What is the appropriate strategy for diagnosing NAFLD using ultrasonography in obese children?

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Original article

Background: **The aim of this study is to identify obese children who are candidates for a potential diagnosis of non-alcoholic fatty liver disease (NAFLD).**

Methods: **We enrolled 242 obese children (122 boys and 120 girls) aged 7-16 years who were examined with abdominal ultrasonography in our pediatric obesity clinic. We compared patients in the normal group with those in the NAFLD group (mild disease, moderate to severe disease) and identified the optimal anthropometric parameters among height, weight, body mass index (BMI), waist circumference, hip circumference, waist to height ratio (WHtR), and waist to hip ratio to predict NAFLD using a receiver operating characteristic curve analysis. We also investigated risk factors associated with NAFLD for the anthropometric parameters and the biochemical model using logistic regression.**

Results: **The high- and low-risk groups for hepatic steatosis relative to a WHtR of 0.56 as the standard point showed significant differences in hepatic steatosis severity grade (P<0.001), BMI (P=0.004), hip circumference (P=0.090), aspartate aminotransferase (P<0.001), alanine aminotransferase (P<0.001), triglycerides (P=0.001), and the triglyceride to high-density lipoprotein (HDL) cholesterol ratio (P=0.006). Risk factors for hepatic steatosis on logistic regression analysis were male sex (odds ratio: 3.68, 95% confidence interval: 1.76-7.70), WHtR >0.56 (2.25, 1.05-4.81), and waist circumference >90th percentile (20.22, 9.21-44.36) in the anthropometric parameter model and elevated alanine aminotransferase levels (boys >25.8 U/L, girls >22.1 U/L) (6.93, 2.52-19.03), hypertriglyceridemia (>110 mg/dL) (3.80, 1.23-11.75), and triglyceride to HDL cholesterol ratio >3 (9.23, 2.95-8.83) in the biochemical parameter model.**

Conclusions: **A diagnostic approach to hepatic steatosis is recommended as part of the proper screening and stratification of risk factors in obese children. WHtR is a simple and convenient method of effectively identifying obese children who are candidates for hepatic steatosis screening.**

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Introduction

Nonalcoholic fatty liver disease (NAFLD), a major chronic liver disease in children, has a wide spectrum from simple steatosis to advanced liver disease.[1] The prognosis of pediatric NAFLD is uncertain due to limited diagnostic evaluation and a lack of long-term follow-up studies. However, as in adults, pediatric hepatic steatosis is a common, clinically asymptomatic, and reversible condition, whereas nonalcoholic steatohepatitis (NASH) can progress to advanced liver disease.[2,3] As a direct consequence of the worldwide increase in childhood obesity, the incidence of NAFLD has been increasing.[4] The prevalence of NAFLD is approximately 3%-10% in the general pediatric population, and it increases to 20%-70% in obese children and adolescents.[2,5-7]

Detecting hepatic steatosis, the early stage of NAFLD, is important for preventing other metabolic complications as well as advanced liver disease. Although hepatic steatosis is asymptomatic and benign, the metabolic state of hepatic steatosis has already been associated with the derangement of glucose and lipid metabolism.[8] In the pediatric obesity clinic, clinicians see many patients who do not meet the diagnostic criteria of complicated obesity, such as metabolic syndrome, but are suspected of being close to developing hepatic

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steatosis. Although there is lack of diagnostic criteria for metabolic syndrome including NAFLD, both entities share similar pathophysiological mechanisms and metabolic syndrome may be preceded by NAFLD.[8-11]

The best diagnostic method for NAFLD is a liver biopsy, but it is difficult to perform in the pediatric obesity clinic for NAFLD screening because of cost, complications, and ethical considerations.[12] Ultrasonography (US) is most widely used for screening of NAFLD. In their pediatric population study, Shannon et al[13] showed that the ultrasonographic quantitative severity of hepatic steatosis correlated with the histological degree of steatosis on liver biopsy. US can be applied as a useful screening tool for NAFLD and especially for hepatic steatosis, although it is limited by its inability to distinguish between simple hepatic steatosis and NASH.[14] Because our primary purpose is the early diagnosis of hepatic steatosis for the prevention of advanced disease, this limitation of US is not crucial and the detection of hepatic steatosis is sufficiently significant.

