Original article

Association Between Anthropometry and High Blood Pressure in a Representative Sample of Preschoolers in Madrid

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A B S T R A C T

Introduction and objectives: Program SI! is a multi-level, school-based intervention for the promotion of cardiovascular health from early childhood. The aim of this paper is to characterize the prevalence of obesity and high blood pressure in the preschoolers enrolled in the study, and to compare various criteria for classifying obesity.
Methods: The study was a cluster-randomized controlled intervention trial including 24 state schools in Madrid (Spain). Weight, height, triceps and subscapular skinfold thicknesses, waist circumference, and systolic and diastolic blood pressure were measured in 2011 children (1009 boys and 1002 girls) aged 3 to 5 years (3.7 [0.9]). Body mass index and blood pressure were classified by corresponding task force criteria. Obesity was studied by 6 different criteria. Associations of body mass index, body weight, body fat, and waist circumference on blood pressure were examined, and the risk of high blood pressure in relation to tertiles of body mass index was calculated.
Results: The prevalence of obesity according to the International Obesity Task Force varied from 2% at age 3 to 8% at age 5, and the overall prevalence of high blood pressure ($\geq$ 90th percentile) was 20%. Sex- and age-specific criteria for obesity showed better agreement with the reference than a single generalized cutoff. The risk of high blood pressure was higher for the highest tertile of body mass index distribution.
Conclusions: The highest prevalence of obesity and high blood pressure was found among older children. The classification of obesity in children was more accurate using sex- and age-specific cutoffs.

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Asociación entre antropometría y presión arterial alta en una muestra representativa de preescolares de Madrid

R E S U M E N

Introducción y objetivos: El Programa SI! es una intervención escolar de promoción de salud cardiovascular en la infancia. El objetivo de este artículo es caracterizar la prevalencia de obesidad y presión arterial alta entre los preescolares del estudio del Programa SI! y comparar distintos criterios de clasificación de obesidad.
Métodos: El diseño es una intervención controlada y aleatorizada por grupos en 24 colegios públicos de Madrid. Se midió peso, talla, pliegues tricipital y subescapular, circunferencia de la cintura y presión arterial en 2.011 preescolares (1.009 niños y 1.002 niñas) de 3 a 5 (3,7 ± 0,9) años. El índice de masa corporal y la presión arterial se clasificaron siguiendo criterios internacionales. Se estudiaron seis criterios diferentes de obesidad, los efectos del índice de masa corporal, peso, porcentaje de grasa y circunferencia de la cintura en la presión arterial y el riesgo de presión arterial alta por terciles de índice de masa corporal.
Resultados: La prevalencia de obesidad osciló del 2% (niños de 3 años) al 8% (niños de 5) y la de presión arterial alta fue del 20%. Se ha encontrado mejor concordancia con la referencia internacional para los criterios de obesidad específicos para sexo y edad que con puntos de corte únicos. El riesgo de presión arterial alta aumentó en cada tercil de índice de masa corporal.

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Conclusiones: Los niños mayores mostraron la mayor prevalencia de obesidad y presión arterial alta. La clasificación de obesidad fue más precisa utilizando criterios específicos para sexo y edad.
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Abbreviations

BF: body fat
BMI: body mass index
CVD: cardiovascular disease
DBP: diastolic blood pressure
IOTF: International Obesity Task Force
SBP: systolic blood pressure

INTRODUCTION

The worldwide epidemic of obesity is a leading concern in prevention and public health policies, particularly those directed at children.[1] Program SI! is a multi-level, school based-intervention that has been successfully implemented in Colombia[2] and Spain.[3,4] The Program SI! intervention introduces a global vision of health promotion based on four connected components related to cardiovascular health: diet (promoting acquisition of healthy dietary habits), physical activity (healthy and balanced management of leisure time), human body (knowledge of the human body and heart), and Emotions (effective management of emotions, aimed at developing behaviors that protect against substance abuse and psychological disorders).

