The effects of physical activity during childhood, adolescence, and adulthood on cardiovascular risk factors among adults

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SUMMARY

OBJECTIVES: *To analyze the association between physical activity during life and cardiovascular risk factors among adults.*

DESIGN: *The sample was composed of 101 adults (59 men) between 30 and 50 years old, who were recruited from different gyms and from a University in Brasil. Participants were divided according to their engagement in sports in early life (self-reported) and current physical activity (pedometer) (sports participation during childhood/adolescence and currently active [n=26], sports participation during childhood/adolescence and currently inactive [n=26], and control [n=49]). Cardiovascular risk factors were measured, such as body fat (through DXA), HDL-C, triglycerides, HOMA index, systolic blood pressure, diastolic blood pressure, and C-reactive protein. We adopted the covariates of chronological age, sex, alcohol consumption, tobacco, and body mass index. General estimating equations were used, with p<0.05. Results: After the adjustments of the final model, individuals engaged in sports during childhood and adolescence and inactive during adulthood presented lower body fat, when compared to participants persistently inactive (p<0.001). Participants persistently active presented lower body fat (p<0.001) and lower c-reactive protein (p=0.010) when compared to the control group.*

CONCLUSION: *Early sports participation was associated with reduced body fat, and being physically active throughout life was associated with reduced body fat and C-reactive protein.*

KEYWORDS: *Motor activity. Sports. Chronic disease. Exercise.*

INTRODUCTION

Physical activity is recognized as a protective factor for several diseases during adulthood[1-3]. Physical activity during childhood and adolescence can also affect cardiovascular diseases, through indirect pathways, as the maintenance of physical activity practice, or protecting against morbidities developed during childhood and adolescence, and prolonged to adulthood[4-5]. However, recent evidence

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highlights a possible direct association between physical activity during early ages and cardiovascular diseases during adulthood, particularly through epigenetics[5-6].

Similarly, in addition to the association between early physical activity and prospective cardiovascular outcomes through direct pathways[2,7], the literature has shown that the benefits can be greater among individuals who remain active throughout life[8]. However, this issue is not clear among adults.

In this sense, our aim was to analyze the association between physical activity during childhood, adolescence, and adulthood, and cardiovascular risk factors among adults.

METHODS

Sample

The present study has been carried out in Presidente Prudente, a middle-sized city located in the western region of Sao Paulo State, Brasil. The sample comprised 122 adults (69 men and 53 women), aged between 30 and 50 years old who were recruited in fitness clubs (spread out in different regions of the city) and in the campus of the Sao Paulo State University (fitness clubs, *n* = 100; university staff, *n* = 22). The sample size calculation was based on an equation for correlation, which indicated the need to evaluate at least 114 subjects to detect correlation coefficients of $r = 0.26$, with a power of 80% and a statistical significance of 5%.

To participate in the study, the individuals fulfilled all inclusion criteria previously established: (i) Sports participation in early life (both childhood and adolescence) or absence of sports participation in early life (control group); (ii) aged between 30 and 50 years old; (iii) no previous history of stroke or infarction; (iv) no amputation or visual impairment due to diabetes mellitus. Due to missing data, 15 (five men) individuals were excluded from the sample; moreover, six individuals were excluded because they did not practice physical activity during childhood and adolescence and became physically active during adulthood. All participants agreed to participate and signed a consent form. The study protocol was previously approved by the Research Ethics Committee of the University. More detailed procedures were previously published[9]. Thus, the final sample included 101 subjects (59 men and 42 women).

Early sports participation and current physical activity

Early sports participation, which comprised the period of childhood and adolescence, was assessed by two questions: 1) "Outside of school, did you engage in any organized/supervised sports for at least one year between agews seven and ten?"; 2) "Outside of school, did you engage in any organized/supervised sports for at least one year between the ages of 11 and 17?". Early sports participation was adopted as one of the inclusion criteria of the study; therefore, only participants who responded "yes" or "no" to both questions were included in the study.

Current physical activity (Current-PA) was monitored using a pedometer (Digi- Walker Yamax, SW200) for seven consecutive days. At the end of each day, the participant recorded the number of steps accumulated, and, in the following morning, the device was reset to start a new count. The mean number of steps of the week was used in the analyses.

Body fat

Body fat was estimated through the use of a Dual Energy X-ray Absorptiometry device (DXA) (Lunar Model – DPX-NT General Electric [GE]®). Body fat was expressed in percentage (%BF) using a GE Medical Systems Lunar software, version 4.7.

