A novel indicator of children lipid accumulation product associated with dyslipidemia in Chinese children and adolescents

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Research

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Abstract

Background and aims

The dyslipidemia contributed to more than half Cardiovascular disease (CVD) which ranked first in all causes of death in the world. Children's lipid accumulation product (CLAP) is significantly related to cardiac metabolic risk factors in children and adolescents. The present study was to explore a novel indicator of children's lipid accumulation product (CLAP) associated with dyslipidemia in Chinese children and adolescents.

Methods

A total of 683 children and adolescents aged 8-15 years were recruited using the stratified cluster sampling method in this cross-sectional study, and were measured their body height, weight, waist circumference (WC), abdominal skinfold thickness (AST), triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C), dietary behaviors and physical activities. A logistic regression model and receiver operating characteristic curve (ROC curve) were used to compare the effects of CLAP for predicting dyslipidemia.

Results

The prevalence of dyslipidemia was 13.6% (13.9% in boys and 13.2% in girls). The AUC (95%CI) of CLAP for predicting dyslipidemia was 0.76 (0.66-0.84) in girls, was 0.83 (0.76-0.89) in boys, and was higher than those of Sweight, SWC, SAST, SWHtR, and SBMI, respectively. The P_{85} of CLAP was the optimal value to predict dyslipidemia among girls (*OR* (95% CI): 10.54(5.09-21.82), AUC (95% CI): 0.72 (0.62-0.81). The P_{75} of CLAP was the optimal value to predict dyslipidemia among boys (*OR* (95% CI): 8.74(4.54-16.85), AUC (95% CI): 0.73 (95% CI 0.65-0.81).

Conclusions

The CLAP was a novel indicator associated with dyslipidemia in Chinese children and adolescents, and performed better than weight, WC, AST, WHtR, and BMI.

1. Introduction

The dyslipidemia contributed to more than half Cardiovascular disease (CVD) which ranked first in all causes of death in the world[1]. Data from the World Health Organization (WHO) showed that ischemic heart disease and stroke were the leading killers among the 56.9 million deaths worldwide in 2016, causing a total of 15.2 million deaths[2]. Studies showed that dyslipidemia was associated with cardiovascular risk factors (such as obesity, diabetes mellitus, hypertension and smoking), and was associated with carotid artery elasticity, intima-media thickness and brachial flow-mediated dilatation from childhood to adulthood [3–7]. In recent decades, the prevalence of dyslipidemia has increased rapidly and shows a trend of younger age[8]. In addition, dyslipidemia in children and adolescents was closely related to chronic diseases such as adult lipid metabolism disorders and atherosclerotic CVD[9]. In china, the studies showed blood lipid levels in children aged 7–16 were significantly increased [10, 11]. The dyslipidemia is modifiable and can be prevented or controlled through the consumption of a healthy diet and adequate physical activity from early life[12].

Previous studies revealed that obesity was one of the most important risk factors for dyslipidemia[3, 13, 14]. At present, indicators of commonly using childhood obesity are body mass index (BMI), WC, abdominal skin thickness (AST), and waist height ratio (WHtR). BMI associated with dyslipidemia has been confirmed in children and adolescents [15]. As well known, BMI is the most commonly used index, which can reflect total body composition[16]. However, BMI does not distinguish between lean body mass and fat body weight [17]. WC serves as an important index to reflect central adiposity and is considered to be more strongly associated with certain risk factors of CVD compared to BMI, and WHtR has a higher ability to predict dyslipidemia than BMI[18]. However, WC and WHtR cannot reflect the state of lipid accumulation in children. Kahn et al.[19] proposed a new marker, LAP, to show total lipid accumulation in adults: LAP for men = [WC (cm)-65] × TG (mmol / L); LAP for women = [WC (cm) -58] × TG (mmol / L). Existing research showed that LAP was significantly related to cardiac metabolic risk factors such as high TG and low HDL. LAP could better reflect the excessive accumulation of lipids in the body, and the excessive accumulation of lipids is the main risk of cardiac metabolic diseases factor[20]. However, LAP cannot be directly applied to show lipid accumulation in children and adolescents. Zhang et al.[21] developed children's lipid accumulation product (CLAP) that was calculated using the formula of WC (cm) × TG(mmol/L) × AST (mm)/100, and reported that CLAP was significantly associated with metabolic syndrome (MS), and was better than BMI and WHtR for predicting MS. Wang et al.[22] showed that CLAP was significantly associated with hypertension in children and adolescents, and can more effectively predict childhood hypertension than WC, WHtR, BMI, AST, and TG can. Yuan et al.[23] showed that the CLAP was significantly associated with impaired fasting glucose (IFG) in Chinese boys, and it performed better than WC, WHtR, AST and TG. The purpose of this study was to explore power of a novel CLAP for predicting dyslipidemia among children and adolescents.

