AN EVALUATION OF THE PROFICIENCY OF NOVICE SKINFOLD TESTERS ASSESSING BODY COMPOSITION AMONG INTERCOLLEGIATE AND HIGH SCHOOL WRESTLERS

By

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CHAPTER I

INTRODUCTION

The human body is composed of many different component tissues including bone, muscle, and fat. The relative amounts of these tissues determines body composition and is of great importance to our overall physical well-being.

There are several methods for determining body composition. There are new exciting techniques on the horizon which may, in time, prove to be more accurate than normal laboratory procedures, but they are presently very expensive, and not enough data have been generated for accurate conclusion. Techniques for determining body composition include computerized axial tomography (CAT) scans, magnetic resonance imaging (MRI), and dual photon absorptiometry (Gatorade Sports Science Exchange Roundtable, 1990). Height and weight tables are one of the most common methods, but these tables have a major limitation because they do not distinguish among bone, muscle, and fat (Golding, Clayton, & Sinning, 1989). Therefore, the need for more accurate assessment methods for determining body composition has become apparent (Jackson & Pollock, 1985). Hydrostatic weighing is often considered the "gold standard" or criterion against which other field methods are compared (Gatorade Sports Science Exchange Roundtable, 1990).

A simple and frequently used field technique for determining body composition is skinfold measurements (Opplinger, Looney, & Tipton, 1987).

Hydrostatic weighing is a popular and valid method, but often not feasible for the clinical setting or for mass testing (Jackson & Pollock, 1985). With the hydrostatic weighing procedure, body volume is computed as the difference between body weight measured in air and weight measured during water submersion (McArdle, Katch, & Katch, 1981). The density of the whole body is simply the ratio of the total weight of the body to the total body volume, the latter being estimated by the weight of the volume of water displaced when the body is completely submerged in water (Wilmore, 1969). Body fat percentage is then computed from body density using the formula provided by Siri (1956). The densities of bone and muscle tissues are higher than water, while fat is less dense than water. Thus, a person with more bone and muscle mass will weigh more in water and thus have a higher body density and lower percentage of body fat (Nieman, 1990). Prior to hydrostatic weighing, total body volume must be corrected for the volume of air remaining in the lungs at the time of the measurement (usually residual volume), and the volume of gas in the gastro-intestinal tract (Wilmore, 1969). Gastro-intestinal gas is generally considered a constant value of 100ml (Francis, 1990). Residual volume can be measured directly using the helium dilution method (Comroe, Forster, Dubois, et al, 1962).

The rationale for skinfold measurements is based on the fact that approximately one-half of the total body fat content is located in the fat deposits directly beneath the skin and measurement of this subcutaneous fat is closely related to total body fat (McArdle, Katch, & Katch, 1981). This approach is based upon two assumptions: (1) the thickness of the subcutaneous adipose tissue reflects a constant proportion of the total body fat, and (2) the sites selected for measurement represent the average thickness of the subcutaneous adipose (Lukaski, 1987).

Statement of the Problem

This study will determine if a single training session can enable novice testers to determine a skinfold body composition measure, expressed as a percentage of fat, that is essentially similar ($p < .05$) to the same measure determined by trained personnel using hydrostatic weighing.

Significance of the Study

A major goal of intercollegiate and high school wrestlers is to maintain a target weight and minimize the relative amount of body fat. Consequently, wrestlers keep their weights chronically low or lose weight during the competitive season and then re-gain it in the off season. Other wrestlers lose and gain weight constantly. Weight restriction and fluctuation are produced by dramatic changes in diet and activity which alter metabolism, endocrine function, and body composition in addition to other psychological parameters (Brownell, Steen, & Wilmore, 1987). Therefore, wrestlers attempt to strike a balance between optimal health and competitive readiness.

