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EARLY SPORT PRACTICE PROMOTES BETTER METABOLIC PROFILE INDEPENDENTLY OF CURRENT PHYSICAL ACTIVITY

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Abstract

Introduction: It is not clear if early and current physical activity (even interrelated) constitute two independent variables and, thus, affecting independently health outcomes in adulthood.

Objective: To analyze the relationship of early sport practice with hemodynamic variables and metabolic in adulthood.

Methods: Participated in the study 69 men and 53 women with aged between 30 and 50 years. All volunteers were submitted to assessments of physical activity by questionnaire [Early Sport Practice (Early-SP)] and pedometer [Current Physical Activity (Current-PA)], and to body composition analysis using to a Dual Energy X-ray Absorptiometry. Were measurements of systolic and diastolic blood pressure (auscultatory method). The blood analysis were collected for determination of fasting glucose, insulin, lipid profile and high sensitive C-reactive protein (hsCRP), subsequently, was calculated HOMA-IR for all volunteers.

Results: Triglycerides (β = -66.3 [-106.2;-26.4]), HDL-C (β = 8.5 [3.1;13.9]), VLDL-C (β = -13.6 [-19.2;-8.1]) and HOMA-IR (β = -0.91 [-1.4;-0.3]) were significantly related to Early-SP independently of current physical activity plus %BF. On the other hand, hsCRP was not (β = -1.27 [-3.1;0.6]; *P*-value = 0.184). All relationships remained statistically significant independently of additional HOMA-IR adjustments.

Conclusion: Early-SP is related to beneficial profile of lipid variables in later life, which is not mediated by Current-PA, obesity and insulin resistance.

Key words: *physical activity, childhood, adolescence, inflammation, obesity*

Introduction

In adult populations, regular physical activity promotes many health benefits related to improvement of metabolic and cardiovascular outcomes [1-3]. The maintenance of physical activity practice between two specific periods of time constitutes the "tracking of physical activity" [4-7]. Over the last years has been observed decline in physical activity and fitness from early life to adulthood [8,9]. In adults, tracking of physical activity from childhood to adolescence has been less investigated than current physical activity in adulthood, mainly its relationship with health outcomes in later life [1,3,10].

Although other studies have identified that tracking of sport practice from childhood to adolescence affects self-report of cardiovascular/metabolic diseases and bone mineral density in adulthood [3,11,12], it is not completely clear the pathways by which this protective effect can happens. Initially, this protective effect could be attributed to the maintenance of physical activity from early life to adulthood, because this behavior tracks throughout life [3] and, hence, it would be effective in the control of adiposity and insulin resistance throughout life.

On the other hand, it is not clear if early and current physical activity (even interrelated) constitute two independent variables and, thus, affecting independently health outcomes in adulthood [13]. This hypothesis should be taken into account, because the effects of be expose to adverse behavioral/environmental variables in early life may persist into adulthood [14,15]. Thus, the aim of this study was to analyze the relationship of early sport practice (performed during childhood and adolescence) with hemodynamic variables and metabolic in adulthood. We have hypothesized that early sport practice affects hemodynamic, metabolic and inflammatory variables in adulthood, independently of current physical activity and obesity.

Methods

Participants

The sample was composed of 122 adults (69 men and 53 women), aged between 30 and 50 years, who were recruited in fitness clubs and the Sao Paulo State University - UNESP from Presidente Prudente, Brazil (fitness clubs, n = 100; university staff, n = 22). The sample size calculation was based in an equation for correlation, which indicated the need to evaluate at least 114 subjects to detect correlation coefficients of 0.26, with 80% power and 5% significance. The presented study constitutes the baseline measures of a 12 months cohort study that is being conducted from 2013 to 2014. To participate in the study, the subject fulfilled all inclusion criteria previously established: (i) either physical activity throughout life (active in childhood and adolescence) or absence of physical activity throughout life (inactive in childhood and adolescence); (ii) aged between 30 and 50; (iii) no previous history of stroke or infarction; (iv) no amputation or visual impairment due to diabetes mellitus.

