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Longitudinal Examination of the Incidence of Obesity in Adolescent Females

Carol A. Costello
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Carol A. Costello entitled "Longitudinal Examination of the Incidence of Obesity in Adolescent Females." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Gail W. Disney, Major Professor

We have read this thesis and recommend its acceptance:

Jean D. Skinner, John T. Smith

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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LONGITUDINAL EXAMINATION OF THE INCIDENCE OF OBESITY IN ADOLESCENT FEMALES

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Carol A. Costello

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ABSTRACT

The persistence and incidence of obesity was investigated in 61 black and 29 white females residing in Knox County, Tennessee. These girls were 16.0 ± 0.5 years of age and had been previously studied at 9, 10, 11, and 14 years of age. Data collected on these girls and 40 additional 12- and 14-year-old girls included height, weight, triceps circumference, triceps skinfold thickness, 24-hour dietary recalls, and an activity recall. A questionnaire concerned with attitudes toward physical activity was devised, pilot tested, and administered. An obesity index was devised from height, weight, and triceps measurements of the girls with the use of factor analysis. Girls were divided into quartiles according to the obesity index and into three groups according to the triceps skinfold measurements. A girl was considered obese if she was in the 4th obesity index quartile or had a triceps skinfold measurement equal to or greater than the 85th percentile as determined from the Ten State Nutrition Survey data.

The persistence of obesity decreased as the time between examinations increased, although a significant relationship still existed between age 9 and age 16. Seventy-one percent of the girls who were obese when 9 years old still were obese at age 16 according to the obesity index method; 87% of the thin or normal girls remained so over the 7-year period. Forty percent of the girls remained obese according to the triceps skinfold method and 85% remained thin or normal over the 7-year period.

Incidence of obesity ranged from 17% when the girls were 10 years of age to 27% for the 11-year-olds. At age 16, 19% of the sample were obese.

The obese girls consumed significantly fewer kilocalories than the thin girls. There were no significant differences for activity levels or attitudes toward physical activity among the thin, normal, and obese girls. These results indicate that factors other than excessive energy intake or low energy expenditure may be responsible for the obese state of some individuals.

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CHAPTER I

INTRODUCTION

Obesity constitutes a major health problem in most Western countries (1). Various factors have been implicated such as overeating, decreased activity level, emotional disturbances, and metabolic disorders; however, no one yet has been able to conclude that obesity is caused by only one of these factors. Therapy, for the most part, is unsuccessful and prevention should be considered as the most cost-effective intervention.

The incidence of childhood obesity has been estimated in studies of specific age groups. Incidence rates range from 16% for 7 15-year-old females (2) to 11-17% for females 14-18 years of age (3).

Although it has been reported that as many as 80% of all overweight children become obese adults (4), there is still disagreement concerning the persistence of obesity into adult life. No conclusions have been made due to the small number of longitudinal studies.

This research is an attempt to provide more longitudinal data regarding the persistence of obesity throughout a 7-year period. Two of the factors which may contribute to obesity, activity level and number of kilocalories consumed, also will be considered to note if there are differences between obese and non-obese adolescent females.

CHAPTER II

REVIEW OF LITERATURE

Etiology of Childhood Obesity

Various theories are offered as to why obesity develops and many factors have been implicated in the etiology of childhood and adolescent obesity. Studies indicate that there are emotional factors that may lead to obesity. A community study in Newcastle reported that 60% of the obese 10-year olds had 2 or more of the following risk factors: (1) obesity in a 1st degree relative, (2) an elderly mother, (3) being an only child, and (4) the absence of one parent (5). It also is reported that obese children and adolescents have larger appetites, a family history of obesity, and respond to stress and depression with eating (6,7).

Seltzer and Mayer (8) state that obesity occurs in certain physical and morphological types. The obese were found to be more endomorphic and considerably less ectomorphic than the non-obese girls. Endomorphy can be correlated with the amount of body fat and predisposes one to lay down fat unless weight control intervenes.

Forbes (9) concludes that there are two groups of obese children. The first group has a definite increase in lean body mass as well as fat while the second group has fat accumulation exclusively. The age of onset of obesity determines the group into which the child falls. The group which has excessive fat accumulation without an appreciable increase in lean body mass is composed predominantly of people who became obese during mid or late childhood.

Overnutrition in infancy has been found to increase the incidence of obesity in childhood and adulthood. Shukla et al. (10) examined 300 babies and found that by 3 months of age, 90% were receiving solid foods. This overnutrition at an early age may lead to the development of obesity. When reexamined at 6 months of age, 16.7% were classified as obese and a further 27.7% were classified overweight. Eid (11) reports similar findings in which excessive weight gain during the first 6 months of life was related to obesity in subjects reexamined at 6-8 years of age. Charney et al. (12) obtained a height-weight ratio for infants and reexamined them at 20-30 years of age. Infants who were in the 90th percentile for the height-weight ratio at least once in the 6-month period were found to be 2.6 times more likely to be obese than the infants who were within the normal height-weight percentiles.

A child is very likely to become obese if one or both of his parents are obese. Data reveal that if both parents are obese, a child has an 80% probability of becoming obese compared to 7% for the child who has non-obese parents (13). Correlations as high as 0.96 have been found between obese infants and obese parents (10). Whether this is due to hereditary or environmental factors still is unanswered.

A very important concept to consider when examining the theories of obesity is the actual increase in adipose cell number (hyperplasia) and cell size (hypertrophy). Whereas hypertrophy can occur throughout the life span, researchers believe that hyperplasia develops only during the perinatal and adolescent periods (4, 14-18).

Adipose cell number has been studied in both adolescents and adults. The obese have been found to have a fat cell number equal to two times that of the non-obese (19). Significant correlations have been found between the cell number and total body weight, total body fat, and percent body fat in young adults and indicates that cell number contributes to total body fat (16,20). Salans et al. (20) calculated the mean number of adipose cells in 78 obese and 21 non-obese subjects. They found that the obese could be divided into a group of hypercellular obese and a group with a normal number of adipose cells. Onset age of obesity for the hypercellular group was 7.00±0.05 years versus 27.00±2.00 years for the normocellular group. None of the 78 patients had hypercellularity if the onset age of obesity was greater than 20 years of age. Hypercellularity has long-lasting effects and even weight reduction does not significantly change the number (21). It is possible to decrease cell size; however, once cell number is established, it is relatively stable.

