The epidemiology of abdominal adiposity

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Chapter 4

Measuring abdominal adiposity in 6 to 7 year-old children

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ABSTRACT

Background/objectives: Both intra-abdominal adipose tissue (IAAT) and subcutaneous abdominal adipose tissue (SAAT) are associated with cardiovascular risk factors, even in childhood. Currently, the gold standard in assessing IAAT and SAAT is computed tomography (CT), which is not widely applicable. The aim of this study was to estimate abdominal fat using anthropometry, dual-energy X-ray absorptiometry (DEXA) and ultrasound, and compare these estimates with the amounts of IAAT and SAAT determined by CT in 6 to 7-year-old children.

Subjects/methods: In 31 healthy children, weight, height, circumferences, skinfolds, DEXA, abdominal ultrasound and CT were performed. Measurements were compared by simple correlations and receiver operating characteristic analyses.

Results: Total abdominal fat on CT did not differ between boys and girls (86.5 versus 89.8 cm^3, P=0.84). Boys had a higher IAAT to SAAT ratio than girls (0.56 versus 0.37, P=0.03). The sum of supra-iliac and abdominal skinfolds was most strongly correlated with SAAT on CT (r=0.93, P<0.001), and the abdominal skinfold with IAAT on CT (r=0.72, P<0.001). Diagnosis of subcutaneous abdominal and intra-abdominal adiposity can also be made using skinfolds. The associations with circumferences, body mass index and DEXA were less pronounced; however, these techniques can also be used to classify children according to SAAT and IAAT. Ultrasound can be used to diagnose subcutaneous adiposity, although it was not superior to skinfold measurements.

Conclusion: Skinfold measurements are the best non-invasive technique in predicting subcutaneous as well as intra-abdominal fat in our population of 6 to 7-year-old children.

INTRODUCTION

Worldwide, childhood obesity has become a major public health issue and its prevalence has increased drastically over the past decades both in the United States and in Europe (1, 2). It is associated with an increased risk of several chronic diseases such as type 2 diabetes and cardiovascular disease (3).

Although overall body fat is an important indicator of weight-related diseases, location of body fat is even more significant. Epidemiological studies have shown that, already in childhood, abdominal fat appears to be significantly associated with an unfavourable metabolic profile, including insulin resistance, decreased high-density lipoprotein and elevated low-density lipoprotein-cholesterol concentrations and high concentrations of triacylglycerol (4-10). Although it has been suggested that subcutaneous abdominal adipose tissue (SAAT) is independently associated with insulin resistance (7), most research suggests that SAAT has a protective effect on metabolic risk (11). In view of this protective effect, it is important to evaluate both intra-abdominal adipose tissue (IAAT) and SAAT in the assessment of metabolic risk. It is known that the accumulation of intra-abdominal fat starts in early childhood (7, 9), emphasizing the importance of assessment and prevention of abdominal adiposity at a young age.

Currently, the gold standard in assessing IAAT and SAAT is considered to be computed tomography (CT), owing to its higher resolution (12) and lower coefficients of variation (13) compared with magnetic resonance imaging. In general, a single slice CT is obtained, as CT confers radiation exposure (14-16). However, the use of CT is limited because of its limited availability, cost and exposure to ionizing radiation. Therefore, indirect techniques to assess abdominal fat have been used, such as anthropometry, ultrasound and dual-energy X-ray absorptiometry (DEXA), which confers a much lower radiation dose than CT. However, the validity of these techniques has not been studied in young children. Although ultrasound measurements have been validated in adults (17), to our knowledge no studies have been performed in children.

Therefore, the aim of this study was to estimate abdominal fat using anthropometry, DEXA and ultrasound, and compare these estimates with the amount of intra-abdominal and subcutaneous abdominal fat tissue determined by single slice CT in 6 to 7-year-old children.

SUBJECTS AND METHODS

Study population

This study was performed in 14 boys and 17 girls, aged 6–7 years. Children being diagnosed with diseases or using medication known to affect body composition were excluded from the study. Written informed consent was obtained from the parents and verbal assent was provided by the children. The study was undertaken with the approval of the Medical Ethics Committee of the University Medical Center Groningen, and was performed in accordance with the Declaration of Helsinki. Both total body fat and abdominal fat were assessed. Results regarding the assessment of total body fat are described elsewhere (18).