All participants agreed to participate and signed a written consent form and the study protocol was previously approved by the Ethics Research Committee of the University.

Independent variables

Physical activity

***Early sport practice*:** Early sport practice (Early-SP), which comprised the period of childhood and adolescence was assessed by two questions [1,3]: (i) "Outside of school, did you engage in any organized/supervised sporting activity (with teacher of primary school, coach's team, etc.) during at least 1 year between 7 and 10 years old?" and (ii) "Outside of school, did you engage in any organized/supervised sporting activity (with teacher of little school, coach's team, etc.) during at least 1 year between 11 and 17 years old?"[3]. The Early-SP was adopted as one of the inclusion criteria of the study, therefore only were included in the study either the subjects who responded to both questions with "yes" or with both with "no".

***Current physical activity*:** Current physical activity (Current-PA) was monitored using a pedometer (Digi-Walker Yamax, SW200), during a period of seven consecutive days. All subjects received instructions about the operation of the device, such as reset and registering the values, fixing position of the hip side of the front of the same and to remove it only during periods of sleep, water activities (such as swimming, showering and bathing). At the end of each day, the subjects recorded the number of steps performed all day long. The following morning, to start collecting of data, the button of "reset" was pressed to reset the equipment and start a new count. The mean values of steps of the week were attributed as Current-PA and stratified into two groups: Active (≥10,000 steps/day) and Inactive (<10,000 steps/day) [16].

Dependent variables

Hemodynamic variables

The measurement of blood pressure (BP) was performed by means of auscultatory method. After 10 minute of rest in a sitting position were measured systolic (SBP) and diastolic blood pressure (DBP) with the assistance of aneroid sphygmomanometer (Bic®) and a stethoscope (Littmann Classic II®), being the cuff placed on the right arm, lifted to the height of the midpoint of the sternum and supported on a table [17]. The participants were evaluated three times with an interval of one minute between each measurement. The final value of BP was the average of the last two measurements of each individual.

Metabolic and inflammatory variables

To measure the metabolic variables (fasting glucose, triglycerides [TG], total cholesterol [TC], high density lipoprotein [HDL-C], low density lipoprotein [LDL-C], Very low density lipoprotein [VLDL-C] and insulin) and inflammatory marker (high sensitive C-reactive protein [hsCRP]), all collections of blood samples and biochemical analyzes were performed in a private laboratory that meets 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 analyze the fasting glucose, TG, TC, HDL-C, LDL-C and VLDL-C was used a unit enzymatic colorimetric kit processed in Autohumalyzer A5. The analysis of insulin in the blood chemiluminescence was performed too. To calculate the HOMA-IR (Homeostatic Model Assessment - Insulin resistence) were used the dosage in fasting blood glucose (mmol/L) and insulin (IU/mL) using the formula: HOMA-IR = (Fasting glucose * insulin) ÷ 22.5 [18]. The dosage of hsCRP was determined by the turbidimetric method using a kit for enzyme linked assay.

Potential confounder

Body fatness

Body fatness was estimated through the use of a Dual Energy X-ray Absorptiometry device. The subjects were assessed using the equipment of the Lunar Model – DPX-NT (*General Electric* [GE]®), wearing lightweight clothing, barefoot and without any metal on their body. All subjects were positioned supine and aligned, maintaining immovable for approximately 15 minutes. After manual and individual assessment of each subject, performed by a trained researcher, percentage body fatness was expressed in percentages (%BF), using a GE Medical Systems Lunar software, version 4.7.

Statistical analysis

After testing the normality of the data set, the data were expressed as mean values and standard deviation (SD) (the logarithm transformations were used when necessary). Student's t test compared independent means and the analysis of covariance (ANCOVA) compared dependent variables according to current physical activity under the effect of Early-SP (measures of effect size were provided by Eta-squared [ANCOVA] and Hedges'g [Student's *t*-test]). Pearson correlation analyzed the relationship between numerical variables. Linear regression was used as the multivariate model (expressed in values of β and 95% confidence interval [95%CI]) and three models were created: Model-1 adjusted by habitual physical activity; Model-2 adjusted by habitual physical activity and body fatness; Model-3 adjusted by habitual physical activity, body fatness and insulin resistance. BioEstat software (version 5.0) performed all statistical analysis and significance level was set at a $P < 0.05$.

