Relationship between health risk indicators and somatotype components according to physical activity in children

Relación entre indicadores de riesgo para la salud y componentes del somatótipo según la actividad física en niños

Relação entre indicadores de risco à saúde e componentes do somatótipo consoante atividade física em crianças

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Vieira, D., dos Santos, K. F., Pereira, E., Neto, S., Thuany, M., & Gomes, T. N. (2023). Relação entre indicadores de risco à saúde e componentes do somatótipo consoante atividade física em crianças. *Revista Ciencias de la Actividad Física UCM, 24*(2), julio-diciembre, 1-13. https://doi.org/10.29035/rcaf.24.2.3

ABSTRACT

This study analysed the relationship between health risk indicators and somatotype components according to physical activity levels in children. This epidemiological and school-based research comprised 168 children of both sexes (56% boys), aged between 6 to 11 years. Demographic information (sex, age) was obtained. Anthropometric information (body height; body mass; contracted arm, waist, hip, and calf circumferences), body composition (subcutaneous adiposity and somatotype), systolic and diastolic blood pressure, and physical activity level (active; inactive) were measured. The waist-hip ratio and waist-to-height ratio were computed. Comparison, correlation, and multiple linear regression analysis were performed, considering 95% of the confidence interval. Boys presented higher values for physical activity, waist-hip, and waist-to-height ratio. Active children were older, had a larger waist and hip circumference, and higher systolic blood pressure. Among the active group, sex was associated with waist circumference and waist-to-height ratio, while age was associated with hip circumference and diastolic blood pressure. Among inactive children, all predictors (except for sex for hip circumference) were significantly associated with waist and hip circumferences, explaining ≅83% and 85% of the expression of these variables, respectively. The relationship between health risk indicators and somatotype components was higher among inactive children. Regardless of the physical activity level, the endomorphic component shows a significant relationship with health components, with a higher effect among the inactive group, considering the body composition association.

Key words: Cardiometabolic risk; Somatotype; Pediatric population.

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RESUMEN

Este estudio analizó la relación entre indicadores de riesgo para la salud y los componentes del somatótipo según los niveles de actividad física en niños. Se trata de una investigación epidemiológica, compuesta por 168 niños (6 a 11 años) de ambos sexos. Fueron mensuradas: evaluaciones antropométricas (estatura; masa corporal; pliegues de adiposidad subcutánea; perímetros del brazo contraído, cintura, cuadril y pantorrilla), presión arterial sistólica y diastólica, y actividad física (activo/inactivo); el somatótipo, a través del cálculo de: razón cintura-cuadril y razón cintura-estatura. Se realizó el análisis de comparación, correlación y regresión lineal múltiple, considerando intervalo de confianza del 95%. Los niños presentaron mayor número de pasos, razón cintura-cuadril y cintura-estatura. Los niños activos eran mayores, tenían mayor perímetro de cintura, cuadril y presión arterial sistólica. En el grupo físicamente activo, el sexo estuvo asociado directamente al perímetro de cintura y razón cintura-estatura, mientras que la edad se asoció con el perímetro de cuadril y presión arterial diastólica. En los niños inactivos, todas las variables predictoras (excepto para la variable sexo con relación al perímetro de cuadril) se mostraron significativas para el perímetro de la cintura y cuadril, explicando, conjuntamente, ~83% y 85% de la expresión de estas variables, respectivamente. La relación entre indicadores de riesgo para la salud y los componentes del somatotipo fue mayor en niños inactivos. Independientemente del nivel de actividad física, la endomorfia mostró una relación significativa con los componentes de salud, con mayor efecto en el grupo inactivo, con vistas a la asociación con la composición corporal de los sujetos.

Palabras clave: Riesgo cardiometabólico, Somatótipo, Población pediátrica.