Implications of Obesity

Obesity in children and adolescents is associated with many adult diseases. The obese have been found to have higher incidences of diabetes mellitus, hypertension, and cardiovascular diseases (22,23,24); mortality as a result of these factors also is greater (25).

Aside from the increased susceptibility to various adult diseases, the obese also are at a disadvantage emotionally; obesity may interfere with the development of a healthy personality (26). The obese have been found to have an overwhelming preoccupation with body image disturbances (27,28,29). It seems as if the obese are disgusted

with their own bodies and see themselves as grotesque. They are preoccupied with their physical appearance and can cite few positive attributes about themselves. This disorder is not present in every case of obesity but adolescence is the critical period for development (28).

Probably the most important consequence of juvenile obesity is the persistence of obesity into adult life. Juvenile-onset obesity is more resistant to treatment and usually more severe than obesity that develops in adulthood (20,30).

Diagnosis of Obesity

Obesity is very hard to define due to the lack of adequate and consistent diagnostic criteria. Currently, obesity is diagnosed statistically rather than pathologically (31) and only indicates that one group is statistically fatter than the study population. Despite the limitations, attempts have been made to set up empirical criteria to classify members of the population as obese.

Various methods have been used to assess obesity, such as determination of body content of potassium 40, body density, and total body water; however, practical use of these measures is almost impossible in the field setting (32,33). Anthropometric measurements are readily applicable to field study and are used most widely to assess body fatness in children. Height-weight ratios commonly are used to estimate obesity. This measure is inaccurate in the adolescent population due to the differences in muscularity among adolescents of the same age but of differing levels of sexual maturity (34,35).

Triceps skinfold is used widely due to the ease of measurement. Triceps skinfold is measured by calipers that exert a standard force on a predetermined midpoint of the arm (31). Triceps measurements have been found to be positively correlated with the amount of body fat measured by various laboratory methods (32,33) and body weight (18,36). Classification of obesity varies from exceeding the 80th percentile of established norms for triceps measurements to exceeding the 95th percentile (35,37); however, exceeding the 85th percentile very often is used as the criteria for obesity (31,36,38,39).

The use of triceps skinfold is empirically justifiable; however, limitations have been reported. Several sources indicate that triceps skinfold is less reliable as a measure of the degree of obesity in extremely obese subjects than in leaner subjects (31,32) because it does not reflect the quantitative severity among extremely obese subjects (9).

Incidence of Childhood Obesity

The incidence of obesity in childhood and adolescence varies among studies and with the diagnostic criteria used to determine obesity. In a cross-section of 1200 Iowa elementary and high school children (40), 17.0% of the girls were found to be obese and the percentage increased to 22.5% for the girls over 12 years of age. Johnson et al. (41) examined a cross-section of 6346 elementary and secondary children and found an average of 9.0%±2.5% of the boys and 12.5%±2.5% of the girls to be obese. Obesity occurring before grade 6 accounted for two-thirds of these girls. Hampton et al. (3) report that between 11%-17% of 1000 high school students had greater than 25% body fat. In

another study, when fatness was defined as 1 standard deviation above a regression line by regressing the ratio of height to the cube root of weight (2), 16% of the population was defined as fat.

Persistence of Childhood Obesity

The incidence of childhood and adolescent obesity becomes very important when considered as a precursor to adult obesity. Women who reported themselves to have been fat children were found 2.4 times more likely to be obese adults than those who reported themselves to have been nonfat children (42). In a hospital out-patient clinic, one-third of all patients were found to be obese and of this number, one-third were obese as juveniles (7). Abraham and Nordsieck (43) obtained data on children 10-13 years of age and reexamined these adults 20 years later. Of the 50 overweight boys, 43 (86%) were overweight as adults and 40 (80%) of the girls were overweight adults. In the Haase and Hosenfeld study (44), as reported by Lloyd et al. (45), 335 overweight children were examined. Of this group, a subset of 50 adults were reexamined when they were 20-36 years of age. Four-fifths were found still to be grossly overweight and only 11 (22%) were found to be less than 20% overweight.

Other longitudinal studies which reexamined children after a limited time period have shown comparable results. Asher (46) examined 118 cases of simple obesity in school children. Twenty-eight children were obese at age 5 and upon reexamination at age 15, 16 were still obese (47%). Of the 69 obese 15-year-old girls examined, 24 were found to be obese at 10 years of age (39%). Hampton et al. (3) examined high school teenage girls and found that 91.4% of the 140 girls who were

classified as obese in the 12th grade were classified as obese in the 9th grade. The United States Health Examination Surveys examined 2177 children between the ages of 6 and 17 and reexamined them 3-4 years later (35). Results indicate that 68-77% of those classified as obese during the first examination were obese at the time of the reexamination. A nationwide study concerned with fatness classified 11-year olds into groups of fat, average, and thin and reinvestigated them when they were 15-years old (2). Fifty-nine percent who were originally classified as fat remained fat while only 10% of those originally classified as average and 1% of the thin girls, fit into the fat classification upon reexamination.

As can be seen, it appears as if the prognosis for juvenile obesity is poor. One must take into consideration when reviewing the above studies that the results only represent the study from which the information was taken and cannot be used to draw conclusions about the entire population. Also, the criteria for determining obesity is highly variable among the studies.

Factors Relating to Obesity: Kilocalorie Consumption and Activity

Energy intake and energy output always have been considered when discussing the etiology of obesity. These two factors ideally should be in equilibrium. Generally an increase in food intake or a decrease in activity will result in weight gain and if continued, obesity.

Results indicate that the obese do not consume significantly more kilocalories than the non-obese (5,27,40,47,48,49,50). In fact, the Iowa Department of Agriculture reported that only 4% of the obese

teenagers ate excessively (26). Eppright et al. (40) found that 12-year old obese girls consumed an average of 94 kilocalories fewer than the non-obese girls and the obese girls over 12 years of age consumed an average of 231 kilocalories fewer. One study indicated that the trend is the same for obese versus non-obese boys; however, the kilocalorie difference was much greater (51). Dietary recalls were used to collect data during the school year and at summer camp. During the school year, an average of 465 fewer kilocalories were consumed by the obese boys. While at summer camp a mean of 1227 fewer kilocalories were consumed by the same boys. It appears as if the boys were more conscious of their food intake at camp.