Results

In the overall sample, pedometer analysis identified that 28.7% of the subjects were physically active (≥10,000 steps/day) and also 47.5% of them were also considered physically active in Early-PA.

Table 1. *Mean and standard-deviation (SD) of variables according to early and current physical activity (Presidente Prudente, Brazil [n= 122])*

	Early Sport Practice			Current Physical Activity		
	Active (n = 58)	Inactive (n = 64)	Hedges' g	Active (n = 35)	Inactive (n = 87)	Hedges' g
	Mean (SD)	Mean (SD)	Effect size	Mean (SD)	Mean (SD)	Effect size
Age (years)	39.5 (5.8)	39.7 (6.3)	-0.033	39.0 (5.6)	39.9 (6.3)	-0.147
%BF	25.4 (7.8)	38.6 (9.2)[b]	-1.541§	25.2 (8.2)	35.2 (10.4)[d]	-1.018§
SBP (mmHg)	110.1 (12.0)	114.0 (13.5)	-0.304	110.0 (11.9)	113.0 (13.2)	-0.234
DBP (mmHg)	76.9 (7.1)	79.9 (8.0)[b]	-0.395	77.4 (7.6)	78.9 (7.7)	-0.196
TG (mg/dL)	97.5 (81.0)	148.7 (87.7)[b]	-0.605	112.5 (100.2)	129.2 (82.8)	-0.190
TC (mg/dL)*	2.27 (0.08)	2.29 (0.06)	-0.285	2.27 (0.08)	2.29 (0.09)	-0.229
HDL-C (mg/dL)	54.3 (12.4)	48.4 (10.8)[b]	0.509	53.2 (13.1)	50.4 (11.4)	0.234
LDL-C (mg/dL)	118.6 (28.6)	121.9 (29.3)	-0.114	115.1 (31.6)	122.4 (27.7)	-0.253
VLDL-C (mg/dL)*	1.17 (0.2)	1.40 (0.2)[b]	-1.150§	1.20 (0.2)	1.33 (0.2)[d]	-0.650
Glucose (mg/dL)	90.1 (6.8)	103.1 (42.8)[b]	-0.414	90.1 (7.2)	99.7 (37.2)	-0.303
HOMA-IR*	-0.07 (0.2)	0.25 (0.2)[b]	-1.600§	-0.03 (0.2)	0.15 (0.2)[d]	-1.229§
hsCRP (mg/L)*	-0.01 (0.4)	0.40 (0.5)[b]	-0.901§	-0.08 (0.4)	0.33 (0.4)[d]	-1.025§

*= variable under logarithm transformation; [b] P <0.05 between Active and Inactive in early sport practice; [d] P <0.05 between Active and inactive current physical activity, §= large effect size (≥0.800), %BF= Percentage of body fat, SBP = Systolic blood pressure, DBP = Diastolic blood pressure, TG = triglycerides, TC = total cholesterol, HDL-C = high-density cholesterol, LDL-C = Cholesterol low Density, VLDL-C = Very low Density Cholesterol, HOMA-IR = Homeostatic Model Assessment - insulin resistance, hsCRP = high sensitive C-reactive protein.

Table 2. *Analysis of covariance between early sport practice and current physical activity in adults (Presidente Prudente, Brazil [n = 122])*