2. Materials And Methods

2.1. Study population

In this study, 683 students, including 366 boys (53.6%) and 317 girls (46.4%), aged 8–15 years were effectively recruited from two nine-year-system schools using a stratified cluster sampling method. The present study was approved by the Medical Ethics Committee of Bengbu Medical College (2015 No.003). The participants' guardians signed informed consents before medical measurements.

2.2. Outcomes and covariates

All medical staff received standard training. Participants were asked to fast, barefoot, stand upright, and wear light clothing for measurement.

Measurement of anthropometric indexes

The height is measured with a mechanical height gauge with an accuracy of 0.1 cm. Use an electronic weight scale to measure weight with an accuracy of 0.1 kg. Use nylon tape to measure the WC, that is, the circumference of the WC located 1 cm above the navel with an accuracy of 0.1 cm. AST is measured using a skinfold thickness gauge and is the thickness of the skinfold at the junction of the right midclavicular line and the horizontal line of the abdominal button, with an accuracy of 0.1 mm.

Survey of behavioral indexes

In this study, we surveyed the frequency of dietary behaviors, including the consumption of milk, nuts, carbonated drinks, outside meals, fresh vegetables, breakfast, fruits, eggs, Western fast food, fried foods, and high-energy snacks. Each dietary behavior score was assigned 0 points for never, 0.25 points for 1 time per month, 0.5 points for 2 times per month, 2 points for 1–3 times per week, 5 points for 4–6 times per week, and 7 points for 1 time per day. The total scores of healthy dietary behaviors (including fruits, eggs, milk, fresh vegetables, breakfast, and nuts) and risky dietary behaviors (including outside meals, Western fast food, carbonated drinks, fried foods, and high-energy snacks) were calculated. According to the P_{75} of healthy and risky dietary behaviors total scores, the children were divided into two groups, $\geq P_{75}$ and $< P_{75}$, respectively. Physical activity was investigated through the Children's Leisure Activity Study Survey (CLASS) questionnaire[24]. The moderate to vigorous physical activity time was divided into ≥60 min and < 60 min grades[25]. The sedentary activity time was divided into ≥120 min and < 120 min grades[26].

Measurement of triglyceride, total cholesterol, high-density lipoprotein, and low-density lipoprotein

Medical staff collected 3 ml of fasting venous blood for each survey subject. And use automatic biochemical analyzer detect TG, TC, LDL-C and HDL-C.

Calculation of derivative indicators

BMI = weight (kg)/ [height (m)]^2; WHtR = WC(cm)/height (cm); CLAP = WC(cm) × TG (mmol/L) × AST(mm) /100; Non-high-density lipoprotein cholesterol (non-HDL-C) = TC(mmol/L) -HDL-C (mmol / L).

Diagnostic criteria

Overweight or obesity was screened using Standards of WS/T 586–2018 school-age children developed by the China Obesity Working Group[27]. WHtR ≥ 0.46 was used to defined as abdominal obesity [28]. Dyslipidemia standards: TG ≥ 1.47 mmol / L or TC ≥ 5.18 mmol / L or non-HDL-C ≥ 3.76 mmol / L or HDL-C < 1.03 mmol / L was defined as dyslipidemia[8].

2.3. Statistical analysis

Statistical analysis was performed using SPSS23.0. The mean ± standard deviation or proportion (%) were used to describe the measurement or enumeration data, respectively. The logarithmic CLAP (LnCLAP), weight, height, BMI, WC, WHtR, and AST were standardized for sex and age using a normal deviation method. The *t*-test and chi-square test were used to compare the differences of above factors between boys and girls. In addition, the receiver operating characteristic (ROC) was determined to analyze the predictive capabilities of the above standardized variables for dyslipidemia. The associations of overall obesity, abdominal obesity, SlnCLAP with dyslipidemia were analyzed using Logistic regression models. $p < 0.05$ was considered significant.

