INFLUENCE OF PHYSICAL ACTIVITY AND OTHER VARIABLES ON BODY COMPOSITION MEASUREMENTS OF ADOLESCENT FEMALES IN OKLAHOMA

By

LUANN LAURICE SOLIAH

Bachelor of Science
North Dakota State University
Fargo, North Dakota
1978

Master of Science
Kansas State University
Manhattan, Kansas
1980

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
May, 1985

INFLUENCE OF PHYSICAL ACTIVITY AND OTHER VARIABLES ON BODY COMPOSITION MEASUREMENTS OF ADOLESCENT FEMALES IN OKLAHOMA

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGMENTS

The author would like to express her sincere gratitude to Dr. Esther Winterfeldt for her guidance and assistance in the course of this study. Grateful appreciation is also expressed to the other committee members, Dr. William Warde, Dr. Lea Ebro, and Dr. Marguerite Scruggs, for their advice during the duration of my graduate program. Thanks are also due to Dr. Mary Alice Kenney for her help in providing direction during the initial phases of the research.

Greatest appreciation is reserved for my parents, Mr. and Mrs. Maurice Soliah, in acknowledgment of their constant encouragement and loving support. To my brother, Marvin M. Soliah, sincere thanks is extended for his concern and interest in my career.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Obesity is a major nutritional problem in developed countries (Meyer and Neumann, 1977). Several chronic health problems have been directly related to obesity (Buskirk, 1974; Mallick, 1983). Although many of these serious medical problems are deferred to adult life, a significant proportion of adult obesity has its origins in childhood or adolescence (Zack, Harlan, Leaverton, and Cornoni-Huntley, 1979). Between three and 13 percent of children and teenagers in America are obese (Meyer and Neumann, 1977); and in the absence of an intentional alteration in their exercise and/or dietary patterns, most will become overweight adults (Mayer, 1975).

Obesity is generally acknowledged to be the result of an imbalance between energy expenditure and energy intake (Gwinup, 1975). When treating obesity, however, the major emphasis has been traditionally placed on decreasing energy intake, and little attention has been given to increasing energy expenditure (Gwinup, 1975). While it is true that some obese persons overeat, studies have shown that many eat less than their leaner counterparts; and they are far less physically active (Johnson, Burke, and Mayer, 1956; Bullen, Reed, and Mayer, 1964; Mayer, 1968; Gwinup, 1975). Therefore, when assessing adolescents, it is necessary to collect dietary information as well as physical activity information (Hager, 1981).

Exercise with caloric restriction offers several important advantages over caloric restriction alone. FIrst, vigorous exercise programs have resulted in the reduction of body fat stores (Lewis, Haskell, Wood, Manoogian, Bailey, and Peretra, 1976; Botvin, Cantlon, Carter, and Williams, 1979; Leon, Conrad, Hunninghake, and Serfas, 1979), as opposed to water loss or extensive loss of vital lean tissue which can occur with "crash" or "fad" diets, fasting, or low carbohydrate diets (Fineberg, 1972). Second, exercise improves the function of the cardiorespiratory and muscular systems (Franklin and Rubenfire, 1980). Third, physical activity and recreational games can be enjoyable leisure time activities, whereas few people enjoy dieting (Franklin and Rubenfire, 1980).

In addition to physical inactivity, many other environmental factors affect body fatness and body weight status. These include socioeconomic status (SES), energy intake, race, age, dieting habits, and the educational level of the parents (Malina, 1971; Garn, 1975; Garn and Clark, 1976; Kohrs, Wang, Eklund, Paulsen, and O'Neal, 1979; Frisch, 1980).

Significance of the Problem

Recently there has been greater interest in the effects of increased physical activity on body composition and body weight of adult men and women (Lewis et al., 1976; Leon et al., 1979; Baecke, Van Staveren, and Burema, 1983). However, there is a paucity of published information on the exercise patterns of adolescent females and cross-sectional data are needed to determine the extent to which physical activity or weight maintenance programs are being practiced among teenagers. Likewise, more information is needed on the influence which these patterns have on body composition and body weight of adolescent females.

More information is also needed on the prevalence of obesity among teenage girls in relation to their environmental and demographic characteristics (Dietz and Gordon, 1981). The social environment, and more specifically the family environment, needs to be examined to clarify which characteristics may be correlated with obesity.