Dependent Variables	Homogeneity of variances (P - value)	ANCOVA (P - value)	Eta-squared	ANCOVA (P - value)	*Eta*-squared
		Early Sport Practice	Early Sport Practice	Current Physical Activity	Current Physical Activity
% BF	0.403	0.001	0.272§	0.022	0.043
SBP (mmHg)	0.750	0.199	---	0.646	---
DBP (mmHg)	0.727	0.050	0.032	0.989	---
Glucose (mg/dL)	0.084	0.079	---	0.574	---
TG (mg/dL)	0.675	0.002	0.081	0.565	---
TC (mg/dL)*	0.034	0.270	---	0.416	---
HDL-C (mg/dL)	0.958	0.012	0.051	0.945	---
LDL-C (mg/dL)	0.394	0.915	---	0.290	---
VLDL-C (mg/dL)*	0.047	0.001	0.178§	0.663	---
HOMA-IR*	0.009	0.001	0.248§	0.491	---
hsCRP (mg/L)*	0.002	0.001	0.084	0.012	0.054

*= analysis of covariance performed with dependent variable under logarithm transformation due non homogeneity of variances; §= large effect size (≥0.140), %BF = Percentage of body fatness, SBP = systolic blood pressure, DBP = diastolic blood pressure, TG = triglycerides, TC = total cholesterol, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, VLDL-C = very low density cholesterol, HOMA-IR = Homeostatic Model Assessment - insulin resistance, hsCRP = high sensitive C-reactive protein.

Table 3. *Relationship between early sport practice, current physical activity and dependent variables in adulthood (Presidente Prudente, Brazil [n = 122])*

	Current Physical Activity		Early Physical Activity	
Dependent Variables	r ($r_{95\%CI}$)	β ($\beta_{95\%CI}$)*	r ($r_{95\%CI}$)	β ($\beta_{95\%CI}$) §
% BF	-0.437 (-0.570 to -0.281)	-4.3 (-8.1; -0.6)	-0.638 (-0.733 to -0.519)	-11.4 (-14 to -8.1)
SBP (mmHg)	-0.129 (-0.300 to 0.050)	---	-0.180 (-0.347 to -0.002)	-3.3 (-8.5 to 1.7)
DBP (mmHg)	-0.112 (-0.284 to 0.067)	---	-0.216 (-0.379 to -0.040)	-3.1 (-6.1 to 0.1)
Glucose (mg/dL)	-0.114 (-0.286 to 0.065)	---	-0.190 (-0.356 to -0.013)	-11.3 (-23 to 1.3)
TG (mg/dL)	-0.189 (-0.355 to -0.012)	-10.9 (-26; 48)	-0.434 (-0.568 to -0.278)	-55.6 (-89 to -21)
TC (mg/dL)	-0.127 (-0.298 to 0.052)	---	-0.142 (-0.312 to 0.037)	---
HDL-C (mg/dL)	0.093 (-0.086 to 0.266)	---	0.261 (0.087 to 0.419)	6.1 (1.32 to 10.6)
LDL-C (mg/dL)	-0.138 (-0.308 to 0.041)	---	-0.068 (-0.243 to 0.111)	---
VLDL-C (mg/dL)	-0.239 (-0.400 to -0.064)	-1.2 (-6.5; 4.1)	-0.474 (-0.601 to -0.323)	-11.1 (-15 to -6.2)
HOMA-IR	-0.295 (-0.449 to -0.124)	-0.1 (-0.7; 0.3)	-0.592 (-0.696 to -0.463)	-1.2 (-1.6 to -0.6)
hsCRP (mg/L)	-0.369 (-0.513 to -0.205)	-1.5 (-3.4; 0.2)	-0.408 (-0.546 to -0.248)	-2.1 (-3.8 to -0.4)

*= linear regression adjusted by early physical activity, §= linear regression adjusted by current physical activity, %BF = Percentage of body fatness, SBP = systolic blood pressure, DBP = diastolic blood pressure, TG = triglycerides, TC = total cholesterol, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, VLDL-C = very low density cholesterol, HOMA-IR = Homeostatic Model Assessment - insulin resistance, hsCRP = high sensitive C-reactive protein.

