A Comparison of Hydrostatic Weighing and the Tanita Body Fat Analyzer for Estimating Percent Body Fat in NCAA Division III Collegiate Wrestlers

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Abstract

Abstract. Bruflat L, Hetman S, Lozano J. A Comparison of Hydrostatic Weighing and the Tanita Body Fat Analyzer for Estimating Percent Body Fat in NCAA Division III Collegiate Wrestlers. *J. Undergrad. Kin. Res. 2005:1(1):60-66.* The purpose of this study was to compare percent body fat (%BF) estimated by leg-to-leg bioelectrical impedance analysis (LBIA) with hydrostatic weighing (HW) in a group (n = 9) of NCAA Division III collegiate wrestlers (mean ± SD, age: 20.5 ± 2.5 yrs; height: 177.3 ± 5.4 cm; weight: 82.1 ± 16.8 kg). Hydrostatic weighing is presently an NCAA approved method for estimating %BF, while LBIA is not currently an NCAA approved method. Each subject had both assessments performed on the same day. LBIA measurements (Athletic mode) were determined using a Tanita body fat analyzer (model TBF-300A). Hydrostatic weighing, corrected for residual lung volume, was used as the criterion measurement. No significant differences (p > 0.5) were found between %BF (mean ± SD) estimated by LBIA (11.9 ± 6.3) and HW (12.3 ± 6.8), t (8) = 0.574, p = 0.582. There was a significant correlation (r = 0.95; p < 0.01) in %BF between LBIA and HW. These data contradict previous findings from Dixon et al. (2005), which reported that LBIA using the Tanita body fat analyzer significantly underestimated %BF. More research is needed to determine if LBIA via the Tanita body fat analyzer is a valid instrument for the assessment of %BF in Division III collegiate wrestlers or other athletic populations.

Key Word: Bio-electrical impedance, Body composition, Obesity

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Introduction

Obesity is an epidemic in our society that must be handled with utmost scrutiny in an attempt to fix the problem. Since 1980 the number of obese youth has more than tripled and 30% of the current US adult population is said to be obese (1). Obesity has been found to have a direct correlation with cardiovascular disease and many other illnesses such as hypertension, type 2 diabetes, stroke, gallbladder disease, osteoarthritis, and sleep apnea to name a few (1). Obesity has been defined as the condition of having an excess of nonessential body fat; having a BMI of 30 or greater or having a percent body fat greater than 24% for men and 31% for women (2). Body composition by definition is the proportion of fat and fat-free mass (muscle, bone, and water) in the body (2). Body composition is an extremely important factor to consider when looking at a variety of health related issues. These issues could include everything from overall health fitness to sport performance. There are many methods out there used for estimating body fat percentage, however some have proven to be more accurate than others.(3,4,5,6,7) For example, three site skinfold measurements are cost effective and time efficient, yet only give us an estimate of +/- 4%.(2) Hydrodensitometry is shown to be more accurate, yet it takes much more time and is more expensive (4). It is also important that we find a way in which testing can be done in a standardized fashion.

Out of the several ways to test body fat, the two ways of testing that we are concerned with are hydrostatic weighing, which has been said to be the "gold standard" (5), and bioelectrical impedance; more specifically the Tanita body fat analyzer. While there have been numerous studies conducted concerning hydrostatic weighing, there has been little done concerning the relationship between the new Tanita body fat analyzer and hydrostatic weighing. We are interested to see if the Tanita holds true to the results we obtain when using hydrostatic weighing. Our question remains, is there a difference in the outcomes of the two ways of testing body fat, or are the two machines relatively comparable in the results they produce?

Several Studies have shown that when comparing skin fold, bioelectrical impedance, hydrostatic weighing and air displacement test, the results produced are very similar and the difference remains minimal.(8,3,5,7,) Gaining this knowledge could be very beneficial to a university such as our own. Body fat % testing is used by students, and especially athletes. Collegiate wrestlers are required by the Wrestling Weight Certification Program to test their % body fat each season and are required to keep their % body fat above 5% (9).If we can prove a relationship between these two methods, it could save a lot of time and work in the future. With this in mind, the purpose of this study is to find out whether there is a definite relationship between hydrostatic weighing and the Tanita body fat analyzer. It is hypothesized that there will not be a significant difference in the measurements between the Tanita body fat analyzer and hydrostatic weighing.

Methods

Subjects

We decided to use collegiate wrestlers because knowledge of their body composition could be used as a tool for training and performance in their sport. They are also required by the Wrestling Weight Certification Program (WWCP) to keep a % body fat above 5% by collegiate rule (9). We tested 9 collegiate, male wrestlers, ranging from 18-26 years of age. The subjects were all trained and in-season athletes. The mean ± standard deviation (SD) age, height, and weight of the subjects were 20.5 ± 2.50 yrs, 69.8 ± 2.11 in, and 180.9 ± 37.1 lbs. respectively. The subjects all gave their written informed consent to the experimental protocol and the study was approved by the University Human Subjects IRB.

