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# THE COMPARISON OF ESTIMATED BODY FATNESS WITH TWO DIFFERENT FIELD METHODS IN YOUNG WRESTLERS

# PRIMERJAVA OCENJENE TELESNE MAŠČOBE Z DVEMA RAZLIČNIMA METODAMA PRI MLADIH ROKOBORCIH

## ABSTRACT

Practical body composition equations developed up to now are open to testing on different groups of athletes. The purpose of the study was to compare the estimation of body composition with two different equations, using skinfold and body neck and waist circumference in young wrestlers. One hundred and ten wrestlers (age:14.5 ± 1.2 years) voluntarily participated in the study and were divided into two categories based on body weight percentile scores (thin and heavy). Body composition analyses were determined by using two field methods, one of these was the skinfold method including the abdomen, subscapular, and triceps regions, and the other method was the indirect body composition determination using waist, and neck circumferences using the equations. The results showed that there were significant differences between the calculation results of equations for both the thin group and also heavy group. However, while the rate of error difference in the calculations of the two equations obtained from skinfold and body circumference measurements was low in the heavy group (Standard error of mean (SEM) Range; 2.6 %BF – Difference 16.5%), it was significantly higher in the thin group (SEM Range; 4.7 %BF - Difference 51.6%). The Skinfold equation was significantly underestimated for both groups when compared to the circumferential equation results. The findings showed that the field methods used in this study could be insufficient and, misleading to determine the body composition of young candidate wrestlers.

*Keywords:* Body composition, wrestlers, estimation equations, body circumferences, skinfold

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## IZVLEČEK

Namen študije je bil primerjati oceno telesne maščobe pri mladih rokoborcih z dvema različnima enačbama z uporabo kožne gube ter obsega vratu. V študiji je prostovoljno sodelovalo 110 rokoborcev (starost: 14.5 ± 1.2 leta), ki so bili glede na percentilne ocene telesne teže razdeljeni v dve kategoriji (vitki in težki). Analize telesne sestave so bile določene z uporabo dveh terenskih metod, od katerih je bila ena metoda kožnih gub, ki je vključevala področje trebuha, hrbta (subscapularis) in nadlahti, druga metoda pa je bila posredno določanje telesne sestave s pomočjo obsega pasu in vratu z uporabo enačb. Rezultati so pokazali, da so obstajale pomembne razlike med rezultati izračunov z enačbami tako za vitko kot tudi za težko skupino rokoborcev. Medtem ko je bila stopnja razlike napak pri izračunih obeh enačb, pridobljenih z meritvami kožnih gub in telesnih obsegov, pri težki skupini nizka (standardna napaka srednje vrednosti (SEM) razpon; 2.6 % BF - razlika 16.5 %), pa je bila pri vitki skupini bistveno večja (SEM razpon; 4.7 % BF - razlika 51.6 %). V primerjavi z rezultati enačbe obsegov je bila enačba kožnih gub pri obeh skupinah bistveno podcenjena. Ugotovitve so pokazale, da so lahko terenske metode, uporabljene v tej študiji, nezadostne in zavajajoče za določanje telesne sestave mladih kandidatov za rokoborce.

*Ključne besede:* Telesna sestava, rokoborci, enačbe za oceno, telesni obseg, kožna guba

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## INTRODUCTION

In participation of sports in children, the psychological and physiological characteristics of them, the nature of sports, and their structural features are carrying importance (Manna 2014; Telford *et al.* 2016; Witt, Dangi 2018). Body composition is also naturally effected in wrestling sport for children participating, it requires high muscular resistance, strength, and endurance, thanks to including one-to-one combat characteristics with the opponent (Agata, Monyeki 2018; Ara et al. 2006; Caleyachetty et al. 2012; Hussey *et al.* 2007; Orntoft et al. 2018). Body composition has a significant effect on sports performance according to the type of sport, and it has been found that different levels of effects on performance (Demirkan et al. 2013). Body composition is an important determinant of performance in weight class sports such as wrestling that require both leanness and high levels of fat-free mass (FFM) for increased power and strength relative to body mass (Caleyachetty et al. 2012; Houtkooper 1996; Malina, Geithner 2011; Roemmich, Sinning 1997).