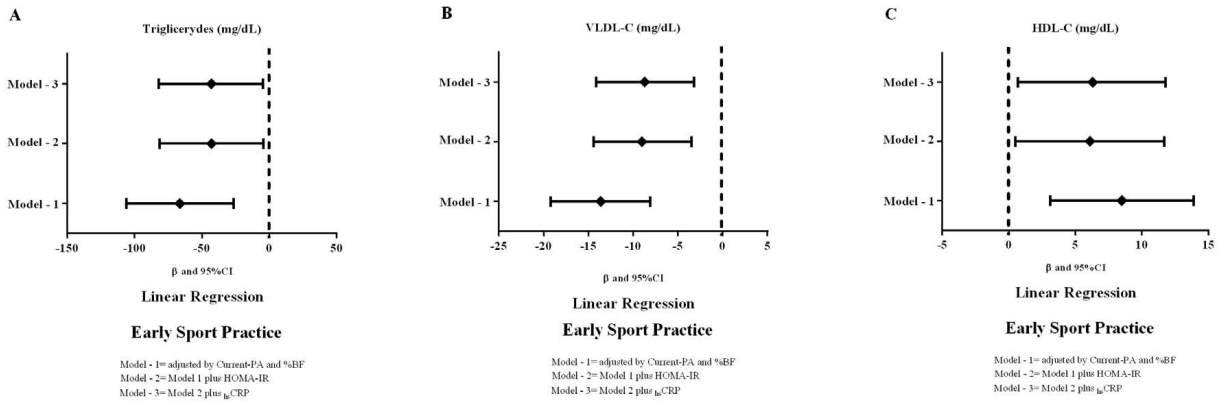

Figure 1. *Adjusted relationship between early sport practice and lipid profile variables in adults (Panel A, B and C) (Presidente Prudente, Brazil [n = 122])*

Adults physically active in adulthood had lower %BF, VLDL-C, HOMA-IR and hsCRP values than inactive individuals (effect size ranging from -0.147 to -1.229). Furthermore, when analyzed Early-PA, physically active subjects in early life had lower values of %BF, DBP, HDL-C, VLDL-C, TG, glucose, HOMA-IR (P = 0.001) and hsCRP when compared to inactive ones (effect size ranging from -0.033 to -1.600) (Table 1).

In general, the covariance of the dependent variables were better explained by Early-SP (values ranging from 3.2% to 27.9%) than Current-PA (values ranging from 4.3% to 5.4%) (Table 2).

Coefficient correlations were higher in Early-SP than Current-PA. Independently of current physical activity, Early-SP was significantly related to %BF (β = -11.4 [-14; -8.1]), TG (β = -55.6 [-89; -21]), HDL-C (β = 6.1 [1.32; 10.6]), VLDL-C (β = -11.1 [-15; -6.2]), HOMA-IR (β = -1.2 [-1.6; -0.6]) and hsCRP (β = -2.1 [-3.8; -0.4]). On the other hand, Current-PA was related to %BF (β = -4.3 [-8.1; -0.6]), independently of Early-SP (Table 3).

In additional analysis, TG (β = -66.3 [-106.2; -26.4]), HDL-C (β = 8.5 [3.1; 13.9]), VLDL-C (β = -13.6 [-19.2; -8.1]) and HOMA-IR (β = -0.91 [-1.4; -0.3]) remained significantly related to Early-SP independently of current physical activity plus %BF. On the other hand, hsCRP was not (β = -1.27 [-3.1; 0.6]; P = 0.184). Finally, all relationships remained statistically significant independently of HOMA-IR and hsCRP adjustments (TG, β = -43.4 [-82.1; -4.6]) (Fig. 1, Panels A, B and C).

Discussion

In the present study, although only Early-SP was negatively related to blood glucose and pressure, current physical activity had a decisive effect in this rela-

tionship, even without direct relation with glucose and blood pressure. Regarding hemodynamic variables, similar findings were found in Dutch adults, in which the accumulated vigorous physical activity during 24 years of follow-up was related to lower arterial stiffness [8]. In fact, relevant literature has pointed out that prolonged physical activity practice can act in the activation, mobilization and differentiation of stem/progenitors cells in cardiac/endothelial tissues leading to management and improvement tissues related to cardiovascular system [19].