Typically, maintenance of a target weight results from weight-cutting which involves fluid restriction, liquid deprivation, and/or sweating; procedures which yield losses of 3%-20% of body weight. Correspondingly, reductions in strength, cardiovascular, thermoregulatory, and renal function have been noted as a result of weight-cutting (Thorland, Johnson, Cisar, & Housh, 1987). According to Katch (Gatorade Sports Science Exchange Roundtable, 1990), wrestlers who engage in such weight-cutting practices should be monitored and should have their body composition assessed regularly. Therefore accurate measurements of body composition are needed to make reliable determinations of a wrestler's minimal weight.

One of the problems associated with the assessment of the body composition of wrestlers is the availability of an inexpensive yet accurate method for coaches, physicians, and sports trainers to use (Williford, Smith, Mansfield, Conerly, & Bishop, 1985). Skinfold and circumference measurements provide the convenience of an estimate of body fat in the absence of the substantial equipment, resources, and skilled personnel required for hydrostatic weighing or the recently developed sophisticated methods including, electrical conductivity and gamma ray spectrometric procedures (Hyner, Marconyak, Black, & Melby, 1986).

Many collegiate and high school wrestling coaches do not regularly assess the athletes' body composition. This could be due to a lack of training or simply the lack of facilities and\or equipment necessary for the accurate assessment of body composition. It would seem that an inexpensive and accurate method that could be learned with minimal training in methodology could be highly useful in the high school and college wrestling environment. Finally, there are very few studies in the literature which compare body composition measures as determined by novice skinfold testers with hydrostatic weighing measures as determined by trained technicians.

Hypothesis

There will be no significant relationship ($p < .05$) between the percent of body fat estimated by hydrostatic weighing, using trained personnel, and the percent of body fat estimated from skinfold measurements performed by novice testers after one training session.

Extent of the Study

Limitations

1. There was no attempt to randomly select participants.

2. Gastro-intestinal gas volume was considered to be a constant value of 100ml (Francis, 1990).

Delimitations

1. The fifteen subjects were members of the Oklahoma State University wrestling team or a high school wrestling team.
2. The subjects served as the novice testers.

Assumptions

1. It was assumed that the thickness of subcutaneous adipose tissue reflects a constant proportion of the total body fat (Lukaski, 1987).
2. It was assumed that the sites selected for skinfold measurements represent the average thickness of the subcutaneous adipose (Lukaski, 1987).
3. It was assumed that the subjects would follow directions pertaining to fasting and performing a full, maximal expiration, prior to and during hydrostatic weighing.

Definitions

Conceptual

Body Composition: The proportions of fat, muscle and bone making up the body. Usually expressed as percent of body fat and percent of lean body mass (Nieman, 1990).

Body density: The specific gravity of the body, which can be tested by underwater weighing. Compares the weight of the body to the weight of the same volume of water. Result can be used to estimate the percentage of body fat (Nieman, 1990).

Residual Volume: The volume of air remaining in the lungs following the greatest possible maximal expiration (Wilmore, 1969).

Skinfold: The thickness of the double layer of skin and subcutaneous fat (McArdle, Katch, & Katch, 1981).

Skinfold measurements: The use of calipers to measure the thickness of a double fold of skin and fat at various sites (Nieman, 1990).

Skinfold sites used in this study: General rules for obtaining and measuring skinfolds are found in Appendix A (Nieman, 1990). However, for this study, sites were not marked as described in rule 1. Description of skinfold sites used in this study follow.

> Abdomen: "A horizontal fold is picked up slightly more than one inch (3 cm) to the side of and one-half inch below the naval" (Nieman, 1990, p. 118).
>
> Chest: "The chest skinfold is measured using a skinfold with its long axis directed to the nipple. The skinfold is picked up just next to the anterior axillary fold (front of armpit line). The measurement is taken one-quarter to one-half inch from the fingers. The site is approximately one inch from the anterior axillary line towards the nipple" (Nieman, 1990,p.118).
>
> Ilium: "A diagonal fold above the crest of the

ilium. The person being measured should stand erect with feet together. The arms should hang by the sides, but can be moved slightly to improve access to the site. A diagonal fold should be grasped just to the rear of the midaxillary line, following the natural cleavage line of the skin" (Nieman, 1990, p. 120).

