Medicina Sportiva
Med Sport 12 (2): 36-40, 2008
DOI: 10.2478/v10036-008-0007-9

THE INFLUENCE OF RELIABILITY IN MEASURING SKINFOLDS ON THE RELIABILITY OF RESULT OF ENDOMORPHIC AND MESOMORPHIC COMPONENTS OF SOMATOTYPE

Petr Kutáč[A, B, E, F, G], **Vojtěch Gajda**[A, C, D]

Department of Physical Education, Pedagogical Faculty of Ostrava, Czech Republik

Abstract

Introduction: The somatotype has been identified as one possibility to qualify the physique of an individual through application of the anthropometric method to serve as a supplementary method to determine the individual´s physical composition.

Aim: The study aims to evaluate the impact of skinfolds measurement on the somatotype endomorphic and mesomorphic component determination by comparing the measurement results of individuals with little experience.

Methods: To carry out this study, we recruited students from the Department of Physical Education, Pedagogical Faculty. The group of workers with little experience consisted of four randomly selected students who attended a seminar serving the purpose of learning the skinfold measuring technique. An expert in this area was asked to lead the seminar. The individual calculations were carried out by means of the statistic product SPSS 15.0.

Results: The results of our investigation showed difficulty in skinfolds measurement accuracy, in particular, with respect to an experience and training in the applied methodology. They showed that the students measured reliably, but with a systemic error. While the measurement of skinfold suprailiac proved to be the least problematic, the measurement of skinfold on the calf showed to be most problematic.

Conclusion: The study showed that in the area of measuring the impact of the skinfold on the components of somatotype, the monitored faults of measurement do not influence the result of mesomorphy component value. As a result of the endomorphic component value, the mentioned faults are clearly visible (the differences in the result are statistically significant).

Key words: *body composition, somatotype, endomorphy, mesomorphy, measuring of skinfolds, reliability of measuring*

Introduction

The somatotype serves as one of the possibilities of measuring the physique of an individual by applying the anthropometric methods that serve as the supplemental methods for the physical composition (1,2). The evaluation is based on relationship among three morphological components the values of which are calculated from the anthropometric measurements. The first - endomorphy component relates to the relative obesity or slimness of the individual, the second – mesomorphy component relates to the relative muscle skeletal development in relation to the stature, and the third – ectomorphy component relates to the relative length of the parts of the body (3). The somatotype provides us with information on some somatic signs of the individual that we can use not only for following the ontogenesis of an individual at various age (4-8), but also for investigation of his/her somatic conditions for a given sports event at the selection of sports talents (9). The importance of somatic characteristics of an individual (somatotype) in sports is supported by earlier publications (10-14) and current studies (15-22) that focus on characteristics of the top sportsmen of the representation selections in various age categories. The P.T. students are an important monitored group as they follow a curriculum that requires a special sports performance. The authors mainly followed the somatic characteristic of these students in relation to the curriculum this population group followed (13, 23-25).

With respect to the applied measuring methodology (technology of measuring the skinfolds thickness and components calculation), the question of reliability of these measurements arises. Can the results of the measurements performed by various authors without proving their objectivity be compared? While the methodologies of measuring individual anthropometric parameters are accurately described and unified (including a sufficiently exact armamentarium), given our experience, certain abnormalities can appear when measuring the thickness of skinfolds. The exactness of skinfolds measurement does not only depend on the type of caliper used, but, predominantly, on the experience level of the person administering the measuring technique (localization and pulling out of skinfold). Therefore, we explored the question of reliability and objectivity regarding the measurement of the thickness of skinfolds in our study.

Due to the thickness of skinfolds measuring results influences the values of endomorphy and mesomorphy components, we will view the real significance of the obtained differences in relation to the changed values of relevant components (endomorphy and mesomorphy) of the somatotype of explored probands.

Aim

1. Based on the repeated measurements of four skinfolds (subscapular, suprailiac, on the triceps, and on the calf) with a caliper type Best by an expert (a worker with a substantial practical experience) to find out its reliability.
2. To verify the reliability of measuring at the choice of common academic population on the ground of comparing the results of measuring four skinfolds (identical with the measuring in point 1.) by an expert and workers with a short experience. In case of significant differences to evaluate the skinfolds influence on the values of endomorphy and mesomorphy components of somatotype.