RESUMO

Este estudo analisou a relação entre indicadores de risco à saúde e as componentes do somatótipo consoante os níveis de atividade física em crianças. Trata-se de uma pesquisa epidemiológica de base escolar, composta por 168 crianças (6 a 11 anos) de ambos os sexos. Informações demográficas foram obtidas. Avaliações antropométricas (estatura; massa corporal; pregas de adiposidade subcutânea; perímetros do braço contraído, cintura, quadril e panturrilha), pressão arterial sistólica e diastólica, e atividade física (ativo; inativo) foram mensuradas. O somatótipo, razão cintura-quadril e razão cintura-estatura foram calculados. Análise de comparação, correlação e regressão linear múltipla foram realizadas, considerando intervalo de confiança de 95%. Meninos apresentaram maior número de passos, razão cintura-quadril e cintura-estatura. Crianças ativas eram mais velhas, possuíam maior perímetro de cintura, quadril e pressão arterial sistólica. No grupo fisicamente ativo, o sexo esteve associado diretamente ao perímetro de cintura e razão cintura-estatura, enquanto a idade associou-se com a perímetro de quadril e pressão arterial diastólica. Nas crianças inativas, todas as variáveis preditoras (exceto para a variável sexo em relação ao perímetro de quadril) mostraram-se significativas para o perímetro da cintura e quadril, explicando, conjuntamente, ~83% e 85% da expressão destas variáveis, respectivamente. A relação entre indicadores de risco à saúde e as componentes do somatótipo foi maior em crianças inativas. Independentemente do nível de atividade física, a endomorfia mostrou relação significativa com os componentes de saúde, com maior efeito no grupo inativo, tendo em vista a associação com a composição corporal dos sujeitos.

Palavras chave: Risco cardiometabólico; Somatótipo; População pediátrica..

INTRODUCTION

The number of overweight/obese children and adolescents has increased in recent years. Data from the World Health Organization [WHO] indicate that between 1975 and 2016 there was an increase from 4% to 18% in the prevalence of overweight in the pediatric population (World Health Organization [WHO], 2020). In Brazil, data from the Food and Nutrition Surveillance System [SISVAN] indicate that approximately 30% of individuals in this age group are overweight (SISVAN, 2021). This information is alarming, considering the costs of the public health system, as well as the comorbidities associated with this condition (Ferrari et al., 2019; Fredriksen et al., 2018; Nilson et al., 2020), which include cardiovascular diseases, type II diabetes, and hypertension (Alves et al., 2017). On the other hand, regular physical activity, combined with a healthy diet, can lead to a healthier lifestyle (Enriquez-del Castillo et al., 2022; Vieira et al., 2022), since, among other things, it contributes to reducing body weight (Lee & Yoon, 2018), improving lipid profile and insulin sensitivity, and reducing the risk of developing cardiometabolic diseases (Kumar et al., 2015; Whooten et al., 2019).

Thus, anthropometric indicators [body mass index (BMI), waist circumference, waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) (Li et al., 2020) and body composition (somatotype) (Bar-or et al., 2009) have been widely used to predict health outcomes. Previous studies have shown associations between BMI and waist circumference with several diseases, highlighting their importance for identifying cardiometabolic risk in children and adolescents (Aguilar-Morales et al., 2018; López-González et al., 2016; Quadros et al., 2019). In short, the use of anthropometric measurements has proven to be a more accessible, low-cost, and easy-to-measure alternative to blood tests for identifying health risks in the pediatric population, in addition to showing an important relationship with the expression of childhood obesity (Li et al., 2020). In this context, anthropometric indicators can be used not only for nutritional purposes, but also to assess health risk and the development of cardiovascular diseases and arterial hypertension (Andrade et al., 2019). However, there is a gap in the literature regarding the relationship between cardiovascular risk indicators and somatotype in children, as well as the role of physical activity in this relationship (Almeida et al., 2015). Previous studies that evaluated the relationship between anthropometric indicators and cardiometabolic risk highlighted the importance of using other factors in future investigations (Li et al., 2020). Thus, the objective of the present study was to analyze the relationship between health risk indicators and somatotype components, considering sex and different levels of physical activity in children.

METHODS

Design and sample

This is a school-based epidemiological study, resulting from the longitudinal-mixed research project “Relationship between Physical Activity, Motor Skills, Cognitive Abilities and School Performance in Children aged 3 to 12”. The following inclusion criteria were considered for participation in the study: i) children should be enrolled in school; ii) agree to participate in the project by presenting the signed Informed Consent Form by their legal guardians; and iii) not have physical and/or cognitive disabilities. The sample was selected randomly. A total of 168 children of both sexes (56% boys), aged between 6 and 11 years, participated in the study. The project was approved by the Ethics Committee of the Federal University of Viçosa (opinion no. 1,888,177).