To our knowledge, there are many scientific studies, and prediction equations on body composition measurements that include practical methods for coaches and researchers, expressing the importance to find the appropriate formulas that can make accurate predictions indirectly. It was mentioned in the related literature that body composition can vary according to sports, gender, age, and also racial, and regional factors (Reilly et al. 1995; Slaughter et al. 1988; Wagner, Heyward 2000; Wang et al. 2000). This study consisted of two aims; a) to compare the results taken by two practical body composition (BC) field methods based on the structure of the young candidate wrestlers as the thin and the heavy weight, b) to present in which group the two different BC results closely correlated with each other. It was hypothesized that the results of body composition could change based on body structures.

## METHODS

### Participants

The participants attending this study in the sport familiarity camp performed by the Turkish Wrestling Federation in Antalya, Turkey were recruited from 8 cities in the southeastern portion of the country. The current sample of cadet wrestlers had 3.2 ± 2.6 years (Mean ±SD) of wrestling experience (range: 1–5 years). Informed consent was received from the parents because the participants were under the age of 18 years old. Written approval also was taken

from the Turkish Wrestling Federation for the study. The present study was approved by the Hitit University non-interventional Ethics Committee. In this study, the participants were separated into the BMI (kg / m2) percentile values index developed by Neyzi *et al.* [2015]. Subjects were divided into two groups with an average age of (14.5 ± 1.2), those below 50 percentiles (BMI <21) as the "thin group" and those above (BMI> 21) as the "heavy group", and comparisons were made accordingly.

## Body composition analysis

*Skinfold (SKF) testing*

Eight variables including Body mass (kg), height, body mass index (BMI), abdomen, subscapular and triceps skinfolds, waist, and neck circumferences were taken from each wrestler. The body height and mass of the participants were measured to the nearest 0.5 cm and 0.1 kg (Seca 220 Germany). Skin-fold thickness (mm) was taken from the wrestlers at three identified anatomical landmark sites (triceps, subscapular, and abdomen) using a Holtain caliper. Total body density (Db) was determined from the three SKF measures using the prediction equation Db = [1.0982 - (sum SKF) 0.000815] + [(sum SKF) 0.00000084] validated by Lohman (1981). Percent body fat was then estimated from body density using the equation by Johnson et al. (1988).

-     Percent Fat = (5.30/Density-4.89) ×100

*Circumference of neck and waist measurements (CNW)*

Due to its practicality and usefulness, the Naval Health research center equation was used to determine the body composition (Fat %) of young wrestlers using the anthropometric circumference of neck and waist measurements. The equation was developed at the Naval Health Research Center (NHRC), San Diego, California and it was used in a study conducted by Shaheen et al. (2019).

-     Circumference of neck and waist body fat equation: %BF = 495 / (1.0324 - 0.19077 * log10 (waist - neck) + 0.15456 * log10 (height)) – 450

## Statistical Analysis

Descriptive parametric basic statistics such as mean standard deviation, percentage frequencies, and ranges are used in this study. The Shapiro-Wilk test was used to test the normality of the data distribution. After normality assumptions were checked, one simple t-test was used to

determine the differences between the two body fat equations. Pearson correlation analysis was performed to determine the relationships among the variables. All data are presented as mean ± SD.  In this study, significance was determined as p≤ 0.05.


## RESULTS

Physical characteristics of young, recruited wrestlers, according to the all group, heavy group, and thin group are shown in Table 1.

The changes in fat percentages of the subjects obtained with two different equations were found to be significantly different for all three groups (for all: 3.8 %, heavy: 2.6 %, thin: 4.7%) ($p<$ 0.01). The difference in fat percentage results obtained from these two equations and methods showed an error rate of 32.8 % for the whole subjects, 16.5 % for the heavy group, and, 51.6 % for the thin group (Table 2).

The correlation analysis was performed on the variables including Body Mass, BMI, Fat % SKF, Fat % CNW., ∑Skinfold, Neck, and Waist Circumferences separately for each group. It was seen to have a generally higher level of correlation between the variables in the heavy group than in the thin group (p<0.01) (Table 3).