Relatively little is known about the effects of various sources of dietary energy and dieting habits on the development of obesity (Dietz and Gordon, 1981; Morgan, Johnson and Stampley, 1983). Viewed broadly, the current knowledge base suggests that the problem of obesity cannot be based only on the frequencies of a few characteristics, but rather on a host of factors which play a role in the genesis of obesity (Dietz and Gordon, 1981; Brownell, 1984).

Problem Statement

One major problem in nutritional assessment is the difficulty of correlating energy output, reported dietary energy intake, and fatness. There is a theoretical basis for expecting a relationship based on physical laws of energy conservation. Yet, findings of studies designed to verify the relation are contradictory (Garrett, Pangle, and Mann, 1966; Byrd, Smith, and Shackleford, 1974; Johnson, Stone, Alfredo-Lopez, Hebert, Kilgore, and Byrd, 1982). Nevertheless, if the relationship between energy output, dietary energy intake, and fatness could be established, there would be several potential benefits for treatment, nutrition education, and prevention of obesity.

Purpose and Objectives

The purpose of this study was to examine the influence of three

different levels of physical activity (high, medium, and low) on (1) the body weight status of subjects and (2) body composition, estimated from measurements of triceps skinfold thickness and arm circumference. Also, other variables such as SES, energy intake, race, age, dieting habits, and the educational level of the parents, were examined to determine if they had an influence on body weight status. Triceps skinfold, weight, body weight for height, and arm circumference data were ranked to determine if relative peer positions were consistent across these variables.

To further understand the relationship between physical activity and body composition, subjects from a nearby 4-H club of known and different physical activity levels (high, medium, and low) were contacted and asked to keep an activity diary for three days. The diary was then compared to their responses on a physical activity recall.

Race, age, SES, dieting habits, energy intake, and the educational level of the parents were also examined to determine and account for their effects on body composition. None of the above variables, when used alone, may provide reliable relationships to body status. Consequently, combinations of measures were evaluated to gain a better understanding of the relationship.

Specifically, the objectives of this study were:

1. To relate various levels of physical activity to parameters derived from body weight, height, triceps skinfold, and arm circumference measurements of adolescent females.

2. To compare peer ranks for triceps skinfold, weight, arm circumference, and body weight for height data.

3. Two different formats (recall and diary) were used to compare the measurement of physical activity; subjects were classified per activity category (high, medium, or low) for both forms.

4. To develop a predictive formula for body composition including the influence of the following variables: physical activity, age, dieting habits, educational level of parents, race, SES, and energy intake.

Hypotheses

The following hypotheses were formulated for this study.

Hypothesis 1: There will be no significant relationship between various levels of physical activity and body weight, height, triceps skinfold, and arm circumference measurements of adolescent females.

Hypothesis 2: A comparison of peer ranking of triceps skinfold, weight, arm circumference, and body weight for height ranks will not be significant.

Hypothesis 3: Two methods of estimated activity will lead to the classification of subjects in the same activity category.

Hypothesis 4: There will be no significant relationship between body composition and any of the demographic, physical activity, heredity, or dietary intake variables.

Assumptions

The following assumptions were recognized in this study:

1. The information obtained by interviewing the subjects and their parents was correct.

2. The 24-hour food intake recalls were accurate and complete.

3. Energy expenditure of adolescent females was accurately estimated from physical activity interviews and/or diaries.

Limitations

The following limitations were recognized:

1. The sample was an invited sample within a 70-mile radius of Stillwater, rather than a random sample from throughout Oklahoma; thus the generalizations will be limited to this group.

2. Measurement error is always present in any instrument. Anthropometric and other records are never exactly reproducible.

3. Skinfold was measured at only one body site for each subject.

Definitions

The following definitions were used in this study:

Adolescent female: A female who was between the ages of 11.5 and 16.5 years as of March 1, 1981.

Obesity: A weight that is 20 percent above the weight for height established by the National Center for Health Statistics (NCHS) for the standard individual (HANES I) (NCHS, 1973).

Overweight: A weight that is 10 percent or more above the weight for height established by the NCHS (1973).

Underweight: A weight that is 10 percent or more below the weight for height established by the NCHS (1973).

Standard weight: 100 percent of the 50th percentile, weight for females of the same height and age in the HANES I data (NCHS, 1973).

Weight for height: The weight of each girl as a percentage of the median (50th percentile) weight, for females of the same height in the HANES I data (NCHS, 1973).

