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Association between acanthosis nigricans and overweight with hypertension in children and adolescents from low-income families

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SUMMARY

OBJECTIVE: This study aimed to describe the prevalence of acanthosis nigricans and high blood pressure in children and adolescents from low-income families, and to verify the association of elevated blood pressure with nutritional status and the presence of acanthosis nigricans.

METHODS: This is a cross-sectional and controlled study with 232 children and adolescents from an institution for low-income families. Pubertal stage, body mass index Z-score, waist-to-height circumference ratio (increased waist-to-height circumference ratio >0.5), the presence of acanthosis nigricans, and blood pressure were assessed.

RESULTS: The prevalence of excess weight and the change in waist-to-height circumference ratio was 37.9%. Acanthosis nigricans and increased blood pressure occurred in 20.3 and 34.8%, respectively. The prevalence of acanthosis nigricans and hypertension was higher in individuals with excess weight (p<0.001; p<0.001) and with an increased waist-to-height circumference ratio (p=0.009; p<0.001). Logistic regression showed a significant and independent association of body mass index Z-score (OR 2.35; 95%CI 1.52–3.65; p<0.001) and the presence of acanthosis nigricans (OR 2.43; 95%CI 1.12–5.23; p=0.023) with elevated blood pressure.

CONCLUSION: Acanthosis nigricans and elevated blood pressure occurred in one-fifth and one-third of the individuals in an institution for children from low-income families. Overweight and the presence of acanthosis nigricans increased the risk of high blood pressure more than twofold.

KEYWORDS: Acanthosis nigricans. Arterial pressure. Pediatric obesity. Cardiometabolic risk factors.

INTRODUCTION

The prevalence of childhood obesity has increased tenfold in the last four decades worldwide[1]. In Brazil, excess weight (overweight and obesity) was observed in 30% of children aged between 5 and 9 years and in 19.4% of adolescents[2].

Children and adolescents with obesity may present cardiometabolic risks, including arterial hypertension, which present insulin resistance as a central mechanism. Acanthosis nigricans (AN) occurs more frequently in conditions such as hyperinsulinism, insulin resistance, type 2 diabetes, and obesity at all ages, including pediatric age. The assessment of AN can be performed in a practical way and is part of the routine pediatric physical examination, assisting in the early diagnosis of these conditions[3-5].

A meta-analysis including 47 cross-sectional studies with children and adolescents showed that overweight and obesity increased the risk of hypertension by 5 and 15 times, respectively[6].

Studies evaluating the association between AN and arterial hypertension with excess weight in children and adolescents from low-income families in our country are rarely reported in the literature[7].

The aims of this study were to describe the prevalence of AN and high blood pressure (BP) in children and adolescents from low-income families and to verify the association of elevated BP with nutritional status and the presence of AN.

METHODS

Since this is a cross-sectional study, 232 children and adolescents from an institution for children from low-income families in situations of social vulnerability in the city of Santo André, Brazil were included. The study was conducted from January to December 2019.

The exclusion criteria were as follows: patients with chronic diseases (except overweight, asthma, and rhinitis),

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such as genetic, cardiovascular, endocrine, and renal diseases, acute infections, and those using hormonal and non-hormonal anti-inflammatory drugs in 3 months prior to the clinical evaluation.

The anthropometric assessment was performed according to protocols standardized by the World Health Organization (WHO) and the Ministry of Health of Brazil[8,9]. Weight and height measurements were expressed as body mass index Z-score (zBMI), calculated using the WHO Anthro and WHO Anthro Plus 3.2.2 software. For the anthropometric classification, the cutoff points recommended by the WHO were adopted[10]. The children's waist measurement was also obtained using an inextensible measuring tape, positioned at the midpoint between the superior border of the iliac crest and the last fixed rib cage, which was used to calculate the waist-to-height circumference ratio (WHtR). WHtR was classified as altered when the value was equal to or greater than 0.5[11].

The pubertal stage was defined by a single professional (pediatrician) and classified according to what was proposed by Marshall and Tanner[12,13].

BP was measured in the right arm relaxed, at heart height, with the palm facing up and supported on a rigid surface, with the individual seated and at rest. A sphygmomanometer was used with a cuff suitable for arm circumference. Three measurements were obtained with a minimum interval of 2 min between them, and the mean of the values was calculated. BP was classified according to the criteria of the Manual de orientação de hipertensão arterial na infância e adolescência da Sociedade Brasileira de Pediatria – 2019[14]: altered blood pressure levels (elevated BP): ≥90th percentile (P90) for age, sex, and height (BP ≥P90 and <P95: elevated BP; PB ≥P95 and <P95+12 mmHg: hypertension stage 1; BP ≥P95+12 mmHg: hypertension stage 2).