Materials and Methods

For accuracy of skinfolds measurement rating (repeated measurement by an expert) we recruited first year students with a concentration in Leisure Time Management, at the Department of Physical Education, Pedagogical Faculty - KTV PdF OU. 32 students (18 men and 14 women) were administered this measurement procedure.

For the second aim – comparing the results of measuring four skinfolds by an expert and workers with a short experience, the 3rd year students majoring in the pedagogy study – TV specialization at KTV PdF OU (n = 25 students, 7 men and 18 women).

The group of workers with a short experience consisted of four randomly selected students of the seminar. The purpose of the seminar was to gain an experience in the skinfolds thickness measuring technique. Due to a great experience in this area, the seminar lecturer was asked to perform this position.

The measurement for the first aim accomplishment (repeated measurement by an expert) due to a higher number of students was carried out in two stages (16 students were measured in every stage). On Tuesday there was measured the first group and on Wednesday the same week there was measured the second group. The measurement was repeated within one week when every group again was measured on the same day and at the same time as in the first measurement.

The measurement for the second aim accomplishment (comparing the results of measuring by an expert and workers with a short experience) was carried out with the selected group of students on the same day.

The measurements were always carried out in the alphabetical order. The values of skinfolds were measured at individual persons gradually in a given sequence. The expert measured all anthropometric parameters that were necessary for determination of somatotypes in the selected group. The methodology Heathová-Carter (3) was used and thoroughly observed for the somatotype determination. There was measured the stature, body weight, biepicondylar parameter of humerus and femur, circumference of contracted shoulder, maximum circumference of the calf and skinfold subscapular, suprailiac, on the triceps and on the calf (1). The values were always measured on the right side of the body. The values of individual components were calculated by means of ANTROPO program.

We characterized all monitored variables by the basic descriptive statistic measures. The normality of their distribution was verified by Kolmogorov-Smirnov and Shapiro-Wilka tests. The reliability of measuring by an expert is verified through the coefficient of stability (r_{stab}). The difference in both measurements was qualified by a paired t-test.

We used Cronbach's coefficient α, coefficient of absolute reliability R*(for a single measurement) for evaluation of the consistency of expert's measuring and measuring of workers with a short experience. The values of these measurement averages were analyzed by applying the analysis of variance (ANOVA). The calculations were carried out by means of the statistic product SPSS 15.0. The significance level α=0.05 was determined for all tests.

Results

1. The reliability of measuring by an expert

Table 1 presents the basic descriptive characteristics of the skinfolds measurement at the group being under examination (n = 32).

Table 1. *Basic descriptive statistics of the examined body*

Skinfold	$\overline{x}$ (mm)		*S*		*V*	
	1. meas.	2. meas.				
subscapular	7.3	8.1	2.7	2.5	0.37	0.31
on the triceps	12.5	13.1	5.5	5.6	0.44	0.43
suprailiac	9.6	8.8	6.8	6.0	0.70	0.68
on the calf	11.5	11.5	5.3	5.2	0.46	0.46

$\overline{x}$ - mean *S* - standard deviation *V* - coefficient of variance

The normality of distribution was disrupted at the suprailiac when there was disrupted the skewness at the first and second measurement, and at the second measurement we also registered the disturbance of sharpness (kurtosis). At the subscapular we noted the disturbance of skewness and sharpness in both measurements.

The coefficients of stability in measuring the thickness of individual skinfolds together with testing the relevance of difference measured by paired t–test (Table 2). The significance of difference in average values of both measurements showed only at the variables where the skewness and sharpness of normal distribution were strongly disrupted. The disturbance of assumed distribution normality at the monitored variables in the paired t–test could be one of the reasons of ascertained statistical significance.

Table 2. *Coefficient of stability and relevancy of paired t-test gained at the expert*

Skinfold	r_{stab}	absolute difference	t-test
subscapular	0.891	0.8	*
on the triceps	0.936	0.6	
suprailiac	0.970	0.8	*
on the calf	0.970	0	

r_{stab} – coefficient of stability * p<.05

Crucial for our examination is the appraisal of the real significance based on the changes in monitored somatotype components. At the repeated measuring no proved significant differences at both monitored components was noted (Table 3) and the reliability of measuring these components verified by test-retest method is very high.