CHAPTER II

REVIEW OF LITERATURE

Physical growth at adolescence, anthropometric measurements, and selected variables (physical activity, race, socioeconomic status, educational level of parents, and mean energy intake) affecting growth will be reviewed. The clinical significance of upper arm anthropometry and relevant research studies among adolescent females will also be discussed.

Physical Growth at Adolescence

Growth has been defined as "the progressive development of a living being or part of an organism from its earliest stage to maturity, including the attendant increase in size" (Sinclair, 1973). Growth is a form of motion; and in general, the velocity of growth progressively decreases from birth, but this decrease is interrupted with an acceleration of growth which is known as the adolescent growth spurt (Tanner, 1962).

The adolescent spurt is a phenomenon that occurs in all children, though it varies in intensity and duration from one child to another (Tanner, 1962). In girls, it occurs from 10 1/2 to 13 years of age, though wide variations are possible (Tanner, 1962). Girls add about 16 cm to their height between the ages of 10 1/2 to 13 years; with a peak velocity at about 12 years of age (Tanner, Whitehouse, and

Takaishi, 1966). The conclusion of the spurt is followed by slower growth; girls reach 98 percent of their final height by the average age of 16 1/2 (Tanner, Whitehouse, and Takaishi, 1966).

During the adolescent growth spurt, girls may add 16 kg to their weight (Tanner, Whitehouse, and Takaishi, 1966). The peak velocity for the spurt in weight is delayed behind the peak velocity for height by about three months (Tanner, Whitehouse, and Takaishi, 1966). Weight increase is usually a good indicator of satisfactory progress of growth in children. The increase in weight is desirable when it is due to the deposition of bone and muscle and not adipose tissue (Sinclair, 1973).

Measurement of the Body

Anthropometry is a technique for quantitatively measuring the form of the human body (Davenport, 1927). Measurement and evaluation of growth and development during adolescence is an important part of the clinical examination (McKigney, 1975; Hooley, 1980). This information is especially valuable when it is obtained over several years with regular, accurate, and consistent records of anthropometric measurements and physical development (Hooley, 1980).

Physical measurements reflect the total nutritional status over a lifetime, as well as genetic and other influences. Some measurements such as height and head circumference reflect chronic nutritional status (McKigney, 1975). Others such as weight, midarm circumference, skinfold thicknesses, weight/height ratios, midarm/height, and chest/head circumference ratios reflect present nutritional status (Womersley and Durnin, 1977; Gray and Gray, 1980). Height, weight, midupper arm circumference and triceps skinfold measurements will be reviewed.

Height. Height measurements reflect nutrition and should be measured as accurately as possible (Hamill, Driyd, Johnson, Reed, Roche, and Moore, 1979). The lack of proper growth may be a sign that the child is experiencing nutritional inadequacy (Hamill et al., 1979; Gray and Gray, 1980). The pattern of growth over time and a person's progress along a channel are the best measures of whether the diet is supplying sufficient nutrients for growth, energy, and other physiological needs (Martin and Beal, 1978). It is commonly accepted that the adult height of a child who grows up under favorable environmental conditions is to a large extent dependent on heredity (Tanner, Whitehouse, Marshall, and Carter, 1975). Each parent exerts an equal statistical effect on a child's stature (Tanner et al., 1975).

Age plays an important part in the assessment of height, particularly during adolescence. Growth is relatively even until puberty, when the growth spurt occurs. A marked increase in growth velocity is experienced by all children, but at different chronological ages (NCHS, 1973). A child's height at any age reflects both how tall he will ultimately become and how far advanced he is toward that goal (Tanner et al., 1975). It takes time, however, for the child to reach his adult height.

Weight. Weight measurements reflect present nutritional status, which is the cumulative result of lifelong growth and energy balance. In adults, weight reflects more recent nutrition of the subject than does height, since height ceases to increase in teens, while weight may change continually. Buzina and Urema (1973) stated that the use of body weight information is improved if the shape and size of the skeletal frame is considered. Changes in body weight are to a certain extent within the control of an individual. Weight may be gained by exercising

and eating a diet satisfactory in quantity and quality. Under these conditions the size and weight of the muscles increase (Sinclair, 1973). Weight may also be increased when the diet contains more calories than the body can expend or whenever there is a lack of exercise in proportion to energy intake.