Midaxillary: "A horizontal fold on the midaxillary line at the level of the xiphi-sternal junction (bottom of the sternum where the xiphoid process begins). The arm of the person being measured can be moved slightly backward during measurement to allow easy access to the site" (Nieman, 1990, p. 120).

Subscapular: "The site is just below the lowest angle of the scapula. A fold is taken on a diagonal line directed at a 45-degree angle towards the right side. To locate the site, the measurer should feel for the bottom of the scapula" (Nieman, 1990, p. 120).

Thigh: "A vertical fold on the front of the thigh, midway between the hip (inguinal crease) and the nearest border of the patella or knee cap. The body weight should be shifted to the left foot during measurement" (Nieman, 1990, p. 118).

Triceps: "A vertical fold on the rear midline of the upper arm, halfway between the lateral projection of the acromion process of the scapula (bump on the backside of the shoulder) and the inferior part of the olecranon process (the elbow). The skinfold is measured with the arm hanging loosely at the side. The measurer stands behind the person being measured and picks up the skinfold site on the back of the arm, with the thumb and index finger directed down towards the feet. The triceps skinfold is picked up with the left thumb and index finger, approximately one-half inch above the site where the tips of the caliper will be applied" (Nieman, 1990, p. 119).

Subcutaneous fat: The fat depots directly beneath the skin (McArdle, Katch, & Katch, 1981).

Underwater (hydrostatic) weighing: The most widely used laboratory procedure for measuring body density. In this procedure, whole body density is calculated from body volume according to Archimedes' principle of displacement which states that an object submerged in water is buoyed up by the weight of the water displaced (Nieman, 1990).

Functional

Novice tester: A person with no experience measuring skinfolds.

Experienced tester: A person that works in a sports medicine setting, routinely tests a variety of subjects, both athletes and the lay public, and during the past year has tested more than one hundred subjects.

CHAPTER II

REVIEW OF LITERATURE

Numerous studies have been conducted comparing the relationship between body composition as determined through the use of skinfold measurements and body composition as determined by hydrostatic weighing. The results from many of these studies are consistent when assessing the error associated with different techniques for determining body fat percentage, specifically, hydrostatic weighing and skinfold measurements. According to Nieman (1990), the standard error of estimate for percent body fat when using the hydrostatic weighing technique is 2.7 percent. The use of skinfold measurements will add about one percent to this measurement error. The skinfold measurements were based on the seven-site skinfold equation. Also, Jackson, Schmidt, and Pollack (1980), found that hydrostatic weighing had a standard error of approximately 2.7 percent. They found that the sum of the three-site, (different combinations of three-sites), and the sum of the seven-site skinfold equations yielded approximately the same standard error of measurement, which was 3.5 percent to 3.9 percent. Studies have shown the accuracy of hydrostatic weighing to be as low as within one percent, (Lukaski, 1987), and as high as 4 percent (Wilmore, Buskirk, DiGirolamo, and Lohman, 1986).

Body fat percentage determined from skinfold measurements are generally considered to be within 3 to 6 percent of actual body fat percentage, whether using a combination of three sites or the seven-site equation.

In a recent study conducted by Opplinger, Clark, and Kuta (1992), skinfold measurements of wrestlers made by clinic-trainee testers were compared to measurements made by experienced testers. The purpose of the study was to determine the efficacy of the Wisconsin Interscholastic Athletic Association clinics used to train skinfold testers. Experienced testers served as the criterion against which the clinic-trainee testers were compared. The sites measured included the triceps, subscapula, and abdominal locations as defined in the Anthropometric Standardization Reference Manual (Lohman, Roche, & Martorell, 1988). The results suggested that testers can receive adequate training through clinics to provide accurate skinfold measurements, and these testers minimally influence the validity of skinfold prediction equations. The data demonstrated high reliability for skinfold measurements made by trained testers using laboratory-quality calipers.