A decrease in energy output may be a factor contributing to an increase in body weight. The non-obese have been found to be involved in more active sports such as swimming, hiking, and bicycling while the obese picked less active sports or were found to spend more time watching television (27,50,51,52). Bullen et al. (53) appraised the physical activity of obese and non-obese girls with the use of a motion picture camera while the girls engaged in three sports. The obese were found to be far less active and to be standing or sitting more often than the non-obese; however, there may be problems with the validity of this study because the girls were aware that they were being photographed and this may have altered their activity.

Other researchers have found that there were no differences between the physical activity of the obese and non-obese (5,47,48).

Wilkinson et al. (5) hypothesized that the majority of the obese already reached an equilibrium and that food intake and exercise make little difference with their obesity.

CHAPTER III

METHODS

General Plan

The S-87 Regional Nutritional Project began in 1974 with approximately 120 preadolescent girls. The girls, who were 9.0±0.5 years of age at the beginning of the study, were selected from families living in Knox County, Tennessee. Informed written consent was obtained from parents or guardians. At the onset of the study approximately 50% of the girls were black and 50% were white. Subjects in two income categories with approximately 50% in each group were selected. Upper income was represented by families receiving $2,000 or more/person/year and lower income was represented by families with incomes of $1200 or less/person/year.

In 1975, 1976, and 1979 data were collected again on the girls. By 1979, 94 of the original group remained in the study. In 1981, data were collected from approximately 80 of the girls who now were 16.0±0.5 years of age. Approximately 40 12- and 14-year-old girls were chosen as the new subjects for collection of regional longitudinal data in subsequent years. This sample also was composed of 50% white and 50% black females. Of these white and black girls, 10-15% came from low income and high income categories.

Longitudinal data concerned with the persistence of obesity involved only the 80 16-year-old girls. The entire sample (120) was used for the dietary and activity data.

Weight

Weight was measured in kilograms with the use of a single beam balance.[1] Subjects were instructed to remove shoes and other clothing. Estimated nude body weight was calculated by subtracting the approximate weight of clothing, which was determined by weighing of similar articles, from the total body weight.

Height

Height was measured in centimeters with the use of a GPM Anthropometer.[2] Shoes were removed and the subject was instructed to place heels together and stand straight. A vertical bar was lowered to the crown of the head and height was measured.

Triceps Measurements

Triceps measurements were taken on both the right and left side of the body by a graduate student attending The University of Tennessee, Knoxville, who had been trained in anthropometric measurements. With the subject standing, the arm was bent to a 90 degree angle at the elbow. An EnSure Inser-tape from Ross Laboratories was placed from the lateral margin of the acromial process on the scapula to the tip of the olecranon. The midpoint was marked on the arm and circumference was measured in centimeters at this point with the Inser-tape. With the

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[1]Health-O-Meter Model 400 DHI. Continental Scale Corporation, Chicago, IL.

[2]GPM Anthropological Instruments. Siber Precision, Inc., 450 Barell Avenue, Carlstadt, NJ.

arm hanging at the side, the skinfold at the midpoint was lifted approximately 1 cm from the site of measurement and the calipers applied.[3] Three triceps skinfold measurements were taken and the average to the nearest 0.5 mm was recorded for both arms. Triceps measurements from the nondominate arm only will be considered hereafter because data from the previous years were recorded in this manner.

Triceps skinfold measurements were divided into three categories by using percentiles for triceps skinfold derived from the Ten State Nutrition Survey (54). Each girl's triceps measurement was coded by year and according to the age of the girl as follows: (1) triceps skinfold less than or equal to the 15th percentile of the Ten State Nutrition Survey sample, (2) triceps measurements falling between the 15th and 85th percentile, and (3) skinfold measurements greater than or equal to the 85th percentile as determined by the Ten State Nutrition Survey data. These percentiles will be referred to as the TS standards.

Obesity Index

The obesity index was formulated with the use of factor analysis. Factor analysis resolves complex relationships into the interactions of fewer and simpler forms (55). The variables height, weight, triceps circumference, and triceps skinfold were processed under a Statistical Analysis System (SAS) Proc Factor method with the number of factors limited to one. Weightings in relation to each other were determined

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[3] Lange Skinfold Caliper Catalog No. 120. Siber Precision, Inc., 450 Barell Avenue, Carlstadt, NJ.

and the value for the variables were multiplied by these weightings to give a number that represented the factor score.

The values were divided into quartiles. Each girl was coded for the years 1974, 1975, 1976, 1979, and 1981 with a 1, 2, 3, or 4 with 4 having the largest value and representing the most obese girls and 1 with the lowest values representing the thinnest girls.

Dietary Recalls

Two 24-hour recalls were obtained from each girl. The first recall was taken at the girl's school. The girls were taken out of class and were interviewed out of the hearing range of the other participants. Trained interviewers recorded the food consumed in household units, which were later converted to grams. Vitamin or mineral supplements taken also were recorded. Food models were used to help estimate portion sizes.

The second recall was taken at least two weeks after the first interview. This recall was taken at The University of Tennessee Hospital in the same manner as described above.

Diets were coded and nutrient composition was determined with the use of the Extended Table of Nutrient Values.[4] The average of the two recalls will be used in any future discussion.

Questionnaire Concerning Attitudes Toward Activity

The objective of this questionnaire was to note the attitudes the girls had toward physical activity or sports. Physical activity

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[4]Department of Experimental Statistics, Louisiana State University, Baton Rouge, LA.

was not defined, leaving the subjects to decide what they considered physical activity to be.

The questionnaire was adapted from an attitude questionnaire devised by Adams (56). An equal number of positive and negative questions were present. Two questions also were included which were concerned with whether the cause of obesity is due to excess food or a decrease in physical activity (see Appendix). The questionnaire was pilot tested in an 8th grade home economics class at Greenback Junior High School, Greenback, Tennessee. Questions which the girls had trouble answering or that were ambiguous were discarded. The questionnaire was administered at The University of Tennessee Hospital while the girls were waiting to donate blood and urine samples. Although most of the girls were in a large waiting room, they answered the questionnaire alone.

Results of the questionnaire were coded and subjected to factor analysis with the use of the Statistical Analysis System (SAS) package. Varimax rotation and maximum likelihood solution were specified as the options of the factor analysis. The statements with factor loadings that were significant (greater than ±0.40) were retained and the factor analysis was performed again. Statements were loaded on three factors; however, only two factors were interpretable and these were retained for further data analysis. Table 1 includes the statements which loaded on factor 1 and factor 2 and the subjective headings that were chosen. A total score for factors 1 and 2 for each individual was calculated by multiplying the coded response for each statement by the appropriate factor loading and summing the products.