Demographic information

Through the use of a questionnaire, answered by the legal guardians, information was obtained about the sex and age of the children.

Anthropometry and body composition

Anthropometric and body composition assessments were performed according to procedures described by the International Society for the Advancement of Kinanthropometry [ISAK], (2011). Height (cm) was measured using a Sanny portable stadiometer (accuracy of 0.1 cm), and body mass (kg) was measured using a Techline digital scale (accuracy of 0.1 kg). For both assessments, the children were barefoot and wearing light clothing.

The circumferences of the contracted arm, waist, hip and calf were measured using a non-elastic Sanny tape measure (accuracy of 0.1 cm); The bone diameters of the humerus and femur were measured using a Sanny caliper (accuracy of 0.1 cm), and the subcutaneous adiposity folds (triceps, subscapular, suprailiac and calf) were measured using a Cescorf adipometer (accuracy of 0.1 mm). Using information on waist circumference, hip circumference and height, the WHR and WHtR were determined. The somatotype components (endomorphy, mesomorphy and ectomorphy) were estimated using the Heath and Carter method (Heath & Carter, 1967), using continuous values of each component.

Blood Pressure

At least three blood pressure measurements were taken using an Omron automatic arm blood pressure monitor (model HEM 7113). Before taking the first measurement, the children remained at rest for five minutes, sitting with their legs parallel (not crossed), feet resting on the floor, properly leaning back in the chair, and with their right arm relaxed on the table, slightly flexed and with the palm of the hand facing upwards, at heart level. The cuff was placed 2-3 cm above the elbow, covering the brachial artery. The other two measurements were taken at three-minute intervals, in accordance with the Brazilian Guideline for Arterial Hypertension (Malachias, 2016). For the analysis, the mean value of the three measurements for systolic blood pressure (SBP) and diastolic blood pressure (DBP) was considered.

Physical Activity

Physical activity was assessed using a pedometer (Yamax, Digi-Walker, model SW 200, Japan). The children's daily steps were recorded for one week (minimum of two weekend days). The parents/guardians of the participating children received all necessary instructions regarding how to use and record the pedometer results, aiming at the reliability of the records. The children were informed that the device could be used throughout the day and should only be removed to sleep and for water activities. The device was attached to the waist, in the right midaxillary line. Since the pedometers did not have internal memory, the guardians received a form to fill in the number of daily steps, and were asked to record on the form the number of steps the child had taken during the day, as shown on the device. The average number of daily steps taken was estimated and considered for analysis. Based on the results presented in the daily average of steps for each subject and taking into account the cutoff points suggested by Tudor-Locke et al. (2011) (12000 steps for girls and 15000 steps for boys), the children were classified into two groups: active (<12000 steps, girls, and <15000 steps, boys) and inactive (≥12000 steps, girls, and ≥15000 steps, girls).

Statistical analysis

The normality of data distribution was tested using the Kolmogorov-Sminorv test, and descriptive analysis was presented using the median (interquartile range) and frequency (%). The Mann-Whitney U test was used to estimate differences in age, health risk indicators and somatotype components, considering both sexes and physical activity level (active/inactive). Spearman correlation analysis was performed between the variables, according to sex. The magnitude of the correlation was determined using the values proposed by Batterham and Hopkins (Batterham & Hopkins, 2006), as follows: r < 0.1, trivial; r = 0.1 to <0.3, small; r = 0.3 to <0.5, moderate; r = 0.5 to <0.7, strong; r = 0.7 to <0.9, very strong; r = 0.9 to <1.0, almost perfect; r = 1, perfect. To verify the association between health risk indicators (waist and hip circumference, WHR, WHtR, SBP and DBP) and somatotype components (endomorphy, mesomorphy and ectomorph) in active and inactive children, multiple linear regression models were constructed. In all analyses, sex and age were considered as covariates. Effect size estimates were presented using R^2. The analyses were performed using GraphPad Prism 8.0.1 and IBM SPSS 25.0 software, considering a 95% confidence interval.