There appear to be no studies in the literature which compare body composition assessment among intercollegiate or high school wrestlers using novice practitioners and body composition assessment using hydrostatic weighing. Hyner, Marconyak, Black, and Melby (1986) conducted a similar study in which novice practitioners assessed body composition after a short training session using skinfold and circumference measurements. Data on thirty non-obese individuals who served as both the novice practitioners and subjects were compared to measurements taken by an experienced technician. Results suggested that with minimal training, novice practitioners estimate body fat percentage reliably and with acceptable accuracy when compared to an experienced skinfold technician.

CHAPTER III

METHODOLOGY

Procedures

Selection of Subjects

The subjects were fifteen volunteers, between the ages of fourteen and twenty-two, one from a university wrestling team and the remainder from various high school wrestling teams. The subjects had no experience using skinfold measurements to determine body composition. Each wrestler acted as a tester and a subject. Permission was granted from the Oklahoma State University wrestling coaches to use members of the wrestling team and high school participants in a wrestling camp as subjects.

Pretest Instructions

The day before the collection of data, the subjects were briefed by the researcher on the purpose of the study and testing procedures. During the briefing, the subjects were instructed to fast four to five hours prior to hydrostatic weighing and to bring a swimsuit. A signed consent form was obtained from each subject (Appendix B). IRB approval was obtained (Appendix D). An information sheet with rules for measuring skinfolds was given to the subjects prior to the training period (Appendix A).

Novice Tester Training

All questions concerning rules for measuring skinfolds were addressed before proceeding. A technician experienced in assessing body composition described the procedures for measuring skinfolds to the novice testers. Photographs depicting specific anatomical sites were used to show the testers exact locations for grasping the skin and applying the skinfold caliper. The testers were allowed to practice the procedure until they felt comfortable performing the measurements. The training session lasted less than one hour. Experienced testers were available to answer questions or provide assistance as needed for the novice testers.

Skinfold Measurements

Each subject was given a body composition form to record all data (Appendix C). After the training session, each subject performed skinfold measurements on all of the other subjects in the study. Seven skinfold measurements were taken on the right side of the subject being tested. Skinfold measurements were made with a Lange skinfold caliper and recorded to the nearest 0.5 millimeter (mm). The fold of the skin was firmly grasped between the thumb and forefinger and lifted up approximately one-half inch.

The fold was pinched and lifted to insure that no musculature was being grasped. The contact surface of the calipers was placed below the thumb and forefinger while continuing to hold the skinfold firmly. The reading, in millimeters, on the dial of the Lange caliper was taken after the full spring pressure of the instrument had been applied. Care was taken to insure that sufficient time was allowed for the full pressure of the caliper to take effect, but without the fat being overcompressed. This procedure was repeated at least three times at each location. An average of two consecutive pinches that did not vary more than 0.5 mm were used. Landmarks for the skinfold measurements were defined according to Nieman (1990). The results from each skinfold location were recorded on the body composition form (Appendix C).

Hydrostatic Weighing

Subjects were weighed to the nearest kilogram on a Healthameter platform scale. Weight was transferred to the body composition form and utilized in the hydrostatic weighing program. Residual volume was measured directly using the helium dilution method (Comroe, Forster, Dubois, et al, 1962). Subjects assumed a sitting position similar to the position needed for hydrostatic weighing during the measurement of residual volume. Prior to hydrostatic weighing, the subject attempted to evacuate bowel and bladder. The subject then entered the tank and submerged completely to insure that hair and swimsuit were thoroughly soaked prior to being weighed. A five kilogram weight was attached to the seat harness in order to tare the scale (Vacumetrics Incorporated, 1991). The scale read 0.0 kilogram before proceeding. When this procedure was completed the subject attached the five kilogram weight belt to his waist to insure total submersion while being weighed. The subject then assumed a position in the seat harness such that the buttocks were at the far back of the seat harness. The subject was instructed to remove all air bubbles from the surface of the body, hair, and from inside the swimsuit. The hydrostatic weighing procedure was explained thoroughly to the subject and he was allowed to practice the procedure until he felt comfortable. The subject was then instructed to exhale all the air possible from his lungs and slowly lean forward until his head was underwater. The subject, while forcibly expelling the remaining air from the lungs, was suspended fully on the seat harness in a tuck position. This position was held as long as possible or until the tester obtained a stable reading on the scale, at which time a knock on the side of the tank signified to the subject that it was time to come up. The procedure was repeated until two exact measurements were obtained in succession. Body density was determined from the highest of the two exact measurements.