The skin of the cervical and bilateral axillary regions was evaluated in search of AN, the regions where acanthosis occurs most frequently[15]. Each child was evaluated simultaneously by two pediatricians.

The data were entered, revised, and consolidated in an Excel spreadsheet (Office®). For statistical analysis, Epi InfoTM, version 7.2.2.6 was used. Qualitative variables were presented as absolute numbers and percentages and compared through the χ^2 test: logistic regression (dependent variable: elevated BP (≥P90); independent variables: zBMI, WHtR) and the presence of acanthosis. The significance level adopted was 5%.

This study was approved by the Research Ethics Committee of the Centro Universitário FMABC, under opinion number: 3.058.583.

RESULTS

The study included 232 children and adolescents aged 4–14 years (mean 8.4±3.2 years). The general characteristics of the study population are presented in Table 1. Excess weight (overweight and obesity) and a change in WHtR occurred in 37.9% of the participants. Cervical and/or axillary AN and elevated blood pressure (≥P90) were observed in 20.3% and 34.8% of participants, respectively.

Table 2 shows the general characteristics stratified according to the presence of AN and BP. There was no difference between the overweight and non-overweight groups regarding sex, age, or pubertal stage. Individuals with AN had a higher prevalence of overweight (p<0.001) and altered WHtR (p=0.009).

There was no difference between the groups of individuals with normal BP in relation to sex, age, and pubertal stage. The group of children with altered BP presented a higher prevalence of overweight (p<0.001), change in WHtR (p<0.001), and AN (p<0.001) (Table 2).

Logistic regression showed a significant and independent association of zBMI (OR 2.35; 95%CI 1.52–3.65; p<0.001) and the presence of AN (OR 2.43; 95%CI 1.12–5.23; p=0.023) with elevated BP. There was no association between WHtR and the risk of elevated BP (p=0.567) (Table 3).

Table 1. General characteristics of the study population (n=232).

		n	%
Sex	Male	124	53.5
	Female	108	46.5
Age	<10 years	151	65.1
	≥10 years	81	34.9
Puberty	Prepubescent	164	70.7
	Pubescent	68	29.3
zBMI	Normal weight	144	62.1
	Overweight	49	21.1
	Obesity	28	12.1
	Severe obesity	11	4.7
WHtR	<0.5	144	62.1
	≥0.5	88	37.9
Acanthosis nigricans	Absent	185	79.7
	Present	47	20.3
Blood pressure	Normal	151	65.1
	Elevated	37	15.9
	Hypertension stage 1	37	15.9
	Hypertension stage 2	7	3

zBMI: body mass index Z-score; WHtR: waist-to-height circumference ratio.

Table 2. Comparison of clinical variables in relation to acanthosis nigricans (absent or present) and blood pressure (normal or increased).

		Absent AN (n=185)	Present AN (n=47)	p-value	Normal BP (n=151)	Elevated BP (n=81)	p-value
Sex	Male	101	23	0.595	79	45	0.738
	Female	84	24		72	36	
Age	<10 years	118	33	0.512	103	48	0.222
	≥10 years	67	14		48	33	
Puberty	Prepubescent	131	33	1	110	54	0.403
	Pubescent	54	14		41	27	
zBMI	Normal weight	131	13	<0.001*	116	28	<0.001*
	Overweight	54	34		35	53	
WHtR	<0.5	123	21	0.009*	107	37	<0.001*
	≥0.5	62	26		44	44	
AN	Absent				134	51	<0.001*
	Present				17	30	

AN: acanthosis nigricans; BP: blood pressure; zBMI: body mass index Z-score; WHtR: waist-to-height circumference ratio. Elevated BP group: children with BP ≥90th percentile for sex, age, and height. *Significance level of χ^2 test.

Table 3. Logistic regression of variables associated with elevated blood pressure (n=232).

	OR	95%CI		p-value
zBMI	2.35	1.52	3.65	<0.001*
WHtR	1.23	0.60	2.49	0.567
Presence of AN	2.43	1.12	5.23	0.023*

zBMI: body mass index Z-score; WHtR: waist-to-height circumference ratio; AN: acanthosis nigricans. Dependent variable elevated BP group: children with BP ≥90th percentile for sex, age, and height. Independent variables: zBMI classification, classification of WHtR, and classification of the presence of AN. *Significance level of χ^2 test.