Cardiovascular risk factors

The measurement of systolic (SBP) and diastolic blood pressure (DBP) were performed according to the Brazilian guidelines of hypertension[10]. The participants were evaluated three times with an interval of one minute between each measurement. The final value of blood pressure was the average of the last two measurements.

To measurement of metabolic variables and inflammatory marker (high sensitive C-reactive protein [hsCRP]), collection of blood samples and biochemical analyses were performed in a private laboratory that met the criteria of standardization and quality control adopted by the Brazilian Health Ministry. Blood samples were collected after a fasting period of 12 hours. To calculate the HOMA-IR (Homeostatic Model Assessment-Insulin resistance), we used the dosage of fasting blood glucose (mmol/L) and insulin (IU/mL) applying the formula: HOMA-IR = (Fasting glucose * insulin) ÷ 22.5 [11]. To measure the fasting glucose, total cholesterol (TC), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C), an enzymatic colorimetric kit processed in an Autohumalyzer A5 unit was used.

Covariates

Current smoking (yes or no) and alcohol consumption (weekly consumption) were accessed through a face-to-face interview. To estimate body mass index, we measured height using a stadiometer (Standard, Sanny®, Brasil), with a precision of 0.1cm and body mass was measured using a digital scale (PL 200, Filizola, Brasil), with a precision of 0.1kg.

Statistical analyses

Descriptive statistics was composed of mean and standard deviation. The Mann-Whitney test was used to compare groups, while general estimating equations (GEE) were used to compare individuals with early sports participation and physically active, early sports participation and physically inactive, and no sports participation and physically inactive, adjusted by covariates. Statistical significance (p-value) was set at 0.05, and the statistical software STATA (version 15.1) was used in all analyses.

RESULTS

The final sample included 101 adults (59 men) between 30 and 50 years old; the characteristics of the sample are presented in Table 1. In general, men presented higher systolic blood pressure ($p<0.001$), diastolic blood pressure ($p<0.001$), and triglycerides ($p=0.001$), and lower HDL-C ($p<0.05$). On the other hand, women presented more body fat ($p<0.001$).

General estimating equation models of the association between cardiovascular risk variables and physical activity maintenance patterns are presented in Table 2. Model 1 is adjusted by chronological age and sex. Both the group of physical activity only during childhood and adolescence and the group of physical activity during childhood/adolescence and adulthood presented lower body fat (%), Triglycerides, HOMA, and C-reactive protein as well as greater HDL-C ($p<0.001$) compared to the control group.

After the first set of analyses, models were also adjusted by other covariates (tobacco smoking, alcohol consumption, and BMI) (model 2). The variables that remained significant were body fat, triglycerides, and HOMA. The C-reactive protein was significantly lower only for the group of individuals physically active during childhood, adolescence, and adulthood. After this, significant values from model 2 were included as covariates in model 3 (body fat, triglycerides, HOMA, and C-reactive protein) in addition to the other covariates. The group of physical activity during childhood and adolescence but not during adulthood, and the group of physical activity during childhood, adolescence, and adulthood presented lower body fat (Wald=54.91; $p<0.001$). On the other hand, only the group of physical activity during childhood, adolescence, and adulthood remained with lower C-reactive protein (Wald=9.16; $p=0.010$).

DISCUSSION

Our main findings were that after the adjustment for all covariates, individuals who were physically active during childhood and adolescence, but were not physically active during adulthood, presented lower body fat when compared to the control group, while the group engaged in sports during childhood and adolescence, and still physically active during adulthood, presented lower body fat and C-reactive protein when compared to the control group.

This finding is consistent with the classic hypothesis that physical activity during childhood and adolescence can affect later body composition through modifications in body fat induced during the early ages and prolonged to adulthood[4,5,12]. Also, concerning the direct association of early sports participation with reduced body fat, physical exercise can promote DNA methylation in some genes associated with body adiposity[13], having a direct association in this path.

On the other hand, only the group with physical activity during childhood, adolescence, and adulthood presented lower C-reactive protein. This finding can be explained because C-reactive protein is more dependent on the current levels of physical activity[14], especially because C-reactive protein is an indicator of the actual inflammation process. In this sense, the role of previous physical activity should pass through the maintenance of physical activity from childhood to adulthood[2]. Another potential mechanism of this association should be body-fat maintenance throughout life, which is an important factor related to C-reactive protein[15], and, in our study, presented association

TABLE 1. CHARACTERISTICS OF THE SAMPLE (N=101).

