-54.0)	Reference
No	39.6 (34.1-45.4)	0.82 (0.63-1.08)
Physically active between 15-17 years old	P = 0.033	
Yes	50.3 (42.5-58.0)	Reference
No	40.2 (35.2-45.3)	0.79 (0.61-1.05)
Current physical activity	P < 0.001	
Yes	23.9 (16.3-33.5)	Reference
No	47.4 (42.7-52.1)	1.98 (1.27-3.08)
Physically active between 6-17 years old and current physical activity	P = 0.002	
Yes	16.1 (7.0-32.6)	Reference
No	44.9 (40.5-49.4)	2.78 (1.15-6.76)

% (CI95%): Relative frequency and confidence interval of 95% for prevalence; PR (CI95%): Prevalence Ratio and confidence intervals of 95%. Bold denotes statistical significance at P < 0.05.

of physical activity of all categories with overweight. A higher prevalence of overweight was found in teachers who do not perform physical activity currently compared to active teachers (47.4 vs 23.9 %, PR = 1.98) and in those who were not classified as active in childhood, adolescence, and currently (44.9 vs 16.1 %, PR = 2.78), P < 0.05.

The multivariate association between independent variables and overweight is presented in Table III. In all models analyzed, teachers who are currently physically inactive (PR = 1.55 to 2.17) and those who were physically inactive between 6-17 years of age and remain inactive currently (PR = 3.69 to 4.69) presented a higher likelihood of being overweight compared to those who

Tab. III. Multivariate association between previous and current physical activity and overweight among elementary teachers.

Variables	Adjusted PR ^a (CI95%)	Adjusted PR ^b (CI95%)	Adjusted PR ^c (CI95%)
Physically active between 6-10 years old			
Yes	Reference	Reference	Reference
No	1.03 (0.76-1.40)	1.12 (0.77-1.62)	1.13 (0.79-1.63)
Physically active between 12-14 years old			
Yes	Reference	Reference	Reference
No	0.98 (0.73-1.31)	0.96 (0.66-1.40)	0.96 (0.66-1.39)
Physically active between 15-17 years old			
Yes	Reference	Reference	Reference
No	0.90 (0.68-1.19)	0.83 (0.61-1.13)	0.76 (0.52-1.10)
Current physical activity			
Yes	Reference	Reference	Reference
No	2.09 (1.43-3.08)	2.17 (1.48-3.19)	1.55 (1.04-2.31)
Physically active between 6-17 years old and current physical activity			
Yes	Reference	Reference	Reference
No	4.69 (1.81-12.17)	-	3.69 (1.36-10.02)

PR (CI95%): Prevalence Ratio and confidence intervals of 95%; Bold denotes statistical significance at P < 0.05;

^a Multivariate analysis adjusted for sex, age, skin color and income;

^b Multivariate analysis adjusted for sex, age, skin color, income, sedentary behavior, medication use for weight control, nutritionist counseling, current and previous physical activity;

^c Variables inserted in model ^b plus the clustering of current and previous physical activity.

are currently active or those who were active in all periods analyzed respectively. Being inactive in any period of childhood or adolescence was not associated with overweight (PR = 0.76 to 1.13).

Discussion

Previous studies have demonstrated that physical activity during early life is associated with a variety of health indicators such as a lower prevalence of chronic diseases [11-13], lower carotid intima-media thickness [14], better metabolic profile [15], bone health [16-18], overweight [19], and body fat [15]. Two hypotheses can explain the long-term benefits of early physical activity. First, the classical model advocates that the practice of physical activity during childhood leads to lower body fatness and higher physical activity in adulthood and consequently prevents future health disorders. Second, in the alternative model the same mechanisms as the classical models occur, however modifications in DNA methylation also occur, which result in future protection for cardiovascular disease and diabetes [12].

In the present study there was no association between previous physical activity and overweight in adulthood, while teachers who reported not being currently active presented a higher likelihood of overweight. These results are not in line with previous studies that described positive benefits of physical activity during childhood on adult health [11-18], including overweight and body fat [15, 19]. On the other hand, the results corroborate those describing the positive effect of current physical activity on overweight [7, 8]. The results suggest that the positive effect of physical activity on body mass and body fat occurs at the period when physical activity is performed, and for this reason, adults who currently practice physical activity have more favorable benefits on overweight compared to those who only performed earlier physical activity. This can be seen through the recommendation of regular physical activity on the prevention of weight regain after initial weight loss [4]. When analyzing the participants who reported physical activity in all periods analyzed, the magnitude of association was more than twofold higher compared to those who were only currently active (PR = 1.55 vs 3.69). This suggests that exposure to higher energy expenditure in all stages of life results in less body fat accumulation in adult life. This finding reinforces in part both classical and alternative models that explain the mechanisms by which long-term benefits of physical activity in childhood occur [12] and indicates that although current physical activity promotes a positive effect on adult health, the benefits are more pronounced if physical activity is performed in more than one period of life.

