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SUBCUTANEOUS FAT THICKNESS IN OBESE CHILDREN MEASURED BY CALIPER AND ULTRASOUND

ABSTRACT: *The report presented has compared the values of subcutaneous fat thickness in obese children measured by caliper and ultrasound. The measurements were carried out in 23 boys and 21 girls at 3 points of the body (triceps, subscapula, abdomen). The correspondence of both measurements was found only in the fat thickness on the abdomen, occurring in both sexes. A significant correlation between the two methods was seen in males for all the points of measuring, in females only for measurements above the triceps.*

KEY WORDS: *Fat — Skinfold — Obesity — Ultrasound — Caliper.*

INTRODUCTION

With the progress of medical electronics, literature gives more and more reports dealing with the measuring of subcutaneous fat layer using modern examining methods, e. g. ultrasonography (Volz, Ostrove 1984), magnetic resonance imaging — MRI (Hayes et al. 1988), bioelectrical impedance — BIA (Jackson et al. 1988), and others. The results obtained in this way are then compared with the values of classical measurements of skinfolds by caliper and their reliability and reciprocal replaceability, when establishing the total adiposity, are judged.

The subjects of those studies are mostly adults with an average amount of body fat. Therefore our report has compared the values of subcutaneous fat measured by caliper and ultrasound in obese children.

METHODS

In the period 1986 — 1989, 23 boys and 21 girls hospitalized for obesity in the Children's Clinic were examined. The subcutaneous fat layer was measured at 3 points of their bodies (triceps, subscapula, abdomen) by caliper of the 'Best' type using Pařízková's method (1973) and by ultrasound device MARK 600 with the frequency of sound 7.5 MHz and velocity 1450 m/s.

The results obtained were compared by means of Student's pair t-test and correlation coefficient. To eliminate possible non-gaussian distribution, the results were verified by non-parametric tests — Wilcoxon two sample test and Spearman rank-correlation test.

RESULTS AND DISCUSSION

Table 1 shows the essential statistical characteristics of selected body features and fat layers measured, Table 2 gives the comparison of the two methods of measurements.

The average age of our patients was about 12 years, body height of boys as well as that of girls corresponded with the norm of the average population. Body weight and percent fat (according to Pařízková J. 1973) nearly doubled the norm of healthy population of the same age.

The assessment of height/weight proportionality by means of 'body mass index' gives evidence of pathological obesity, BMI values are on the limit of 30 units in both sexes of our patients (Table 1).

Figures 1 and 2 show the comparison of fat thickness by means of the two methods of measurement at 3 points of the body surface.

TABLE 1. Basic descriptive statistics of measures.

	BOYS (n = 23)			GIRLS (n = 21)		
	Mean	SD	SE	Mean	SD	SE
Age (year)	11.6	2.8	0.6	12.3	2.8	0.6
Height (cm)	155.9	17.2	3.6	151.5	10.3	2.2
Weight (kg)	74.4	26.0	5.4	72.6	19.8	4.3
Fatness (mm) *	230.1	53.9	12.1	218.6	61.9	14.6
Fatness (%) *	29.8	4.4	1.0	30.7	3.2	0.8
Body mass index	29.3	5.4	1.1	30.5	6.1	1.3
ULTRASOUND						
Abdomen (mm)	47.5	14.6	3.1	37.2	13.1	2.9
Subscapula (mm)	19.7	5.5	1.2	21.2	7.9	1.8
Triceps (mm)	17.7	5.1	1.1	17.9	5.7	1.3
CALIPER						
Abdomen (mm)	44.7	8.1	1.7	40.8	9.9	2.2
Subscapula (mm)	31.6	7.6	1.6	30.1	7.7	1.7
Triceps (mm)	24.1	5.2	1.1	26.3	7.5	1.7

* - by Pařízková J. (1973) - 10 sites

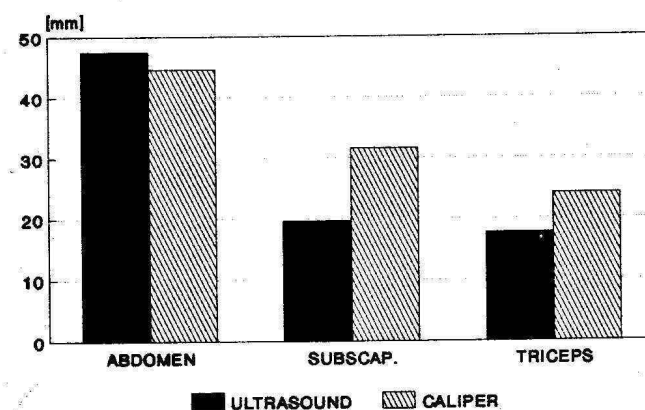


FIGURE 1. Comparison between ultrasound and caliper fat measures — BOYS.