To perform a stepwise US evaluation of hepatic steatosis in obese children, a reliable index is needed to identify appropriate candidates. There is an ongoing debate regarding which parameters adequately reflect NAFLD, the appropriate cutoff values of each parameter, the timing of liver US examination, and how close the correlation is between hepatic fatty infiltration on US and anthropometric biochemical parameters. Conventional guidelines have focused on serum aspartate transaminase elevation as a determinant of NAFLD, but this strategy was poorly associated with fatty liver determination on both US and liver biopsy.[13] Moreover, the cutoff value of alanine aminotransferase for NAFLD screening was set at a much lower level than the conventional cutoff point in pediatric studies.[15,16] A reliable and universally available anthropometric index that is uninfluenced by sex and age would be very valuable and effective in the selection of candidates for hepatic steatosis screening.

In this study, we used hepatic US to diagnose hepatic steatosis in overweight and obese children and compared various anthropometric and biochemical parameters according to the US-determined hepatic steatosis grade. First, we identified a reliable anthropometric index that can be universally and simply applied while selecting candidates for screening hepatic steatosis. Second, the NAFLD risk group was stratified according to anthropometric and biochemical parameters before progression to complicated metabolic syndrome. Based on this study's findings, we propose a paradigm for effectively diagnosing hepatic steatosis by selecting a risk group using an anthropometric index and screening for hepatic fatty infiltration on US in a pediatric obesity clinic.

Methods

Study population

We enrolled 242 obese children (122 boys and 120 girls) aged 7-16 years who were examined by abdominal US at the pediatric obesity clinic of the Bundang CHA Medical Center between January and December 2013. Obese children were defined as those who had a body mass index (BMI) >85th percentile adjusted for age and sex using 2007 Korean reference data and were previously screened through their school health check-up service and referred to the obesity clinic. Inclusion criteria were abdominal US findings consistent with the diagnosis of NAFLD,[17] while exclusion criteria were the presence of hepatic virus infections, autoimmune liver disease, metabolic liver disease, and Wilson's disease, history of parenteral nutrition, and use of medications to influence steatosis. The study was approved by the Institutional Review Board of Bundang CHA Medical Center.

Anthropometric and laboratory assessment

Anthropometric indices including height, weight, waist circumference, and hip circumference were measured by trained investigators according to a standard protocol. Height and weight were obtained by standard measurements. BMI was calculated as weight (kg)/height (m^2). Waist circumference was measured at the midpoint between the inferior border of the rib cage and the superior aspect of the iliac crest at the end of normal expiration. Hip circumference was measured at the level of the greater trochanter. The waist-to-height ratio (WHtR) was calculated as waist circumference (cm) divided by height (cm). The waist-to-hip ratio (WHR) was calculated as waist circumference (cm) divided by hip circumference (cm). Levels of fasting glucose, total cholesterol, high-density lipoprotein (HDL) cholesterol, triglyceride, alanine aminotransferase (ALT), and aspartate aminotransferase (AST) were determined. Subjects with liver enzyme levels above normal values for their age were evaluated for causes other than obesity, including hepatitis A, B, and C, Wilson's disease, autoimmune hepatitis, and other infectious or metabolic disorders.

Liver US examination

All enrolled obese children (n=242) underwent an US liver study by an experienced radiologist who was blinded to the patients' laboratory data. The sonograms were taken with an Acuson Sequoia 3000 ultrasound system using a 3.5-MHz convex probe. US manifestations of fatty infiltration included increased hepatic parenchymal echogenicity, obscuration of the intrahepatic vessel walls, and increased relative

echogenicity of the liver compared with the right kidney or spleen.[17] Based on the US pattern, fatty infiltration was semiquantitatively classified into normal, mild NAFLD, and moderate to severe NAFLD by a single observer.

Statistical analysis

All of the statistical analyses were performed using IBM SPSS statistics 20 (SPSS Inc., Chicago, Illinois, USA). Data were summarized as mean±SD. Differences between the two groups were evaluated using Student's *t* test. One-way analysis of variance was used to evaluate differences in continuous variables among the normal, mild NAFLD, and moderate to severe NAFLD groups. A stepwise multivariate logistic regression analysis was used to investigate risk factors associated with NAFLD. A receiver operating characteristic (ROC) curve analysis was generated to identify optimal anthropometric parameters for NAFLD prediction in obese children. The ROC curve analysis was used to calculate differences in the area under the ROC curve (AUC), which were then used to identify the most powerful predictive parameters for NAFLD. Sensitivity, specificity, and Youden's index were used to validate anthropometric parameters for NAFLD diagnosis.