3. Results

3.1 Demographics

A total of 683 children (366 boys and 317 girls) aged 8-15 years were effectively recruited in this study. The prevalence of dyslipidemia was 13.6% (13.9% in boys and 13.2% in girls). As shown in table 1, the Shieght, Sweight, SBMI, SWC, SWHtR, SAST, SLnCLAP, TC, LDL, and TG in boys with dyslipidemia were significantly higher than those with nondyslipidemia (P<0.05), respectively. In addition, moderate to vigorous physical activity time <60 min per day increased risk of dyslipidemia compared with moderate to vigorous physical activity time ≥60 min in boys (P<0.05). The Sweight, SBMI, SWC, SWHtR, SAST, SLnCLAP, TC, LDL, and TG among girls with dyslipidemia were significantly higher than those with nondyslipidemia (P<0.05). The HDL in boys and girls with dyslipidemia were significantly lower than those with nondyslipidemia (P<0.05), respectively.

3.2The power of predicting dyslipidemia

As shown in Table 2 and Figure 1, the areas under the curve (AUC (95%CI)) of Sheight, Sweight, SWC, SAST, SWHtR, SBMI and SLnCLAP for predicting dyslipidemia were 0.60 (0.52-0.68), 0.70 (0.62-0.77), 0.70 (0.61-0.77), 0.69 (0.61-0.77), 0.67 (0.58-0.76), 0.68 (0.59-0.76), 0.83 (0.76-0.89) in boys, and were 0.50 (0.40-0.59), 0.60 (0.50-0.69), 0.62 (0.51-0.71), 0.59 (0.48-0.68), 0.63 (0.53-0.73), 0.63 (0.54-0.72), 0.76 (0.66-0.84) in girls, respectively. Thus, the powers of CLAP for predicting dyslipidemia were higher than those of Sheight, Sweight, SWC, SAST, SWHtR, SBMI in girls and boys, respectively.

3.3 An optimal cutoff point of LnCLAP for predicting dyslipidemia

As shown in Table 3, the results showed that *OR* (95% CI) of P_{75}, P_{80}, P_{85}, P_{90}, and P_{95} of lnCLAP for predicting dyslipidemia were 8.12(4.28-15.42), 7.71(4.08-14.57), 12.51(6.33-24.70), 13.26(5.83-30.15), 17.62(6.33-49.07) in boys, and were 5.59(2.83-11.03), 6.66(3.33-13.32), 10.54(5.09-21.82), 15.12(6.61-34.56), 16.88(5.43-52.47) in girls, respectively. In addition, the areas under the curve (AUC(95%CI)) of P_{75}, P_{80}, P_{85}, P_{90}, and P_{95} of lnCLAP for predicting dyslipidemia were 0.73 (0.65-0.81), 0.71 (0.63-0.80), 0.72 (0.64-0.81), 0.67 (0.58-0.76), 0.62 (0.53-0.71) in boys, and were 0.69 (0.60-0.78), 0.69 (0.60-0.79), 0.72

(0.62-0.81), 0.69 (0.59-0.79), 0.61(0.51-0.71) in girls, respectively. From above results, we know that the optimal cutoff point of lnCLAP should be P_{75} in boys, and P_{85} in girls.

3.4 Comparisons of correlations of BMI, WHtR, CLAP with dyslipidemia

As shown in Table 4, the obesity (based on BMI), abdominal obesity (based on WHtR) and SlnCLAP $\geq P_{75}$ were significantly related to dyslipidemia (OR(95%CI):4.18 (2.21-7.87), 3.95(2.12-7.36), and 8.74(4.54-16.85) in boys, respectively; 2.94(1.42-6.06), 2.08(1.07-4.04), 10.54(5.09-21.82) in girls, respectively). The areas under the curve (AUC (95%CI)) of obesity (based on BMI), abdominal obesity (based on WHtR), SlnCLAP $\geq P_{75}$ for predicting dyslipidemia were 0.64 (0.55-0.73), 0.65 (0.57-0.74), 0.731 (0.65-0.81) in boys, and were 0.59 (0.50-0.69), 0.58 (0.49-0.68), 0.72 (0.62-0.81) in girls, respectively.