RESULTS

Table 1 presents descriptive information by sex and physical activity level. Overall, 85.7% of the participants were inactive. Regarding sex, boys were more active [8833.9 (6235.6–13201.7) steps, p = 0.03] and presented higher values for WHR [0.85 (0.83–0.88), p<0.001] and WHtR [0.44 (0.42–0.49), p= 0.03]. On the other hand, girls presented higher values for the endomorphy [5.0 (3.9–6.5), p<0.001] and ectomorphy [3.2 (1.7–4.3), p = 0.04] components, and lower values for mesomorphy [3.9 (3.2–4.7), p<0.001] when compared to boys. Differences according to physical activity level were observed. Active children were older [9.0 (8.0–10.0) years, p = 0.01], had larger waist [60.7 (56.4–69.9) cm, p = 0.03] and hip [77.0 (67.4–81.7) cm, p = 0.01] perimeters, as well as higher SBP values [111.3 (106.0–116.3) mmHg, p<0.001)], compared to their inactive peers. The results of the correlation analysis are presented in Figure 1. For both sexes, a positive and weak relationship was observed between age and physical activity [(boys, r: 0.31; 95%CI 0.10–0.48; p = 0.002) (girls, r: 0.37; 95%CI 0.14–0.55; p 0.001)]. A negative relationship was observed for physical activity and WHtR (r: -0.26; 95%CI -0.20–0.22; p 0.01) and mesomorphy (r: -0.22; 95%CI -0.40–-0.01; p 0.03) in boys; For girls, a positive relationship was observed between physical activity and hip circumference (r: 0.28; 95%CI 0.05–0.48; p<0.001) and SBP (r: 0.31; 95%CI 0.07–0.51; p<0.01). In boys, a strong correlation was also noted between WHR and the three components of the somatotype [endomorphy (r: 0.78; 95%CI 0.68–0.85; p<0.001), mesomorphy (r: 0.79; 95%CI 0.69–0.85; p<0.001) and ectomorphy (-0.93; 95%CI -0.95–-0.89; p<0.001)].

Table 1

Descriptive information [median (interquartile range)] and U-Mann Whitney test results, considering sex and physical activity level.

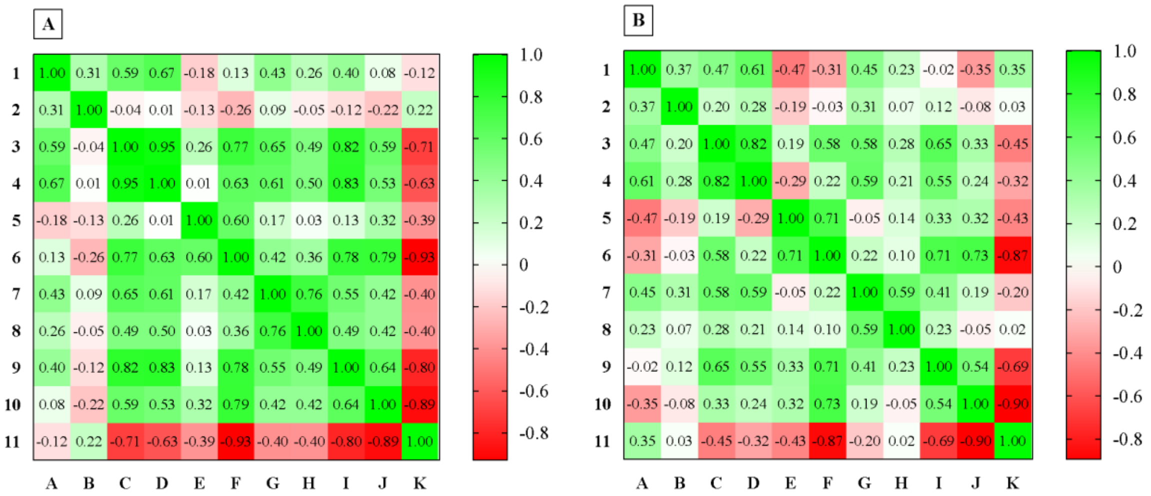
Variables	Gender				Physical activity				Total
	Female (44,0%)	Male (56,0%)	U	*p*	Active (14,3%)	Inactive (85,7%)	U	*p*	
Age (years)	9,0(6,5-10,0)	8,50(7,0-9,7)	3459	0,45	9,0(8,0-10,0)	8,0(6,0-10,0)	1144	**0,01**	9,0 (7,0-10,0)
Physical Activity (number of steps)	7811,1(4597,2-10836,0)	8833,9(6235,6-13201,7)	2802	**0,03**	17832,5(15851,5-19723,1)	7640,7(5193,8-10263,3)	23	**<0,001**	8238,5(5792,2-11708,4)
Waist circumference (cm)	57,0(53,8-62,7)	58,6(54,6-67,5)	2945	0,89	60,7(56,4-69,9)	57,5(54,1-64,8)	1272	**0,03**	58,0 (54,3-65,4)
Hip Circumference (cm)	70,7(64,3-78,1)	69,6(64,2-79,1)	3357	0,88	77,0(67,4-81,7)	69,6(63,7-76,2)	1159	**0,01**	70,0 (64,2-78,5)
WHR	0,82(0,79-0,85)	0,85(0,83-0,88)	1949	**<0,001**	0,83(0,81-0,87)	0,84(0,81-0,87)	1547	0,47	0,84 (0,81-0,87)
WHtR	0,43(0,40-0,47)	0,44(0,42-0,49)	2815	**0,03**	0,44(0,41-0,49)	0,45(0,41-0,47)	1631	0,66	0,44 (0,41-0,48)
SBP (mmHg)	104(98,1-110,2)	106,0(100,0-102,2)	2833	0,30	111,3(106,0-116,3)	104,0(98,6-109,8)	885	**<0,001**	104,6(99,0-111,2)
DBP (mmHg)	62,0(57,0-65,5)	59,8(55,7-64,6)	2678	0,12	64,6(58,0-66,6)	60,3(56,0-64,3)	1180	0,05	60,6(56,0-65,0)
Endomorphy	5,0(3,9-6,5)	3,1(2,4-5,5)	2054	**<0,001**	4,5(3,5-6,9)	4,1(2,8-5,9)	1366	0,10	4,2 (2,9-6,0)
Mesomorphy	3,9(3,2-4,7)	4,6(4,0-5,3)	2141	**<0,001**	4,7(3,8-5,1)	4,2(3,5-5,0)	1502	0,30	4,3 (3,5-5,0)
Ectomorphy	3,2 (1,7-4,3)	2,7(1,4-3,6)	2860	**0,04**	2,5(1,2-3,6)	3,1(1,6-3,9)	1505	0,31	3,1 (1,5-3,8)