Similarly, glucose metabolism seems apparently also affected by tracking of physical activity, even in elderlies the maintenance of physical activity throughout life enhances glycogen synthase kinase-3 phosphorylation and glucose transporter type-4 expression on skeletal muscle [20]. In other words, our findings ratify the importance of the physical activity maintenance throughout life to these specific outcomes [1,3,11].

On the other hand, if compared to blood glucose, the insulin resistance presents divergent pattern when considered its relationship with Early-SP, because happened independently of current physical activity and obesity. Indeed, previous epidemiological studies have reported lower self-report of diabetes in adults engaged in sport activities in early life [3]. The regular physical exercise represents an important agent in the prevention of insulin resistance and diabetes mellitus, because is linked to the release of anti-oxidants and anti-inflammatory agents [21,22], independently of body fatness [22]. Apparently this protective redox effect related to physical activity/exercise could be observed in early life and maintained throughout life too.

Moreover, insulin resistance and inflammation are strongly linked, because hsCRP is released by the liver in response to IL-6 plasma values, which is strongly related to insulin resistance [23,24]. In our study, insulin resistance and inflammation were positively related (r= 0.388 [95%CI= 0.226 to 0.529]). Early-SP was related to inflammation independently of current physical activity, but mediated mainly by body composition. Therefore, our findings identify that promotion of sport practice among pediatric populations constitutes a relevant action targeting the prevention of inflammation status in adulthood, mainly due yours effects over insulin resistance and obesity.

In this sample, lipid variables were related only to Early-SP, which happened independently of the insertion of current physical activity in the multivariate model. The initial hypothesis to explain our findings was based in the belief that these relationships with lipid variables would be mediated mainly by the effect of Early-SP over body fatness. However, this initial hypothesis was rejected and, thus, two other hypotheses were postulated.

First, it is known that sport practice (mainly organized sports) during early life encompasses different healthy behaviors, such as increased consumption of fruits and vegetables [11]. Likewise, higher engagement in sport practice is observed in groups with higher socio economic status [25], which constitutes also an important determinant of fruit and vegetable consumption during adolescence [26]. In a hypothetical model, whether this sport practice is maintained during early life, healthy eating behaviors will be probably maintained too, not only in early life but also in later life [27]. On the other hand, it is well documented pathways by which increased adiposity harmfully affect lipid profile [23] and, thus, it is not possible does not highlight that Early-SP and lipid variables were related, independently of body fatness, insulin resistance and inflammation.

With this in mind, our second hypothesis to explain our findings was based in epigenetic pathways. In fact, the deoxyribonucleic acid (DNA) framework is previously genetically designed, but the expression of some genes (methylation) can be dramatically increased or decreased by behavioral factors (e.g. smoking, diet [helping to support, at least in part, our first hypothesis] and physical activity) and this variability in gene expression is related to development of many diseases [15,28,29]. Methylation rates are modified throughout life by this behavioral factor, but there are more sensitive periods of life (early life is one of these periods), in which is thought that if this methylation rate is modified the effect could be maintained in later life [30]. Agreeing with this point of view, White et al. [14] identified that global DNA methylation is increased in subjects with higher physical activity in three specific periods of life (childhood, adolescence and adulthood). However, the authors do not analyzed separately subjects physically active in both childhood and adolescence, which would offer more solid support to our argumentation. Finally, if this hypothesis is furthermore confirmed opens avenues to new research lines related to sport medicine in pediatric population and provides new pathways to explain how early physical activity prevents diseases during early and later life too.

The study has strengths, such as the use of an accurate method to assess body composition (instead of anthropometric measures widely used in similar studies) and the analysis of seven days to assess current physical activity (instead of 3 days as observed in the scientific literature); on the other hand, the limitations should recognize too. The main limitations of this study arising from its cross-sectional design with retrospective characteristics. This design possesses limited power over the inferences and self-reported of early physical activity, which is exposed to memory bias (however, it is emphasized that the use of restrict definition of orga-

nized sport can aid in memorization, since it eliminates large range of other common activities [e.g. recreational soccer, physical education classes, etc.]; moreover, this method has high reproducibility [3]). Finally, the use of different methods to measure early and current physical activity can explain some differences in the results, mainly because the use of questionnaire to assess early sport practice constitutes a method more expose to memory bias and it is not possible to estimate accurately intensity/duration of this early sport practice. Thus, the difference between both methods to assess physical activity should be taken into account in the interpretation of our findings.