Anthropometry and abdominal fat assessment

Children were measured barefoot in their underwear. All anthropometric measurements were carried out by one trained observer. Body weight was measured using a calibrated digital scale (Model 770, Seca, Hamburg, Germany) and recorded to the nearest 0.1 kg. Stature was assessed using a digital stadiometer (digital pole measure PM-5016, KDS, Kyoto, Japan) and recorded to the nearest 0.1cm (19). Waist circumference was measured during gentle expiration, at the mid-point between the lower costal margin and the iliac crest. Hip circumference was measured at the greater trochanters. Both circumferences were obtained in standing position and recorded to the nearest 0.1 cm. Waist-to-hip ratio (WHR) and waist-to-stature ratio (WSR) were calculated. Skinfold thicknesses were obtained at the right side of the body using a Harpenden skinfold caliper (CMS Instruments, London, UK). The vertical abdominal, supra-iliac, subscapular and triceps skinfolds were measured. In addition, the sum of the supra-iliac and abdominal skinfolds was calculated, as well as a subscapular to triceps skinfold thicknesses ratio. All the above-mentioned measurements were performed in duplicate and a third measurement was performed if weight differed by more than 0.5 kg, height differed by more than 0.2 cm, circumferences differed by more than 0.5 cm and if skinfold thicknesses differed by more than 2mm. The mean of two measurements or of the two nearest readings was used to calculate means.

Dual-energy X-ray absorptiometry measurements were conducted using the Hologic Discovery A (Hologic Inc., Bedford, MA, USA). Regional fat was derived using the Hologic software version 12.3. In addition to the trunk fat area, two abdominal areas were drawn: one between the lower costal margin and the iliac crest (R1), and another narrower one at L3 with a height equal to the vertebra (R2). All scans and analyses were performed by the same, trained technician.

The ultrasound measurements were obtained with a Siemens Antares system (Siemens AG, Munich, Germany), using a C 2–5MHz curved array transducer. The transducer was placed at the midline between the lower costal margin and the iliac crest. Intra-abdominal fat distances were measured from the peritoneum to the corpus of the lumbar vertebra (17) and were obtained longitudinally at a medial, right lateral and left lateral angle. Subcutaneous fat thickness was measured at the medial point on a transverse plan, between the skin and the linea alba. To avoid compression of the skin, a gel spacer (Aquaflex US gel pad, Parker Laboratory, Orange, NJ, USA) was used. These ultrasound measurements have been validated in an adult population (17). Our scans were obtained by two trained sonographers and the intra-class correlation coefficients were 0.75 and 0.85 for IAAT and SAAT, respectively.
Computed tomography was performed using a Siemens Somatom Sensation 64 (Siemens AG, Forchheim, Germany). A single cross-sectional slice of 18mm thickness was obtained at the intervertebral space between L4 and L5. Subcutaneous abdominal adipose tissue and intra-abdominal fat volume were calculated using Syngo Volume Calculation with threshold values for fat of -150 to -50 Hounsfield units. All scans and analyses of the images were performed by a single, trained technician.

Statistical analysis

Pearson's correlation coefficients were calculated to assess the associations between the different methods of measuring abdominal fat. Calculation of non-parametric Spearman correlation coefficients provided similar results, as did the Lin's concordance correlation coefficients. We evaluated differences between correlation coefficients using an equation described by Blalock that provides a t-statistic (20). Diagnostic value was determined by calculating the areas under the receiver operating characteristic curves. We defined the highest quintile of CT measurements as cases of abdominal adiposity (17). We also conducted linear regression analyses to assess the variance in abdominal fat explained by the various techniques. All statistical analyses were performed using SPSS version 14.0 (SPSS, Chicago, IL, USA). The level of statistical significance was set at $P<0.05$.

RESULTS

Our study population consisted of 17 girls and 14 boys, clinical data of whom are summarized in Table 1. Age, weight, height and body mass index (BMI) did not differ significantly between boys and girls. Total abdominal fat on CT was not significantly different between boys (mean 86.5cm^3) and girls (mean

89.8cm^3). However, boys had relatively more IAAT compared with SAAT than girls (mean ratios 0.56 versus 0.37). Apart from small differences in waist-to-hip ratio (difference 0.03) and waist-to-stature ratio (difference 0.02), all other measurements of abdominal fat were not significantly different between boys and girls. Three girls (17.6%) and two boys (14.3%) were overweight.