Variables	Men (n=59)	Women (n=42)	p
Chronological age (years)	39.3 ± 5.8	40.2 ± 6.8	**0.513**
BMI (kg/m^2)	27.2 ± 3.8	25.3 ± 5.0	**0.004**
Body fat (%)	27.3 ± 8.2	37.3 ± 10.9	**<0.001**
Systolic blood pressure (mmHg)	117.3 ± 9.8	104.5 ± 11.9	**<0.001**
Diastolic blood pressure (mmHg)	81.4 ± 5.5	74.8 ± 7.6	**<0.001**
HOMA (score)	1.63 ± 1.36	1.27 ± 0.91	**0.148**
HDL-C (mg/dL)	47.1 ± 9.9	58.9 ± 12.1	**<0.001**
Tryglicerids (mg/dL)	142.0 ± 100.0	87.7 ± 43.7	**0.001**
C-reactive protein (mg/dL)	2.90 ± 3.40	3.69 ± 4.55	**0.959**
Mean number of steps (n)	8,314 ± 3,494	8,324 ± 3,399	**0.995**
Current physically active (%)	25.4%	27.9%	**0.931**
Early sports practice (%)	54.2%	46.5%	**0.512**
Tobacco smoking (%)	6.8%	0%	**0.085**
Alcohol drinking (≥2x week) (%)	20.3%	11.9%	**0.264**

Values are presented in means and standard deviations BMI, body mass index.

TABLE 2. GENERAL ESTIMATING EQUATIONS OF THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY PATTERNS AND CARDIOVASCULAR RISK FACTORS (N=101).

	Physical activity patterns				
	Control (n=49)	Early practice / inactive (n=26)	Early practice / active (n=26)		
	Mean (95%CI)	Mean (95%CI)	Mean (95%CI)	Wald	p
Model 1					
Body fat (%)	37.8 (36.3 to 39.5)	26.0 (23.5 to 28.7)[a]	23.6 (21.0 to 26.6)[a]	90.21	<0.001
HDL-C (mg/dL)	47.6 (45.3 to 50.1)	55.3 (51.1 to 59.8)[a]	55.7 (51.8 to 60.0)[a]	16.77	<0.001
Triglycerides (mg/dL)	144.3 (125.3 to 166.3)	84.0 (71.8 to 98.3)[a]	90.9 (70.1 to 117.8)[a]	27.76	<0.001
HOMA (score)	2.06 (1.71 to 2.47)	0.95 (0.78 to 1.15)[a]	0.87 (0.74 to 1.02)[a]	54.01	<0.001
Systolic blood pressure (mmHg)	113.8 (110.8 to 116.9)	110.3 (106.5 to 114.2)	109.5 (106.0 to 113.0)	4.09	0.130
Diastolic blood pressure (mmHg)	79.8 (77.8 to 81.8)	78.1 (76.3 to 79.9)	76.7 (74.4 to 79.1)	4.10	0.129
C-reactive protein (mg/dL)	4.76 (3.69 to 6.13)	2.20 (1.22 to 3.98)[a]	1.30 (0.85 to 1.98)[a]	29.11	<0.001
Model 2					
Body fat (%)	35.0 (33.7 to 36.4)	27.48 (25.5 to 29.7)[a]	24.72 (22.7 to 26.9)[a]	66.65	<0.001
HDL-C (mg/dL)	49.1 (46.6 to 51.8)	53.5 (49.6 to 57.8)	53.8 (50.3 to 57.7)	4.89	0.087
Triglycerides (mg/dL)	132.3 (118.4 to 147.8)	89.63 (75.8 to 105.9)[a]	96.03 (73.7 to 125.1)[a]	15.64	<0.001
HOMA (score)	1.67 (1.44 to 1.93)	1.07 (0.90 to 1.27)[a]	1.01 (0.85 to 1.21)[a]	17.66	<0.001
Systolic blood pressure (mmHg)	110.7 (108.1 to 113.3)	113.0 (108.8 to 117.3)	112.14 (109.1 to 115.3)	0.85	0.654
Diastolic blood pressure (mmHg)	78.8 (76.9 to 81.1)	78.98 (76.9 to 81.1)	77.48 (75.3 to 79.8)	1.16	0.560
C-reactive protein (mg/dL)	4.08 (3.18 to 5.22)	2.41 (1.35 to 4.31)	1.44 (0.95 to 2.18)[a]	17.51	<0.001
Model 3					
Body fat (%)	34.8 (33.3 to 36.3)	27.5 (25.6 to 29.5)[a]	24.9 (22.9 to 27.1)[a]	54.91	<0.001
HDL-C (mg/dL)	-	-	-	-	-
Triglycerides (mg/dL)	126.7 (107.7 to 149.1)	92.1 (77.6 to 109.3)	98.4 (72.5 to 133.5)	5.47	0.065
HOMA (score)	1.43 (1.24 to 1.66)	1.18 (1.02 to 1.37)	1.14 (0.97 to 1.34)	4.11	0.128
Systolic blood pressure (mmHg)	-	-	-	-	-
Diastolic blood pressure (mmHg)	-	-	-	-	-
C-reactive protein (mg/dL)	4.12 (2.83 to 5.99)	2.13 (1.47 to 3.09)	1.33 (0.77 to 2.29)[a]	9.16	0.010