Instrumentation

Lange skinfold calipers were used to obtain measurements for the seven sites: triceps, subscapular, midaxillary, ilium, abdomen, chest, and thigh. Body fat percentage was determined by obtaining a sum of the seven sites and referring to the formula provided by Jackson and Pollock (1985) for estimated percent body fat. The hydrostatic weighing was done with a computerized hydrostatic weighing system (catalogue number 17060) obtained from Vacumetrics in Ventura, California. Body composition from hydrostatic weighing was derived using the formula from Siri (1956). Residual volume was measured with a MasterLab CompactPFT manufactured by Jaeger (Erich Jaeger, 1990).

Research Design

The research is classified as a descriptive correlational survey. Two methods for estimating body fat percentage were compared. The results were analyzed utilizing a Pearson r correlation to determine if a relationship existed between the two methods. The two methods utilized for determining body composition were the seven site skinfold technique, described by Jackson and Pollock (1985), performed by novice testers after one training session and the hydrostatic weighing technique, described by Brodie (1988), as performed by trained, competent personnel.

Statistical Analysis

The sum of the seven skinfolds was tabulated and body fat percentage was determined for each subject. The mean body fat percentage was then calculated for each subject. Body fat percentage determined from hydrostatic weighing was transferred from computer printout to the respective subject's body composition form. Correlation techniques were used to determine the relationship between the mean body composition estimated from skinfold measurements performed by novice testers after one training session and body composition estimated from hydrostatic weighing. Significance of the relationship between data sets was determined with .05 chosen as the alpha level.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to test the hypothesis that there would be no relationship between percentage of body fat determined by the seven site skinfold technique, described by Jackson and Pollock (1985), performed by novice testers after one training session and the hydrostatic weighing technique, described by Brodie (1988), as performed by trained, competent personnel. The data collected in the study were analyzed utilizing a Pearson r to determine if a relationship existed between the two methods.

RESULTS

The normative data for each subject are given in Table I on page 21.

The mean of all skinfold measurements for each subject was calculated and compared to each subjects' hydrostatic weight. The average standard deviation for body fat percentage as determined by novice testers was ± 1.46. This low variability is an indication of reasonable consistency among the subjects' measurements. Also, the difference between each subjects' mean weight and hydrostatic weight was calculated. The average difference between the two weights among all subjects was 1.49 percent. The average age among all subjects was 16.8 years.

TABLE I

NORMATIVE DATA COMPARING SKINFOLD AND HYDROSTATIC BODY COMPOSITION (PERCENT OF FAT) DETERMINATION OF SCHOLASTIC WRESTLERS

Subject #	SKF Mean ± (%)	SD	HWT (%)	Difference (%)	Age (years)
1	13.13	1.98	9.73	+3.40	22
2	9.72	1.17	9.73	-0.01	15
3	10.29	0.76	10.91	-0.62	17
4	8.25	2.25	7.38	+0.87	16
5	7.74	1.19	7.38	+0.36	17
6	4.97	0.64	4.29	+0.68	16
7	10.36	1.22	6.22	+4.14	14
8	8.77	1.73	4.68	+4.09	17
9	11.46	1.85	9.73	+1.73	17
10	10.21	0.86	5.06	+5.15	18
11	10.31	1.70	9.73	+0.58	17
12	6.73	1.39	4.68	+2.05	17
13	12.34	1.22	12.90	-0.56	17
14	24.29	1.72	27.34	-3.05	16
15	12.97	2.22	9.34	+3.63	16
Averages:		SD 1.46		Difference 1.49	Age 16.8