TABLE 1

RESULTS OF FACTOR ANALYSIS FROM THE ATTITUDES TOWARD PHYSICAL ACTIVITY QUESTIONNAIRE

Factor 1 Importance and Enjoyment of Physical Activity	Loadings
I'm as physically active as my friends.	0.772
I participate in sports even if my friends may tease me.	0.756
One can lose weight by participating in sports.	0.694
Physical activity is growing in importance in our society.	0.652
Physical education classes are a pleasant break.	0.643
One reason I enjoy the weekends is that I can be active in sports to a greater extent than when I have classes all day.	0.632
Activity should be a part of my daily routine.	0.586
I enjoy participating in physical activity.	0.505
I like participating in physical activity on the weekends and after school.	0.481
Girls are overweight because they overeat.	0.479
I enjoy participating in a variety of sports.	0.454
Factor 2 Passive Attitude Towards Physical Activity	
Outside of PE class, I hardly participate in any physical activity.	0.796
I like the sports that require the least amount of effort.	0.721
I dislike physical activity.	0.597
I like very active sports.	-0.562
I enjoy participating in physical activity.	-0.532
I'd rather observe sports than participate.	0.526
I'd rather watch TV or read than participate in sports.	0.524
I enjoy participating in a variety of sports.	-0.513
Physical activity is boring to me.	0.466
My physical appearance prevents me from participating in some physical activities.	0.419

Activity Questionnaire

A number representative of activity output was obtained with the use of an activity questionnaire adapted from Taylor et al. (57) and modified by the S-150 Technical Committee. The activity data were obtained by trained interviewers on the same day the dietary recall was taken at the schools. The girls were questioned on their participation in 19 activities over the past year. A miscellaneous category also was included. The subjects were asked if they participated in the activity seasonally (less than 6 months of the year); yearly, monthly, or weekly; the number of minutes participated; and the intensity in which they participated in the activity. If the subject responsed that she participated weekly, the number of days per week was recorded.

A total score was formulated by adding the coded numbers for seasonally (1--less than 6 months, 2--more than 6 months), frequency within the year (1--yearly, 2--monthly, and 3--weekly), and the level of activity for the sport as determined by kilocalories expended per hour of activity according to Guthrie (58), Pike and Brown (59), and Whitney and Hamilton (60) (1--light, 2--moderate, and 3--heavy).

Statistical Analysis

Statistical analysis was performed with the use of the Statistical Analysis System (SAS) developed by Barr et al. (61). One-way analysis of variance was performed among kilocalorie consumption and the obesity index quartiles and the three groups differentiated by the triceps skinfold measurement. Analysis of variance also was used to note differences between the activity output and the obesity index quartiles and the three triceps skinfold groups. Once again analysis of variance

was performed for each factor score obtained from factor analysis of the activity attitudes questionnaire and the obesity index quartiles. The three groups of individuals obtained from triceps skinfold measurements were analyzed also using the same method.

Chi square statistic was performed among the following four cells: individuals that were in the 4th obesity index quartile at 9 years of age, those who were in the 1st, 2nd, or 3rd quartile at 9 years of age, the individuals in the 4th obesity index quartile at 16 years of age, and those in the 1st, 2nd, or 3rd quartile at 16 years of age. Spearman's correlation coefficient also was calculated among these groups.

Spearman's correlation was calculated among the years for each individual to note if the girl's obesity index quartile and triceps category deviated significantly throughout the years. Spearman's correlation also was calculated between the obesity index quartile the girl was in, and the triceps skinfold category the girl was in for the same year. Spearman's correlation coefficient was used because the data was ranked rather than continuous (62).

CHAPTER IV

RESULTS

The incidence of obesity, as defined as a triceps skinfold greater than or equal to the 85th TS standard (54) is shown in Table 2. Incidences of obesity range from 17% of the sample when the girls were 10 years of age to 27% of the sample when the girls were 11 years old. Also shown is the thinner group of the sample having triceps skinfold measurements less than or equal to the 15th TS standard (54). In 1976, or when the girls were 11 years of age, only 8% of the sample met this criteria while 11% of the sample did when the girls were 9 years of age.

Various statistics were employed to determine if an individual who was classified as obese at 9 years of age still was classified as obese at age 16. The data in Table 3 indicates the percentage of individuals who were classified in the 4th quartile at 9 years of age and remained in the 4th at 10, 11, 14, and 16 years of age as determined by the chi square statistic. Approximately 88% of the individuals who were obese at age 9 were still obese at 11 years of age. By 16 years of age, 71% of those who were obese at age 9 remained obese. Results for each year were significant at $p \leq 0.01$ according to Spearman's correlation coefficients. Also shown in Table 3 is the percentage of individuals who remained in the 1st, 2nd, or 3rd quartile as a reflection of their status at 9 years of age. Of the sample classified in the 1st, 2nd, or 3rd quartile at 9 years of age, 95% remained in these quartiles at 11 years of age. The percentage at age 16 dropped to 87% of the sample.

TABLE 2

PERCENT OF SAMPLE WITH TRICEPS SKINFOLD MEASUREMENTS
≥ 85TH PERCENTILE AND ≤ 15TH PERCENTILE

Year	Age Years	Percentile ≤15 %	Percentile ≥85 %
1974	9 (80)	11	19
1975	10 (78)	10	17
1976	11 (79)	8	27
1979	14 (78)	9	19
1981	16 (80)	9	19

[1] Triceps skinfold measurements used as percentile criteria were obtained from Frisancho, A. R. (1974) Am. J. Clin. Nut. 27, 1052-1058. Numbers in parentheses are the number of subjects.

TABLE 3

PERCENT OF INDIVIDUALS REMAINING IN THE SAME OBESITY INDEX QUARTILE AS A REFLECTION OF THEIR CLASSIFICATION WHEN 9 YEARS OLD[1]

Age Years	4th Quartile %	1st, 2nd, or 3rd Quartile %
10 (78)	72	90
11 (79)	88	95
14 (75)	75	93
16 (80)	71	87

[1]Numbers in parentheses are the number of subjects. Percentages all were significant at $p \leq 0.01$ as determined by Spearman's correlation coefficient.