Tests and Procedures

We compared two methods of body fat analysis: hydrostatic weighing; and the Tanita bioelectrical impedance body fat analyzer. As stated previously, the hydrostatic weighing is viewed as the "Gold Standard" in body composition assessment.
The Tanita is a more recent method of testing which uses bioelectrical impedance as its method of analysis. The Tanita is very time efficient and easy to use. We first tested the

subjects using the Tanita. Subjects were informed to be wearing as little clothing as possible, to have previously urinated, to be dry and also refrained from exercising and eating during the previous 6 hours. An accurate height is then collected and recorded for the subject. The Tanita is then calibrated and the settings are adjusted by the tester. The height is entered into the monitor as is the body type. The mode we used in our study was the athlete mode. The subject then must stand barefoot on the Tanita being sure not to touch anything else and wait for the reading. The subjects weight is displayed first and after a few more seconds the % body fat is calculated and shown on the screen.

% Body Fat via Hydrostatic Weighing
Subjects were first informed to be wearing a speedo or bathing suit, they must first shower and wash off any products from their bodies. Subjects were also required to urinate and were told to try not to eat or exercise in the previous 6 hours. Next a dry weight is recorded. The tank is then calibrated by the technician, the chair is tared, and the temperature of the water was recorded. The water temperature for all tests ranged between 30-36ºC. The variance between the water temperature on separate days played no significant difference because it was accounted for in the mathematical formulas. Following the calibration, the subject was instructed to enter the water, once seated on the chair they must perform a series of trials. These trials consisted of the subject submerging themselves completely under the water while exhaling as much oxygen from their lungs as possible. The density is recorded and about 5-6 more trials were performed. A "best of" or average was then taken from these trials and used in formulas (body density formula) to determine body fat percentage (Siri Formula). The last piece of information needed to complete the formulas to figure out the % body fat for the hydrostatic weighing is the residual lung volume. All methods of testing were performed by testers with experience in administration and evaluation, and we had access to all three in the University of Wisconsin Eau Claire Kinesiology Lab.

Determination of Residual Lung Volume
We tested residual lung volume by way of nitrogen washout technique. We used a residual lung volume analyzer by Extratech Corporation which indirectly measures the remaining air in the subjects lungs. The subject was hooked up to the machine via mouthpiece and instructed to expel as much air out of his lungs as possible. When all the air that the subject could expel was out, a bag containing 5L of oxygen was then made available to the subject to casually breathe until the machine made no more readings. This then is where we come up with our residual lung volume.

Statistical Analysis
To compare the mean differences between the two machines we used a paired t-Test, and the variability of the data collected was used to determine the validity of the devices. We used Pearson's r correlation to test the relationship between the methods and SPSS 13.0 software for all statistical analyses. We determined our sample size due to the amount of volunteers that we were able to attain from those willing to come in for the testing. We tried to aquaint their schedules as much as we could with the available lab time. After the data was collected, we compared the results from each body fat analyzing device to one another. The independent variables were the devices used to measure the body fat

percentage of the subjects, the Tanita and hydrostatic weighing. The dependent variables were the body fat % of the subjects.

Table 1. Descriptive statistics of the subjects (mean ± SD).

	N	Minimum	Maximum	Mean	SD
Age	9	18.0	26.0	20.6	2.5
Height	9	66.0	72.0	69.9	2.1
Weight	9	138.4	244.6	180.9	37.1

Results

No significant differences ($p > 0.5$) were found between %BF (mean ± SD) estimated by LBIA (11.9 ± 6.3) and HW (12.3 ± 6.8), $t\ (8) = 0.574$, $p = 0.582$. There was a significant correlation ($r = 0.95$; $p < 0.01$) in %BF between LBIA and HW. The characteristics of the men tested are reported in Table 1 and the % body fat between the Tanita and Hydrostatic weighing are reported in Figure 1.