Note. Median (interquartile range); U (U-MannWhitney); Physical activity assessed as number of steps/day; WHR (waist-to-hip ratio); WHtR (waist-to-height ratio); SBP (systolic blood pressure); DBP (diastolic blood pressure).

In girls, WHR showed a moderate relationship with endomorphy (r: 0.33, 95%CI 0.10 – 0.52, p 0.004) and mesomorphy (r: 0.32, 95%CI 0.08 – 0.51, p 0.006), while WHtR had a strong correlation with ectomorphy (r: -0.87; 95%CI -0.91 – -0.79; p<0.001) (Supplementary Table 1 and 2).

Figure 1

Spearman correlation matrix according to sex (A, male; B, female).



Note: 1/A, Age (years); 2/B, Physical activity (steps/day); 3/C, Waist circumference (cm); 4/D, Hip circumference (cm); 5/E, WHR (waist-to-hip ratio); 6/F, WHtR (waist-to-height ratio); 7/G, SBP (systolic blood pressure); 8/H, DBP (diastolic blood pressure); 9/I, Endomorphy; 10/J, Mesomorphy; 11/K, Ectomorphy.

Table 2 presents the results of the multiple linear regression analysis. In the group of active children, sex was directly associated with waist circumference (β: 5.93; 95% CI: 0.81–11.0) and WHtR (β: 0.03; 95% CI: 0.00–0.05), while age was associated with hip circumference (β: 3.62; 95% CI: 0.82–6.42) and BPD (β: 4.15; 95% CI: 0.56–7.73). Among the somatotype components, only endomorphy showed a significant association with waist circumference (β: 3.00; 95% CI: 0.52–5.45) and WHtR (β: 0.01; 95% CI: 0.00–0.02). Regarding the inactive group, all predictor variables were significant for waist and hip circumference, jointly explaining ~83% and 85% of their expressions, respectively. Furthermore, endomorphy and ectomorphy were associated with WHtR (β: 0.01, 95% CI: 0.00–0.01 and β: -0.01; 95% CI: -0.02– -0.01, respectively), and endomorphy with SBP (β: 0.03, 95% CI: 0.06–2.37).

Table 2

Results of the association between health risk indicators, sex, age and somatotype components in active and inactive children.

