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Simple anthropometric measurements to predict dyslipidemias in Mexican school-age children: a cross-sectional study

Maria del Carmen Caamaño[1,2], Olga Patricia García[1], María del Rocío Arellano[1], Karina de la Torre-Carbot[1], Jorge L. Rosado[1,2*]

[1]School of Natural Sciences, Universidad Autónoma de Querétaro, Querétaro, Mexico;
[*]Corresponding Author: jlrosado@prodigy.net.mx
[2]Disease and Development Center for Chronic Diseases, Querétaro, Mexico.

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ABSTRACT

Objective: The purpose of this study was to identify the best predictors of dyslipidemias in Mexican obese children using different anthropometric and body composition measurements. Methods: In an observational, cross-sectional study, 905 children from 5 schools were measured for weight, height, waist and hip circumference, and triceps and subscapular skinfolds. A fasting blood sample was taken from a random sub-sample of 306 children to determine lipid profile. Abnormal total cholesterol, LDL, HDL, triglycerides, total cholesterol to HDL ratio, and LDL to HDL ratio, were determined. Logistic regressions and ROC analysis were carried out to determine the best anthropometric predictors of these risk factors. Results: Prevalence of elevated total cholesterol, triglycerides and LDL cholesterol was 14%, 56% and 58%, respectively. In logistic regressions, BMI and triceps skinfold had the highest odds ratios to predict elevated total cholesterol (1.05, 95% CI: 0.97 - 1.14; 1.07, 1.01 - 1.13, respectively), triglycerides (1.19, 1.11 - 1.27; 1.12, 1.08 - 1.17, respectively), LDL cholesterol (1.11, 1.04 - 1.18; 1.09, 1.05 - 1.14, respectively), total cholesterol to HDL ratio (1.06, 1.00-1.14; 1.07,1.03-1.12, respectively) and LDL to HDL ratio risk (1.08,1.01-1.15; 1.07, 1.03-1.12, respectively). After BMI and triceps skinfold, subscapular skinfold also predicted dyslipidemias, except for low HDL; both skinfolds had a narrower odds ratio confidence interval than BMI. In ROC analysis, subscapular skinfold was the best predictor of elevated triglycerides with an AUC ≥ 0.7. Conclusion: Anthropometric measurements are not strongly associated with dyslipidemias in Mexican children. However, since triceps and subscapular skinfolds were better predictors than other anthropometry measures, they may be a simple way to predict dyslipidemias in Mexican children.

Keywords: Cardiovascular Risk; Dyslipidemia; Lipids; Anthropometry and Children

1. INTRODUCTION

Obesity is a major public health problem in Mexican children [1,2]. About 26% of children between 5 to 12 years of age are overweight or obese, and this age group had the highest rates of obesity increase in the past 10 years. The high prevalence of obesity in Mexican population is associated with the increased incidence in chronic diseases observed in recent years [3,4]. An excess in body fat is associated with insulin resistance and metabolic syndrome which results in a greater probability of developing type 2 diabetes and hyperlipidemia [5,6]. Dyslipidemia and the consequent cardiovascular (CV) diseases constitute the first cause of mortality in Mexican adults [7]. In children, obesity produces an increase in the prevalence of CV risk factors such as high concentration of total cholesterol, tryglicerides or low concentrations of HDL [8-11].

Anthropometric measures are useful and practical methods for screening and surveillance of childhood obesity [12]. The most widely used are weight and height which are used to determine Body Mass Index (BMI), waist and hip circumferences, and skinfolds measurements [13-16]. Some studies have recommended to identify children with dyslipidemia by measuring BMI or waist circumference (WC) [11,15,17-19]. However, other studies have suggested that different anthropometry and body composition measurements, such as skinfold measurements and waist-to-height ratio (WHtR), could predict better the risk for CV diseases [10,20,21].

It has been observed that dyslipidemias, such as low high-density lipoprotein cholesterol (HDL), elevated low-density lipoprotein cholesterol (LDL) and triglycerides (TG) are associated with body fat, even in the absence of elevated body weight [17,22]. In addition, fat distribution may differ according to gender or ethnicity, thus these variables may affect the relationship between obesity and dyslipidemias [17,23].

The objective of this study was to identify the best predictors of abnormal lipoproteins and triglycerides in obese children from elementary schools in Queretaro, Mexico, using different anthropometric measurements.

2. METHODS

2.1. Subjects and Place of the Study

Children aged 6 to 12 y from 5 elementary schools in the city of Querétaro, Mexico, participated in the study. Parents of all children from 1st to 6th grade received oral and written information about the study and those that accepted to participate signed a consent form. The study was performed in accordance with the Helsinki Declaration, and the study protocol was approved by the Internal Committee of Human Research of the University of Querétaro.

From 905 children that participated, 17% were overweight and 18% were obese [24], according to the WHO cut off criteria [25] (according to international cut-off points (IOTF) [26]: 21% were overweight and 13% were obese) [24]. A sub-sample was selected to include approximately the same proportion of children with overweight or obesity than with normal weight to participate in the present study. Three hundred and six children participated in a cross-sectional study. A calculation of 300 children was established to detect a significant Area Under the Curve (AUC) of 0.6 to predict dyslipidemias from each anthropometry measurement compared with 0.5 considering a type I error of 0.05 and a type II error of 0.20. An AUC value of 0.5 means that the prediction is equal to chance, and AUC value of 1 means perfect prediction. This sample size was calculated with MedCalc software V.9.6.4.0 (Mariakerke, Belgium).