Data in Table 4 indicate the percentage of individuals who had a triceps skinfold greater than or equal to the 85th TS standard at 9 years of age and remained in this category at 10, 11, 14, and 16 years of age. Approximately 93% of those individuals with triceps skinfold measurements greater than or equal to the 85th TS standard at 9 years of age, fell into this same category at 11 years of age (significant at $p \leq 0.01$). Forty percent of those individuals who were classified as obese at 9 years of age still were classified as obese by age 16 (significant at $p \leq 0.05$ as noted by Spearman's correlation coefficient). Data in Table 4 also show the percentage of individuals who had triceps skinfold measurements less than the 85th TS standard at age 9 and those remaining in this group at 10, 11, 14, and 16 years of age. As high as 94% of the sample that had triceps skinfold measurement of less than the 85th TS standard at 9 years of age remained in this category at 10 years of age. The percentage at age 16 dropped to 85% of the sample.

The data in Table 5 illustrate the correlation coefficients among the obesity index quartiles for each age. The correlation coefficients were significant ($p \leq 0.01$) for every age but were highest for the ages that were consequetive.

The data in Table 6 display the correlation coefficients among the triceps skinfold groups for each age. This statistic examined all the quartiles grouped together. The correlations were highly significant ($p \leq 0.01$) for all ages except for age 16. Correlation of the triceps groups at 9 years of age with the triceps groups at 16 years of age was the lowest ($r=0.27$).

TABLE 4

PERCENT OF INDIVIDUALS REMAINING IN THE SAME TRICEPS SKINFOLD CATEGORY AS A REFLECTION OF THEIR CLASSIFICATION WHEN 9 YEARS OLD[1]

Age Years	Percentile <85 %	Percentile ≥85 %
10 (78)	94[a]	60[a]
11 (79)	89[a]	93[a]
14 (75)	85[b]	36
16 (80)	85[b]	40[b]

[1] Numbers in parentheses are the number of subjects. Percentages are significant at $p \leq 0.05$ = a or $p \leq 0.01$ = b as determined by Spearman's correlation coefficient.

TABLE 5

SPEARMAN'S CORRELATION COEFFICIENTS FOR ALL OBESITY INDEX QUARTILES[1]

Age (Years)	9	10	11	14
10	0.89 (78)			
11	0.91 (79)	0.91 (77)		
14	0.77 (75)	0.80 (73)	0.81 (74)	
16	0.56 (80)	0.59 (78)	0.59 (79)	0.74 (77)

[1] Numbers in parentheses are the number of subjects. All correlations were significant at $p \leq 0.01$.

TABLE 6

SPEARMAN'S CORRELATION COEFFICIENTS FOR ALL TRICEPS SKINFOLD GROUPS[1]

Age (Years)	9	10	11	14
10	0.62 (78)			
11	0.71 (79)	0.71 (77)		
14	0.35 (75)	0.64 (73)	0.48 (74)	
16	0.27 (80)	0.38 (78)	0.30 (79)	0.54 (77)

[1]Numbers in parentheses are the number of subjects. All correlations were significant at $p \leq 0.01$.

Correlation coefficients also were calculated between the obesity index quartiles and the three groups obtained from the triceps skinfold measurements (Table 7). For every year, the correlation coefficients were highly significant ($p \leq 0.01$) between the two methods of classifying the girls as "obese, normal, or thin."

Mean kilocalorie consumption for the two days is shown in Table 8. The girls with triceps greater than or equal to the 85th TS standard consumed significantly fewer kilocalories than the other girls ($p \leq 0.05$). Also shown is the kilocalorie consumption of the girls in the different obesity index quartiles. The girls in the 4th quartile or the obese group consumed significantly fewer kilocalories than the girls in the 1st quartile ($p \leq 0.01$) on the two days recalled.

Least squared means were obtained for the raw scores from the activity questionnaire (Table 9). No significant differences were found among the three triceps groups or among the obesity index quartiles; however, there was a trend toward a decrease in the raw activity score as triceps skinfold measurements increased or as the quartile the girls were in increased.

There were no significant differences among the mean scores for the three groups of triceps skinfold for factor 1 and factor 2 (Table 10). There also was no significant difference among the obesity index quartiles' mean score for either factor.

TABLE 7

SPEARMAN'S CORRELATION COEFFICIENTS BETWEEN OBESITY INDEX QUARTILES AND TRICEPS SKINFOLD GROUPS[1]

Years	Approximate Age of Subjects Years	Correlation Coefficients
1974 (80)	9	0.62
1975 (78)	10	0.61
1976 (79)	11	0.68
1979 (77)	14	0.67
1981 (80)	16	0.61

[1] Numbers in parentheses are the number of subjects. All correlations were significant at $p \leq 0.01$.

TABLE 8

MEAN KILOCALORIES + STANDARD DEVIATION CONSUMED BY GIRLS 12, 14, AND 16 YEARS OF AGE IN THE DIFFERENT TRICEPS SKINFOLD GROUPS AND OBESITY INDEX QUARTILES[1]

Triceps Skinfold Percentiles	Kilocalories ± Std. Dev.	Obesity Index Quartiles	Kilocalories ± Std Dev.
≤15th	2382 ± 838[a] (14)	1	2470 ± 778[c] (28)
		2	1969 ± 677[cd] (33)
Between 15th and 85th	2089 ± 710[a] (80)	3	2095 ± 731[cd] (27)
≥85th	1726 ± 640[b] (26)	4	1706 ± 559[d] (32)

[1] Numbers in parentheses are the number of subjects. Means within the columns with different superscripts are significantly different. a or b = $p \leq 0.05$; c or d = $p \leq 0.01$.

TABLE 9

MEANS FOR ACTIVITY LEVEL SCORES FOR TRICEPS SKINFOLD GROUPS AND OBESITY INDEX QUARTILES OF GIRLS 12, 14, AND 16 YEARS OF AGE

Triceps Skinfold Percentile	Activity Score	Obesity Index Quartile	Activity Score
≤15th	51.90 ± 5.00 (14)[1]	1	53.27 ± 3.32 (28)
		2	45.96 ± 2.99 (33)
Between 15th and 85th	47.27 ± 1.93 (80)	3	47.54 ± 3.32 (27)
≥85th	44.44 ± 3.95 (26)	4	42.64 ± 3.32 (32)

[1]Least square means ± standard error. Numbers in parentheses are the number of subjects.