DISCUSSION

Overweight and the presence of AN increased the risk of elevated BP in the study population by 2.3 and 2.4 times, respectively. The association between these risk factors (overweight, presence of AN, and elevated BP) increases the risk of future cardiovascular events[16]. More than one-third of the participants had overweight and/or altered WHtR. This study was conducted in an institution for children in situations of social vulnerability from low-income families. Food disorders may justify the higher prevalence of overweight and obesity in this population. Childhood obesity is increased by low socioeconomic status and place of residence[17,18]. A cross-sectional study conducted on 175 children and adolescents aged 6–17 years, from a low-income community in the city of Santa Rita do Sapucaí, Brazil, observed 37.2% of overweight, the levels similar to that observed in this study[7].

The prevalence of AN in this study was one in five children. Sex, age, and pubertal stage did not influence the risk of AN. Children with AN had higher zBMI and WHtR levels. A study conducted in Turkey evaluated 160 overweight children and adolescents (10.4±3.3 years old), and also found no significant difference in the presence of AN in relation to these variables. Apparently, the only predictive factors for AN are hyperinsulinism and the severity of obesity[19]. A systematic review showed that AN is associated with insulin resistance and risk for type 2 diabetes mellitus[20]. A study on 8,371 children from territories belonging to the United States in the Pacific demonstrated that intervention measures addressing eating habits, lifestyle, and sleep and screen time control significantly reduced excess weight, waist circumference, and the presence of AN when compared to the control group (overweight [effect size] d= -3.95%; 95%CI -7.47 to -0.43); waist circumference (d= -0.71%; 95%CI -1.37 to -0.05), and AN prevalence (d= -2.28%; 95%CI -2.77 to -1.57)[21].

One-third of the participants had increased blood pressure (≥P90). Sex, age, and pubertal stage did not influence the risk of altered BP. Children with elevated BP had a higher prevalence of increased zBMI, WHtR, and the presence of AN. A meta-analysis of 41 studies on hypertension in Africa, involving 52,918 participants aged 3–19 years from 10 countries, described a total prevalence of 18.8% of elevated BP and hypertension, with a significant predominance in overweight children (p<0.001)[22]. Another meta-analysis of 64 studies conducted in India, with 187,990 participants aged 4–19 years, described a similar prevalence of 17% of elevated BP and hypertension, also with significant predominance in overweight children (p<0.001)[23]. Song et al.

conducted a meta-analysis on the worldwide prevalence of childhood hypertension with 186,630 participants under 19 years of age and described that overweight (OR 4.99; 95%CI 2.18–8.81, p<0.001) and obesity (OR 15.27; 95%CI 7.31–25.38, p<0.001) significantly increase the risk of elevated BP[6]. A systematic review and meta-analysis study with 18,925 children showed that an intervention combining diet and physical activity significantly reduced children's blood pressure [effect size d= -1.64 mmHg (95%CI -2.56 to -0.71; p=0.001) for systolic BP and d= -1.44 mmHg (95%CI -2.28 to -0.60; p=0.001) for diastolic BP][24].

The high prevalence of elevated blood pressure in this study can be attributed to low socioeconomic status. Martinovic et al. evaluated 434 children aged 6–13 years from two schools in Montenegro and found that the worst socioeconomic level is a risk factor for increased blood pressure (p=0.021)[25]. In addition, although BP was verified three times in each child, measurements were obtained on the same day. The measurements were performed at the institution, with the presence of teachers and caregivers, but without the family members. Some children may have felt uncomfortable with transient elevated BP, not allowing us to affirm that this alteration represents a definitive diagnosis.

CONCLUSIONS

This study demonstrated that AN and BP increased in one-fifth and one-third of the individuals in an institution for children in situations of social vulnerability with low family income. Overweight and the presence of AN increased the risk of high blood pressure more than twofold.

BP measurement and skin assessment for AN add less time to a pediatric consultation and may help in the early diagnosis of comorbidities associated with childhood obesity, anticipating measures to control overweight and reduce future cardiometabolic risks.

AUTHOR CONTRIBUTION

CAV: Data curation, Formal analysis, Writing – original draft. **JCPF:** Data curation, Methodology, Investigation, Project administration, Writing – original draft. **LSS:** Formal analysis, Methodology. **FISS:** Conceptualization, Methodology, Validation, Writing – review & editing. **ROSS:** Conceptualization, Methodology, Visualization, Writing – review & editing.

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