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A COMPARISON OF SKINFOLD MEASUREMENTS USING THE BEST AND HARPENDEN CALIPERS *

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SEVERAL different calipers have been used for measuring skinfold thickness in man. The Best caliper was introduced in 1954, and has round contact surfaces 3 mm in diameter giving a total pressure of 200 g, or approximately 30 g/mm². The Harpenden Caliper was introduced in 1955 (Edwards et al. 1955, Tanner and Whitehouse 1955), and has rectangular contact surfaces 14 × 5 mm which exert a pressure of 10 g/mm². Although there is still no agreement on the shape of the contact surfaces it is now agreed that the pressure should always

TABLE 1

Mean heights and weights for all subjects

Age Group (yrs)	Height (cm)			Weight (kg)		
MALES	Mean	S. D.	No.	Mean	S. D.	No.
6.00- 9.99	127.4	9.9	111	27.4	8.5	111
10.00-12.99	146.4	9.9	83	37.9	7.2	86
13.00-15.99	162.9	11.0	80	51.9	13.4	81
16.00 +	176.8	6.4	215	73.8	11.3	215
FEMALES						
6.00- 9.99	127.4	9.4	125	26.2	5.5	125
10.00-12.99	148.1	13.9	120	41.3	10.3	130
13.00-15.99	158.5	8.2	67	50.2	8.3	67
16.00 +	164.9	5.8	46	63.0	6.8	46

be 10 g/mm² and not vary with the opening of the caliper (Brožek and Keys, 1950-51).

In the present study, comparisons of the readings obtained by the two calipers have been made in 863 Czech urban subjects of both sexes aged 6 to 71 years (Tables 1 and 2). The skinfold measurements used were subcutaneous biceps, triceps, subscapular and suprailiac. The Best (1954)

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TABLE 2

Means and standard errors for skinfolds using Harpenden and Best calipers (left side) (untransformed measurements in mm) for all subjects grouped by age and sex

Age Group	No.		Biceps Mean	Biceps s. e.	Triceps Mean	Triceps s .e.	Subscapular Mean	Subscapular s. e.	Suprailiac Mean	Suprailiac s. e.
MALES										
6.00- 9.99	111	Harpenden	4.4	0.2	8.8	0.3	5.5	0.3	4.6	0.3
		Best	3.9	0.3	9.0	0.4	5.2	0.4	5.0	0.5
10.00-12.99	86	Harpenden	4.6	0.2	9.2	0.4	6.0	0.3	5.0	0.4
		Best	3.7	0.3	9.2	0.5	5.2	0.4	4.9	0.5
13.00-15.99	81	Harpenden	3.9	0.3	7.9	0.4	6.6	0.5	6.0	0.7
		Best	3.3	0.4	7.8	0.5	6.0	0.6	5.9	0.8
16.00 +	215	Harpenden	3.6	0.2	6.9	0.2	9.1	0.3	7.8	0.4
		Best	3.1	0.3	6.8	0.2	9.1	0.3	8.2	0.4
FEMALES										
6.00- 9.99	125	Harpenden	5.1	0.2	10.1	0.3	6.4	0.3	5.6	0.3
		Best	4.4	0.3	10.3	0.4	5.6	0.3	6.0	0.4
10.00-12.99	130	Harpenden	5.8	0.2	10.7	0.3	7.6	0.3	7.3	0.5
		Best	5.3	0.3	11.3	0.4	7.1	0.4	8.2	0.7
13.00-15.99	67	Harpenden	5.5	0.2	10.7	0.4	7.8	0.3	7.3	0.4
		Best	5.1	0.3	11.2	0.6	7.4	0.4	8.1	0.5
16.00 +	46	Harpenden	5.3	0.3	12.6	0.6	9.8	0.6	9.6	0.7
		Best	4.7	0.4	12.5	0.8	9.3	0.6	10.2	0.8

caliper as modified by Pařízková (1957, 1961) and the Harpenden caliper (Tanner and Whitehouse 1962, Tanner 1962) were used, on the left side of the body.

All measurements were made by the same observer.

Since the Harpenden caliper has now come into general use there will often be bodies of measurements not all made by the same caliper. The aim of the present paper is to give a method of converting measurements made using the Best calipers to those made using the Harpenden calipers. Because of the difference in the size and shape of the contact surfaces and the different pressures of the two calipers, the average difference between Harpenden and Best caliper measurements may be expected to depend on the compressibility, which in turn may depend on the thickness and site of the skinfold, and the age and sex of the subject. Compressibility of skinfolds has recenly been studied by Clegg and Kent (1967) who show that in general it is greater at high values of the fold at any particular site and greater in females than in males. We have therefore analysed data separately for males and females and for the different sites.