SKF = skinfold
HWT = body composition determined by hydrostatic weighing
\+ = overestimated skinfold percentage
\- = underestimated skinfold percentage

Results of Pearson r Analysis

The results of the Pearson r analysis are given in Table II. Each wrestler acted as a tester and subject, therefore, fifteen correlations are presented between body composition as determined by skinfold measurements and body composition as determined by hydrostatic weighing. All correlation coefficients between the two methods were statistically significant ($p < .01$). The average correlation coefficient among all of the subjects was 0.8842.

TABLE II

CORRELATION COEFFICIENTS COMPARING SKINFOLD AND HYDROSTATIC BODY COMPOSITION (PERCENT OF FAT) DETERMINATION OF SCHOLASTIC WRESTLERS

$n = 15$

.9373
.9366
.9358
.9351
.9346
.9275
.9167
.9104
.8962
.8896
.8882
.8689
.7985
.7815
.7059

Average: .8842

DISCUSSION

The results suggested that a single training session enabled novice testers to determine a skinfold body composition measure that was essentially similar to a measure determined by trained personnel using hydrostatic weighing. Since the single training session was the primary focus of the study, these results are encouraging due to the fact that many collegiate and high school wrestling coaches do not regularly assess body composition for their athletes.

The findings in this study are in agreement with previous research by Hyner, Marconyak, Black, and Melby (1986) who found that with minimal training, novice practitioners estimate body fat percentages reliably and with acceptable accuracy when compared to an experienced skinfold technician. Similarly, Opplinger, Clark, and Kuta (1992) reported that skinfold testers can receive adequate training through clinics to provide accurate skinfold measurements, and these testers minimally influence the validity of skinfold prediction equations. In their study experienced skinfold testers served as the criterion against which the clinic-trained testers were compared. Acknowledging the fact that hydrostatic weighing is the criterion method for determining body composition, neither of these studies compared skinfold results with hydrostatic weighing results.

This research project yielded strong correlations between body composition determined by novice skinfold testers after a single training session and body composition as determined by competent, trained personnel using the hydrostatic weighing technique. However, certain factors could lead to these strong correlations. The use of subjects with low body fat percentages could be one factor because it is easier to perform skinfold measurements on lean people, therefore, achieving more accurate results. However, one of the subjects' body composition determined by hydrostatic weighing was 27.34 percent, and the skinfold testers only underestimated his body composition by 3.05 percent. Therefore, further testing using more obese subjects seems warranted. Also, the subjects reported that the use of pictures depicting each anatomical skinfold site proved highly beneficial in determining exactly where to place the skinfold caliper.

It seems clear that this study suggests that acceptable body composition assessments, through the use of skinfold measurements are accurate and can be provided at low cost. Skinfold calipers used in this study are inexpensive in comparison to the hydrostatic weighing apparatus. The ease with which the subjects learned the technique and were able to make accurate measurements suggests that body composition analysis, after minimal training in methodology could be highly useful in the college and high school wrestling environment. Furthermore, it is assumed that reliability could be further improved through practitioner experience and periodic reliability checks using experienced skinfold technicians or hydrostatic weighing techniques.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Summary

Numerous studies have been conducted comparing the relationship between body composition as determined through the use of skinfold measurements and body composition as determined by hydrostatic weighing. However, research utilizing novice skinfold testers is less prevalent. This study specifically examined the relationship between body composition as determined by the seven site skinfold technique, performed by novice testers after one training session, and the hydrostatic weighing technique.

The data collected in this study was analyzed utilizing a Pearson r to determine if a relationship existed between the two methods.

Findings

Based on the hypothesis stated and the limits of this study, the data yielded the following findings:

The results were essentially similar between body composition measurements, expressed as percentage of body fat, obtained from the seven site skinfold technique, performed by novice testers after a single training session, and the hydrostatic weighing technique performed by trained personnel.