TABLE 10

FACTOR ANALYSIS SCORE OF ATTITUDES TOWARD ACTIVITY QUESTIONNAIRE FOR THE TRICEPS SKINFOLD GROUPS AND OBESITY INDEX QUARTILES OF GIRLS 12, 14, AND 16 YEARS OF AGE

Triceps Skinfold Percentile	Factor 1	Factor 2
<15th	5.074 ± 1.005 (11)[1]	1.782 ± 0.708 (11)
Between 15th and 85th	5.478 ± 0.931 (63)	1.244 ± 0.895 (63)
≥85th	5.196 ± 1.381 (19)	1.364 ± 0.991 (19)
Obesity Index Quartile	**Factor 1**	**Factor 2**
1	5.400 ± 0.756 (22)	1.468 ± 0.819 (22)
2	5.498 ± 0.858 (25)	1.528 ± 0.929 (25)
3	5.247 ± 1.354 (18)	1.155 ± 0.999 (18)
4	5.320 ± 1.199 (28)	1.166 ± 0.878 (28)

[1]Values are mean scores ± standard deviation. Numbers in parentheses are the number of subjects.

CHAPTER V

DISCUSSION

The incidence of obesity was highest in 1976 when the girls were 11 years old, with 27% of the sample classified as obese and only 8% of the sample having a triceps skinfold measurement less than or equal to the 15th TS standard (Table 2, page 20). The incidences of obesity at 9, 10, 14, and 16 years of age are approximately the same with variation only at 11 years of age. This high incidence rate may be partially due to an increase in fat that usually is laid down at the beginning of puberty (9,63). Young et al. (63) reported an increase in mean triceps skinfold measurements from 13.9 mm when the girls were 11 years old to 16.3 mm when the measurements were taken at age twelve. Total skinfold for 12 sites increased from 121.3 mm when the girls were 11 years to 142.4 mm for the girls when they were 12.

In 1981, 19% of the 16-year-old girls were classified as obese. This indicates that almost 20% of the 16-year olds were obese while only 9% of the girls had a triceps skinfold measurements in the lowest 15th TS standard. Eppright et al. (40) reported that the incidence of obesity among 15-18-year old girls in Iowa was as high as 27%. However, other researchers reported smaller percentages, 12-17%, as being obese (2,3,41). It should be noted that the incidence reflects the method used to classify the subject as obese, and this may be the primary factor in the diversity among percentages.

The persistence of obesity into adulthood is one of the most serious consequences of juvenile obesity. The persistence of obesity was examined as a function of the obesity index. The data in Table 3, page 21, illustrate the percentage of girls who remained obese as a reflection of being obese when they were 9 years old. According to this means of classifying the girls as obese, the percentages of girls remaining obese throughout the examination period are highly significant. The highest percentage was observed when the girls were 10 years of age, with 88% remaining obese over the 1-year period. This figure and the lowest percentage reported, 72% for 10-year olds, are related to the incidence of obesity recorded for those years (Tables 2 and 3, pages 20-21). With the lower incidence rate, it is likely that some of the obese girls dropped into a lower quartile.

Of the girls that were classified as obese according to the obesity index at 9 years of age, 71% were still obese at age 16 or 7 years later. This figure compares with the 40% that remained obese according to the girls' triceps skinfold measurements. The variance among the percentages could be due to the smaller number of obese individuals that were in the most obese triceps group. The higher percentage recorded with the obesity index method also may be a direct reflection of weight. In the formulation of the obesity index, triceps skinfold measurements were a major component of the index, and obviously another component of the index must have influenced the higher percentages recorded with the obesity index. Weight may be the main contributing factor. The increased percentage of those remaining obese according

to the obesity index when age 10 as compared with age 16, reflects the girls who remained overweight throughout the years. It should be noted that the highest percentages of persistence in the literature were obtained by examining a measurement of the individual's weight rather than a combination of factors (43).

A very high percentage of the girls remained in the 1st, 2nd, or 3rd quartile over the 7-year period (Table 3, page 22). This suggests that only a small percentage (13%) of the girls who were normal or thin when they were 9 became obese during the 7 years. This contrasts with the 71% that remained obese.

The data in Table 4, page 23, reveal the percentage of girls remaining obese, according to triceps skinfold measurements, as a reflection of age 9. The percentage of girls remaining obese in most cases decreased as the girls got older; however, the values still are significant ($p \leq 0.05$) except when the girls were 14 years of age. Apparently, at age 14 some of the girls' triceps skinfold measurements fell below the 85th TS standard, but upon reexamination 2 years later the percentage increased to 40%.

In 1976, or when the girls were 11 years old, 93% of those classified as obese at age 9 were still obese. This extremely high percentage probably is due to the high incidence of obesity that was recorded at 11 years of age (Table 2, page 20). By 1981, or 7 years later, 40% of the girls who were obese at 9 still were considered obese. Although there were no studies in which girls were examined initially at the same ages of the present study and reexamined after 7 years, the reported values in the literature are

comparable at these ages (2,3,35,46). Asher (46) who examined girls at 10 years of age, found that 39% of these girls were obese at age 15.

A very high percentage of the 9-year-old girls with triceps skinfold measurements less than the 85th TS standard remained in this category throughout the 7 years (Table 4, page 23). This indicates that if a girl is in the thin or normal range when 9 years old, there is a good chance that the girl will remain in this category. Only 15% of the normal or thin girls became obese in the 7-year period, while 40% of the obese girls remained obese.

Examining all the individuals together rather than just the obese, the data in Table 5, page 24, depict how well the girls remained within the same obesity index quartiles. The high correlations reflect that many girls are remaining in the same quartiles. All the correlations were highly significant ($p \leq 0.01$); however, they do decrease as the girls' ages between correlations increase. In most cases, the highest correlations were found for the ages that were consecutive.

The highest correlation for remaining in the same category at age 16 for the obesity index was at age 14. The girls remained in the same obesity index quartiles between these 2 years much more than any other years. Of the early years when the girls were 9, 10, and 11, 11 years of age (1976) best reflects the quartiles the girls ended up in when they were 16 years old. The correlation between 10 years of age and 16 years of age is not much lower than the above correlation; therefore, according to this study, the obesity index at age 10 is the earliest representative predictor of the quartile the girl will be categorized in at age 16.