Table 1. Physical characteristics of young recruited wrestlers, according to the all group, heavy group, and thin group.

| Parameters\Groups | All Subjects (N=110) | Heavy Subjects (N=42) | Thin Subjects (N=68) |
|---|---|---|---|
| Age (year) | 14.5 ± 1.2 | 14.8 ± 0.9 | 14.3 ± 1.3 |
| Height (cm) | 1.63 ± 0.1 | 1.66 ± 0.1 | 1.59 ± 0.1 |
| Body Mass (kg) | 57.2 ± 15.5 | 70.5 ± 15 | 48.9 ± 8.6 |
| BMI (kg/m$^2$) | 21.3 ± 3.9 | 25.1 ± 3.6 | 18.9 ± 1.5 |
| ∑Skinfold (mm) | 37.5 ± 18.6 | 53.3 ± 21.3 | 27.6 ± 5.1 |
| Triceps (mm) | 12.1 ± 5.4 | 16.6 ± 5.9 | 9.4 ± 2.4 |
| Abdomen (mm) | 16.4 ± 10.3 | 24.8 ± 12.4 | 11.2 ± 3.0 |
| Subscapular (mm) | 8.9 ± 3.7 | 11.9 ± 4.3 | 7.0 ± 1.2 |
| Neck Circum. (mm) | 34.4 ± 3.1 | 36.8 ± 3.0 | 33.1 ± 2.3 |
| Waist Circum (mm) | 72.9 ± 9.5 | 81.1 ± 10.0 | 67.9 ± 4.3 |

Table 2. The comparison of body fat percentage based on two field body composition estimation equations.

| Parameters\Groups | All Subjects (N=110) | Heavy Subjects (N=42) | Thin Subjects (N=68) | p |
|---|---|---|---|---|
| Percent Fat SKF Eq. (%) | 7.8 ± 6.3* | 13.2 ± 7.0† | 4.4 ± 1.9▲ | |
| Percent Fat CNW (%) | 11.6 ± 5.3* | 15.8 ± 6.3† | 9.1 ± 2.1▲ | 0.00 |
| Differences, (% Fat, Estimations mistakes) | 3.8  (32.8) | 2.6 (16.5) | 4.7 (51.6) | |

p<0.05[*†▲] Significant differences, between two different estimation equations for three groups (one simple t-test).

Table 3. Summary of the association between body mass, BMI, SKF body fat estimates %, circumference body fat estimates %, ∑Skinfold, neck, and waist circumference for thin (n=68) heavy wrestlers (n=42), and all wrestlers (AW, n=110).

| Variables | Thin Heavy | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1.Body Mass | Thin | 1 | | | | | | |
| | Heavy | 1 | | | | | | |
| | AW | 1 | | | | | | |
| 2.BMI | Thin | 0.77** | 1 | | | | | |
| | Heavy | 0.84** | 1 | | | | | |
| | AW | 0.90** | 1 | | | | | |
| 3.Fat % SKF | Thin | 0.18 | 0.27 | 1 | | | | |
| | Heavy | 0.60** | 0.82** | 1 | | | | |
| | AW | 0.70** | 0.83** | 1 | | | | |
| 4.Fat % CNW | Thin | 0.11 | 0.28 | 0.38* | 1 | | | |
| | Heavy | 0.53** | 0.80** | 0.86** | 1 | | | |
| | AW | 0.59** | 0.77** | 0.80** | 1 | | | |
| 5.∑Skinfold | Thin | 0.26 | 0.33 | 0.63** | 0.17 | 1 | | |
| | Heavy | 0.59** | 0.80** | 0.96** | 0.89** | 1 | | |
| | AW | 0.70** | 0.83** | 0.99** | 0.79** | 1 | | |
| 6.Neck Circum. | Thin | 0.87** | 0.74** | 0.05 | 0.01 | 0.19 | 1 | |
| | Heavy | 0.81** | 0.62** | 0.33 | 0.19 | 0.26 | 1 | |
| | AW | 0.89** | 0.78** | 0.50** | 0.37 | 0.50** | 1 | |
| 7.Waist Circum. | Thin | 0.73** | 0.74** | 0.17 | 0.42** | 0.26 | 0.82** | 1 |
| | Heavy | 0.87** | 0.91** | 0.81** | 0.85** | 0.81** | 0.65** | 1 |
| | AW | 0.91** | 0.92** | 0.79** | 0.85** | 0.79** | 0.78** | 1 |