RESULTS

For each site and sex, the Harpenden measurements were plotted against the Best measurements. These plots indicated that straight lines would fit the data quite closely. We have fitted both a sraight line and a quadratic, of Harpenden on Best for all these groups and examined the fit in each case. Graphical examination of the residuals, i. e. the difference between the actual observed value of the Harpenden measurement and that predicted by the curve, indicates that (after appropriate standardization) these are symmetrically distributed with constant variance and an approximately normal distribution about zero.

The addition of age and a quadratic term as extra regression variables in the predicting equation, although giving statistically significant non-zero coefficients in most groups, does not modify the pattern to any appreciable extent, and the simple linear prediction is recommended for practical use. A summary of the predictions with the residual mean squares is given in Table 3. The residual mean square could be used as a minimum estimate of the variance for a single future observation about its predicted value. In fact a more exact estimate will depend on the value of the Best skinfold, but the adjustment involved over the normal range of measurements is only of the order of 5%, and for practical use,

an average value is given. For example for biceps measurement in boys, the residual mean square is 0.48 and the average value is 0.50 giving a standard deviation of 0.71 (all measurements in mm). For a Best measurement of 10.0 the predicted Harpenden value is 8.89 and approximate 95% confidence limits are given by 8.89 ± 1.42 i. e. from 7.47 to 10.31. In fact the largest observed residual is 2.1 which is about 3 standard deviations.

TABLE 3

Prediction equations

	Biceps	Triceps	Subscapular	Suprailiac
Males	$y = 1.43 + 0.75x$ (0.71)	$y = 1.51 + 0.81x$ (0.89)	$y = 1.42 + 0.85x$ (0.87)	$y = 0.92 + 0.82x$ (1.14)
Females	$y = 2.02 + 0.70x$ (0.80)	$y = 2.13 + 0.77x$ (0.94)	$y = 1.80 + 0.82x$ (0.89)	$y = 1.26 + 0.75x$ (1.40)

All Measurements are in mm.
y = predicted Harpenden value x = Best Measurement
Figures in parenthesis are the estimated standard deviations of prediction

DISCUSSION

We have investigated methods for converting skinfold measurements made using the Best Calipers to those made using the Harpenden calipers. Linear prediction equations are given for each site and sex. It is found that although some improvement in prediction can be obtained by introducing further terms into the equations, the gain is small. The possibility remains however, that the relationship between the Harpenden and Best calipers depends on age in a complicated way, not allowed for by introducing age as a simple regression variable. We therefore also carried out the analysis within the four age groups for each sex used in Tables 1 and 2. The results of this analysis indicate that no improvement in prediction is obtained. Differences between the results from the two calipers are clearly in part due to the pressure exerted on a skinfold being in one case 30 gm/mm^2 and the other 10 gm/mm^2. The effects noted by Clegg and Kent (1967) are not seen unequivocally in our data, and our comparison is probably influenced by the different shapes of the contact surfaces, which was not the case in Clegg and Kent's study.

The error in the predicted values using the equations in Table 3 are of the same order as the measurement error of repeated measurements made by different measurers on a single individual (see Edwards et al. 1955).

TABLE 4

Comparison of prediction equations

		Total Variance of Harpenden	Residual Variance after fitting Best Measurement		
			Linear	Quadratic	Quadratic and Age Term
Males	Biceps	4.31	0.48	0.44	0.43
	Triceps	11.48	0.77	0.76	0.74
	Subscap.	16.54	0.74	0.72	0.69
	Suprail.	28.15	1.43	1.25	1.20
Females	Biceps	4.11	0.61	0.59	0.58
	Triceps	10.84	0.87	0.87	0.87
	Subscap.	11.68	0.76	0.76	0.74
	Suprail.	19.90	1.92	1.75	1.58

SUMMARY AND ABSTRACT

Measurements of Biceps, Triceps, Subscapular and Suprailiac skinfolds have been made on 863 subjects of both sexes aged 6 to 70 years. Each subject was measured once with the Best Caliper and once with the Harpenden Caliper. The readings of the two calipers differed systematically by varying amounts. Linear regression equations are given for each site and sex for converting a measurement made using the Best Caliper to an equivalent Harpenden Caliper value.

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