Notes. Model 1: Adjusted for sex and chronological age. Model 2: Model 1 + tobacco smoking, alcohol consumption, and body mass index. Model 3: Model 2 + Body fat, triglycerides, HOMA, and C-reactive protein. a = p<0.05 vs. control. CI = confidence interval. Significant differences in bold with both groups (physical activity in early life but not currently, and physical activity throughout life).

Regarding the strength of our study, the adjustment of the analysis by several potential confounders, as well as the approach of adopting physical activity maintenance patterns, are the most important factors. On the other hand, our findings should be inferred with caution due to some limitations, such as reduced sample size, which did not allow us to stratify the results by sex, retrospective design, which can reduce causal inference due to super estimation of previous sports engagement, as well as the lack of socioeconomic indicator. It was not possible to include a fourth group (physical activity during adulthood, but no sports participation in childhood and adolescence) because of the low prevalence in our sample (5.6%). Moreover, we did not present an indicator of physical fitness, which could be a potential mediator. On the other hand, we presented good measures of body fat[16], direct physical activity through pedometer, and metabolic variables.

CONCLUSION

Thus, early engagement in sports (during childhood and/or adolescence, but not adulthood) was associated with reduced body fat, and physical activity during childhood, adolescence, and adulthood were associated with lower body fat and C-reactive protein, independent of potential confounders. Therefore, intervention strategies aiming to promote physical activity should be conducted even among children, aiming to impact cardiovascular health in adulthood.

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Conflict of interest

The authors report no conflicts of interest

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RESUMO

OBJETIVO: *Analisar a associação entre atividade física durante a vida e fatores de risco cardiovasculares entre adultos.*

DESIGN: *A amostra foi composta por 101 adultos (59 homens) entre 30 e 50 anos, os quais foram recrutados em diferentes academias de ginástica e uma universidade brasileira. Os participantes foram divididos de acordo com o engajamento prévio (autorrelatado) e atual de atividade física (mensurada por pedômetro) (participação esportiva durante a infância/adolescência e prática atual [n=26], participação esportiva durante a infância/adolescência e ausência de prática atual [n=26] e controle [n=49]). Como fatores de risco cardiovasculares foram mensurados gordura corporal (por meio de DXA), HDL, triglicérides, índice Homa, pressão arterial sistólica e diastólica, além da proteína c-reativa. Foram adotadas como covariáveis: idade cronológica, sexo, consumo de álcool e índice de massa corporal. Equações gerais de estimativa foram utilizadas adotando p<0,05.*

RESULTADOS: *Após os ajustes no modelo final, indivíduos engajados em esporte durante a infância e adolescência e inativos durante a idade adulta apresentaram menor gordura corporal quando comparados com participantes persistentemente inativos (p<0,001). Participantes persistentemente ativos apresentaram menor gordura corporal (p<0,001) e proteína c-reativa (p=0,010) quando comparados ao grupo controle.*

CONCLUSÃO: *Prática esportiva prévia (durante infância e adolescência) foi associada com redução da gordura corporal e ser fisicamente ativo ao longo da vida foi associado à redução da gordura corporal e proteína c-reativa.*

PALAVRAS-CHAVE: *Atividade motora. Esportes. Doença crônica. Exercício.*

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