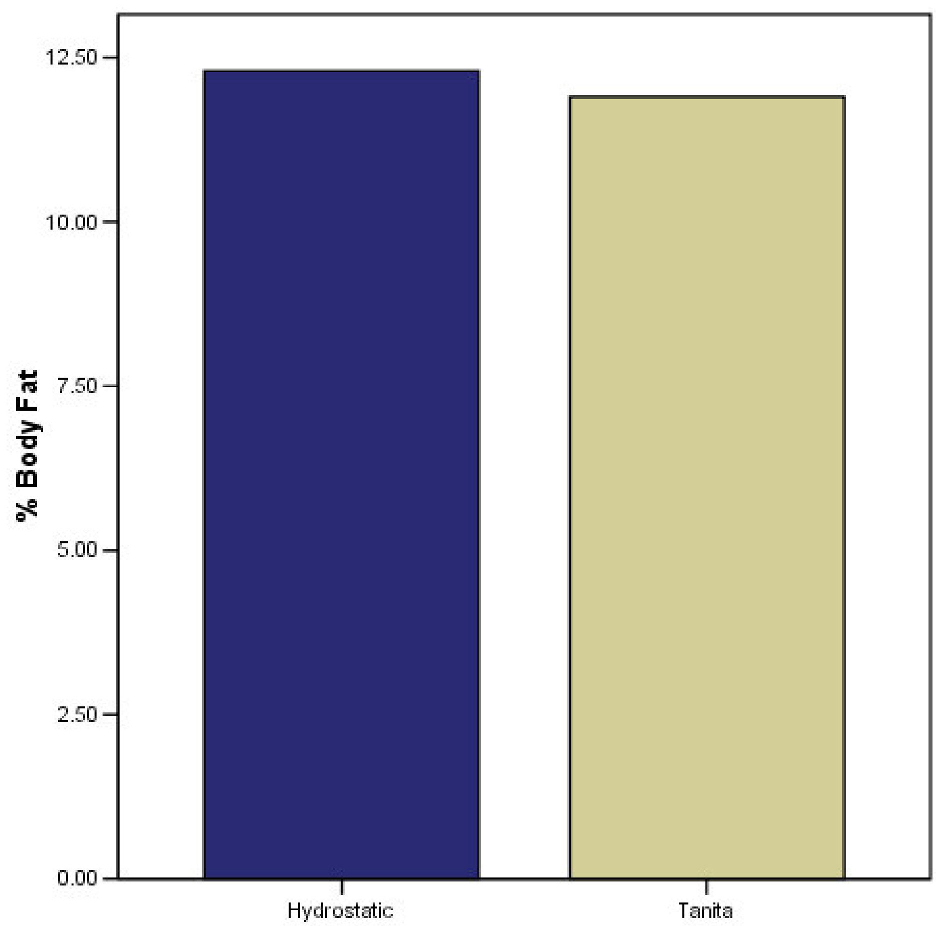

Figure 1. Mean % Body Fat: Tanita vs. Hydrostatic Weighing.

Discussion

The main objective of our study was to test the BMI of Collegiate Wrestlers using two different methods to see if there is a strong correlation in the results obtained from both methods. We were happy with the numbers we got from the small number of volunteers we tested. We found our results to be in agreement with many previous studies in that the Tanita Body Fat Analyzer is capable of producing accurate results in accordance with the more generally accepted form of testing, hydrostatic weighing(3,5,7,8). All of these previous studies had found the Tanita body fat analyzer to be an accurate means of testing % body fat. The one thing that all studies have in common is that the Tanita is not as precise in it's measurements, but accurate. Studies that indicate that the Tanita is not as precise as they would like were in the medical and professional fields (4,6,9). In assuming that hydrostatic weighing is the "gold standard" in measuring BMI, we chose not to compare any other form of testing to the Tanita, holding true the assumption that the underwater weighing would be the accepted value. Some results from a previous study showed that if used for medical purposes, the Tanita may not be as capable or precise of a form of % body fat measurement (4). One reason doctors may not use the Tanita is because they may want very precise measurements when administering certain drugs, where as the Tanita has shown in the present study that it is accurate, but not as precise. What we can take from our study is that the Tanita is a fine piece of equipment to use and if time, space, or money is limited it can give the user a fairly accurate reading of what there body fat percentage is. In the time it takes to rinse off and step on the scale for a reading, the subjects of our study using the Tanita were done by the time others were even ready to enter the tank.

Assumptions and Limitations

One limitation of the study was we hoped to have more research subjects. We were happy that the subjects we were able to gather information from were of varying weights, heights, and ages. This gave us a good idea of the Tanita's ability to measure many different body types as accurately as the underwater tank. We came into the study with the assumption that the hydrostatic tank is a constant when done correctly, therefore the results from the Tanita could be compared to the hydrostatic tank results in order to assess the correlation between the two methods of measuring % body fat.

Conclusion

The purpose of our study was to find out if people really need to go through the long process of the hydrostatic tank to find out their % body fat, or if the little scale in the corner can generate a relatively accurate finding. With no significant differences between the Tanita body fat analyzer and hydrostatic weighing, the results of the present study support the conclusions of many previous studies (5,6,9) We conclude that the Tanita is an accurate form of judging % body fat and could be used for people who want an idea of what there % body fat is without having to jump through all of the loops. Using information from other research done on other forms of BMI testing, we hypothesized that the Tanita could give results close to the underwater tank. Our results were consistent with that of others who concluded that it could be done. This could help the collegiate ranks of athletes whom are required to test % body fat. Instead of having to take a day out of practice to rush the team into the lab to get tested, a coach could literally test a whole team in a matter of minutes and get accurate results. There is also a limited amount of space for testing error due to the machine doing all of the work. The person doing the testing does not need to account for all of the important procedures involved with testing subjects in the hydrostatic tank. The Tanita could be a valuable tool in the Collegiate ranks, but we would like to see more tests run on woman, athletes vs. non-athletes, and the elderly to observe the results attained when done on varying body types. Also, we are interested to see if someone with metal pins or any type of medical support system in their body would counter act the electrical pulse that runs through the body during measurement.

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