Table 3. *Values of morphological components of both measurements by an expert*

Component	$\overline{x}$ (mm)		S		r
	1. meas.	2. meas.	1. meas.	2. meas.	
endomorphy	3.1	3.14	1.24	1.12	0.975
mesomorphy	3.94	3.89	1.15	1.07	0.975

$\overline{x}$ - mean S - standard deviation r – correlation coefficient

2. Comparison of measuring results by an expert and workers with a short experience

At the first look at Table 4 (descriptive statistic characteristics of skinflods measurement results) it is obvious that there are significant differences between the values measured by worker with various experience level.

The values of Crombach's coefficient α and absolute reliability coefficient (R*) are shown in Table 5. The found out values are relatively high and they are between 0.707 and 0.959. In physics the value of Crombach's coefficient $\alpha > 0.8$ (26) is considered as an acceptable reliability.

From Crombach's coefficient α the reliability of the measurement average can be assessed and from absolute reliability coefficient (R*) the reliability of individual measurement can be assessed. Crombach's coefficient α determines the consistency from coefficients of correlation between individual measurements (it means regardless the systemic measurement error).

Table 4. *The results of measuring skinfolds*

Skinfold		Expert (mm)	Student 1 (mm)	Student 2 (mm)	Student 3 (mm)	Student 4 (mm)
Subscap.	$\overline{x}$	10.5	8.3	8.7	10.5	7.0
	s	3.8	3.3	3.3	3.5	1.8
Suprail.	$\overline{x}$	7.1	7.2	7.6	9.6	7.1
	s	3.9	3.5	3.6	4.6	3.3
Triceps	$\overline{x}$	17.1	11.6	11.5	14.8	13.6
	s	6.2	4.8	4.6	5.5	5.6
Calf	$\overline{x}$	16.0	9.8	8.7	14.7	13.2
	s	7.5	5.5	4.6	4.7	6.0

$\overline{x}$ - mean s – standard deviation

Table 5. *Values of coefficients of reliability*

Coefficients	Subscap.	Suprail.	Triceps	Σ of three folds	Calf
α	0.929	0.935	0.935	0.959	0.924
R*	0.724	0.742	0.741	0.824	0.707

α - Crombach´s α R* - coefficient of absolute reliability

By collecting the results of measurements of the same group tested by workers with various experience level, we can consider the average result as highly reliable. In case of a single worker results, we have to be cautious because $R^* < 0.8$.

We used ANOVA to determine the difference in the average values measured by individual workers. The conditions for its application were satisfied at all measurements (and their totals) except the thickness on the calf. In order to ensure the condition of distribution normality, we transformed the original variable into a new variable which was analyzed. The statistically significant difference of workers´ measurement averages was proved in all monitored cases. At a closer look at the post hoc (Duncan´s test) analysis, our results showed that the expert ´s measurement always statistically significantly varied from those of the workers with little experience. Thus, the measurements of workers with various experience level cannot be considered identical.

In the group of workers with little experience, no proved statistically significant difference in measuring the skinfolds and their total, except for the thickness of skinfold on the triceps (Table 6), were found.

Table 6. *Results of Duncan's test of mean of measuring skinfold on the triceps*

Worker	n	Group 1	Group 2
Student 2	25	11.5	
Student 1	25	11.6	
Student 4	25	13.6	13.6
Student 3	25		14.8

Discussion

It is shown the results from measurements of workers with a short experience can be considered to be identical except for casual deviations. The difference in measuring the skinfold thickness on the triceps is not considered to be objectively too significant.

There is a question whether the statistically proved difference in measuring skinfolds between an expert and a group of workers with a short experience has a real influence in light of setting the mesomorphy and endomorphy components of somatotype. For the endomorphy components determination there is used a simple sum of three skinfolds (on the triceps, subscapular, suprailiac) and this sum is then substituted in a regressive equation of a linear function (27). On the ground of this equation it is easy to prove that the *4mm* difference in sum of skinfolds means 0.5 point of endomorphy component. We found out the maximum difference of 7 mm in the results between an expert and group of workers with a short experience. Such a difference can be regarded as objectively significant because it presents approximately the value of 1 point of the endomorphy component as this component was evaluated with 0.5 point (3) accuracy.