The average values of fat thickness in both groups measured by caliper and ultrasound on the abdomen show no significant differences in both sexes ($P > 0.05$). This finding is in contrast with the results of Volz and Ostrove (1984) in healthy adults. Hayes et al. (1988) have reported on the correspondence of both methods of measurement on the abdomen in healthy males only. In our boys the abdominal skinfold average values measured by ultrasound were significantly higher than those in girls ($P < 0.05$).

In the two other points of measurement (triceps, subscapula) our groups of boys and girls showed significantly higher fat thickness average values when measured by caliper ($P < 0.01$). The same was found by Volz and Ostrove (1984). On the contrary, Hayes et al. (1988) found higher values of fat by ultrasonography — those, however, are not statistically significant at these sites in males.

Hayes et al. and Volz, Ostrove have revealed multiple echoes during sonographic measurement of fat, particularly in thick fat layers above the abdominal area. This phenomenon, which can deform the interpretation of the results obtained, has been explained by fat layering inside the fat tissue and by

TABLE 2. Comparison between measurements for each method at individual points.

Points of measurement	Correlation coefficient	Spearman rank-correlation	Student's pair t-test	Wilcoxon test
BOYS (n = 23)				
AU/AC	0.60 **	0.62 **	1.133 N. S.	90.0 N. S.
TU/TC	0.48 *	0.54 **	5.720 **	8.0 **
SU/SC	0.44 *	0.32 N. S.	7.804 **	1.5 **
GIRLS (n = 21)				
AU/AC	0.38 N. S.	0.34 N. S.	1.212 N. S.	78.5 N. S.
TU/TC	0.63 **	0.45 *	6.406 **	8.5 **
SU/SC	0.21 N. S.	0.24 N. S.	4.010 **	26.5 **

Points: A - abdomen, T - triceps, S - subscapula
Method: U - ultrasound, C - caliper
** - $P < 0.01$; * - $P < 0.05$; N. S. - non-significant

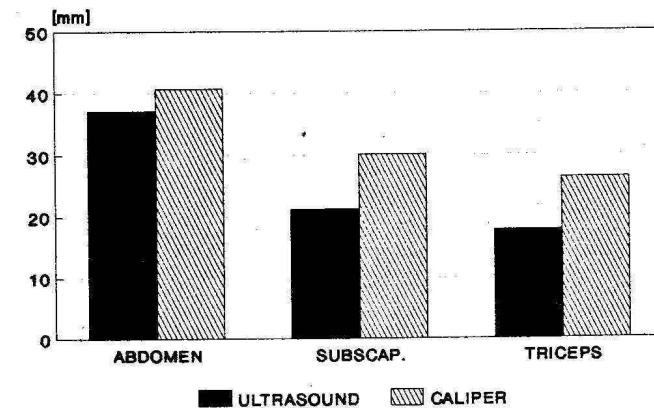


FIGURE 2. Comparison between ultrasound and caliper fat measures — GIRLS.

reflections on superficial membranes of these layers. Hayes et al. have also shown that higher values of ultrasound measurements can cause discrete echoes within a tissue situated under the fat layer. We ourselves have not seen that, which is documented by corresponding results of measuring thick abdominal fat layer either by caliper or ultrasound. The structure and density of fat tissue in obese children seem to be rather different from those of adults with the average layer of subcutaneous fat. According to Volz, Ostrove (1984) and Bullen et al. (1965) we have expressed the average values of skinfolds of subcutaneous fat measured by caliper in percentage of the values determined by ultrasound. The abdominal skinfolds corresponded roughly in 50% (46 - 53%) with the values of ultrasound measurements, which gives evidence of coincident results from the two methods, one-half subscapular skinfolds and those above triceps corresponded in 31% - 37% for both sexes. These values are much lower than the data found by the authors mentioned (60 - 90%). It is possible that the anatomical limit which influences the lift of a skinfold measured by caliper from the underlying tissue is, in obese children, lower than in healthy adults.

Comparing the results of measured levels by correlation coefficient (Table 2), a significant dependence was proved of the two methods at all the measured points in boys, in girls only for the values above triceps. However, correlation values are lower than those mentioned by Booth et al. (1966), and Volz, Ostrove (1984), particularly in girls.

CONCLUSIONS

1. Fat layers measured on the abdomen do not show statistically significant differences in the two methods, in both sexes of patients. The results of both methods are equivalent for this skinfold.
2. In the other two skinfolds (triceps, subscapula) the values in both boys and girls measured by ultra-

sound, are significantly lower than the data obtained by caliper ($P < 0.01$).

3. A statistically significant dependence between the two methods of measurement was shown on the abdomen and triceps in boys ($P < 0.01$), in girls only over triceps ($P < 0.05$).
4. For collation non-parametric methods (Spearman and Wilcoxon tests) were also tried. These methods confirmed the results mentioned above.
5. Even though the values obtained by caliper do not always give the data about the absolute subcutaneous layer thickness, they are easily applicable due to their simplicity and results show to be more reliable.

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