The triceps skinfold correlations for each year follow the same approximate pattern as the obesity index quartiles; however, correlations and the levels of probability are lower (Table 6, page 25). Once again, the closer the years are to each other, the more significant the correlation is. Of the years when the girls were 9, 10, or 11, 11 years of age best reflects which TS standard the girls were categorized in when they were 16 years of age. The lower correlation coefficients could be due to the smaller number of girls in the two extreme groups (thin and obese girls) and the large number of girls in the middle or "normal" group. Also, this method is dependent on one measure and is influenced more easily than the obesity index which is made up of four variables.

Due to the two methods of classifying the girls, correlations were performed to see if the same girls were classified as "obese, normal, or thin" by both methods (Table 7, page 27). Correlations were highly significant ($p \leq 0.01$) for each year, thereby indicating that the girls were classified approximately the same by both methods.

Triceps skinfold measurements have been used widely to assess body fat. Correlation coefficients for triceps skinfold measurements with methods for assessing body fat range from 0.49 (total body water) (63) to 0.93 (total body fat and relative weight) (9). Although the correlations represented in Table 6, page 25, consider the total sample of individuals, the obesity index may have the potential to be used as a predictor of obesity. The obesity index takes into account four variables that all are related to the degree of obesity. This method

may not be the ultimate measurement of obesity but does take into consideration four important factors while the triceps skinfold measurement only considers one. In addition, the obesity index also may be used with different age groups. Further research should be instituted to compare the obesity index with laboratory methods of assessing body fat.

No more than 15 years ago, obesity was considered a problem that was caused by overeating and lack of self-control (64). Research intervened and showed that the obese do not necessarily consume more kilocalories than the non-obese. In the present study, it was found that the obese (girls with triceps skinfold measurements greater than or equal to the 85th TS standard) consumed significantly fewer kilocalories than the girls with triceps skinfold measurements less than or equal to the 15th TS standard (Table 8, page 28). The girls in the 4th obesity index quartile consumed significantly fewer kilocalories than the girls in the 1st obesity index quartile. Both methods exhibit what is now in the literature in that the obese consume fewer kilocalories than the control groups (3,40,50,51,65) or that there is no difference between the control groups and obese groups in kilocalorie consumption (5,27,47,48,49).

Although the number of individuals classified as obese differ for the two methods, the kilocalorie consumption by both obese groups are approximately the same. The thinner girls, as determined by both methods, also consumed approximately the same number of kilocalories. This comparison illustrates that the 4th quartile of the obesity index represents a larger number of obese girls in the sample population that

have a low kilocalorie consumption as compared with the number with triceps skinfold measurements above or equal to the 85th TS standard.

It should be pointed out that the dietary recalls were kept for only 2 days of the entire year and may or may not be representative. Most subjects knew when the second recall would be taken and may have altered their intake in anticipation of the recall. These limitations partially may be responsible for differences. However, Madden et al. (66) compared observed intakes with 24-hour recalls on the same individuals and concluded that if a difference is detected between two groups, the researcher can be almost certain that a difference does actually exist and in fact, the difference may be greater than observed.

Another factor that may contribute to obesity is a decrease in physical activity. No significant differences were found among the groups (as determined by triceps skinfold measurements or by the obesity index quartiles) for activity levels (Table 9, page 29). There is, however, a general trend for the activity level to decrease as the girls are more obese.

Reports in the literature indicate that the obese do not choose the more strenuous activities but tend to pick the more sedentary ones. In the case of the present activity questionnaire, a total score was calculated and every activity, even walking, was taken into account. Not as much emphasis was placed on the lighter activities; however, they were included. If a more sensitive questionnaire had been employed, the results may have been more discriminating and may have indicated significant differences.

Because two of the factors that have been implicated in the onset and treatment of obesity, high kilocalorie consumption and a decrease in energy output, were shown not to differ between the obese and the thin girls, other factors not considered in this study may be instrumental in the development of obesity. Hereditary factors (13), emotional factors (5-7), or metabolic factors, in which the obese individual is more energy efficient than the thin or normal individual (67-69), have been linked to obesity in laboratory animals and in humans. These factors are very difficult to measure quantitatively in humans; however, they should be given consideration during intervention periods.

Although no questionnaire concerned with the attitudes toward physical activity was found in the literature, an attempt was made to observe if there were any differences in the mean scores for attitudes toward activity of the "thin, normal, and obese" girls. No significant differences for factor 1 were found among the means of the triceps skinfold groups; however, the "normal" group had the highest mean score (Table 10, page 30). Factor 1 represented the concept of enjoying activity and feeling that physical activity is important. Therefore, the girls with the "normal" triceps skinfold measurements were the most positive toward this concept, with the thin girls and the obese girls not feeling that this is as important.

Factor 2 represented a passive attitude toward physical activity. Once again there was no significant difference among the means; however, the girls with the "normal" triceps skinfold measurements had the lowest mean. This indicates that these girls had the least passive attitude toward physical activity. The thinner girls had the most passive

attitude; however, this contradicts their raw activity level score (Table 9, page 29). The obese girls had a mean that was closer to the "normal" girls suggesting that their attitudes toward physical activity were not as passive as the thin girls. This also contradicts their raw activity level score (Table 9, page 29) which was the lowest of all groups.

Various explanations may be cited to explain these discrepancies. One explanation could be the problem previously mentioned with the activity questionnaire not being very discriminating. Another possible problem is that the activity questionnaire was taken by the recall method and some girls may exaggerate their actual activities. The obese may think they participate in activity to a higher degree than they actually do.

There were no significant differences among the mean scores for factor 1 when examining the obesity quartiles. The thinner girls did have a higher score indicating a more positive attitude toward the importance and enjoyment of physical activity with the obese girls not having as strong an attitude.

The girls in the 1st and 2nd quartiles scored higher on factor 2 than did the girls in the 3rd and 4th quartiles. This indicates that while the thinner girls had a more positive attitude toward factor 1, they also had a more passive attitude toward physical activity. The obese girls, on the other hand, scored lower on both factor 1 and factor 2 than did the girls in the 1st and 2nd quartiles. These results describe a lower passive attitude toward physical activity for the obese girls while also having a lower score on the attitude toward the importance and enjoyment of physical activity. It is obvious that these results conflict; however, no explanation can be found.

CHAPTER VI

SUMMARY

Triceps skinfold measurements greater than or equal to the 85th TS standard (54) or location of the girl in the 4th quartile of the obesity index were the 2 methods used to classify which portion of the sample was obese. According to these 2 methods, the persistance of obesity over a 7-year period and incidence of obesity for girls at 9, 10, 11, 14, and 16 years of age were investigated. Kilocalorie consumption, activity levels, and attitudes towards physical activity also were investigated to note if any differences were present due to a girl being obese.