Variables		Waist Circumference	Hip Circumference	WHR	WHtR	SBP	DBP
				Active (14,3%)			
Intercept	β	20,82	38,29	0,82	0,41	23,95	11,64
	p	0,20	0,13	**0,001**	**0,001**	0,59	0,71
	IC95%	-17,3–75,0	-12,3–88,9	0,39–1,25	0,19–0,62	-69,3–117	-54,3–77,5
Sex, male	β	5,93	2,19	0,47	0,03	-2,47	0,26
	p	**0,02**	0,42	0,05	**0,01**	0,59	0,93
	IC95%	0,81–11,0	-3,42–7,81	-0,001–0,09	-0,001–0,09	-12,1–7,20	-6,57–7,10
Age, years	β	2,01	3,62	-0,13	0,00	2,39	4,15
	p	0,11	**0,01**	0,27	0,94	0,33	**0,02**
	IC95%	-0,53–4,56	0,82–6,42	-0,03–0,01	-0,01–0,01	-2,67–7,47	0,56–7,73
Endomorphy	β	3,00	2,37	0,11	0,01	2,71	0,85
	p	**0,01**	0,08	0,32	**0,02**	0,25	0,61
	IC95%	0,52–5,45	-0,31–5,06	-0,01–0,03	0,00–0,02	-2,18–7,61	-2,61–4,31
Mesomorphy	β	0,11	-1,07	0,11	0,002	8,71	1,36
	p	0,96	0,71	0,65	0,89	0,14	0,73
	IC95%	-5,36–5,59	-7,09–4,94	-0,04–0,06	-0,02–0,02	-3,21–20,6	-7,06–9,78
Ectomorphy	β	-1,31	-1,82	0,00	-0,01	5,01	1,08
	p	0,63	0,55	0,98	0,17	0,38	0,78
	IC95%	-7,11–5,47	-8,18–4,53	-0,05–0,05	-0,04–0,009	-6,92–16,9	-7,35–9,52
	R^2	*0,80*	*0,74*	*0,50*	*0,88*	*0,44*	*0,40*
				Inactive (85,7%)			
Intercept	β	29,98	35,03	0,88	0,44	77,94	46,46
	p	**0,001**	**0,001**	**0,001**	**0,001**	**0,001**	**0,001**
	IC95%	23,5–36,3	28,8–41,2	0,79–0,97	0,40–0,47	65,5–90,3	35,7–57,2
Sex	β	3,12	1,30	0,24	0,01	2,35	-0,07
	p	**<0,001**	0,12	0,05	**0,003**	0,16	0,95
	IC95%	1,42–4,83	-0,34–2,94	-0,00–0,04	0,005–0,02	-0,97–5,68	-2,97–2,81
Age, years	β	2,51	3,50	-0,007	-8,84	1,88	0,43
	p	**<0,001**	**<0,001**	**0,04**	0,94	**<0,001**	0,30
	IC95%	2,03–2,99	3,04–3,96	-0,01–0,00	-0,003–0,003	0,94–2,83	-0,38–1,25
Endomorphy	β	1,89	1,80	0,003	0,01	1,21	0,99
	p	**<0,001**	**<0,001**	0,48	**<0,001**	**0,03**	0,05
	IC95%	1,29–2,48	1,23–2,37	-0,006–0,01	0,005–0,01	0,06 –2,37	-0,009–1,99
Mesomorphy	β	1,01	0,73	0,003	0,004	0,98	0,96
	p	**0,003**	**0,02**	0,58	0,05	0,12	0,08
	IC95%	0,36–1,67	0,10–1,36	-0,007–0,01	0,00–0,007	-0,27–2,23	-0,12–2,04
Ectomorphy	β	-1,81	-1,76	0,006	-0,01	-0,14	0,64
	p	**<0,001**	**<0,001**	0,40	**<0,001**	0,87	0,42
	IC95%	-2,76– -0,86	-2,67– -0,85	-0,02–0,008	-0,02– -0,01	-1,99–1,69	-0,95–2,25
	R^2	*0,82*	*0,85*	*0,16*	*0,82*	*0,32*	*0,14*

Note. Waist (cm); Hip (cm). WHR (waist-to-hip ratio); WHtR (waist-to-height ratio); SBP (systolic blood pressure); DBP (diastolic blood pressure); 95%CI (95% confidence interval).