Body Composition. Midupper arm circumference and triceps skinfold measurements reflect present nutritional status and indirectly indicate adipose tissue stores (Lowenstein and Phillips, 1973). The presence of excess body fat can be determined from these measurements since the amount of subcutaneous fat is proportional to the volume of total body fat (Gray and Gray, 1980; Hooley, 1980; Himes, Roche, and Webb, 1980). The relationship between skinfold thickness and body fat content is independent of height when age and sex are specified (Seltzer and Mayer, 1965). Likewise, arm muscle circumference, derived from arm circumference and triceps skinfold, is an indirect gross indicator of lean body mass or muscle mass (Hooley, 1980).

Skinfold measurements are translated into body fat percentages by using predictive equations to calculate body density and by selecting formulas to determine total body fat (Rathbun and Pace, 1945; Keys and Brozek, 1953; Brozek, Grande, Anderson, and Keys, 1963). Further justification for their use is provided by high correlations between triceps skinfold and radiographic, densitometric, isotope dilution, and potassium-40 counting techniques (Mayer, 1973; Ward, Krzywicki, Rahman, Quaas, Nelson, and Consolazio, 1975; Gray and Gray, 1980).

The use of midarm circumference and triceps skinfold measurements have become widespread because the procedures are reliable, easy, and require relatively little equipment (Himes, Roche, and Webb, 1980).

Nevertheless, limitations in their use do exist. Skinfold measurements have the highest accuracy when they are applied to healthy subjects who are not grossly obese or severely underweight (Schemmel, 1980). Yet, the correlation between arm measurement and muscle mass is sufficient to assess body fat and its excess (Gray and Gray, 1980; Dietz, 1981). Thus, one would seldom classify an individual with ample body fat stores as depleted; similarly, subjects with depleted stores would seldom be classified in the adequate range (Gray and Gray, 1980).

Standards for Evaluating Growth and Body Composition

Standards for height and weight are useful in following the growth progress of individual children and in assessing the health and nutrition status of different populations and social groups (Tanner and Whitehouse, 1962). They are not sufficient by themselves to answer questions about body composition or fat content (Hooley, 1980).

Laboratory and anthropometric methods are available to provide estimates of body composition. Laboratory methods (body density, potassium-40 counting, isotope dilution) yield the most exact quantification of body fat, although cumbersome equipment and time required for most of these measurements precludes practical application (Dietz, 1981). Anthropometric measurements have been used and researched broadly because of their practical application in clinical settings. Triceps skinfold (TSF), weight, height, and upper arm circumference are the four measures most widely used to assess body fat and its excess in children (Gray and Gray, 1980; Dietz, 1981).

Growth Charts

General growth patterns of United States children have been well characterized since the 1890's (Boas, 1892). Bowditch developed the first growth charts for average height and weight data of American children (Roberts, 1935). His studies of Boston children served as models for many subsequent studies (Hamill et al., 1979). Some of the more notable growth charts that have been available include those developed by Wetzel (1941), Stuart and Meredith (1946), and Reed and Stuart (1959).

Unfortunately, growth charts may have only local or short-term application because of the population group sampled, limited distribution, or temporal changes in growth patterns (Hamill et al., 1979). Appropriate interpretation of growth measurements requires knowledge of the origin of the data.

Recently, the National Center for Health Statistics (NCHS) has prepared new percentile curves for assessing physical growth (height and weight) of children in the United States from birth to 18 years of age (NCHS, 1977). The curves are based on standardized measurements made on large, nationally representative samples of children obtained in the Health and Nutrition Examination Survey I (HANES) (NCHS, 1976, 1977). The charts are age and sex specific; the data is displayed as smoothed percentile curves (NCHS, 1976). In addition, racial, socioeconomic, and geographic variability is known and documented which permits adjustments of normal limits for the growth of children from various segments of the United States (NCHS, 1976, 1977).

Growth has been generally described as being within normal limits when values plotted for height and weight follow intermediate percentiles (measurements between the 25th and 75th percentiles)

(NCHS, 1976, 1977). Measurements between the 10th and 25th, and the 75th and 90th, percentiles may or may not be normal, depending on the pattern of prior and subsequent measurements, genetic, and environmental factors affecting the child (NCHS, 1976, 1977). Values above the 90th and below the 10th percentiles should be checked for measurement and recording accuracy and possibly be referred for further medical evaluation (NCHS, 1976, 1977).

Use of the charts in various health and clinical settings assists identification of individual growth and/or nutritional abnormalities (Hamill et al., 1979). Plotting values for an individual child graphically indicates where the child ranks relative to contemporary United States children of the same age and sex.