Table 1. Comparison of characteristics of obese children according to NAFLD severity

Variables	Normal (*n*=98)	Mild NAFLD (*n*=70)	Moderate-to-severe NAFLD (*n*=74)
Age (y)	8.8±2.1	10.6±1.9*	11.8±1.7 †,‡
Sex (boys), *n* (%)	29 (30.0)	38 (54.3)	55 (74.3)
Anthropometric parameters			
Height (cm)	135.7±12.2	148.4±12.0*	155.5±12.0†,‡
Weight (cm)	42.0±11.8	57.0±14.2*	68.4±18.1†,‡
BMI (kg/m^2)	22.4±2.3	25.4±2.8*	27.8±3.8†,‡
BMI >95th percentile, *n* (%)	55 (56.1)	47 (67.1)	56 (75.7)
Waist circumference (cm)	74.4±7.2	85.1±7.1*	92.0±9.1†,‡
Waist circumference > 90th percentile, *n* (%)	71 (72.4)	59 (84.3)	69 (93.2)
Hip circumference (cm)	89.0±12.2	95.8±13.5*	101.0±9.8†,‡
WHtR	0.55±0.03	0.57±0.04*	0.59±0.05†,‡
WHR	0.83±0.05	0.88±0.05*	0.94±0.05†,‡
Biochemical parameters			
AST (U/L)	24.0±7.8	32.8±18.7*	44.1±26.7†,‡
ALT (U/L)	19.9±21.3	49.3±48.5*	79.7±53.6†,‡
Total cholesterol (mg/dL)	163.9±26.0	165.1±31.1	171.0±30.0
Triglycerides (mg/dL)	70.5±24.2	101.2±26.4*	152.0±49.5†,‡
HDL cholesterol (mg/dL)	55.0±9.8	51.2±7.8*	45.1±8.6†,‡
Fasting glucose (mg/dL)	96.8±6.8	97.6±5.8	97.5±7.3

*: normal group *vs*. mild NAFLD group; †: mild NAFLD group *vs*. moderate to severe NAFLD group; ‡: normal group *vs*. moderate to severe NAFLD group. NAFLD: nonalcoholic fatty liver disease; BMI: body mass index; WHtR: waist-to-height ratio; WHR: waist-to-hip ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase; HDL: high-density lipoprotein.

Results

Patient characteristics

The main demographic and clinical characteristics of the study population are summarized in Table 1. The prevalence of hepatic steatosis in the study population as determined by US screening was 59.2% (*n*=144; 93 boys and 51 girls). The prevalence was 76.2% (93/122) in boys and 42.5% (51/120) in girls. Boys showed a more severe degree of hepatic steatosis at diagnosis. The mean age at the time of first diagnosis increased according to hepatic steatosis severity grade (8.8±2.1 years in the normal group, 10.6±1.9 years in the mild hepatic steatosis group, and 11.8±1.7 years in the moderate to severe hepatic steatosis group). Anthropometric measurements including height, weight, BMI, waist circumference, hip circumference, WHtR, and WHR increased significantly with hepatic steatosis severity, with higher values seen in the group with more severe disease. This appears to be influenced by the age factor to some degree. Among the biochemical markers, mean serum AST, ALT, and triglyceride levels increased and HDL cholesterol levels decreased according to hepatic steatosis grade. Serum fasting glucose and total cholesterol levels did not differ among the three groups (Table 1). Within the same hepatic steatosis grade, there were no statistically significant differences in biochemical parameters by sex.

Appropriate anthropometric parameters for the US assessment of hepatic steatosis

AUC and 95% confidence interval (CI) of the anthropometric parameters measured in the study population are shown in Table 2. Among the anthropometric measurements, BMI, weight, waist

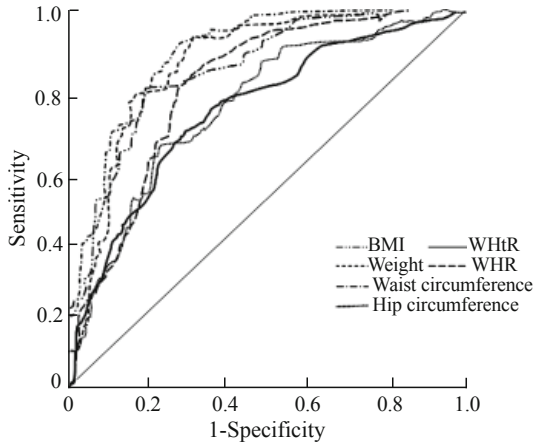

Fig. The receiver operating characteristic curves for anthropometric parameters for nonalcoholic fatty liver disease in our study population. BMI: body mass index; WHtR: waist-to-height ratio; WHR: waist-to-hip ratio.

Table 2. AUCs and cutoff values of anthropometric parameters for NAFLD in our study population

Parameters	AUC	95% CI of AUC	*P* value	Cutoff	Sensitivity	Specificity	Youden's index
BMI	0.86	0.81-0.90	<0.001	23.75	0.77	0.86	0.62
Weight	0.87	0.82-0.92	<0.001	43.85	0.80	0.80	0.66
Waist circumference	0.90	0.85-0.94	<0.001	77.90	0.90	0.80	0.70
Hip circumference	0.77	0.71-0.83	<0.001	95.10	0.82	0.77	0.59
Waist-to-height ratio	0.76	0.70-0.82	<0.001	0.56	0.75	0.75	0.50
Waist-to-hip ratio	0.82	0.76-0.88	<0.001	0.81	0.84	0.73	0.57

The optimal cutoff values corresponded to the highest Youden's index values. BMI: body mass index; AUCs: areas under the curve; CI: confidence interval; NAFLD: nonalcoholic fatty liver disease; Youden's index: sensitivity+specificity-1.

Table 3. Comparison of hepatic steatosis risk groups according to WHtR

Variables	Low-risk group WHtR <0.56 (*n*=120)	High-risk group WHtR >0.56 (*n*=122)	*P* value
Age (y)	10.62±2.2	9.84±2.35	0.363
Sex	-	-	0.158
Height (cm)	143.88±15.56	146.97±13.72	0.081
Weight (kg)	49.51±16.39	59.27±19.00	0.265
BMI (kg/m^2)	23.14±2.77	29.63±3.79	0.004
Waist circumference (cm)	77.32±8.84	88.34±9.97	0.546
Hip circumference (cm)	91.37±9.31	97.34±7.13	0.090
Waist to hip ratio	0.84±0.06	0.89±0.06	0.716
Fasting glucose (mg/dL)	97.12±6.20	97.34±7.13	0.128
AST (U/L)	28.36±12.70	36.93±24.92	<0.001
ALT (U/L)	34.93±37.73	58.32±54.93	<0.001
Total cholesterol (mg/dL)	164.05±30.84	168.78±26.64	0.159
Triglycerides (mg/dL)	88.93±37.57	119.39±53.09	0.001
HDL cholesterol (mg/dL)	52.43±10.31	49.36±9.01	0.290
TG-to-HDL cholesterol	1.82±1.05	2.60±1.55	0.006

WHtR: waist to height ratio; BMI: body mass index; AST: aspartate aminotransferase; ALT: alanine aminotransferase; HDL: high-density lipoprotein; TG: triglyceride. "-": none.

Table 4. Risk factors of NAFLD

Factors included in the model	Odds ratio	95% CI	*P* value
Anthropometric parameter model			
Age (>10 y)	-	-	-
Sex (male)	3.68	1.76-7.70	0.001
BMI >95th percentile	-	-	-
Waist circumference >90th percentile	20.22	9.21-44.36	<0.001
WHtR >0.56	2.25	1.05-4.81	0.037
Biochemical parameter model			
Fasting glucose >110 mg/dL	-	-	-
Elevated AST*	4.88	0.80-29.64	0.085
Elevated ALT >25.8 (M), 22.1 (F) U/L	6.93	2.52-19.03	<0.001
Hypertriglyceridemia >110 mg/dL	3.80	1.23-11.75	0.020
Total cholesterol >200 mg/dL	-	-	-
HDL cholesterol <45 mg/dL	-	-	-
TG-to-HDL cholesterol >3	9.23	2.95-28.83	<0.010

*: AST reference range: <9 years, 50 U/L; 10-15 years, 40 U/L; males 16-19 years, 45 U/L; females 16-19 years, 30 U/L. "-": none; M: male; F: female; HDL: high-density lipoprotein; NAFLD: nonalcoholic fatty liver disease; CI: confidence interval; TG: triglyceride; AST: aspartate aminotransferase; ALT: alanine aminotransferase.

circumference, hip circumference, WHtR, and WHR had an AUC >0.75 for the US diagnosis of hepatic steatosis (Fig.). Waist circumference had the highest AUC (0.90, 95% CI=0.85-0.94). The optimal cutoff points for the diagnosis of hepatic steatosis, which corresponded to the highest Youden's index values, were BMI: 23.75 kg/m^2, weight: 43.85 kg, waist circumference: 77.90 cm, hip circumference: 95.1 cm, WHtR: 0.56, and WHR: 0.81.

The application of waist-to-height ratio for predicting hepatic steatosis

According to the WHtR cutoff obtained from the ROC analysis (Table 2), the study population was divided into low-risk (WHtR <0.56) and high-risk (WHtR >0.56) groups for comparison (Table 3). We found no significant differences in mean age or sex distribution between the groups. The mean BMI (*P*=0.004), serum AST (*P*<0.001), ALT (*P*<0.001), and triglyceride (*P*=0.001) levels, and triglyceride-to-HDL cholesterol ratio (*P*=0.006) were higher in the high-risk than those in the low-risk group.

Risk factors for developing NAFLD

Risk factors for the development of NAFLD in overweight children were explored by logistic regression (Table 4). Logistic models were developed based on factors that influence the risk of NAFLD in overweight children. Obese children with NAFLD had significantly higher odds ratios (OR) of having a WHtR >0.56 (OR=2.25, 95% CI=1.05-4.81), being male (OR=3.68, 95% CI=1.76-7.70), and having a waist circumference >90th percentile (OR=20.22, 95% CI=9.21-44.36), in that order. In the biochemical parameter model, the NAFLD group showed a higher OR for hypertriglyceridemia (OR=3.8, 95% CI=1.23-11.75), an ALT >25.8 U/L for boys or 22.1 U/L for girls (OR=6.93, 95% CI=2.52-19.03), and a triglyceride-to-HDL cholesterol ratio >3 (OR=9.23, 95% CI=2.95-28.83).

Discussion

The primary aim of this study was to identify the most appropriate anthropometric index for predicting hepatic steatosis that can be readily used for screening obese

children who require evaluation for hepatic steatosis. This enables the detection of early-stage NAFLD and hepatic steatosis and prevents progression to advanced liver diseases such as NASH or other metabolic complications of obesity such as insulin-resistant glucose intolerance, dyslipidemia, and cardiovascular disease. Even if US is an effective non-invasive modality for quantifying hepatic steatosis, performing US on all obese children is impractical. In our regression analysis model, a large waist circumference (above the 90th percentile for age and sex) showed the highest OR in the demographic and anthropometric parameter model.

Waist circumference directly reflects abdominal fat and is closely related to the cardiovascular and metabolic complications of obesity.[18-20] Abdominal adiposity induces insulin resistance and free fatty acid accumulation through lipolysis.[21] The increased substrate for hepatic lipogenesis and relative hyperinsulinemia accelerates liver fat storage, leading to NAFLD.[2,22] Manco et al[19] proved that waist circumference was the only component of the metabolic syndrome that correlates with liver fibrosis in children with NAFLD. In addition, a pediatric NAFLD fibrosis index algorithm was developed on the basis of waist circumference, age, and triglyceride levels.[23] Although there is a distinction between the development of NAFLD in obesity and the progression of hepatic fibrosis in hepatic steatosis, it seems clear that a large waist circumference closely reflects the development of NAFLD. However, waist circumference cannot be used as the absolute standard threshold and is inconvenient to use universally across sexes and ages. Another study reported that both waist circumference and WHtR were associated with NAFLD.[21] For this reason, we suggested using WHtR to determine the hepatic steatosis high-risk group as the next best option.

WHtR not only incorporates waist circumference as a measure of abdominal adiposity but also adjusts for an individual's size. WHtR is an age-independent index and does not necessitate age-specific diagnostic references.[24] The use of a percentile scale for a specific age and sex is quite cumbersome in practice. In a previous study in Korean adults,[25] the optimal WHtR cutoff for NAFLD screening was 0.52 for men and 0.53 for women. The cutoff for NAFLD in obese children in our study was higher than the cutoff for NAFLD screening in Korean adults. Furthermore, according to our anthropometric model, the risk of developing NAFLD is higher in obese male children with a waist circumference >90th percentile and a WHtR >0.56. Among biochemical parameters, the identified risk factors were an ALT >25.8 IU/L for boys, >22.1 U/L for girls, hypertriglyceridemia (>110 mg/dL), and a high triglyceride-to-HDL cholesterol ratio (>3).