Conclusion

The results of this study allow us to conclude that early sport practice is related to beneficial profile of lipid variables in later life, which is not mediated by current physical activity, obesity, insulin resistance and inflammation.

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Declaration of interest

The authors report no conflicts of interest.

References

1. Fernandes RA, Christofaro DGD, Casonatto J, et al. Prevalence of dyslipidemia in individuals physically active during childhood, adolescence and adult age. *Arq Bras Cardiol* 2011; 97(4): 317-23. DOI: 10.1590/S0066-782X2011005000083
2. Morseth B, Jkrgensen L, Emaus N, et al. Tracking of Leisure Time Physical Activity during 28 yr in Adults: The Tromsø Study. *Med Sci Sports Exerc* 2011; 43(7): 1229-34. DOI: 10.1249/MSS.0b013e3182084562
3. Fernandes RA, Zanesco A. Early physical activity promotes lower prevalence of chronic diseases in adulthood. *Hypertens Res* 2010; 33(9): 926-31. DOI: 10.1038/hr.2010.106
4. Tudor-Locke C, Giles-Corti B, Knuiman M, et al. Tracking of pedometer-determined physical activity in adults who relocate: results from RESIDE. *Int J Behav Nutr Phys Act* 2008; 5: 39. DOI: 10.1186/1479-5868-5-39
5. Van Mechelen W, Twisk JW, Post GB, et al. Physical activity of young people: the Amsterdam Longitudinal Growth and Health Study. *Med Sci Sports Exerc* 2000; 32(9): 1610-6.
6. Twisk JW, Kemper HC, Van Mechelen W. Tracking of activity and fitness and the relationship with cardiovascular disease risk factors. *Med Sci Sports Exerc* 2000; 32(8): 1455-61.
7. Kemper HC, Snel J, Verschuur R, et al. Tracking of health and risk indicators of cardiovascular diseases from teenager to adult: Amsterdam Growth and Health Study. *Prev Med* 1990; 19(6): 642-55. DOI: 10.1016/0091-7435(90)90061-N
8. Van de Laar RJ, Ferreira I, Van Mechelen W, et al. Lifetime vigorous but not light-to-moderate habitual physical activity impacts favorably on carotid stiffness in young adults: the Amsterdam growth and health longitudinal study. *Hypertension* 2010; 55(1): 33-9. DOI: 10.1161/HYPERTENSIONAHA.109.138289
9. Kemper HC, Twisk JW, van Mechelen W. Changes in aerobic fitness in boys and girls over a period of 25 years: data from the Amsterdam Growth And Health Longitudinal Study revisited and extended. *Pediatr Exerc Sci* 2013; 25(4): 524-35.
10. Reichert FF, Azevedo MR, Breier A, et al. Physical activity and prevalence of hypertension in a population-based sample of Brazilian adults and elderly. *Prev Med* 2009; 49(2-3): 200-4. DOI: 10.1016/j.ypmed.2009.06.009
11. Fernandes RA, Christofaro DG. Casonatto J, et al. Cross-sectional association between healthy and unhealthy food habits and leisure physical activity in adolescents. *J Pediatr (Rio J)* 2011; 87(3): 252-6. DOI: 10.2223/JPED.2093
12. Lima MC, Cayres SU, Agostinete RR, et al. Stability of sports activities during childhood/adolescence and bone mineral density in adulthood. *Rev Bras Ativ Fis Saude* 2013; 18(4): 445-52. DOI: 10.12820/rbafs.v.18n4p445
13. Lima MCS, Barbosa MF, Diniz TA, et al. Early and current physical activity: relationship with intima-media thickness and metabolic variables in adulthood. *Braz J Phys Ther* 2014; 18(5): 462-9. DOI: 10.1590/bjpt-rbf.2014.0040