2.2 Measurements

2.2.1. Anthropometry

Anthropometry and body composition were measured in all children by trained and standardized staff. Parents of enrolled children received written notification with the date of their measurements and were instructed that their children not to eat anything for the previous 12 hours. Measurements were taken on school ground, in a room specifically assigned by school authorities and conditioned for this study. Anthropometry included weight, height, waist, hip circumference, and subscapular and triceps skinfolds. A fasting blood sample was taken to measure plasma lipids concentration.

Anthropometric measurements were performed in duplicate by trained nutritionists following standard procedures [27]. Children were weighed in light clothes, without sweater or jacket and without shoes using an electronic scale (SECA, Erecta 844, Hamburg, Germany) to the nearest 1 g. Height was measured using portable stadimeters (SECA, Bodymeter 208, Germany) with an accuracy of 0.1 cm. Waist and hip circumference were measured to the nearest 0.1 cm using flexible bands (SECA). Children's triceps and subscapular skinfolds thickness were measured on the child's right side following standard procedures to the nearest 1 mm with a Lange caliper (Beta Technology, Inc, Cambridge, MD).

BMI for age was calculated according to the World Health Organization growth curves references [28]: children were identified as overweight when their BMI-for-age Z-score was >1SD and as obese when BMI-for-age Z-score was > 2SD. Waist to height ratios (WHtR) were also calculated.

2.2.2. Lipid Profile

Fasting blood samples were centrifuged at 1800 - 2000 rpm during 15 minutes and plasma was separated and stored at –20˚C until subsequent analysis. Total cholesterol, HDL-cholesterol and triglycerides, were measured by enzymatic/colorimetric methods using a commercial kit (Sera-Pak Kit Bayer Diagnostics, France). LDL was calculated with Friedwald's equation [29].

According to the National Cholesterol Education Program (1992), the cut off values to determine children at risk of a CV disease are: total cholesterol > 170 mg/dL, HDL < 35 mg/dL, LDL > 110 mg/dL. High triglycerides is considered with blood concentrations > 130 mg/dL for children above 10 y and > 100 mg/dL for children aged 10 years or less. Also, total cholesterol to HDL ratio >3.5 and LDL to HDL ratio >2.2 were considered risk factors [30,31].

2.3. Statistical Analysis

Descriptive analysis included central tendency measurements and abnormal lipids or triglycerides prevalence.

Logistic regressions were performed to determine the odds ratio as a measure to predict the probability to present a dyslipidemia according with the cut-off previously described for total cholesterol, LDL, HDL, triglycerides, total cholesterol to HDL ratio, and LDL to HDL ratio based on continuous anthropometry variables adjusting for age. The Receiver Operating Characteristics (ROC) analysis was carried out to evaluate the accuracy of diagnosis of children with a dyslipidemia according to each anthropometry measurements. The AUC was used as a measure of overall performance to predict dyslipidemias from each anthropometry measurement. A significant p value means that the AUC is significantly different from 0.5. All analyses were also performed stratifying by gender. The software used for statistical analysis was SPSS v 18.0 (Chicago Il)

3. RESULTS

Demographic characteristics of subjects included in the study are described in **Table 1**. Boys had higher WHR and WHtR than girls, and girls had a larger hip circumference. Plasma lipids concentration is described in **Table 2**. High total cholesterol concentration was found in 13.5% of the children. Fifty six percent of the studied children presented high TG concentrations; a higher proportion of girls (66%) compared with boys (49%) presented high TG concentration. Fifty eight percent of children presented elevated LDL concentrations, while 24.8% showed total cholesterol to HDL ratio > 3.5 and 64.8% showed a LDL to HDL ratio > 2.2. Obese children had significantly higher LDL, total cholesterol and triglycerides than normal weight and overweight children.

In logistics regression, all dyslipidemias, except for low HDL cholesterol, were associated with one or more anthropometric measures. BMI and triceps skinfold had the highest odds ratios to predict elevated lipids or triglycerides concentration. Odds ratio for BMI and triceps skinfold, respectively were: for high total cholesterol: 1.05, (95%CI) 0.97 - 1.14; 1.07, 1.01 - 1.13, for high triglycerides: 1.19, 1.11 - 1.27; 1.12, 1.08 - 1.17, for high LDL cholesterol: 1.11, 1.04 - 1.18; 1.09, 1.05 - 1.14, for high total cholesterol to HDL ratio: 1.06, 1.00 - 1.14; 1.07, 1.03 - 1.12 and for LDL to HDL ratio: 1.08, 1.01 - 1.15; 1.07, 1.03 - 1.12. After BMI and triceps skinfold the next best predictor of plasma lipids was subscapular skinfold. The odds ratio confidence interval for both skinfolds was narrower than BMI's **(Figure 1)**. When stratifying logistics regressions by gender, less anthropometric measures could predict dyslipidemias among boys, but the results were similar to overall results.