Elevated ALT activity has been traditionally considered as a guideline for a hepatic steatosis evaluation such as US or liver biopsy; however, it does not manifest in direct proportion to hepatic steatosis severity and its cutoff remains undetermined. The conventional normal range of ALT is considered too high to serve as a cutoff.[26,27] Schwimmer et al[15] proposed 95th percentile levels for ALT in healthy weight, metabolically normal, liver disease-free patients of 25.8 U/L in boys and 22.1 U/L in girls. In our study, the mean ALT activity was 19.9±21.3 U/L in the normal group and 34.9±37.7 U/L in the low hepatic steatosis risk group (by WHtR). A cutoff value of 40 U/L has no discrimination capacity for hepatic steatosis. According to the guideline from Schwimmer et al,[15] the OR of an elevated ALT level for hepatic steatosis is sufficiently high in our regression model. Tsuruta et al[16] reported that the OR of an ALT level >30 U/L for NAFLD was 16.9 in a Japanese junior high school population. Based on these results, we believe that ALT activity alone is not suitable for reflecting early NAFLD, especially the state of simple steatosis.[12,26]

In previous pediatric NAFLD studies, hypertriglyceridemia was shown to be associated with NAFLD in obese children.[28-30] Excessive carbohydrate intake increases *de novo* lipogenesis and intrahepatocellular triglyceride levels in the liver. Once the liver is fatty and insulin resistance occurs, the subsequent overproduction of glucose and very-low-density lipoprotein leads to mild hyperglycemia, compensatory hyperinsulinemia, and hypertriglyceridemia.[9] Hypertriglyceridemia is an important initiating factor in the lowering of HDL cholesterol levels.[9] In the lipid profile results in our study, the mean triglyceride levels were in proportion to NAFLD severity, and levels in the WHtR-determined high hepatic steatosis risk group were significantly higher than those in the low-risk group. The HDL cholesterol level in itself was not an independent predictor of NAFLD; however, it showed a significant tendency of decreasing in the more severe NAFLD group.

The triglyceride-to-HDL cholesterol ratio was associated with dyslipidemia, insulin resistance, and cardiovascular disease. Hannon et al[31] suggested that a triglyceride-to-HDL cholesterol ratio >3 was related to insulin resistance in overweight adolescents. Another study showed that cardiovascular and metabolic risk factor levels were significantly high in obese children with a high triglyceride-to-HDL cholesterol ratio.[32] In our study, the mean triglyceride-to-HDL cholesterol ratio (low hepatic steatosis risk group: 1.82±1.05; the high risk group: 2.60±1.55) are much lower than those calculated for cardiovascular disease risk and insulin resistance.[31,32] The OR of a triglyceride-to-

HDL cholesterol ratio for hepatic steatosis on US was the highest in the biochemical parameter model. Accordingly, we hypothesized that the cutoff value of the triglyceride-to-HDL cholesterol ratio for hepatic steatosis is much lower than that for other metabolic complications and that the development of NAFLD precedes the development of other metabolic complications of obesity. This indicates that the development of hepatic steatosis may initiate the metabolic derangement of obesity; thus, its early detection would be very useful for identifying the risk of further metabolic derangements.

The purpose of diagnosing NAFLD is not to treat it but rather to prevent complications of obesity such as metabolic syndrome and advanced liver disease. Therefore, it is important to identify individuals at a high risk of developing NAFLD among obese children. Although US is highly recommend for hepatic steatosis screening in obese children, anthropometric indices (BMI, weight, waist circumference, hip circumference, WHtR, WHR) were reliable factors for the diagnosis of hepatic steatosis on US. In particular, the WHtR was useful for discriminating the hepatic steatosis risk group in obese children. Biochemical parameters (ALT, triglycerides, triglyceride-to-HDL cholesterol ratio) were also positively related to hepatic steatosis severity, but there are limitations regarding their use as a standard point for the early detection of hepatic steatosis.

The limitations of our study include the single-center, cross-sectional study design; as a result, we lacked data on insulin resistance and cardiovascular disease screening was not performed. Second, the study population comprised patients referred to the obesity clinic via population-based school health check-ups. The age distribution of the study population was biased according to the school health check-up schedule. Third, even if the number of enrolled patients was small for an adequate representation of the ROC analysis and cutoff values, we consider our results meaningful for clarifying the important anthropometric and biochemical parameters as well as significant tendencies for cutoff values for hepatic steatosis screening.

In conclusion, the use of hepatic steatosis risk group stratification using an appropriate anthropometric index, WHtR, enabled an effective and tailored intervention.

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