14. White AJ, Sandler DP, Bolick SC, et al. Recreational and household physical activity at different time points and DNA global methylation. *Eur J Cancer* 2013; 49(9): 2199-206. DOI: 10.1016/j.ejca.2013.02.013
15. Waterland RA, Michels KB. Epigenetic epidemiology of the developmental origins hypothesis. *Annu Rev Nutr* 2007; 27: 363-88. DOI: 10.1146/annurev.nutr.27.061406.093705
16. Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med* 2004; 34(1): 1-8.
17. Brazilian Society of Cardiology. VI Brazilian Guidelines on Hypertension. *Arq Bras Cardiol* 2010; 95: (1)1-51. DOI: 10.1590/S0066-782X2010001700001
18. Meng C, Sun M, Wang Z, et al. Insulin Sensitivity and Beta-Cell Function Are Associated with Arterial Stiffness in Individuals without Hypertension. *J Diabetes Res* 2013; 2013: 151675. DOI: 10.1155/2013/151675
19. Figueiredo PA, Appell Coriolano HJ, Duarte JA. Cardiac regeneration and cellular therapy: is there a benefit of exercise? *Int J Sports Med* 2014; 35(3): 181-90. DOI: 10.1055/s-0033-1351253
20. Bunprajun T, Henriksen TI, Scheele C, et al. Lifelong physical activity prevents aging-associated insulin resistance in human skeletal muscle myotubes via increased glucose transporter expression. *PLoS One* 2013; 8(6): e66628. DOI: 10.1371/journal.pone.0066628
21. Moraes C, Davel APC, Rossoni LV, et al. Exercise training improves relaxation response and SOD-1 expression in aortic and mesenteric rings from high caloric diet-fed rats. *BMC Physiology* 2008; 8: 12. DOI: 10.1186/1472-6793-8-12
22. Balducci S, Zanuso S, Nicolucci A, et al. Anti-inflammatory effect of exercise training in subjects with type 2 diabetes and the metabolic syndrome is dependent on exercise modalities and independent of weight loss. *Nutr Metab Cardiovasc Dis* 2010; 20: 608e617. DOI: 10.1016/j.numecd.2009.04.015
23. Huang PL. eNOS, metabolic syndrome and cardiovascular disease. *Trends in Endocrinology and Metabolism* 2009; 20(6): 295-302. DOI: 10.1016/j.tem.2009.03.005
24. Rubin DA1, Hackney AC. Inflammatory cytokines and metabolic risk factors during growth and maturation: influence of physical activity. *Med Sport Sci* 2010; 55: 43-55. DOI: 10.1159/000321971
25. Fernandes RA, Reichert FF, Monteiro HL, et al. Characteristics of family nucleus as correlates of regular participation in sports among adolescents. *Int J Public Health* 2012; 57(2): 431-5. DOI: 10.1007/s00038-010-0207-7
26. Bere E, van Lenthe F, Klepp KI, et al. Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat? *Eur J Public Health* 2008; 18(6): 611-5. DOI: 10.1093/eurpub/ckn081
27. Neumark-Sztainer D, Wall M, Larson NI, et al. Dieting and disordered eating behaviors from adolescence to young adulthood: findings from a 10-year longitudinal study. *J Am Diet Assoc* 2011; 111(7): 1004-11. DOI: 10.1016/j.jada.2011.04.012

28. Elliott HR, Tillin T, McArdle WL, et al. Differences in smoking associated DNA methylation patterns in South Asians and Europeans. *Clin Epigenetics* 2014; 6(1): 4. DOI: 10.1186/1868-7083-6-4
29. Alegría-Torres JA, Baccarelli A, Bollati V. Epigenetics and lifestyle. *Epigenomics* 2011; 3(3): 267-77. DOI: 10.2217/epi.11.22
30. Nagy C1, Turecki G. Sensitive periods in epigenetics: bringing us closer to complex behavioral phenotypes. *Epigenomics* 2012; 4(4): 445-57. DOI: 10.2217/epi.12.37

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