DISCUSSION

The aim of this study was to analyze the relationship between health risk indicators and somatotype components in children with different levels of physical activity. The main results indicated that: (a) most participants were in the inactive group, while older children and boys took more steps than their younger and female peers, respectively; (b) boys had the lowest values for endomorphy and the highest for mesomorphy; (c) children classified as active showed significant associations between endomorphy and risk indicators (waist circumference and WHtR only); (d) in the inactive group, the three somatotype components were associated with waist circumference, hip circumference and WHtR (except for mesomorphy for the latter), and endomorphy was associated with SBP.

Previous studies have been consistent in reporting differences between the sexes for the level of physical activity (Kumar et al., 2015). Even at a young age, girls tend to be less active compared to their peers (Kumar et al., 2015; Whooten et al., 2019). These differences are explained by sociocultural aspects (such as parental support/encouragement), perception of safety, as well as the social designation of certain daily activities as being primarily practiced by individuals of one sex or the other (Whooten et al., 2019). These differences indicate the need for specific interventions to increase children's physical activity levels, especially among females (Sallis et al., 2000). In addition, the prevalence of global physical inactivity, regardless of sex, is significant and is related to approximately 5% of cases of chronic non-communicable diseases and premature mortality in Brazil (Rezende et al., 2015) and around 10% worldwide (Lee et al., 2012; Ozemek et al., 2019). Somatotype analysis enables a morphological understanding of the body based on three components: endomorphy – related to body fat, which may be associated with cardiovascular diseases; mesomorphy – which may be a protective factor for health, as it refers to muscle development, representing fat-free mass; and ectomorphy – which is related to relative linearity, which may be an indicator of malnutrition (Almeida et al., 2013). The present study indicated higher values for mesomorphy and endomorphy in boys and girls, respectively. These findings corroborate previous studies and can be explained by the disparities between the sexes (Marta et al., 2011). In general, women have a higher percentage of fat, while men have more lean mass (fat-free), a difference that can already be perceived in early childhood, but which can be accentuated during puberty (Silventoinen et al., 2021). These morphological aspects may also justify the correlation found between the components of the somatotype with WHR and WHtR, highlighting their relevance in the expression of risk factors to the health of the subjects.

Regardless of the level of physical activity, the data indicate a relationship between endomorphy, waist circumference and WHtR. Previous research has observed that body fat is a common predictor among the three indicators mentioned, playing a relevant role in the development of cardiovascular diseases (Almeida et al., 2015). Although it was not analyzed in this study, the percentage of fat is related to endomorphy, as previously explained, and has a significant correlation with WHtR, representing a risk to the subject's health (Almeida et al., 2015).

In general, inactive children showed a greater relationship between health indicators and somatotype components. Previous studies have suggested that subjects who present high anthropometric risk indicators also showed higher values for endomorphs and mesomorphs and lower values for ectomorphs (Almeida et al., 2013; Almeida et al., 2015). Our results are in line with these findings, but only for inactive children. Furthermore, ectomorph was negatively related to waist circumference, hip circumference and WHtR in the inactive group. Although it appears to have a protective effect, another study found that as cardiovascular risk increases, ectomorph tends to decrease, as observed through the analysis of anthropometric indicators (Almeida et al., 2013).

The present study has limitations. The use of a pedometer to objectively assess physical activity is a low-cost and reliable alternative; however, it does not allow us to obtain information on the intensity of this activity, which would allow a more detailed analysis of the information. Therefore, it is suggested that future research evaluate the effect of physical activity levels on this relationship, using an instrument that actually allows such an assessment. However, we emphasize that few studies have been developed to analyze the relationship between somatotype and health risk indicators in children according to physical activity, which can serve as support for structuring strategies to promote a healthier lifestyle and reduce negative health outcomes.

CONCLUSION

The relationship between health risk indicators and somatotype components was greater in inactive children, which suggests that regular physical activity may play an important role in the relationship between these variables. Although ectomorph appears to have a protective effect, as it is inversely related to health indicators, there is a tendency for this component to decrease with increasing anthropometric risk indicators. Regardless of the level of physical activity, endomorphy showed a significant relationship with health components, with a greater effect in the inactive group, given its association with the subjects' body composition.

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Received: 21-03-2023

Accepted: 08-06-2023