The intervention has been initiated in preschool children (aged 3 years), and its efficacy is currently being evaluated through a cluster-randomized controlled intervention trial.[3] As a part of this evaluation, anthropometry and blood pressure data have been collected at baseline to assess the long-term impact of the intervention on cardiovascular disease (CVD)-related conditions such as obesity and hypertension.

Many studies have shown an association between body mass index (BMI) and CVD risk factors, and most national and international standards define childhood obesity or overweight based on BMI. However, other adiposity markers have also proven to be indicators of CVD, such as waist circumference or specific measures of skinfold thickness.[5,6]

Waist circumference is a simple measurement of abdominal fatness that has been associated with cardiometabolic risk factors not only in adults, but also among preschoolers.[6] An international cutoff for waist circumference is available for adults, although some countries (Turkey, Germany, The Netherlands, and New Zealand) have developed their own values.[7–10] Skinfold thickness is another adiposity indicator directly related to CVD risk factors, and is also a very valuable tool for evaluating the distribution of body fat (BF) in children. Pediatric guidelines recommend the assessment of triceps and subscapular skinfold thicknesses.[5] As for waist circumference, cutoffs for the percentage of BF calculated from skinfolds are available for adults, but there is no consensus cutoff for children.[11–14] High blood pressure is a direct risk factor for CVD among adults, and high blood pressure in children and adolescents frequently develops into hypertension in adults.[15] The estimated prevalence of childhood hypertension in recent studies is 2% to 5%[16–18] and is increasing, probably as a result of the increase in obesity rates.[19]

The objective of this study was to characterize the Program SI! population of preschoolers in terms of anthropometric measurements and its association with the prevalence of high blood pressure, and to determine the prevalence of obesity according to various criteria.

METHODS

Participants

The study was a cluster-randomized, controlled intervention trial including 24 state schools in Madrid (clinical trial registry number NCT01579708). A detailed description of Program SI! was published recently.[3] During the 2010-2011 academic year there were 787 state schools in the Madrid area. To ensure a homogeneous sample, selection was restricted to schools located in the city of Madrid with a canteen service and a minimum of two classes per preschool level. A total of 174 schools satisfied these criteria. We further excluded schools representing extremes according to quartiles of socioeconomic variables, resulting in a sample with these characteristics: 10% to 32% immigrant families, 36% to 54% families receiving state subsidies for books, and 13% to 20% families receiving state subsidies for canteen meals. The remaining 73 schools were invited to a 1-day meeting at which Program SI! was presented; 35 schools agreed to participate, and the final 24 were selected by excluding larger schools with more than 2 classes per level, to yield a sample of medium-sized schools. All children at preschool level in these 24 schools were eligible for participation and were recruited through written consent from their parents in both the control and the intervention schools, resulting in a response rate of 59.1%. Sample distribution by school level was 801 (51.3% girls) from 1st grade ("age 3"), 623 (44.3% girls) from 2nd grade ("age 4") and 587 (53.7% girls) from 3rd grade ("age 5"). Data are treated according to Spanish Law 15/1999 for the Protection of Personal Data, and were processed with a data encryption system to guarantee confidentiality of the information provided. The study protocol was approved by the Madrid Clinical Research Ethics Committee.

Anthropometry and Blood Pressure Assessment

All measurements were made by trained nutritionists according to a standardized protocol.[20] Body weight was measured to the nearest 0.1 kg (Seca 803 electronic scale; Hamburg, Germany) and height to the nearest 0.1 cm (Seca 213 portable stadiometer) with children wearing light clothes and no shoes. Waist circumference was measured to the nearest 0.1 cm directly on the skin at the end of a gentle expiration; measurements were made halfway between the lower costal border and the iliac crest, using a flexible, nonelastic Holtain tape (Crymych, United Kingdom). Triceps skinfold thickness and subscapular skinfold thickness were measured to the nearest 0.2 mm with a Holtain T/W Skinfold Caliper (Crymych, United kingdom). Triceps skinfold thickness was measured at the midpoint between the acromion and the olecranon processes on the posterior surface of the right arm, and subscapular skinfold thickness was measured 2 cm below the inferior angle of the right scapula. BMI was calculated using the standard formula of weight (in kilograms)