The association between clustering of physical activity during childhood, adolescence, and current with overweight described in this study has relevant public health implications, however only 9.7% of the participants presented this characteristic (Tab. I). This demonstrates the complexity of physical activity maintenance, which is

affected by multilevel individual, interpersonal, environmental, regional, and global factors [28]. Although there is tracking of physical activity through childhood into adulthood, longer periods of monitoring result in lower stability of physical activity [29] and a decline can be evidenced over time [30]. The same tendency was found in the present study, since the prevalence of participants with three or more days of physical activity in a week at ages 6-10, 11-14, and 15-17 years were 49.8, 45.5, and 30.1%, while 17.8% of the sample met the guideline for current physical activity. This information suggests the need for support for physical activity in various stages of life to achieve higher health benefits as described in the present study.

The following points provide the implications of the present results. First, although there is growing interest regarding the effects of early physical activity on adult health, literature about this topic is still scarce. The results improve knowledge about the benefits of physical activity during childhood and adolescence on overweight among adults and reinforce the need for physical activity promotion in both early and adult life. Although this is a cross-sectional study, the analysis showed that physical activity in more than one period of life can prevent overweight to a greater extent when compared to physical activity performed only in adult ages. This finding is relevant since overweight is determinant in the emergence of a variety of health disorders [1-3] and the prevalence is still increasing from a global perspective [20]. Considering the body of evidence in the literature and in the present study, it is suggested that future guidelines for physical activity include the long-term effects of physical activity performed in childhood and adolescence. Likewise, future studies should investigate this topic using longitudinal designs to confirm findings from cross-sectional studies.

Some limitations should be described to better understand the results of the present study. Regarding the sample, it was composed of elementary school teachers and a higher proportion of females compared to males is a common characteristic of this profession. It is widely described that males present higher physical activity compared to females [31], however the relationship between physical activity and overweight is present in both sexes [32] and is not sex dependent. In the present study, a multivariate analysis adjusted for sex was used to control this limitation. Physical activity during work should also be considered when investigating overweight in a sample of workers. The health effects of leisure time physical activity can be masked in individuals who perform high physical activity during their job due to higher energy expenditure resulting from labor tasks. The sample of the present study was composed of elementary teachers that commonly present high demands in their job, but not related to high energy expenditure. Furthermore, the prevalence of both overweight and physical activity of the sample studied was similar to the general population [1, 31], which enables generalization of the present results.

Another limitation is that the instruments used to assess physical activity were self-reported and there is an inherent bias of recall when using questionnaires. In addition, isolated questions were elaborated for the present study to estimate physical activity in childhood and adolescence. Unfortunately, there is no questionnaire to assess previous physical activity and isolated questions are often used [11, 12, 14-16, 19]. To minimize this limitation, the construct validity and reproducibility of the questions were tested. The period for which physical activity was assessed should also be discussed; childhood, adolescence, and current physical activity. However, the sample is heterogeneous regarding age (22 to 66 years), which together with the cross-sectional study design, prevents accurate estimation of physical activity between the beginning of adult life and the current period, as well as understanding of the influence of the disruption of an active life in the adult period on the associations. The consequence of this limitation for the present results was that the magnitudes of the associations were probably attenuated. The absence of measures of the body mass index during childhood and adolescence is another limitation that should be considered, since it is a predictor of adult overweight [33]. Although the cross-sectional design can be considered a limitation of the present study, it is an alternative to longitudinal designs which are expensive and require decades of follow-up. The present study is based on the conceptual model of the relationship between physical activity and overweight, a phenomenon widely described in both observational and experimental studies [7-9], which reduces the probability of bias, common when investigating variables that are not yet well understood.

Conclusion

In summary, self-reported physical activity during childhood and adolescence was not associated with overweight in adulthood. Individuals who were not currently engaged in physical activity presented a higher likelihood of being overweight, while not being physically active in childhood, adolescence, and currently increased the magnitude of the association. Although current physical activity is associated with the outcome analyzed, promoting both early and current physical activity seems to be a better strategy to prevent overweight among adults. However, the absence of information regarding physical activity in all periods of adult life prevents understanding of how discontinuity can influence the associations between physical activity and overweight, and, thus, this should be considered in future studies.

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Conflict of interest statement

The author declares no conflict of interest.

Authors' contributions

DHCC conceived and coordinated the project, worked on the study design, data collection, analysis and interpretation, drafting, critical review and final approval of the manuscript.

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Correspondence: Diogo Henrique Constantino Coledam, Federal Institute of Education, Science and Technology of São Paulo, 100 Zélia de Lima Rosa av. Boituva, São Paulo, Brazil - Tel. +55 15 33638610 - E-mail: diogohcc@yahoo.com.br

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