Conclusions

It was concluded from the results that student athletes can accurately determine a body composition measurement in accordance with a measurement determined by the widely accepted hydrostatic weighing technique. This accuracy would allow athletes to monitor their weight gains and losses throughout the competetive season. Also, assessing body composition could help identify athletes succeptible to nutritional disorders and\or improper weight reduction procedures.

Recommendations

It is recommended that intercollegiate and high school wrestlers have their body composition measured throughout the competitive season. This research shows the ease with which one can learn to make skinfold measurements accurately. However, experience on the part of each tester will enhance the accuracy of these results.

The following recommendations are suggested areas for further research:

1. Studies involving a greater number of subjects.

2. Studies involving subjects within a wider range of body composition. Specifically, the use of more obese subjects.

3. Studies involving athletes from other sports that involve achieving and maintaining a target or specific weight, such as boxing, gymnastics, ballet etc.

4. Studies which investigate the test\re-test reliability of novice testers.

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APPENDIXES

APPENDIX A

RULES FOR MEASURING SKINFOLDS

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1. As a general rule, those with little experience in skinfold measurement should mark the site to be measured with a black felt pen.

2. The measurer should feel the site prior to measurement, to familiarize himself and the person being measured with the area where the skinfold will be taken.

3. The skinfold should be firmly grasped by the thumb and index finger of the left hand and pulled away from the body. While this is usually easy with thin people, it is much harder with obese, and can be somewhat uncomfortable for the person being tested. The amount of tissue pinched up must be enough to form a fold with approximately parallel sides. The thicker the fat layer under the skin, the wider the necessary fold (and the more separation needed between thumb and index finger).

4. The caliper is held in the right hand, perpendicular to the skinfold and with the skinfold dial facing up and easily readable. The caliper heads should be placed 1/4-1/2 inch away from the fingers holding the skinfold, so that the pressure of the caliper will not be affected.

5. The skinfold caliper should not be placed too deep into the skinfold or too far away on the tip of the skinfold. Try to visualize where a true double fold of skin thickness is, and place the caliper heads there. It is good practice to position the caliper arms one at a time--first the fixed arm on one side, and the lever arm on the other.

6. The dial is read approximately 4 seconds after the pressure from your hand has been released on the lever arm of the caliper jaw.

7. A minimum of two measurements should be taken at each site. Measurements should be at least 15 seconds apart to allow the skinfold site to return to normal. If consecutive measurements vary by more than 1 mm, more should be taken, until there is consistency.

8. Maintain the pressure with the thumb and forefinger throughout each measurement.

9. Measurements should not be taken when the skin is moist because there is a tendency to grasp extra skin, obtaining inaccurately large values. Also measurements should not be taken immediately after exercise or when the person being measured is overheated, because the shift of body fluid to the skin will inflate normal skinfold size.

10. It takes practice to be able to grasp the same amount of skinfold consistently at the same location every time. Accuracy can be tested by having several technicians take the same measurements and comparing results. It may take up to 20-50 practice sessions to become proficient.

Source: Nieman, D. C. (1990). Fitness and Sports Medicine - an Introduction. Palo Alto: Bull Publishing.

APPENDIX B

INFORMED CONSENT FORM

INFORMED CONSENT FORM

HYDROSTATIC WEIGHING AND SKINFOLD MEASUREMENTS

Explanation of Procedures

The results from the procedures you are about to undergo will be used in a research project at Oklahoma State University. The procedures utilized will be hydrostatic weighing and skinfold measurements to assess body composition. It will be determined, prior to testing, that these tests are appropriate and safe for you. All testing will be conducted by trained personnel and procedures will be explained to your satisfaction at the outset. The testing will require approximately four hours of your time.

Possible Risks

The potential risks for these procedures are minimal. The major risk is the discomfort of holding your breath under water for as long as possible. However, you will not be forcibly held under water at any time. You may come up for air anytime during the hydrostatic weighing procedure. There are no known risks associated with skinfold measurements.

Consent by Subject

The information which is obtained will be treated as privileged and confidential and will not be released or revealed to anyone without your express written consent. Information will, however, be treated in an aggregate manner to provide group information for research purposes. The information derived from testing will be available to the principal investigators only.

I understand that participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time without penalty after notifying the project director.

I may contact Dr. Frank Kulling or Michael Nickell at telephone number 744-6753. I may also contact University Research Services, 001 Life Sciences East, Oklahoma State University, Stillwater, OK 74078; Telephone: (405) 744-5700.

I have read and fully understand the consent form. I sign it freely and voluntarily.

Date ____________________ Time __________ (a.m./p.m.)

Subject Signature ____

Witness Signature ____

I certify that I have personally explained all elements of this form to the subject or his/her representative before requesting the subject or his/her representative to sign it.

____
Project Director or his/her authorized representative

APPENDIX C

BODY COMPOSITION FORM

BODY COMPOSITION FORM

Name ______________________ D.O.B. __________ Subject # ______

Height __________ inches   Residual Volume ________ L.

Weight __________ kg.   Body Fat Percentage ________ %
(by H.W.)

Tester #	________	Tester #	________	Tester #	________
Triceps	____	Triceps	____	Triceps	____
Subscapular	____	Subscapular	____	Subscapular	____
Midaxillary	____	Midaxillary	____	Midaxillary	____
Ilium	____	Ilium	____	Ilium	____
Abdomen	____	Abdomen	____	Abdomen	____
Chest	____	Chest	____	Chest	____
Thigh	____	Thigh	____	Thigh	____
Sum of seven	____	Sum of seven	____	Sum of seven	____
Body Fat % (s.f.)	____	Body Fat % (s.f.)	____	Body Fat % (s.f.)	____

Tester #	________	Tester #	________	Tester #	________
Triceps	____	Triceps	____	Triceps	____
Subscapular	____	Subscapular	____	Subscapular	____
Midaxillary	____	Midaxillary	____	Midaxillary	____
Ilium	____	Ilium	____	Ilium	____
Abdomen	____	Abdomen	____	Abdomen	____
Chest	____	Chest	____	Chest	____
Thigh	____	Thigh	____	Thigh	____
Sum of seven	____	Sum of seven	____	Sum of seven	____
Body Fat % (s.f.)	____	Body Fat % (s.f.)	____	Body Fat % (s.f.)	____

APPENDIX D

IRB APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Date: 06-16-93 **IRB#:** ED-93-088

Proposal Title: AN EVALUATION OF THE PROFICIENCY OF NOVICE SKINFOLD TESTERS ASSESSING BODY COMPOSITION AMONG INTER-COLLEGIATE WRESTLERS

Principal Investigator(s): F. Kulling, Michael Nickell

Reviewed and Processed as: Modifications

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL. ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

MODIFICATIONS RECEIVED AND APPROVED

Signature: Maria L. Tilley
Chair of Institutional Review Board

Date: June 17, 1993

VITA

Michael Allen Nickell

Candidate for the Degree of

Master of Science

Thesis: AN EVALUATION OF THE PROFIECIENCY OF NOVICE SKINFOLD TESTERS ASSESSING BODY COMPOSITION AMONG INTERCOLLEGIATE AND HIGH SCHOOL WRESTLERS

Major Field: Health, Physical Education, and Leisure

Biographical:

Personal Data: Born in Okmulgee, Oklahoma, October 1, 1966, the son of James M. and Kathleen C. Nickell.

Education: Graduated from Okmulgee High School, Okmulgee, Oklahoma, in May 1984; received Bachelor of Science Degree from Oklahoma State University, Stillwater, Oklahoma, in July 1991; completed the requirements for the Master of Science Degree at Oklahoma State University, Stillwater, Oklahoma, in December 1993.

Professional Experience: Graduate Assistant, Oklahoma State University Wellness Center, from August, 1991, to present.