The mesomorphy component determination is calculated by a markedly more difficult method (from the physical height, width of epicondyls of humerus and femur, circumference of contracted shoulder by thickness of skinfold on the triceps, and maximal circumference of calf reduced by thickness of skinfold on the calf). By substituting the *maximal differences* in measuring the thickness of both skinfolds into a calculation equation of mesomorphy component of a person set up of the averages of individual component measurements, the value changed only by *0.27 points*. In the light of the above, we consider the regard the reported differences in measuring the thickness of skinfolds on the triceps and on the calf objectively insignificant for the values of the mesomorphy component.

The results show that the various experience level of workers influences the evaluation of at least one component, thus the individual ´s classification in the corresponding category of somatotype, which is most often determined according to mutual relations of individual components (3,28,29). A faulty classification falsifies the physique of the monitored individual which not only can result in faulty conclusions when selecting the individuals for the sports event (talents selection), but also in faults when preparing and running the training process (30,31).

Conclusions

With respect to the results of repeated expert´s measurements we can regard the monitored technique of measuring the skinfolds as reliable and the differences between the repeated measurements as insignificant, because they did not appear in the final result of somatotype monitored components.

When comparing the results of expert ´s measurements and the measurements of workers with little experience, we noted a high consistency of measurement valued by Crombach´s α**.** The arithmetic average of several workers´ measurements (with a different experience in a given measurement methodology) can be considered reliable in practice. In case adding three skinfolds thickness according to the physical demands on the measurement reliability ($\alpha > 0{,}8$) we consider the individual measurements to be acceptably reliable. The least problematic proved to be the measurement of skinfold suprailiacal and the most problematic was the measurement of the skinfold on the calf. The absolute values of monitored skinfold measurements by experts and the measurements by workers with little experience cannot be considered to be identical.

The mesomorphy components result is not significantly influenced by the outcome differences in skinfolds thickness measurement. As a result of the

endomorphy component, these differences are objectively visible (to the extent of approximately one point of the endomorphic component).