Discussion

In recent years, dyslipidemia in children and adolescents has caused widespread concern, and is one of the strongest risk factors for CVD (CVD) and often emerges during childhood[29, 30]. The studies have indicated that childhood dyslipidemia also persists into adulthood due to obesity [31]. The results of this study showed that the prevalence of dyslipidemia was 13.6% (13.9% in boys and 13.2% in girls). Sapunar et al.[32] reported that the prevalence of dyslipidemia in Spanish children graded 4-6 was 11%. The study from Wang et al.[33] reported that the prevalence of dyslipidemia was 28.1% in boys and 28.9% in girls. In addition, this study found no statistically significant difference in the prevalence of dyslipidemia between boys and girls, which is inconsistent with the results of other studies. Kit et al.[3] reported that the prevalence of dyslipidemia among girls (21.0%) was significantly higher than that among boys (19.3%). The result of the present study showed moderate to vigorous physical activity time <60 min per day increased risk of dyslipidemia. The previous study also reported that leisure-time and school time physical activity were associated with dyslipidemia in children[34].

Several studies showed that children with weight reduction had dyslipidemia clearly benefited them with normalization of lipid profile[35]. Therefore, more and more studies have been conducted on the correlation between dyslipidemia and indicators of reflecting obesity in children. Garcez et al.[36] found a positive correlation of body weight, WC, and BMI with the presence of dyslipidemia in adolescents. Furtado et al.[37] reported that WHtR, WC, BMI and zBMI were significant determinants of lipid and lipoproteins levels. Oliosa et al.[38] reported that a positive correlation of the lipid variables LDL-c, TC, Non-HDLc with BMI and WC. Ribas et al.[39] reported that pupils with an excess of body weight (BMI ³ P_{85}) and abnormal body fat distribution (an elevated %BF) had twice the probability of developing dyslipidemia as normal-weight individuals. Zheng et al.[40] reported that the AUC of BMI z-score and WHtR for predicting dyslipidemia among Chinese boys were 0.66 and 0.72, respectively. In present study, the results showed that the SWC, SWHtR, SBMI in boys and girls with dyslipidemia were significantly higher than those with nondyslipidemia (AUC(95%CI):0.62 (0.51-0.71), 0.63 (0.53-0.73), 0.63 (0.54-0.72) in girls, 0.70 (0.61-0.77), 0.67 (0.58-0.76), 0.68 (0.59-0.76) in boys), and Obesity (based on BMI) and abdominal obesity (based on

WHtR) were significantly related to dyslipidemia (OR(95%CI):4.06 (2.17-7.59) , 3.63(1.97-6.67) in boys, 2.94(1.42-6.06) , 2.08(1.07-4.04) in girls)..

Keys et al.[41] suggested that BMI can indicate relative obesity or body fatness. However, BMI does not distinguish between fat mass and lean body mass, and can use result in large errors in the estimation of body fatness[42, 43]. Studies have shown that WC and WHtR are independently associated with a higher risk for CVD and can predict other overweight related risk factors[44-46]. But they were limited in indicating lipid accumulation in circulating blood[47, 48]. The previous studies showed the CLAP was significantly associated with metabolic syndrome (MS), hypertension, impaired fasting glucose among children and adolescents, and can more effectively associations than WC, WHtR, BMI can [21-23]. The present study showed that the AUC of CLAP for predicting dyslipidemia was higher than that of weight, WC, AST, BMI, WHtR, which indicated that CLAP had more power for predicting dyslipidemia compared with a single indicator. In addition, the optimal cutoff point of CLAP among boys and girls for predicting dyslipidemia were P_{75} and P_{85}, with OR (95% CI) value of 8.74(4.54-16.85) and 10.54(5.09-21.82), respectively.

There were some limitations in this study. This study was a cross-sectional study, which limits inferring causality between CLAP and dyslipidemia. In addition, dietary behaviors and physical activity might be adopted before or after suffering from dyslipidemia.

In summary, based on the results of this study, CLAP was a stronger risk factor for dyslipidemia compared with weight, AST, WC, WHtR and BMI. The optimal value of CLAP to predict dyslipidemia was P_{85} among girls, P_{75} among boys.

Declarations

Ethics approval and consent to participate

The present study was approved by the Medical Ethics Committee of Bengbu Medical College (2015 No.003). The participants' guardians signed informed consents before medical measurements.

Consent for publication

We certify that we have participated sufficiently in the work to take public responsibility for the appropriateness of the study design, and the collection, analysis, interpretation of the data. All authors have read and approved the submission of the manuscript; the manuscript has not been published and is not being considered for publication elsewhere, in whole or in part, in any language, except as an abstract.

Availability of data and materials

All the data are available for interested readers. There are no specialized materials employed in the study.

Competing interests

All authors gave final approval of the submitted manuscript versions and declare no conflicts of interest in this work.

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Authors' contributions

Bangxuan Wang collected and analyzed the data and prepared the first draft of the manuscript. Yongting Yuan and Jingyao HU analyzed and collected the data. Lili Sun, Rongying Yao, Hui Han collected the data and revised the manuscript. Ma Jun and Lianguo Fu conceived and designed the research and revised the manuscript.

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Tables

Table 1 The comparisons of demographic characteristics, physical activity time and dietary behaviors between different genders (mean±SD) or n(%)

Variables	Boys(n=366)		Girls(n=317)	
	Dyslipidemia	Nondyslipidemia	Dyslipidemia	Nondyslipidemia
Age	11.14±1.72	10.71±1.80	10.98±1.98	10.98±1.81
SHeight	0.31±0.88	-0.05±1.00*	0.01±0.96	0.00±0.99
Sweight	0.59±1.05	-0.10±0.95***	0.29±1.12	-0.04±0.96*
SBMI	0.58±1.13	-0.09±0.93***	0.32±1.09	-0.05±0.96*
SWC	0.62±1.07	-0.10±0.94***	0.41±1.20	-0.06±0.94*
SWHtR	0.57±1.13	-0.09±0.94***	0.44±1.16	-0.07±0.94**
SAST	0.62±1.09	-0.10±0.94***	0.31±1.19	-0.05±0.95
SLnCLAP	1.01±0.88	-0.16±0.91***	0.81±1.04	-0.12±0.92***
TC	4.14±0.89	3.66±0.57***	4.29±1.01	3.65±0.63***
LDL	2.18±0.72	1.73±0.46***	2.18±0.78	1.75±0.51**
HDL	1.31±0.32	1.57±0.29***	1.42±0.48	1.51±0.25
TG	1.44±0.47	0.79±0.27***	1.53±0.52	0.87±0.27***
Healthy Dietary behaviors				
P_{75}	40(15.1)	225(84.9)	33(13.3)	216(86.7)
≥P_{75}	11(10.9)	90(89.1)	9(13.2)	59(86.8)
Risk dietary behaviors				
P_{75}	33(13.1)	219(86.9)	35(13.3)	228(86.7)
≥P_{75}	18(15.8)	96(84.2)	7(13.0)	47(87.0)
Moderate-to-vigorous physical activity time				
60min	33(18.0)	150(82.0)*	26(13.8)	163(86.2)
≥60min	18(9.8)	165(90.2)	16(12.5)	112(87.5)
Sedentary activity time				
120min	29(15.3)	161(84.7)	18(13.7)	113(86.3)
≥120min	22(12.5)	154(87.5)	24(12.9)	162(87.1)

Notes: The Sheight, Sweight, SWC, SAST, SBMI, SWHtR and SlnCLAP was the standardized height, weight, WC, AST, BMI, WHtR and lnCLAP by gender and age using normal deviation method.

Abbreviations: Sheight, standardized height; Sweight, standardized weight; SWC, standardized waist circumference; SAST, standardized abdominal skinfold thickness; SBMI, standardized body mass index; SWHtR, standardized waist-height ratio; SlnCLAP, standardized logarithmic children lipid accumulation product.

* p<.05 for significant AUC; ** p<.01 for significant AUC; *** p<.001 for significant AUC.

Table 2 The areas under ROC curves of SlnCLAP, Sheight, Sweight, SWC, SWHtR, SAST, for predicting dyslipidemia

Variables	*AUC*	*SE*	*95%CI of AUC*
Girls			
Sheight	0.50	0.05	0.40-0.59
Sweight	0.60	0.05	0.50-0.69*
SWC	0.62	0.05	0.51-0.71
SAST	0.59	0.05	0.48-0.68
SWHtR	0.63	0.05	0.53-0.73*
SBMI	0.63	0.05	0.54-0.72*
SlnCLAP	0.76	0.05	0.66-0.84***
Boys			
Sheight	0.60	0.04	0.52-0.68*
Sweight	0.70	0.04	0.62-0.77***
SWC	0.69	0.04	0.61-0.77***
SAST	0.69	0.04	0.61-0.77***
SWHtR	0.67	0.04	0.58-0.76***
SBMI	0.68	0.04	0.59-0.76***
SlnCLAP	0.83	0.03	0.76-0.89***

Notes: Sheight, Sweight, SWC, SAST, SWHtR, SBMI, SlnCLAP was the standardized height, weight, WC, AST, WHtR, BMI and lnCLAP by gender-age using normal deviation method, respectively.

Abbreviations: Sheight, standardized height; Sweight, standardized weight; SWC, standardized waist circumference; SAST, standardized abdominal skinfold thickness; SWHtR, standardized waist-height ratio;

SBMI, standardized body mass index; SlnCLAP, standardized logarithmic children lipid accumulation product; AUC, area under receiver operating characteristic (ROC) curve.

* $p < .05$ for significant AUC; ** $p < .01$ for significant AUC; *** $p < .001$ for significant AUC.

Table 3 The associations between anthropometric indexes and dyslipidemia using logistic regressions

SlnCLAP	Non-dyslipidemia	dyslipidemia	OR(95%CI)	AUC	*95%CI of AUC*
Boys					
P_{75} of SlnCLAP					
$<P_{75}$	257(93.5)	18(6.5)	1.00	0.73***	0.65-0.81
$\geq P_{75}$	58(63.7)	33(36.3)	8.12(4.28-15.42)***		
P_{80} of SlnCLAP					
$<P_{80}$	269(92.4)	22(7.6)	1.00	0.71***	0.63-0.80
$\geq P_{80}$	46(61.3)	29(38.7)	7.71(4.08-14.57)***		
P_{85} of SlnCLAP					
$<P_{85}$	289(92.3)	24(7.7)	1.00	0.72***	0.64-0.81
$\geq P_{85}$	26(49.1)	27(50.9)	12.51(6.33-24.70)***		
P_{90} of SlnCLAP					
$<P_{90}$	299(90.6)	31(9.4)	1.00	0.67***	0.58-0.76
$\geq P_{90}$	16(44.4)	20(55.6)	13.26(5.83-30.15)***		
P_{95} of SlnCLAP					
$<P_{95}$	309(89.0)	38(11.0)	1.00	0.62**	0.53-0.71
$\geq P_{95}$	6(31.6)	13(68.4)	17.62(6.33-49.07)***		
Girls					
P_{75} of SlnCLAP					
$<P_{75}$	222(92.5)	18(7.5)	1.00	0.69***	0.60-0.78
$\geq P_{75}$	53(68.8)	24(31.2)	5.59(2.83-11.03)***		
P_{80} of					

SlnCLAP					
$<P_{80}$	236(92.2)	20(7.8)	1.00	0.69***	0.60-0.79
$\geq P_{80}$	39(63.9)	22(36.1)	6.66(3.33-13.32)***		
P_{85} of SlnCLAP					
$<P_{85}$	249(92.6)	20(7.4)	1.00	0.72***	0.62-0.81
$\geq P_{85}$	26(54.2)	22(45.8)	10.54(5.09-21.82)***		
P_{90} of SlnCLAP					
$<P_{90}$	262(91.6)	24(8.4)	1.00	0.69***	0.59-0.79
$\geq P_{90}$	13(41.9)	18(58.1)	15.12(6.61-34.55)***		
P_{95} of SlnCLAP					
$<P_{95}$	270(89.4)	32(10.6)	1.00	0.61*	0.51-0.71
$\geq P_{95}$	5(33.3)	10(66.7)	16.88(5.43-52.47)***		

Abbreviations: SlnCLAP, standardized logarithmic children lipid accumulation product

* $p<.05$; ** $p<.01$, *** $p<.001$

Table 4 The association between WHtR, BMI, lnCLAP and dyslipidemia using logistic regressions

Variables	*b*	*SE*	Wald	*P*	*OR(95%CI)*	AUC	*95%CI of AUC*
boys							
Model1							
Moderate-to-vigorous physical activity							
60min	0				1		
<60min	-0.75	0.32	5.29	0.02	0.47(0.25-0.90)		
obesity (Based on BMI)						0.64	0.55-0.73
no	0				1		
yes	1.43	0.32	19.51	0.00	4.18(2.21-7.87)		
Model2							
Moderate-to-vigorous physical activity							
≥60min	0				1		
<60min	-0.84	0.33	6.62	0.01	0.43(0.23-0.82)		
abdominal obesity (Based on WHtR)						0.65	0.57-0.74
no	0				1		
Yes	1.37	0.32	18.77	0.00	3.95(2.12-7.36)		
Model3							
Moderate-to-vigorous physical activity							
≥60min	0				1		
<60min	-0.87	0.34	6.46	0.01	0.42(0.22-0.82)		
SlnCLAP						0.73	0.65-0.81
□P_{75}	0				1		
≥P_{75}	2.17	0.34	41.94	0.00	8.74(4.54-16.85)		
girls							
Obesity (Based on BMI)						0.59	0.50-0.69
No	0				1		
Yes	1.08	0.37	8.51	0.00	2.94(1.42-6.06)		
Abdominal obesity (Based on WHtR)						0.58	0.49-0.68
No	0				1		

Yes	0.73	0.34	4.60	0.03	2.08(1.07-4.04)		
SlnCLAP						0.72	0.62-0.81
□P_{85}	0				1		
$\geq P_{85}$	2.36	0.37	40.20	0.00	10.54(5.09-21.82)		

Abbreviations: WHtR, waist-height ratio; BMI, body mass index; SlnCLAP, standardized logarithmic children lipid accumulation product