Table 1. Anthropometry characteristics of children that participated in the study.

Anthropometry measurements	All	Boys	Girls	Normal weight	Overweight	Obese
N	306	161	145	94	74	137
Age (y)	9.3 ± 1.6	9.3 ± 1.6	9.4 ± 1.6	9.5 ± 1.6	9.4 ± 1.6	9.3 ± 1.6
Boys (%)	52.6	100	0	54.3	47.3	54.0
Girls (%)	47.4	0	100	45.7	52.7	46.0
BMI Zscore<1 (%)	30.8	31.9	29.7	100	0	0
BMI Zscore>1 (%)	24.3	21.9	26.9	0	100	0
BMI Zscore>2 (%)	44.9	46.2	43.4	0	0	100
BMI (Kg/m2)	20.9 ± 4.1	20.6 ± 4.1	21.1 ± 4.1	16.5 ± 1.6 ^{a}	20.0 ± 1.6 ^{b}	24.3 ± 3.0 ^{c}
BMIfor age (Z score)	1.6 ± 1.3	1.7 ± 1.4	1.5 ± 1.2	0.0 ± 0.7 ^{a}	1.6 ± 0.3 ^{b}	2.7 ± 0.6 ^{c}
Triceps skinfold (mm)	19.0 ± 6.1	18.5 ± 6.4	19.5 ± 5.7	12.8 ± 3.6 ^{a}	18.1 ± 3.9 ^{b}	23.6 ± 4.2 ^{c}
Subescapular skinfold (mm)	14.5 ± 6.8	13.9 ± 6.9	15.1 ± 6.8	7.7 ± 2.6 ^{a}	12.7 ± 3.6 ^{b}	19.9 ± 5.4 ^{c}
Waist circumference (cm)	70.3 ± 11.2	70.8 ± 11.5	69.8 ± 10.8	59.5 ± 5.7 ^{a}	67.6 ± 6.1 ^{b}	79.0 ± 8.6 ^{c}
Hip circumference (cm)	80.0 ± 10.1	78.8 ± 9.8 ^{a}	81.4 ± 10.4 ^{b}	71.7 ± 6.8 ^{a}	78.3 ± 7.1 ^{b}	86.5 ± 8.9 ^{c}
Waist to hip ratio	0.9 ± 0.1	0.9 ± 0.1 ^{a}	0.9 ± 0.1 ^{b}	0.8 ± 0.0 ^{a}	0.9 ± 0.0 ^{b}	0.9 ± 0.1 ^{c}
Skinfolds sum (mm)	33.4 ± 12.4	32.4 ± 12.7	34.6 ± 12.0	20.4 ± 5.9 ^{a}	30.8 ± 6.7 ^{b}	43.5 ± 8.6 ^{c}
Waist to height ratio	51.6 ± 6.9	52.4 ± 7.1 ^{a}	50.8 ± 6.7 ^{b}	43.8 ± 3.0 ^{a}	49.9 ± 3.1 ^{b}	57.6 ± 4.0 ^{c}

Values are means ± SD or %; ^{a,b,c}*Different letters represent significant difference between groups* ($p < 0.05$ *in ANOVA*).

Table 2. Lipids concentration in school-age children.

Lipids concentration	All	Boys	Girls	Normal	Overweight	Obesity
Total cholesterol (mg/dL)	(306) 136.4 ± 31.1	(161) 138.1 ± 30.3	(145) 134.5 ± 31.9	(94) 131.1 ± 28.1 [a]	(74) 128.3 ± 30.5 [a]	(137) 144.2 ± 31.8[b]
Triglycerides (mg/dL)	(301) 118.7 ± 48.8	(157) 111.6 ± 46.6[a]	(144) 126.4 ± 50.1[b]	(93) 103.6 ± 48.6 [a]	(74) 114.4 ± 45.5 [a]	(133) 131.6 ± 47.8[b]
HDL Cholesterol (mg/dL)	(302) 48.2 ± 10.7	(159) 49.1 ± 10.5	(143) 47.1 ± 10.9	(93) 48.4 ± 8.7	(74) 47.8 ± 11.7	(134) 48.3 ± 11.5
LDL Cholesterol (mg/dL)	(296) 118.2 ± 33.3	(156) 117.6 ± 31.3	(140) 118.8 ± 35.5	(93) 114.2 ± 34.9 [a]	(74) 109.5 ± 35.1 [a]	(128) 126.0 ± 29.4[b]
Total cholesterol to HDL ratio	(300) 2.9 ± 0.8	(157) 2.9 ± 0.8	(143) 3.0 ± 0.9	(92) 2.8 ± 0.7 [a]	(73) 2.8 ± 0.9 [a]	(134) 3.1 ± 0.9[b]
LDL cholesterol to HDL ratio	(293) 2.6 ± 0.9	(153) 2.5 ± 0.9	(140) 2.6 ± 0.9	(91) 2.4 ± 0.8 [a]	(73) 2.4 ± 1.0 [a]	(128) 2.8 ± 0.9[b]

Values are (n) mean ± SD; [a,b]Different letters represent significance level of p < 0.05 in ANOVA among gender or BMI category explain.

Among girls, all types of dyslipidemias were predicted by some anthropometric measures; skinfolds had similar odds ratio than BMI but narrower confidence intervals. HDL cholesterol was better predicted only in girls by BMI percentile and WC (**Figures 2-3**).

The ROC analysis showed that the only indicator of dyslipidemia that was fairly well predicted by an anthropometric measurement with an AUC ≥ 70 was high TG by subscapular skinfold (**Table 3**). Among boys, the best predicted dyslipidemias were high TG by the WHR and high LDL cholesterol by the triceps skinfold; among girls, only high TG values were well predicted by subscapular skinfold with the highest AUC value followed by BMI, WHtR, WC and the sum of both skinfolds.

4. DISCUSSION

The prevalence of obesity in school-age Mexican children is high, similar to some developed countries [32] and is one of the highest in the world [1]. As found in other studies in obese children with similar age groups [8,33], the most prevalent dyslipidemia in the present study was high concentration of TG, followed by high concentrations of LDL cholesterol.

In the population studied, dyslipidemias are not consistently present in obese children and non-obese children may present abnormal lipids concentration, which makes difficult to identify children at risk. For this reason the AUC values from ROC curves to predict abnormal lipids and triglycerides concentration from most anthropometric measurements were slightly lower than those reported from obese children in other populations. For instance, in Argentinean school-age children AUC values to predict low HDL and high triglycerides were 0.87, 0.83, and 0.84 for BMI, WC and WHtR, respectively [34] and in Chinese adolescents the AUC to predict clustering of risk factors from BMI in girls and boys were 0.85 and 0.76, and from WC were 0.82 and 0.78, respectively. The highest AUC value found in the present study was 0.72, an acceptable value to predict high triglycerides from subscapular skinfold. The highest AUC values from anthropometric measures, BMI, WC or WHtR, that have been recognized as good predictors of CV disease in other studies [19,35] differed from boys to girls and overall were lower than skinfolds to predict high triglycerides.

Body mass index had the highest odds ratio in logistics regression, which means that the higher the BMI, the higher the risk to have elevated lipids or triglycerides. However the confidence interval for these odds ratio was much wider than other anthropometry measurements that had a similar odds ratio, which means that there is a higher variability of the association between BMI and lipids and TG concentrations than there is with other anthropometric measurements. That may be the reason why in ROC curves, triceps and subscapular skinfolds seemed to diagnose similarly or even better than BMI, WC, or WHtR.

Although different anthropometry measurements have been evaluated to predict body fat or dyslipidemias, few studies have compared skinfolds thickness with BMI or waist measurements to identify children at risk of a CV disease. Results from similar studies are controversial; some studies have found similar results than the ones found in the present study. Teixeira *et al.* [10] concluded that trunk skinfolds predict CV disease as well as DXA body fat variables did in Portuguese pre-adolescents. Maffeis *et al.* [36] found that subscapular and triceps skinfolds, as well as WC, may be helpful in identifying prepubertal children with an adverse blood-lipids profile and hypertension.

In contrast, some studies have recommended different

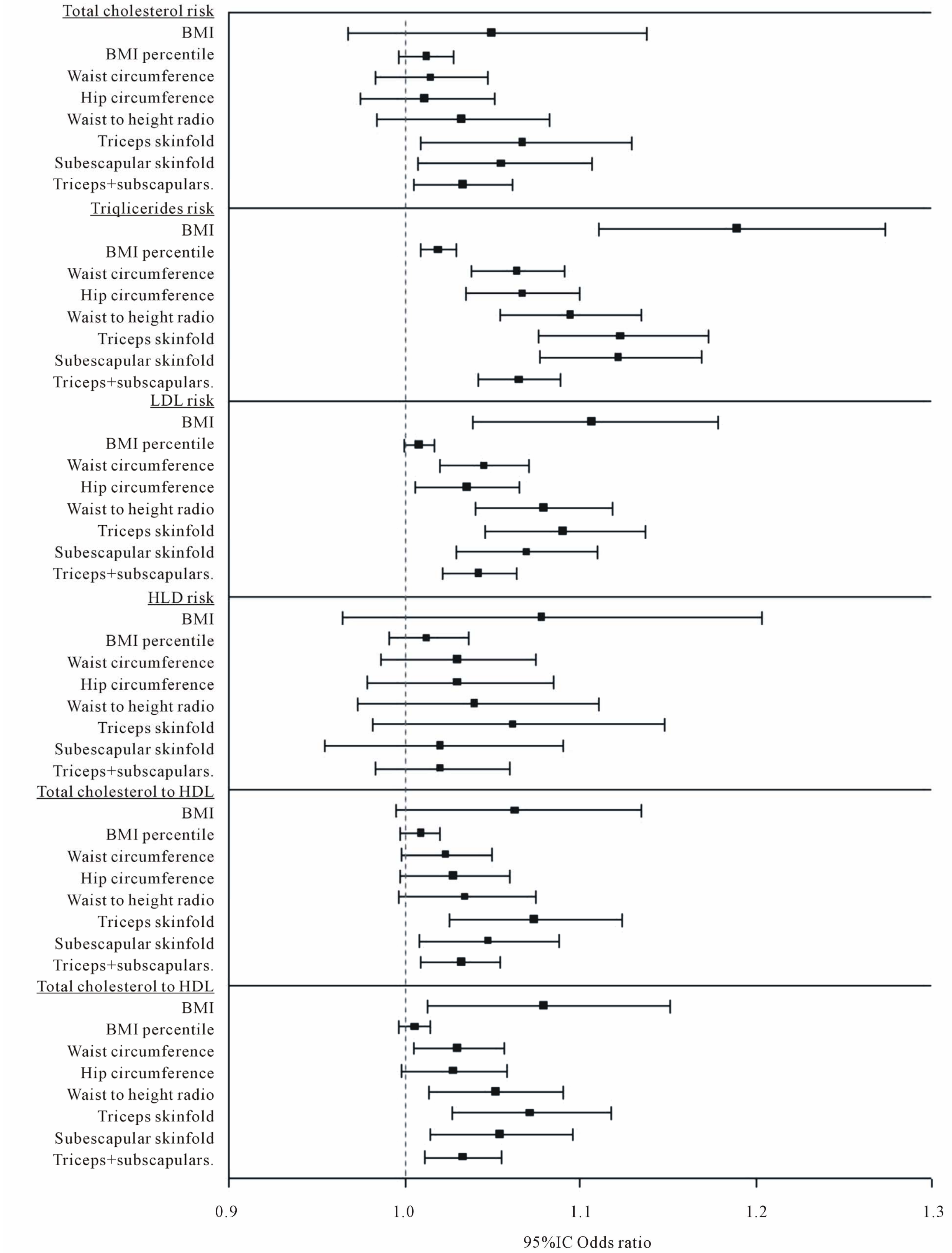

Figure 1. Odds ratio (±95%CI) of different anthropometry measurements to predict dyslipidemias from logistic regressions adjusted for age.

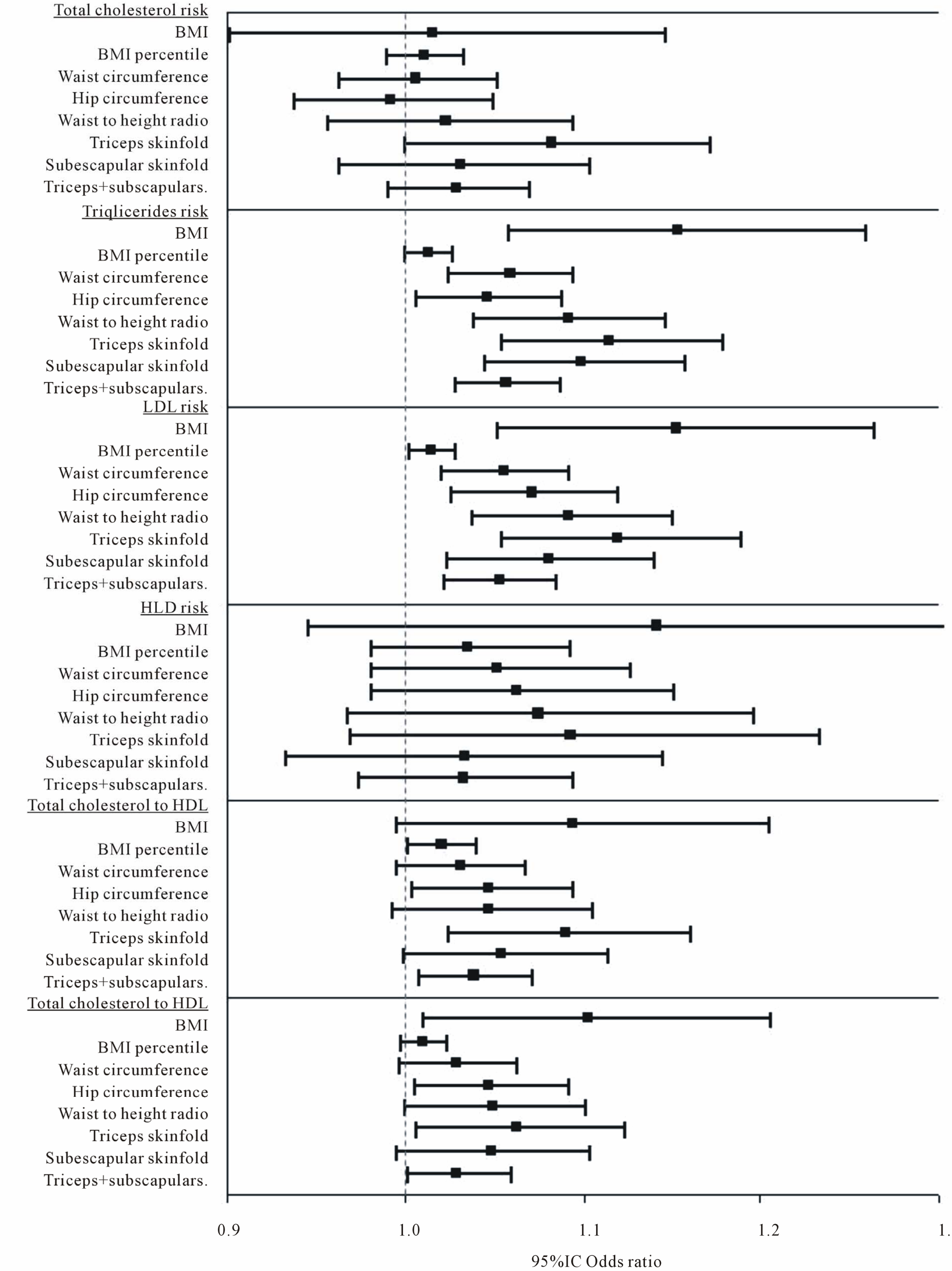

Figure 2. Odds ratio (± 95%CI) of different anthropometry measurements to predict dyslipidemias from logistic regressions adjusted for age in boys.

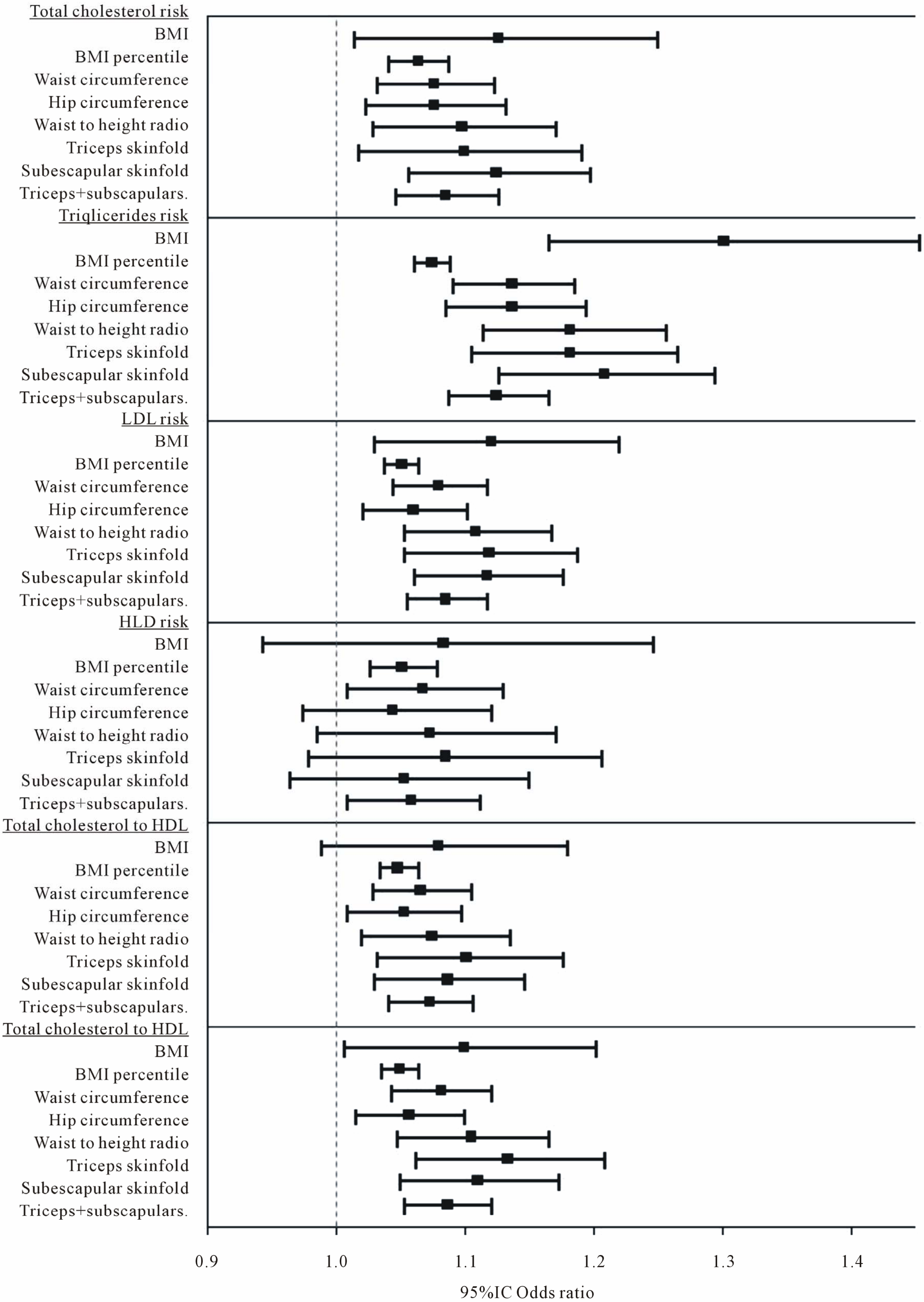

Figure 3. Odds ratio (±95% CI) of different anthropometry measurements to predict dyslipidemias from logistic regressions adjusted for age in girls.

Table 3. Area under the curve from Receiving Operating Characteristics (ROC) to predict dyslipidemia from anthropometry measurements.

Anthropometry[1]	Total Cholesterol	Triglycerides	LDL Cholesterol	HDL Cholesterol	Total Cholesterol to HDL ratio	LDL to HDL ratio
Overall						
BMI	0.56 (0.47 to 0.65)	0.67 (0.61 to 0.73)**	0.62 (0.55 to 0.68)**	0.57 (0.44 to 0.70)	0.58 (0.51 to 0.66)*	0.59 (0.52 to 0.66)*
BMI percentile	0.56 (0.47 to 0.65)	0.66 (0.60 to 0.73)**	0.62 (0.55 to 0.68)**	0.59 (0.46 to 0.71)	0.58 (0.50 to 0.65)*	0.58 (0.51 to 0.65)*
Triceps skinfold	0.61 (0.53 to 0.69)*	0.68 (0.62 to 0.74)**	0.64 (0.58 to 0.71)**	0.60 (0.50 to 0.71)	0.62 (0.55 to 0.69)**	0.62 (0.55 to 0.69)**
Subescapular skinfold	0.61 (0.53 to 0.69)*	0.70 (0.64 to 0.76)**	0.62 (0.56 to 0.69)**	0.56 (0.45 to 0.67)	0.60 (0.53 to 0.67)**	0.60 (0.53 to 0.67)**
Waist	0.57 (0.48 to 0.65)	0.66 (0.60 to 0.72)**	0.63 (0.57 to 0.70)**	0.56 (0.42 to 0.70)	0.59 (0.52 to 0.67)*	0.60 (0.53 to 0.66)**
Hip	0.54 (0.45 to 0.62)	0.63 (0.56 to 0.69)**	0.59 (0.53 to 0.66)**	0.53 (0.39 to 0.67)	0.57 (0.50 to 0.65)	0.58 (0.51 to 0.64)*
Waist to hip ratio	0.56 (0.47 to 0.66)	0.62 (0.56 to 0.69)**	0.62 (0.55 to 0.68)**	0.58 (0.47 to 0.69)	0.56 (0.49 to 0.63)	0.57 (0.50 to 0.64)
Sum of both skinfolds	0.61 (0.53 to 0.69)*	0.70 (0.64 to 0.76)**	0.64 (0.57 to 0.70)**	0.58 (0.47 to 0.69)	0.61 (0.55 to 0.68)**	0.61 (0.55 to 0.68)**
Waist to height ratio	0.57 (0.49 to 0.66)	0.67 (0.60 to 0.73)**	0.64 (0.57 to 0.70)**	0.57 (0.45 to 0.70)	0.57 (0.50 to 0.65)	0.60 (0.53 to 0.66)**
Boys						
BMI	0.54 (0.42 to 0.66)	0.64 (0.55 to 0.73)**	0.67 (0.58 to 0.76)**	0.57 (0.42 to 0.73)	0.60 (0.51 to 0.70)	0.61 (0.52 to 0.71)*
BMI percentile	0.53 (0.40 to 0.65)	0.64 (0.55 to 0.73)**	0.65 (0.56 to 0.74)**	0.67 (0.50 to 0.84)	0.62 (0.52 to 0.72)*	0.62 (0.52 to 0.71)*
Triceps skinfold	0.65 (0.55 to 0.75)	0.69 (0.61 to 0.77)**	0.70 (0.61 to 0.78)**	0.63 (0.51 to 0.75)	0.65 (0.56 to 0.74)**	0.62 (0.53 to 0.72)*
Subescapular skinfold	0.59 (0.49 to 0.69)	0.67 (0.59 to 0.76)**	0.66 (0.57 to 0.75)**	0.57 (0.43 to 0.71)	0.62 (0.53 to 0.71)*	0.61 (0.51 to 0.71)*
Waist	0.55 (0.44 to 0.66)	0.65 (0.56 to 0.73)**	0.67 (0.58 to 0.76)**	0.55 (0.38 to 0.72)	0.59 (0.49 to 0.69)	0.59 (0.49 to 0.69)
Hip	0.52 (0.40 to 0.64)	0.60 (0.51 to 0.69)*	0.66 (0.58 to 0.75)**	0.54 (0.34 to 0.74)	0.59 (0.49 to 0.70)	0.61 (0.51 to 0.70)*
Waist to hip ratio	0.60 (0.47 to 0.74)	0.70 (0.61 to 0.78)**	0.61 (0.52 to 0.70)*	0.56 (0.40 to 0.72)	0.54 (0.45 to 0.64)	0.54 (0.44 to 0.64)
Sum of both skinfolds	0.62 (0.52 to 0.72)	0.69 (0.60 to 0.77)**	0.68 (0.59 to 0.77)**	0.60 (0.46 to 0.73)	0.64 (0.55 to 0.73)*	0.62 (0.52 to 0.71)*
Waist to height ratio	0.55 (0.43 to 0.67)	0.67 (0.58 to 0.76)**	0.67 (0.58 to 0.75)**	0.62 (0.47 to 0.77)	0.59 (0.50 to 0.69)	0.60 (0.50 to 0.70)*
Girls						
BMI	0.58 (0.45 to 0.70)	0.71 (0.62 to 0.80)**	0.57 (0.47 to 0.66)	0.57 (0.38 to 0.77)	0.56 (0.45 to 0.68)	0.56 (0.46 to 0.65)
BMI percentile	0.60 (0.47 to 0.73)	0.71 (0.62 to 0.80)**	0.57 (0.47 to 0.66)	0.52 (0.34 to 0.71)	0.53 (0.42 to 0.65)	0.54 (0.44 to 0.64)
Triceps skinfold	0.57 (0.43 to 0.70)	0.67 (0.58 to 0.77)**	0.60 (0.51 to 0.69)*	0.58 (0.40 to 0.75)	0.59 (0.48 to 0.70)	0.62 (0.53 to 0.71)*
Subescapular skinfold	0.63 (0.50 to 0.76)	0.72 (0.64 to 0.81)**	0.61 (0.51 to 0.70)*	0.54 (0.37 to 0.71)	0.57 (0.47 to 0.68)	0.60 (0.51 to 0.70)*
Waist	0.59 (0.46 to 0.72)	0.70 (0.60 to 0.79)**	0.60 (0.50 to 0.69)	0.58 (0.37 to 0.79)	0.59 (0.49 to 0.70)	0.60 (0.51 to 0.70)*
Hip	0.55 (0.42 to 0.68)	0.64 (0.55 to 0.74)**	0.54 (0.45 to 0.64)	0.51 (0.31 to 0.72)	0.55 (0.44 to 0.66)	0.54 (0.45 to 0.64)
Waist to hip ratio	0.56 (0.43 to 0.69)	0.67 (0.57 to 0.76)**	0.60 (0.51 to 0.70)*	0.62 (0.46 to 0.78)	0.59 (0.50 to 0.69)	0.62 (0.52 to 0.72)*
Sum of both skinfolds	0.60 (0.47 to 0.73)	0.70 (0.61 to 0.79)**	0.61 (0.51 to 0.70)*	0.56 (0.38 to 0.73)	0.58 (0.48 to 0.69)	0.62 (0.52 to 0.71)*
Waist to height ratio	0.60 (0.47 to 0.73)	0.71 (0.62 to 0.81)**	0.59 (0.50 to 0.69)	0.55 (0.36 to 0.75)	0.55 (0.44 to 0.66)	0.59 (0.49 to 0.68)

Values are areas under the curve in the receivers operating characteristics analysis (95% CI) [1]The cut offs considered at risk are: Total Cholesterol >170 mg/dL, triglycerides < 130 mg/dL in children >10y; triglycerides<110 in children ≤ 10 y, LDL cholesterol >110 mg/dL, HDL cholesterol < 35 mg/dL, VLDL cholesterol < Total cholesterol to HDL ratio > 3.5 and LDL to HDL ratio > 2.2 Different to 0.50 * $p < 0.05$, ** $p < 0.01$.

measurements than skinfolds to adequately predict dyslipidemias. Geiss *et al.* [11] concluded that height-to-weight indices, such as BMI, in prepubescent German children, are best predictors of CV risk factors. Feedman *et al.* [37] also reported that WHtR is better than skinfolds to predict adult CV risk in a bi-racial sample of American children; although, in the same study, the prediction from the sum of skinfolds thickness did not differ much from WHtR's.

The different predictors found among studies may be related to ethnicity, gender and age which can affect the relationship between the ratio of subcutaneous fat to total body fat [12,38,39] and consequently anthropometry predictors of dyslipidemias may differ according to such demographic characteristics [40-42]. For in- stance, in the present study high LDL cholesterol was better predicted in boys than in girls, probably because differences of fat deposition between boys and girls. Similarly the distinct ethnic characteristics of our sample may result in a different fat deposition distribution which could have led to a better prediction of dyslipidemias with triceps and subscapular skinfolds.

It is known that skinfold measurement, such as triceps and subscapular thickness, are a direct measure of body fat. Even though skinfolds' thickness do not predict visceral fat as well as other anthropometry measurements, such as WC or WHtR [43], they have been well accepted measurements to predict body fat [44], and consequently they could be good predictors of dyslipidemias.

In order to improve the accurateness of dyslipidemia prediction from triceps and subscapular skinfolds, cutoff values according to age and gender in specific ethnos, such as Mexican children, should be determined. Addo & Himes *et al.* [45] established triceps and subscapular skinfold thickness cut offs for age and gender in American children. A limitation of the present study was that the sample size was insufficient to suggest cutoff values stratified by age and gender in Mexican children or to test the cutoff values already reported [45]. Therefore, future research studies with a larger sample size are recommended to define cutoff values for age and gender that are appropriate for Mexican children, and to confirm its efficacy as part of the strategies of public health programs for the prevention and control of CV disease.

In conclusion, there is a high prevalence of obesity and dyslipidemias in Mexican children; the major health concern is the high triglycerides concentration. Anthropometric measurements are not strongly associated with dyslipidemias in Mexican children. However, since triceps and subscapular skinfolds were better predictors than other anthropometry measures, they may be a simple way to predict dyslipidemias in Mexican children.

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