The tendency for the girls to remain obese differed according to which method of classification was used. The persistance of obesity decreased as the time between examinations increased, although a significant relationship still existed at age 16. Forty percent of the girls who had triceps skinfold greater than or equal to the 85th TS standard (54) when 11 years old remained in this category when re-examined at 16 years of age. A higher percentage (71%) remained in the 4th obesity index quartile from 9 years-16 years of age.

The girls with triceps skinfold measurements greater than or equal to the 85th TS standard (54) consumed significantly fewer kilocalories than the girls with measurements less than or equal to the 15th TS standard ($p \leq 0.05$). The girls in the 4th obesity index quartile consumed significantly fewer kilocalories than the girls in the 1st obesity index quartile ($p \leq 0.01$).

There were no significant differences for activity levels among the triceps groups; however, the obese girls did have the lowest mean activity score. There also were no significant differences among the attitudes toward physical activity in the various groups.

Due to the persistence of obesity throughout the adolescent period, intervention should begin at childhood. If a child becomes obese at an early age, it is very likely that this obesity will persist through adolescence and even into adulthood.

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APPENDIX

Department of Nutrition and Food Science
The University of Tennessee, Knoxville

QUESTIONNAIRE CONCERNING ATTITUDES TOWARD ACTIVITY

Subj. Name_____
Subj. No._____
Date_____

Directions: The following are some statements concerning physical activity. Circle the answer that best expresses the way you feel toward each statement.

1. I enjoy participating in physical activity.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

2. My physical appearance prevents me from participating in some physical activities.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

3. Only thin people can do very well in sports.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

4. I enjoy participating in a variety of sports.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

5. I think physical activity is a good thing for me.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

6. I like very active sports.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

7. Activity should be a part of my daily routine.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

8. One can lose weight by participating in sports.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

9. I dislike physical activity.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

10. Physical activity is growing in importance in our society.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

11. Outside of PE class, I hardly participate in any physical activity.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

12. Girls are overweight because they don't exercise enough.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

13. I like the sports that require the least amount of effort.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

14. Increasing my physical activity will not affect my weight.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

15. Physical activity is boring to me.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

16. I'd rather observe sports than participate.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

17. Overweight girls are capable of doing well in sports.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

18. Physical activity interests only a few people.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

19. I like participating in physical activity on the weekends and after school.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

20. My friends participate in sports much more than I do.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

21. One reason I enjoy the weekends is that I can be active in sports to a greater extent than when I have classes all day.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

22. We should not be expected to take PE in high school.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

23. Physical education classes are a pleasant break.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

24. I'm as physically active as my friends.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

25. I participate in sports even if my friends may tease me.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

26. I'd rather watch TV or read than participate in sports.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

27. Girls are overweight because they overeat.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

28. Physical activity is a waste of time.

Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree

TABLE A-1

MEAN ± STANDARD DEVIATIONS OF HEIGHT, WEIGHT, TRICEPS CIRCUMFERENCE, AND TRICEPS SKINFOLD FOR GIRLS AT 9, 10, 11, 14, AND 16 YEARS OF AGE[1]

Age	Height	Weight	Triceps Circumference	Triceps Skinfold
years	cm	kg	cm	mm
9 (80)	134±6	31.6±6.8	20.5±2.5	12.5±5.2
10 (78)	140±6	35.1±7.5	21.2±2.9	16.0±6.3
11 (79)	147±7	40.9±8.9	22.7±3.4	17.5±7.1
14 (78)	160±6	55.0±10.0	25.5±3.6	17.1±6.8
16 (80)	161±6	58.1±11.3	26.1±3.7	18.0±6.9

[1]Numbers in parentheses are the number of subjects.

TABLE A-2

MEAN ± STANDARD DEVIATIONS OF FACTOR SCORES FOR OBESITY INDEX QUARTILES FOR GIRLS AT 9, 10, 11, 14, AND 16 YEARS OF AGE[1]

Age	Obesity Index Quartiles			
	1	2	3	4
years				
9	-1.104±0.364 (21)	-0.486±0.168 (21)	0.152±0.203 (20)	1.357±0.790 (18)
10	-1.064±0.287 (23)	-0.528±0.155 (17)	0.176±0.281 (19)	1.393±0.653 (17)
11	-1.119±0.303 (24)	-0.436±0.187 (18)	0.167±0.215 (17)	1.398±0.671 (18)
14	-0.994±0.295 (20)	-0.470±0.102 (19)	0.105±0.258 (20)	1.316±0.942 (16)
16	-1.140±0.439 (14)	-0.400±0.137 (27)	0.103±0.184 (19)	1.313±0.775 (20)

[1]Numbers in parentheses are the number of subjects.

TABLE A-3

MEAN ± STANDARD DEVIATIONS OF TRICEPS SKINFOLD MEASUREMENTS WITHIN PERCENTILE CATEGORIES FOR GIRLS AT 9, 10, 11, 14, AND 16 YEARS OF AGE[1]

Age	Triceps Skinfolds		
	≤15th	Between 15th and 85th	≥85th
years	mm	mm	mm
9	6.4±0.9 (9)	12.0±2.4 (56)	22.0±5.3 (15)
10	7.0±1.3 (8)	13.6±2.6 (57)	25.4±5.6 (13)
11	7.2±0.8 (6)	14.3±2.8 (52)	26.6±6.4 (21)
14	7.4±1.6 (7)	15.0±2.5 (56)	28.2±6.7 (15)
16	8.8±1.5 (7)	16.2±3.2 (58)	27.7±6.7 (15)

[1]Numbers in parentheses are the number of subjects.

VITA

Carol A. Costello was born in St. Petersburg, Florida on August 8, 1958. She attended elementary school in Pinellas County and graduated from Dixie Hollins High School in June of 1976. The following September she entered Florida State University in Tallahassee, Florida and completed her Bachelor of Science degree in Nutrition in March of 1980. The following June she began graduate studies at The University of Tennessee, Knoxville, with a major in nutrition. During her graduate program she served as an Agriculture Experiment Station research assistant and a teaching assistant in the Department of Nutrition and Food Sciences. In June 1982, she received her Master of Science degree with a major in nutrition.