Figures

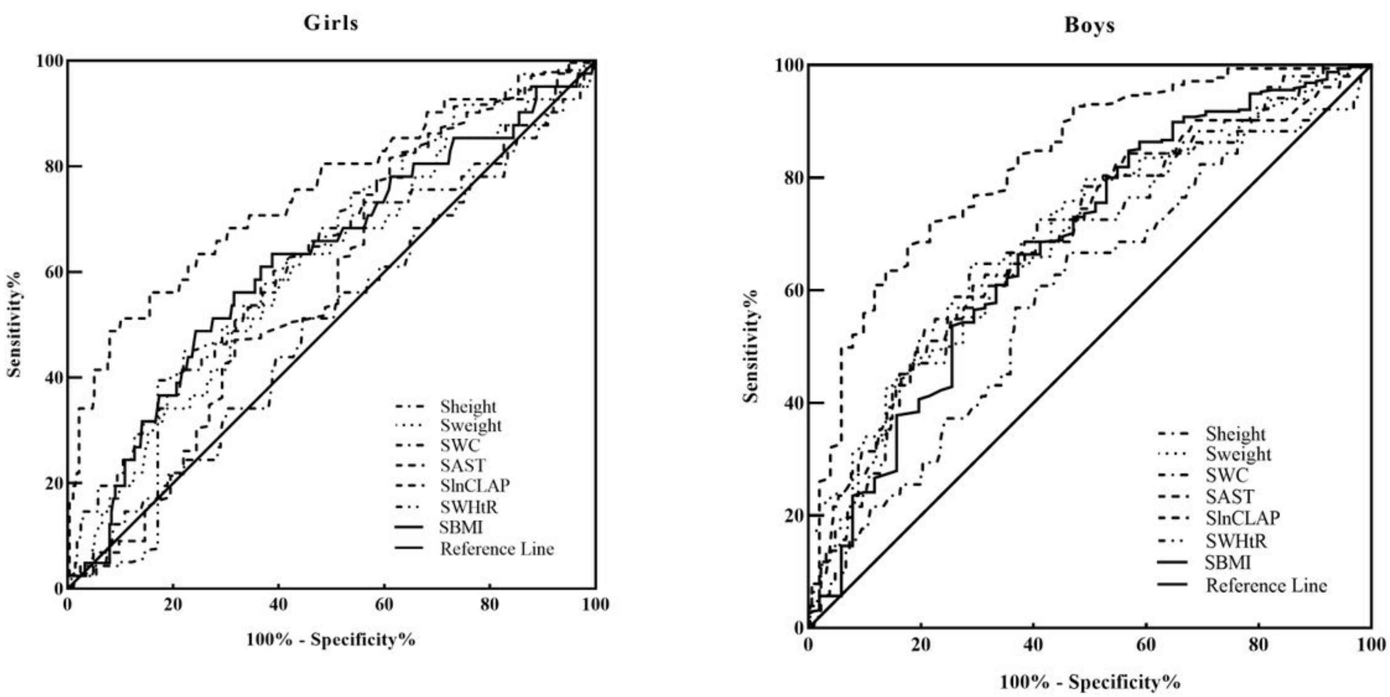

Figure 1

ROC curves of height, weight, WC, AST, lnCLAP, WHtR and BMI to predict dyslipidemia in boys and girls. Abbreviations: WHtR, waist-height ratio; BMI, body mass index; SlnCLAP, standardized logarithmic children lipid accumulation product

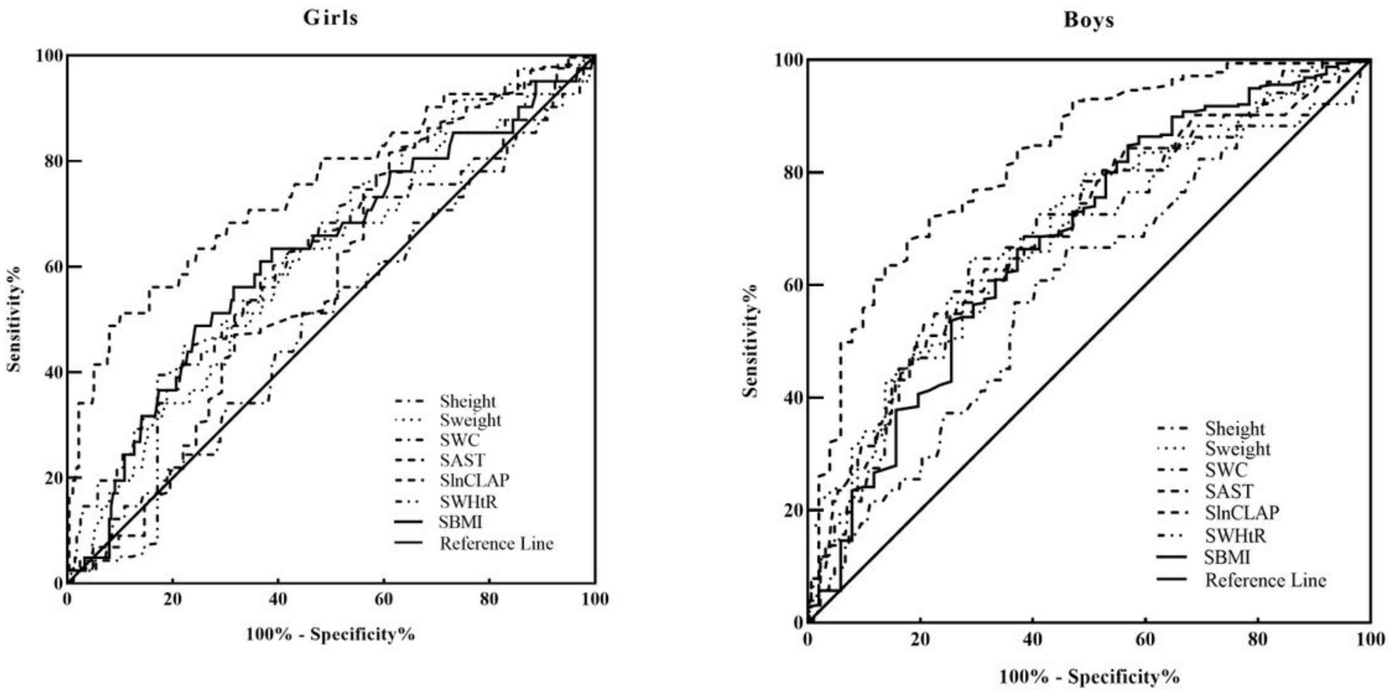

Figure 1

ROC curves of height, weight, WC, AST, lnCLAP, WHtR and BMI to predict dyslipidemia in boys and girls. Abbreviations: WHtR, waist-height ratio; BMI, body mass index; SlnCLAP, standardized logarithmic children lipid accumulation product