## DISCUSSION

Accurate and accessible methods of body composition are necessary to manage healthy body weight throughout the careers of wrestlers during the training and competition periods. The most valid and reliable body composition analysis methods are known as gold standard methods such as Dual X-ray Absorptiometry and Hydrostatic weighing, etc. which are expensive and

relatively inaccessible to athletes. Besides, the use of these assessments requires technical skills and takes more time to evaluate the body composition; therefore, more practical methods are needed. The main findings of the present study determined the significant differences in body fat percentage between the two types of practical estimation methods. Our findings identified the mean differences (% Fat, Estimations mistakes (EM)) in the equation of circumference of neck and waist (CNW) measurements were higher significantly in all groups compared to the SKF equation (Table 2). However, when the findings were evaluated based on the categories depending on body structure, it was found that; the mean fat (%) differences and, estimation mistake percentage (Fat % dif.: 4.7 %, EM: 51.6 %) were evidently higher in the thin group of wrestlers, in comparison to the heavy group of wrestlers (Dif.: 2.6 % - EM: 16.5 %) (Table 2). These findings are supported by the correlation analysis which showed that the correlation between the equations (SKF – CNW fat %) was significantly higher (r=0.86**) in heavy wrestlers, but there was a weak correlation (r=0.38*) in thin wrestlers. In the literature studies related to comparing the body composition equations, Cutrufello et al. (2021) reported that when compared with skinfold, the standard error estimation (SEE) in a wrestler's minimum wrestling weight (MWW) would be within 6.4, 6.8, and 4.8 kg when using air displacement plethysmography (ADP), dual-energy x-ray absorptiometry (DXA), and ultrasound (US) respectively. They identified statistical differences in % body fat and MWW except within the NCAA-approved (SF and ADP) and non-approved (DXA and US) methods. Previously, Brown et al. (2006) found that SEE for %BF ranged from 3.1 to 3.5% when comparing a 3-site SF, ADP, and HW. Housh et al. (1989) compared the equations that the skinfold equation of Lohman and the equations of Tcheng and Tipton by the underwater weighing method. The results of the study (Housh et al. 1989) indicated that the skinfold equation was a more accurate estimation of body density than the equations of Tcheng and Tipton (total error values: 5.54 to 6.06 kg respectively). Montgomery et al. (2017) stated that wide margins of error of each method for the body composition analysis. Therefore, caution would be taken when determining adolescent wrestlers with lower amounts of body fat, as it could lead to result in failing to identify those who did not meet the minimum body fat percentage for competition. In addition, the literature studies conducted by Brown et al. (2006); Clark et al. (2004); Clark et al. (2007) reported that significant correlation values between SF and the other methods included DXA, Air Displacement Plethysmography, Underwater Weighing, Bioelectrical Impedance were observed for %BF and MWW.

Currently, the permitted lowest body fat percentage is accepted 7 % for boys and 12 % for girls by the NFHS [2016]. Accordingly, reliable and valid methods of body composition are needed to implement these important assessments. The tools such as Dual-energy x-ray absorptiometry (DXA) and air displacement plethysmography (ADP) have been known to be reliable and valid methods for determining body composition in adults (Andreoli et al. 2009; Fields *et al.* 2002) and adolescents (Fields et al. 2002), but these instruments are impractical because they can be expensive, not portable, and difficult for assessing large numbers of wrestlers; hence, they are relatively inaccessible to athletes. Despite the disadvantage of requiring  the skill of highly-trained assessors, the skinfold method is a considered valid method for estimating body fat in athletes (Ceniccola et al. 2019; Montgomery et al. 2017).  As based on literature studies and our findings may be suggested that it is necessary to be much more careful in determining the body composition of wrestling using field methods. To avoid erroneous estimates, equation selection and preferences should be made, if possible, after making measurements and comparisons with the methods that can be considered gold standards. Then the most suitable estimation equation could be chosen according to the characteristics of the special wrestling group.

## CONCLUSION

This study showed that the field methods used could be insufficient and misleading to measure wrestlers' body composition accurately in young candidate wrestlers. However, it may be considered that both field methods may be used interchangeably for the body composition analysis in heavy wrestlers relatively, because of the close estimations and higher correlation compared to the thin wrestlers, but may not be used interchangeably in thin wrestlers.

### Limitation

This study only included data from young athletes who are candidates for the sport of wrestling. The study covers the comparison of two field body composition methods that estimated body composition. However, our most important limitation is not using the direct body composition analysis method as the reference gold standard.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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