According to national BMI reference charts, our population was representative of Dutch children in this age group, for whom BMI s.d. (-2s.d.;2s.d.) scores are 15.5 (13.1;19.4) in boys and 15.5 (13.0;19.9) in girls (21).

Subcutaneous abdominal adipose tissue and IAAT measured with CT were correlated (r=0.68, P<0.001) and total abdominal fat was correlated with both SAAT (r=0.99, P=0.001) and IAAT (r=0.76, P<0.001). Skinfold measurements intercorrelated as well (r between 0.68 and 0.96).

Table 1. Population Characteristics

	Girls (n = 17)		*Boys (n = 14)*		P
	Mean	*Range*	*Mean*	*Range*	
Age (years)	6.8	6.0-7.9	6.7	6.3-7.5	0.77
Weight (kg)	25.1	17.5-31.7	25.0	22.0-33.4	0.96
Height (cm)	125.9	113.8-136.9	123.6	117.4-135.9	0.33
BMI (kg/m^2)	15.76	13.51-20.32	16.32	14.67-19.47	0.35
Waist circumference (cm)	56.1	49.7-64.4	57.9	53.7-63.1	0.21
Hip circumference (cm)	63.4	55.7-72.5	63.0	57.0-70.8	0.77
Waist-to -hip ratio	0.89	0.83-0.94	0.92	0.88-0.99	0.01
Waist-to-stature ratio	0.45	0.40-0.52	0.47	0.45-0.53	0.04
Supra-iliac skinfold thickness (mm)	6.0	4.0-15	5.0	3.0-10	0.39
Abdominal skinfold thickness (mm)	8.0	4.0-18	8.0	4.0-16	0.77
Sum of supra-iliac and abdominal skinfolds (mm)	14.0	9.0-31	13.0	8.0-25	0.83
Subscapular to triceps skinfold ratio	0.62	0.44-0.76	0.58	0.34-0.79	0.37
Total abdominal fat on CT (cm^3)	89.8	46.3-204.0	86.5	36.4-162.9	0.84
Subcutaneous abdominal fat on CT (cm^3)	68.2	34.5-169.5	60.4	18.0-132.2	0.60
Intra-abdominal fat on CT (cm^3)	21.6	11.6-35.4	26.0	18.3-37.7	0.09
Intra-abdominal to subcutaneous fat ratio on CT	0.37	0.18-0.72	0.56	0.23-1.13	0.03
Subcutaneous abdominal fat on ultrasound (cm)	5.4	3.4-11.3	5.3	2.7-8.0	0.89
Intra-abdominal fat on ultrasound (cm)	3.5	2.4-4.9	3.4	2.2-4.5	0.50
DEXA R1 (%)	18.4	12.2-25.3	17.4	12.3-25.3	0.47
DEXA R2 (%)	18.8	12.0-26.3	17.6	12.4-26.2	0.43
DEXA trunk fat (%)	15.1	10.2-22.8	17.2	14.6-23.3	0.08

Abbreviations: BMI, body mass index; CT, computed tomography; DEXA, dual-energy X-ray absorptiometry; R1, abdominal region 1; R2, abdominal region2.

P, P-values for sex differences (t-test).

Subcutaneous abdominal adipose tissue

Pearson's correlation coefficients related to SAAT measurement are listed in Table 2. The sum of supra-iliac and abdominal skinfolds (r=0.93) was most strongly correlated with SAAT, but the slightly lower correlations with abdominal skinfold (r=0.91) and BMI (r=0.87) were not significantly different (P≥0.05). Hip and waist circumference also correlated well. Correlation with subcutaneous fat on ultrasound and DEXA R1 and R2 was good, though less than between skinfold measurements and SAAT. There was no correlation with frequently used measures such as subscapular to triceps skinfold ratio, DEXA trunk fat and waist-to-hip ratio. Adjusting for age and height provided similar results.

The ability of the various techniques to identify children with high amounts of SAAT was evaluated through receiver operating characteristic curves. Subcutaneous abdominal adiposity was defined as the highest quintile of SAAT on CT. The areas under the receiver operating characteristic curves (AUCs) showed that subcutaneous abdominal adiposity could be diagnosed adequately using skinfolds. All skinfolds performed well with AUCs from 0.95 to 1.00 (P<0.001), which were comparable to the AUCs for hip and waist circumference, and BMI (all three AUCs were 0.99, P<0.001). Ultrasound performed reasonably well (AUC=0.80, P=0.03). Dual-energy X-ray absorptiometry R1 and R2 were also able to diagnose subcutaneous abdominal adiposity with AUCs of 0.97 and 0.95, respectively.

Table 2 Pearson's correlation coefficients for subcutaneous abdominal adipose tissue (SAAT) measurement

	Total group	P- *value*	*Girls*	P-*value*	*Boys*	P-*value*
CT—sum of supra-iliac and abdominal skinfolds	0.93	0.001	0.92	0.001	0.96	0.001
CT—abdominal skinfold	0.91	0.001	0.93	0.001	0.92	0.001
CT—BMI	0.87	0.001	0.90	0.001	0.91	0.001
CT—supra-iliac skinfold	0.87	0.001	0.85	0.001	0.94	0.001
CT—hip circumference	0.82	0.001	0.77	0.001	0.91	0.001
CT—subcutaneous abdominal fat on ultrasound	0.79	0.001	0.83	0.001	0.73	0.003
CT—DEXA R1	0.78	0.001	0.79	0.001	0.77	0.001
CT—DEXA R2	0.77	0.001	0.80	0.001	0.73	0.003
CT—waist circumference	0.73	0.001	0.80	0.001	0.74	0.003
CT—weight	0.66	0.001	0.59	0.01	0.80	0.001
CT—WSR	0.64	0.001	0.87	0.001	0.47	0.09
CT—height	0.16	0.40	-0.01	0.97	0.44	0.12
CT—subscapular to triceps skinfold ratio	0.13	0.48	0.18	0.50	0.06	0.83
CT—DEXA trunk fat	0.08	0.68	0.19	0.47	-0.03	0.92
CT—WHR	-0.12	0.51	0.20	0.45	-0.48	0.08

Abbreviations: BMI, body mass index; CT, computed tomography; DEXA, dual-energy X-ray absorptiometry; R1, abdominal region 1; R2, abdominal region 2; WHR, waist-to-hip ratio; WSR, waist-to-stature ratio.

According to the stepwise linear regression analysis, 91% of the variation in subcutaneous abdominal fat was explained by the sum of supra-iliac and abdominal skinfolds, BMI and hip circumference. Separate analyses for boys and girls showed that the maximum explained variance is slightly higher for boys (adjusted R^2 0.93 in boys versus 0.89 in girls).

Intra-abdominal adipose tissue

Pearson's correlation coefficients regarding IAAT are listed in Table 3. Abdominal skinfold thickness was most strongly correlated with IAAT (r=0.72), although correlations with the other skinfold measurements, waist and hip circumferences, BMI, weight, waist-to-stature ratio and DEXA R1 and R2 were not significantly different (P≥0.05). There was no correlation with frequently used measurements such as DEXA trunk fat and waist-to-hip ratio, nor with subscapular to triceps skinfold ratio, which is commonly used to assess the relative centrality of fat. In addition, ultrasound measurements were not correlated with IAAT. Results for the midline measurement only, were comparable to the sum of midline and lateral measurements. Dual-energy X-ray absorptiometry regions 1 and 2 (R1 and R2) were correlated with IAAT in boys, but not in girls. Similar results were found after adjustment for age and height.

Table 3 Pearson's correlation coefficients for intra-abdominal adipose tissue (IAAT) measurement

	Total group	P-*value*	*Girls*	P-*value*	*Boys*	P-*value*
CT—abdominal skinfold	0.72	<0.001	0.66	0.004	0.88	<0.001
CT—sum of supra-iliac and abdominal skinfolds	0.72	<0.001	0.72	0.001	0.86	<0.001
CT—waist circumference	0.70	<0.001	0.68	0.003	0.67	0.01
CT—BMI	0.69	<0.001	0.64	0.01	0.75	0.002
CT—hip circumference	0.65	<0.001	0.58	0.01	0.90	<0.001
CT—supra-iliac skinfold	0.64	<0.001	0.74	0.001	0.75	0.002
CT—weight	0.59	<0.001	0.50	0.04	0.84	<0.001
CT—WSR	0.55	0.001	0.63	0.01	0.21	0.48
CT—DEXA R1	0.54	0.002	0.48	0.05	0.81	<0.001
CT—DEXA R2	0.53	0.002	0.48	0.05	0.81	<0.001
CT—height	0.23	0.21	0.14	0.59	0.63	0.02
CT—intra-abdominal fat on ultrasound	0.18	0.32	0.28	0.28	0.15	0.62
CT—DEXA trunk fat	0.18	0.33	0.08	0.73	0.11	0.71
CT—WHR	0.11	0.56	0.32	0.21	-0.55	0.04
CT—subscapular to triceps skinfold ratio	-0.04	0.81	0.07	0.79	-0.06	0.85

Abbreviations: BMI, body mass index; CT, computed tomography; DEXA, dual-energy X-ray absorptiometry; R1, abdominal region 1; R2, abdominal region 2; WHR, waist-to-hip ratio; WSR, waist-to-stature ratio.

Diagnosis of children with intra-abdominal adiposity was evaluated by means of receiver operating characteristic curves. They showed that the highest quintile of IAAT could be diagnosed adequately using skinfolds, with AUCs ranging from 0.86 to 0.92. Intra-abdominal adiposity can also be diagnosed by waist circumference (AUC=0.77, P=0.04), hip circumference (AUC=0.78, P=0.03), DEXA R1 (AUC=0.80, P=0.02) or DEXA R2 (AUC=0.83, P=0.01). Dual-energy X-ray absorptiometry R1 and R2 performed better in boys than in girls. Ultrasound could not diagnose the highest quintile of IAAT (AUC=0.71, P=0.10).

According to the stepwise linear regression analysis, the variation in IAAT could be explained best by abdominal skinfold thicknesses and waist circumference, explaining 56%, which was markedly lower than the maximum explained variance for subcutaneous abdominal adiposity. Separate analyses according to sex showed that in girls, only 54% of the variation in IAAT could be explained, whereas in boys up to 82% was explained. Analyses using the ratio of IAAT to SAAT on CT as gold standard were, in general, mainly determined by SAAT being the larger depot. For example, the ratio of IAAT to SAAT on ultrasound was weakly but significantly correlated with the ratio of IAAT to SAAT on CT (r=0.44, P=0.01). However, DEXA R1 (r= -0.58) and R2 (r= -0.57) were slightly stronger correlated than skinfolds (coefficients between -0.47 and -0.50), and the waist-to-hip ratio also correlated well (r=0.53).

DISCUSSION

Our results show that estimating SAAT and IAAT can be performed by skinfold measurements, particularly using a sum of the supra-iliac and abdominal skinfolds for SAAT and the abdominal skinfold for IAAT. This enables classification of prepubertal children according to the amount of subcutaneous abdominal and intra-abdominal adiposity rather than individually assessing the exact amount of abdominal fat. In accordance with these findings, based on the receiver operating characteristic curves, diagnosis of subcutaneous abdominal and intra-abdominal adiposity can be made using skinfold measurements. The associations with waist and hip circumference, BMI and DEXA assessments tended to be less pronounced, but these techniques can also be used to classify prepubertal children according to SAAT and IAAT. Ultrasound can be used to diagnose subcutaneous adiposity, but it was not superior to skinfold measurements.

Overall, measurements correlated markedly better with SAAT than with IAAT. Skinfold measurements were a direct measure of subcutaneous fat, which infers that they correlate better with SAAT than with IAAT. The observation that circumferences and abdominal regions on DEXA also correlate better with SAAT is because of the fact that they do not distinguish subcutaneous from intra-abdominal fat, implying that they will correlate best with the largest fat depot. In children, the intra-abdominal fat area is relatively small in comparison to the amount of total abdominal fat. Thus, it is understandable that circumferences and DEXA correlate better with SAAT than with IAAT. This idea is supported by the fact that the correlation between total abdominal fat and SAAT on CT (r=0.99) was much stronger than the correlation with IAAT on CT (r=0.76).

Although ultrasound can distinguish between SAAT and IAAT, it did not prove to be a good technique to measure IAAT in children aged 6–7 years. Further analyses were performed to try and explain our findings. Firstly, we correlated the intra-abdominal distance on CT from the peritoneum to the lumbar vertebra (the proxy for IAAT in the ultrasound measurements) with the gold standard IAAT on CT. These were only moderately correlated (r=0.56, P=0.001). Secondly, the intra-abdominal distance from the peritoneum to the lumbar vertebra measured on ultrasound was compared with the equivalent distance measured on CT. Surprisingly, these were not associated (r=0.10, P=0.59). Thus, the fact that ultrasound measurements did not reflect IAAT on CT is because of the combination of both the moderate correlation between IAAT and intra-abdominal distance on CT and the fact that intra-abdominal distance cannot be measured accurately on ultrasound in children. Ultrasound does perform well in assessing SAAT. The subcutaneous distance on CT between the skin and the peritoneum (the proxy for SAAT in the ultrasound measurements) and the gold standard SAAT on CT correlated well (r=0.88, P<0.001). Moreover, we found a good correlation between the subcutaneous distance on ultrasound and CT (r=0.81, P<0.001). These results are in agreement with a study in adults (22). Our finding that the IAAT to SAAT ratio on ultrasound was weakly correlated with the IAAT to SAAT ratio on CT is probably explained by the fact that the ratio is mainly determined by SAAT, which can be adequately measured using ultrasound. Our finding that all analyses using this ratio were mainly determined by SAAT being the larger depot illustrates that use of ratios can be problematic. Therefore, we did not further explore the findings concerning the IAAT to SAAT ratio on CT.

Not many studies have performed various measurements of abdominal fat in prepubertal children. Goran and colleagues performed a study in 101 prepubertal children aged 4–10 years, evaluating waist and hip circumferences, skinfold thicknesses, and total and trunk fat on DEXA scans in comparison with single-slice CT. They showed that SAAT and IAAT can be predicted accurately both with DEXA measurements (R^2 96 and 85%, respectively) and without the DEXA data (R^2 92 and 82%, respectively; (5)). The higher explained variances, compared with our study, might be because of the fact that Goran's population was slightly older and showed higher BMI and higher amounts of fat. A meta-analysis by Brambilla et al. compared weight, BMI and waist circumference obtained by magnetic resonance imaging in 407 children in a broad age range from 7 to 16 years (23). They concluded that waist circumference was the best single predictor of intra-abdominal fat (R^2 64.8%). Body mass index explained 80.4% of the variation in SAAT. These R^2-values are comparable to the maximum explained variances of IAAT and SAAT found in our study (56 and 91%, respectively). In summary, the aforementioned studies show that anthropometric measurements such as skinfolds and waist circumference are able to estimate both SAAT and IAAT. In this respect, these studies are similar to our findings. We did not find any report regarding validation of ultrasound measurements in children.

Interestingly, we found higher amounts of subcutaneous abdominal fat in girls, whereas boys had more intraabdominal fat. These differences were not significant, possibly because of our limited sample size (see Table 1). However, the IAAT to SAAT ratio was significantly higher in boys than in girls (P=0.03). Prepubertal sex differences have also been reported by others (24-27).

The main strength of our study is the narrow, young age category in which we performed a wide range of measurements. However, four limitations need to be addressed. Firstly, in view of our sample size, we were not able to cross validate our results in another population. Therefore, our results need confirmation in further research. Secondly, in view of limiting the radiation exposure, a single-slice CT was performed, in contrast to multiple abdominal slices covering the entire abdomen. Results from a study among premenopausal women showed a substantial intra-subject variability across various abdominal CT slices (28). However, another study among healthy adult men suggested that individual slices gave a good indication of the amount of subcutaneous abdominal and intra-abdominal fat (14). Both the studies concerned CT slices of 10-mm thickness, whereas in our study 18-mm slices were made. This procedure reduces the possibly compromising intra-subject variability. Thirdly, in choosing -150 to -50 HE to calculate fat on CT, the amount of fat might be overestimated as intra-colonic contents are included (29). This could not be adjusted for by the software we used. Finally, two observers performed the ultrasound measurements, possibly resulting in a larger variability in measurements. However, intra-class correlation coefficients for both SAAT (r=0.85) and IAAT (r=0.75) were acceptable and analyses excluding the seven measurements performed by the second observer only were similar to analyses related to the entire group. Thus, our results were not influenced by the fact that two observers performed the ultrasound measurements.

In conclusion, the results of our study suggest that skinfold measurements are the best non-invasive techniques in predicting subcutaneous as well as intra-abdominal fat in 6 to 7-year-old children.

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