References

1. Heyward VH, Wagner DR. Applied body composition assessment. Champaign, IL: Human Kinetics, 2004.
2. Ackland TR, Elliot BC, Bloomfield J. Applied Anatomy and Biomechanics in Sport. Champaign, IL: Human Kinetics, 2008.
3. Riegerová J, Přidalová M, Ulbrichová M. Aplikace fyzické antropologie v tělesné výchově a sportu. Olomouc: Hanex, 2006.
4. Fragoso I, Fortes M, Vieira F, et al. Identifying Maturational Levels During Adolescente: A Methodological Problem. In: Reilly T, Marfell-Jones M, ed. Kinantropometry VIII. London: Routledge, 2003: 69–81.
5. Jürimäe J, Jürimäe T, Leppik A, et al. Relationship between anthropometric variables and physical activity in prepubertal girls. *J Hum Kinetics* 2001; 5: 13–21.
6. Lee AJY, Lin WH. The Influence of Gender and Somatotype on Single-Leg Upright Standing Postural Stability in Children. *J Appl Biomech* 2007; 23: 173-9.
7. Makgae P, Monyeki KD, Brits SJ, et al. Somatotype and blood pressure of rural South African children aged 6 – 13 years: Ellisras longitudinal growth and health study. *Ann Hum Biol* 2007; 34: 240-51.
8. Veldre G. Heath-Carter Somatotype Categories and their Sexual Maturation Differences in 12 – 15 – Year – old Estonian Boys and Girls. *Anthropology* 2004; 13: 269–85.
9. Gil S, Ruiz F, Irazusta J, et al. Selection of young soccer players in terms of anthropometric and physiological factors. *J Sports Med Phys Fitness* 2007; 47: 25-32.
10. Berg K, Latin. RW, Coffey C. Relationship of somatotype and physical characteristic to distance running performance in middle age runners. *J Sports Med Phys Fitness* 1998; 38: 253-7.
11. Carter JE, Ackland TR. Sexual dimorphism in the physique of World Championship divers. *J Sports Sci* 1998; 16: 317-29.
12. Chytráčková J. Možnosti individuálního hodnocení motorické výkonnosti dětí podle somatických předpokladů. In 3 rd. Antrop. Congress. Prague: UK, 1990: 105-6.
13. Pavlík J. Tělesná stavba jako faktor výkonnosti sportovce. Brno: MU PdF Brno, 1999.
14. Rienzi E. Investigation of anthropometric and work-rate profiles of elite South American international soccer players. *J Sports Med Phys Fitness* 2000; 40:162-9.
15. Carter JEL, Ackland TA, Kerr DA, et al. Somatotype and size of elite female basketball players. *J Sports Sci* 2005; 23: 1057-63.
16. Demuth A, Czerniak U, Krykala M, et al. Somatic characteristic of players from chosen national teams of field hockey. *Human Movement* 2007; 8: 27–31.
17. Querioga MR, Ferreira SA, Pereira G, et al. Somatotype and performance in futsal players. *Braz J Kineanthropometry Hum Perform* 2008; 10: 56-61.
18. Sanchez MC, Sanz D, Zabala M. Anthropometric characteristics, body composition and somatotype of elite junior tennis players. *Br J Sports Med* 2007; 41: 793-9.
19. Semple S, Neveling N, Roussouw R. Physical and performance - related profile of elite male South African distance runners. *Afr J Phys Health Educ Recreation Dance* 2003; 9: 238-49.
20. Stewart AD, Benson PJ, Michanikou EG, et al. Body image perception, satisfaction and somatotype in male and female athletes and non athletes: results using a novel morphing technique. *J Sports Sci* 2003; 21: 815–23.
21. Stoklasa H, Malgorzata S. The assessment of somatotype and bone mass density in female athletes. *J Hum Kinetics* 2003; 9: 107-12.
22. Stuelcken M, Pyne D, Sinclair P. Anthropometric characteristics of elite cricket fast bowlers. *J Sports Sci* 2007; 25: 1587-97.
23. Kutáč P, Dobešová P. Hodnocení tělesné stavby studentů 1. ročníku oboru tělesná výchova na PdF OU Ostrava. *Česká Antroplogie* 2001; 51: 116-8.
24. Riegerová J, Přidalová M, Vařeková R, et al. Hodnocení tělesné stavby studentů 1. ročníku FTK UP. In: Riegerová J., ed. Diagnostika pohybového systému. Metody vyšetření, primární prevence, prostředky pohybové terapie. Olomouc: Univerzita Palackého, 1995: 41–9.
25. Wielinski D. Somatotype and body composition of the candidates for Academy of Physical Education in Poland. In: Riegerová J., ed. Diagnostika pohybového systému. Metody vyšetření, primární prevence, prostředky pohybové terapie. Olomouc: Univerzita Palackého, 1997: 114-9.
26. Meloun M., Militky J. Kompendium statistického zpracování dat. Praha: Academia, 2002.
27. Bláha P. Antropometrie českých předškolních dětí ve věku od 3 do 7 let. Praha: Ústav sportovní medicíny, 1990.
28. Veldre G. Heath-Carter somatotype categories and their sexual maturation differences in 12–15–year old Estonian boys and girls. *Pap Anthropol* 2004; 13: 269–85.
29. Veldre G. Heath-Carter somatotypes in 12–15–year old Tartu children. *Yearbook Estonian Anthropometric Register* 2002; 251-65.
30. Chaouachi M, Chaouachi A, Chamari K et al. Effects of dominant somatotype on aerobic capacity trainability. *Br J Sports Med* 2005; 39: 954-9.
31. Legaz AA, Serrano OE, Lafuente BD. Endomorphic in athletes who make different training. *Exerc Soc J Sport Sci* 2001; 28: 362.

Received: February 25, 2008
Accepted: May 23, 2008
Published: June 03, 2008

Address for correspondence:
Petr Kutáč
Varenská 40a
Ostrava 1, 70200
Czech Republik
e-mail: petr.kutac@osu.cz

Vojtech Gajda: vojtech.gajda@osu.cz

Author's contribution
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection