Body Composition of Women With Anorexia Nervosa: A Pilot Study

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The purpose of this study was to examine the estimated body composition values of women hospitalized for treatment of anorexia nervosa in relation to values reported in the literature for women without known dietary problems. Sixteen volunteers between the ages of 16 and 37 years from hospitals in California and Texas participated in the study. Data collected included height, weight, and selected skinfold and circumference measures. Statistical analyses included independent and paired t tests. Significant differences were found between the percent body fat of anorexic subjects ($M = 15.54\%$) and that of normative women in the Jackson, Pollock, and Ward (1980) study ($M = 24.09\%$). When the actual weight of the anorexic subjects ($M = 99.3$ lb) was compared with their theoretical minimal weight calculated by the Behnke (1969) formula ($M = 106.5$ lb), no significant difference was obtained. A comparison of somatogram data for the anorexic women and the reference woman found significant differences at 5 of the 11 sites measured.

Anorexia nervosa is a disorder that should be of interest to adapted physical educators, but few textbooks within this area of specialization mention it (Arnheim & Sinclair, 1985; Fait & Dunn, 1984; Sherrill, 1986). Anorexia nervosa is a multidimensional disorder variously described as “self-inflicted starvation and relentless pursuit of thinness” (Bruch, 1973, p. 3), “a gross disturbance in eating behavior . . . that cannot be accounted for by any known physical disorder” (American Psychiatric Association, 1980, p. 67), and “a psychosomatic disorder characterized by obsessions with food, weight loss, compulsive dieting, and excessive physical activity” (Grant & Fodor, 1986, p. 269).

Some clinicians distinguish between primary and secondary anorexia, the first being a syndrome distinct from other illness and the second referring to weight loss associated with depression, schizophrenia, or other specific psychiatric or physical diseases. Primary anorexia nervosa is the subject of this paper. To avoid confusion, anorexia nervosa has been defined as a serious illness or disorder diagnosed by a physician using the five criteria established by the American Psychiatric Association (APA):

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1. Intense fear of becoming obese, which does not diminish as weight loss progresses;
2. Disturbance of body image, for example, claiming to "feel fat" even when emaciated;
3. Weight loss of at least 25% of original body weight or, if under 18 years of age, weight loss from original body weight plus projected weight gain expected from growth charts may be combined to make the 25%;
4. Refusal to maintain body weight over a minimal normal weight for age and height;
5. No known physical illness that would account for the weight loss.

The prevalence figures for anorexia nervosa range from 1% for adolescent girls (Crisp, Palmer, & Kalucy, 1976) to 7% for dance and modeling students (Garner & Garfinkel, 1980). The condition occurs most frequently in females between ages 14 and 18 years, with the usual range between 12 and 25. Epidemiological studies show, however, that the incidence is increasing, particularly in postadolescent women (Garfinkel & Garner, 1982). Because individuals with anorexia nervosa tend to follow rigorous exercise programs in their drive to minimize body weight, they are likely to be in the areas physical educators frequent: gymnasiums, playing fields, tracks, and dance studios. There is an obvious need for early detection of anorexic behaviors in school, recreational, and other settings and for the development of appropriate preventive programs.

The course of anorexia nervosa may be unremitting until death by starvation occurs. Follow-up studies indicate mortality rates between 15 and 21% (American Psychiatric Association, 1980). Many individuals with anorexia nervosa are hospitalized for treatment that typically includes both medical management and psychotherapy. Adapted physical educators, with special training, may become valuable members of the multidisciplinary team that works with anorexic individuals before, during, and after hospitalization. Their contribution may become especially important in monitoring the exercise of anorexic adolescents who, after hospitalization, return to high school or college. Adapted physical educators trained in fitness, movement, and body image counseling, as recommended by Sherrill (1986), are especially qualified to work with school counselors and other members of the multidisciplinary team in the management of anorexic behaviors.

One area in which anorexics need particular help is body image disturbances. Research shows that anorexic individuals tend to overestimate the size of body parts, particularly the abdomen, buttocks, and upper thighs (Fichter, Meister, & Koch, 1986). One approach to ameliorating this problem is to provide the multidisciplinary team and the anorexic individual information about her true anthropometric measures and body segment proportionality. It is also important to help anorexic individuals understand that dieting does not necessarily lead to loss at desired sites or to reduced amount of fat.

The somatogram, first developed by Behnke (1969) and described in detail by Behnke and Wilmore (1974), seems particularly applicable to the study of anorexic individuals. The somatogram is "a pictorial representation of body seg-
ment proportionality that considers both the individual's segment dimensions in relation to the individual's overall size and shape as well as the dimensions of a reference group” (Freedson, Mihevic, Loucks, & Girandola, 1983, p. 93). This pictorial representation is sometimes called a body profile. The somatogram shows how 11 body parts (shoulder, chest, abdomen, hips/buttocks, thigh, biceps, forearm, wrist, knee, calf, and ankle) deviate from measurements of a reference woman, each of which is designated as 0, having been derived by formula. This reference woman was based on measurements of 13,708 women (Behnke & Wilmore, 1974, p. 56). Actual circumferences of an individual are not shown on the somatogram; instead, deviation values derived by formula are plotted. If anthropometric proportions of the subject are symmetrical, all of the deviation values will fall plus or minus 2% of the vertical zero reference line.

Katch (1985), in recommending the use of girth data as valuable in teaching and coaching, points out that the somatogram has received only limited clinical application, probably because of the tedious calculations involved. According to Katch (1985), the somatogram is particularly helpful in understanding the proportionality of over- and underweight individuals and of body builders and weight lifters. Recently somatogram research has been published on male body builders (Katch, Katch, & Moffatt, 1980), female body builders (Freedson et al., 1983), and female dancers (Calabrese et al., 1983; Clarkson, Freedson, Keller, Carney, & Skinar, 1985; Dolgener, Spasoff, & St. John, 1980). The latter three studies have particular relevance to anorexia nervosa because dancers are considered a high risk population for this condition (Calabrese et al., 1983). For the most part, however, the body segment deviations of the dancers fall close to the reference 0 line except for the biceps, which were smaller, and the calf and ankle, which were larger.

Little research can be found on the body dimensions of anorexic individuals (Crisp, 1969; Fohlin, 1978). Crisp (1969) examined only shoulder and hip breadths, and Fohlin (1978) collected data on several parameters of boys and girls during a period of nutritional repletion. No research can be identified specifically on body density and percent body fat of anorexic individuals.

The average percent body fat for the general female population ranges between 24% (Jackson et al., 1980) and 27% (Behnke & Wilmore, 1974). The percent body fat for dancers has been variously reported at 16.4% (Clarkson et al., 1985), 16.9% (Calabrese et al., 1983), and 22.1% (Dolgener et al., 1980). Whereas the 16.4% and 16.9% were based on data from hydrostatic weighing, the 22.1% was derived from anthropometric measurements. Dolgener et al. (1980) indicated that they believed 22.1% body fat to be “an example of the sometimes extreme inaccuracy of regression equations when used on conditioned females” (p. 606). Little research is available on the percent body fat of underweight persons (Benoit, Marten, & Watten, 1965; Katch, Katch, & Behnke, 1980), and none on that of anorexics. Benoit et al. (1965) stated, “although clinically desired weight reduction occurs during fasting, it is at the expense of lean tissue, which is physiologically undesirable” (p. 611). Katch et al. (1980) reported that, in many underweight persons, fat levels appear to be low but are actually high. Minimal percent body fat believed necessary in women is 12 to 14% (Behnke & Wilmore, 1974). It seems important to examine this criterion in relation to anorexic women.
The rationale for a pilot study on body composition of anorexic individuals thus seems well established. The decision was made to limit this pilot study to aspects of body composition that would be understandable and useful to adapted physical educators who may be asked to work with anorexics. Although research on the biochemical aspects of body composition of anorexics was reviewed, the findings were too technical to be meaningful to most teachers and coaches (Dempsey et al., 1984; Fohlin, 1977; Forbes, Kreipe, Lipinski, & Hodgman, 1984; Ljunggren, Ikkos, & Luft, 1961; Russell et al., 1983). These studies did not report values of percent fat or lean tissue. Ljunggren et al. (1961) indicated that normal, obese, and anorexic persons differ in metabolism in relation to active tissue. Forbes et al. (1984) reported that during recovery about two thirds of the weight gain is lean tissue.

The purpose of this study was to examine the estimated body composition values of women hospitalized for treatment of anorexia nervosa in relation to values reported in the literature for women without any known dietary problems. Specifically the works of Jackson et al. (1980) and of Behnke (1961a, 1961b, 1969) were selected for examination in relation to anorexic women. The following research hypotheses guided this pilot investigation: (a) The percent body fat of anorexic women is significantly less than that of the typical female reported by Jackson et al. (1980); (b) the actual body weight of anorexic women is significantly less than their theoretical minimum weight calculated by the Behnke (1969) formula; and (c) the anorexic woman's somatogram is significantly different from Behnke's (1961a) somatogram for the typical woman.

Method

Subjects

The subjects of this investigation were 16 women, ages 16 to 37 years ($M = 25.4$ years), hospitalized for anorexia nervosa who met the APA criteria for this disorder. The APA diagnostic criteria are stated earlier in this paper.

One hospital in California and one hospital in Texas gave permission for their patients to serve as subjects ($N = 14, 2$, respectively). Although numerous other hospitals were contacted, they were unwilling to permit measurements to be taken of their patients. The sampling design thus consisted of all hospitalized subjects who met APA criteria that the investigators were able to obtain. Prior to data collection, the procedures were explained and the subjects were informed of their rights as participants. All subjects signed a consent form.

All of the subjects reported that they were postmenarche. Medical records indicated that no biological illnesses other than anorexia nervosa had been diagnosed. Duration of anorexia ranged from 4 to 144 months, with a mean duration of illness at 48.9 months. According to the physicians of these women, this range and mean are representative of samples of hospitalized anorexic patients.

Procedures

Data collected included height, weight, and selected skinfold and circumference measures. Skinfolds were the technique employed because permission to do
hydrostatic weighing or volumetric measurement of body density could not be obtained from the hospital personnel and the least obtrusive procedure was skinfolds. Although the use of skinfolds to measure body fat would not be accepted in a laboratory setting, their value in field research is widely acknowledged (Katch, 1985). In many situations, the use of skinfolds is the method of choice (Noble, 1986). Kovach (1982), in describing the nutritional-assessment protocol for anorexia nervosa in his clinic, reported the use of height-weight tables, the triceps skinfold, one arm-muscle determination, and several biochemical measures. The use of 3 skinfold and 11 circumference measures in this study appeared to be an advancement over current clinical practice and were appropriate for a pilot study.

For reliability, all skinfold sites were measured three to five times, or until three identical measures were obtained. Circumference measures from 11 sites (shoulder, chest, forearm, abdomen, hips, thigh, calf, knee, ankle, biceps, and wrist) were taken from the left side of the body using a steel tape in accordance with the procedures of Behnke (1961b). All the data concerning weight, skinfolds, and circumference were collected on an individual during the same day.

The skinfold values obtained for each subject were converted using the density equation of Jackson et al. (1980) and the equation of Brozek, Grande, Anderson, and Keys (1963) for calculating percent body fat. The resulting data for density and percent fat were compared with values found by Jackson et al. (1980) on a generalized population of women by means of the t test for independent means.

Mean actual and minimal body weights were calculated and compared by the t test for correlated means. The Behnke and Wilmore (1974) formula for calculating minimal body weight for height was used as follows: 0.0893 \times (\text{height in inches})^{1.7}.

Skinfold measures were taken from three sites on each subject using calibrated Lange skinfold calipers. The sites measured included the midpoint of the triceps, the top of the iliac crest, and the midportion of the thigh in accordance with the procedures of Jackson et al. (1980). This formula was selected because it is generalized to women. Ideally, a validated group-specific formula should be used to accurately represent the body composition of anorexic women but such a formula is not yet available. The study by Ljunggren et al. (1961) suggests that the cellular mass of anorexics is not qualitatively different from nonanorexic subjects; therefore the generalized formula should apply.

Individual somatograms were developed for each subject. To obtain the values for plotting these somatograms, the circumferences were divided by the reference conversion constants (k) specific to each circumference in order to obtain deviation scores called d values. Next, the sum of the subject’s 11 circumferences was divided by 100 to obtain the reference value D. Finally, the percentage deviation of each d from the reference D was calculated: percentage deviation = (d − D)/D. The resulting percentage deviations were then plotted on the somatogram form to provide a quantitative representation of the shape of the anorexic’s body. The reference conversion constants used in this procedure are found in Behnke and Wilmore (1974, p. 57).

Two composite somatograms (see Figures 1 and 2) were developed also. The first (Figure 1) was developed by summing the percentage deviations of all
Figure 1 — Somatogram for the mean values of anorexic women compared to those of Behnke’s reference woman for visual analysis of percentage deviation of mean values. (Note: The center line denotes the reference woman; the solid line denotes the mean of the anorexic women; asterisks indicate significant differences between anorexic and reference women.)

Figure 2 — Somatogram of the lowest percent fat anorexic individual, the highest percent fat anorexic individual, and the reference woman for visual analysis. (Note: The center line denotes the reference woman; the double dashed line denotes the low percent fat anorexic individual; the solid line denotes the high percent fat anorexic individual.)
subjects on each circumference and then dividing by 16 to obtain the mean percentage deviation. To determine whether a significant difference existed between each mean percentage deviation of the anorexic sample and the population value 0, a $t$ test of significance between sample and population means was computed. To minimize the possible Type I error caused by multiple $t$ tests, the level of significance was set at .003, the value recommended by Dunn (1961) when multiple $t$ tests must be used. The second somatogram (see Figure 2) was developed to show the contrast between the percentage deviations of the anorexic with the lowest percent body fat (subject 16) and the anorexic with the highest percent body fat (subject 5). No calculations were involved in the preparation of this somatogram.

### Results and Discussion

Age, height, weight, percent body fat, minimal weight, and skinfold sums for each subject are presented in Table 1 along with means and standard deviations. These data offer the reader insight into the wide range of individual differences that characterize hospitalized anorexic women.

Significant differences existed between the anorexic women ($N = 16$) and the normative data ($N = 249$) of Jackson et al. (1980) in body density, $t$ (15)

**Table 1**

Raw Data, Means, and Standard Deviations for Anorexic Women

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Ht (in.)</th>
<th>Wt (lb)</th>
<th>% Fat</th>
<th>Minimal weight</th>
<th>Skinfold sums</th>
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<td>1</td>
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The mean density values for anorexic women of 1.0658 and for Jackson et al. (1980) women of 1.0440 suggest that anorexic women are less fat and possibly leaner than normal women. The average percent fat value for the anorexic women was 15.54%, and that of the 249 women in the Jackson et al. study (1980) was 24.09%. Inspection of raw data revealed that 56% of the anorexic subjects had percent body fat measurements above the 12% criterion believed to be minimal for women (Katch et al., 1980). This pilot study has raised many questions. It is possible that deep body fat deposits are affected more by anorexia nervosa than subcutaneous stores; if this is the case, then skinfold measures are not valid indicators of the difference between nonanorexic and anorexic women. More research is needed on how diet, exercise, and/or combinations of the two affect loss of superficial and deep body fat as well as lean muscle tissue.

Edema is a frequent complication in anorexia nervosa; the frequency of clinically apparent edema in patients ranges from 7 to 33% (Garfinkel & Garner, 1982). It is possible therefore that edema may have affected the skinfold findings. Whereas nonhospitalized anorexics often drink large quantities of fluids to reduce hunger and/or ingest salt periodically to provoke weight gains and prevent hospitalization, the subjects in this study were being monitored carefully by hospital staff. However, the mechanisms responsible for edema in anorexics are poorly understood. Reduced plasma proteins are generally believed to be related to edema, but research indicates these are normal in anorexia nervosa (Garfinkel & Garner, 1982). This problem also creates questions concerning the use of anthropometric measures, particularly with nonhospitalized anorexics.

The relationship between the actual body weight of the subjects and their estimated percent body fat was \( r = .63, p < .01 \). It appears that the skinfold/percent body fat relationship is distorted for the anorexic population. If this is so, the effect, theoretically, has been to underestimate the percent body fat of anorexic women. Much more research is needed on the body composition of anorexic women. Until a regression formula can be validated specifically for anorexic women, however, we believe that further studies should not rely on skinfolds.

When the actual weight of the anorexic women \( (M = 99.3 \text{ lb}) \) was compared with their minimal weight calculated by the Behnke and Wilmore (1974) formula \( (M = 106.5 \text{ lb}) \), no significant difference was found, \( t (15) = 1.93, p > .003 \). Although excessively thin at the time of data collection, these subjects were not in danger according to the 12% body fat criterion. Moreover, the subjects had a mean of 15.54% body fat, indicating that they were conserving fat stores in spite of their extreme thinness. Hospitalization was continuing, however, because of the combined physical and emotional status of the subjects. Physicians were extremely guarded in relation to any data collection that might upset patients. Permission to conduct interviews and/or administer attitude inventories was refused. It was stressed that anorexia nervosa is a severe emotional disturbance as well as a physiological problem.

Comparison of the circumference measures of the anorexic women with those of the reference woman indicated only five significant differences (see Figure 1). The 11 sites compared included the chest, abdomen, hips, thigh, biceps, fore-
arm, wrist, knee, calf, ankle, and shoulders. The knee ($t[15] = 6.05$), wrist ($t[15] = 4.09$), biceps ($t[15] = -7.6$), thigh ($t[15] = -5.1$), and chest ($t[15] = 5.23$) were the five sites that showed significant differences ($p < .003$).

The significant differences in the somatogram sites of the anorexic women and the reference woman indicate that anorexic women have both larger- and smaller-than-standard measurements (i.e., points on Figure 1 that deviate from the 0 line). Figure 1 shows that the somatogram values of the biceps, thigh, forearm, and hips of the average anorexic woman were less than those of the reference woman; however, only the biceps and thigh were significantly less. Studies on dancers (Calabrese et al., 1983; Clarkson et al., 1985; Dolgener et al., 1980) have all indicated the biceps to be the circumference that deviates most from the reference woman. Crisp (1969), who limited his research to shoulders and hips of anorexic women, found both measures to be less than those of nonanorexic controls; however, no tests of significance were applied. Surprisingly, the somatogram values for knee, wrist, and chest were all significantly greater than those of the reference woman. Studies on dancers report similar findings on chest measurements, but not knee and wrist.

Individual differences among anorexic women are shown in Figure 2, which depicts values of the lowest fat anorexic individual and the highest fat one. The individual with the least body fat (3.53%) was 18 years old, weighed 101.75 lb, and was 66.75 in. tall. The person with the greatest percentage of body fat (29.48%) was 23 years old, weighed 114.7 lb and was 64 in. tall.

With regard to practical applications of Figures 1 and 2, use of the somatogram is recommended in helping anorexic individuals to understand that their dieting is not necessarily resulting in desirable body conformation changes. Starvation diets result in the loss of lean tissue as well as fat (Katch et al., 1980). How much lean mass versus fat is lost in anorexia is unknown. It appears that for many individuals with anorexia nervosa, however, the subcutaneous fat lost in relation to lean tissue is not as great as expected. Use of the somatogram may lead to a greater awareness among physical educators and the general public in relation to weight loss regimens.

**Conclusion**

From the results of this study it is concluded that women hospitalized for anorexia nervosa vary significantly in the percentage of body fat from both the normal group studied by Jackson et al. (1980) and the reference woman devised by Behnke (1961a) and further described by Behnke and Wilmore (1974). The knee, wrist, and chest sites of the anorexic women in this study were greater in circumference in relation to body size than the reference woman. In spite of their loss of 25% or more of original body weight, anorexic women retained considerable subcutaneous fat at specific body parts. The weight loss of these women may have been partly lean tissue rather than fat. Skinfolds and anthropometric measures should be used only with caution in drawing generalizations about anorexic individuals. It is important that adapted physical educators take courses in body composition and work closely with other members of a multidisciplinary team.
in studying anorexia nervosa. Needed is more research with larger sample sizes and access to more information than was permitted in this study. It is hoped that this paper will increase awareness of anorexia nervosa among adapted physical education personnel and will motivate further research.

References