Standards for Anthropometric Measurements

Early standards for upper arm muscle circumference in children were established by using arm circumference measurements from Polish children and triceps skinfold measurements from British children (Hammond, 1955; Tanner and Whitehouse, 1962). Upper arm standards for children 6-15 years of age have been estimated from measurements taken on British and American children prior to World War II (O'Brien, Girshik, and Hurt, 1941; Hammond, 1955; Tanner and Whitehouse, 1962).

Anthropometric measurements were included as a part of the Ten-State Nutrition Survey (TSNS) 1968-70. This survey included individuals from all socioeconomic groups, but the sample was heavily weighted toward the lower income groups (TSNS, 1972). Based on a cross-sectional sample of subjects from the Ten-State Study, percentiles for right upper arm circumference and triceps skinfold have been reported (Frisancho, 1974).

From these measurements, arm muscle diameter, circumference, and area have been calculated and reported per age and sex group (Frisancho, 1974).

The Health and Nutrition Examination Survey (HANES) represented the civilian, noninstitutionalized population throughout the United States between April, 1971 and June, 1974. Norms for triceps skinfold, arm circumference, arm muscle circumference, arm muscle area, and arm fat area have been established based on data collected in that survey. Age and sex-specific percentiles have been tabulated for each of the parameters (HANES, 1975).

Factors Affecting Growth

Both genetic and environmental factors influence growth, and the progress of any given child is the result of a complex interaction of these factors (Sinclair, 1973). Some factors are chiefly genetic in origin and act by hastening or retarding physiological maturation from an early age (Tanner, 1962). Others originate in the environment and affect the rate of development. Finally, other factors, such as social class, reflect a mixture of genetic and environmental influences and probably act throughout the whole period of growth (Tanner, 1962). Studies that describe the effects of heredity, race, physical activity, socioeconomic status and educational level of parents, and nutrition of adolescent females will be reviewed in this section.

Heredity

Heredity affects adult stature, as well as the rate of growth and duration of growth (Prader, Tanner, and von Harnack, 1963). Body shape and size, deposition of fat, and patterns of maturity are all related

to one's genetic background (Sanders, 1934; Sinclair, 1973). Maturation is also affected by the environment, but genetic influences are still detectable.

The height and size of children are the result of interactions, between their genetic and environmental background, but it is difficult to quantify the relative importance of each factor. In general, the better the environment, the more the genes have a chance to show their potential influence (Tanner, 1962; Tanner et al., 1975).

Race

The effect of race is difficult to separate from the effects of socioeconomic and nutritional circumstances (Tanner, 1962). One racial difference, presumably genetic in origin, seems now to be firmly established. Blacks are ahead of whites at birth in skeletal maturation (Tanner, 1962; Sinclair, 1973). Negro children grow faster during the first two years of life than white children (Scott, Ferguson, Jenkins, and Cutter, 1955). By the fourth year, the initial difference in growth and any skeletal advancement has disappeared. This might possibly be due to the effects of inadequate nutrition (Sinclair, 1973; Dugdale, May, and O'Hara, 1980).

The Ten-State Nutrition Survey found that after three years of age, white females were fatter than black females until adolescence; during adulthood black females were heavier than white (TSNS, 1972; Garn and Clark, 1976). Prothro, Mickles and Tolbert (1976) found no significant differences in body weights and height, between blacks and whites in their study of Alabama adolescents. In Georgia, races differed, but these differences were inconsistent among age groups (DuRant, Martin, Linder, and Weston, 1980). The interaction of race

and age on a weight-for-length index of the entire sample made it difficult for the researchers to form general statements about obesity and thinness based on race (DuRant et al., 1980). It was found, however, that for the first nine or 10 years, the pattern of obesity among black females was similar to that of black males except obesity in females developed approximately two years sooner than in males (DuRant et al., 1980). For whites, the pattern of obesity development was unclear (DuRant et al., 1980).

Malina (1966, 1971) found that the patterns of subcutaneous fat development in black and white girls were similar. Black females increase in fat from six through nine years of age, whereas white females increased through ten years (Malina, 1966). Between 9-11 years, black girls show a decrease in triceps fat followed by a subsequent rise. White girls show a decrease in fat at the triceps site between 10 and 11 years of age which is followed by an increase after age 11 (Malina, 1966). When the arm circumference was measured, there was no consistent difference between blacks and whites (Malina, 1971). When both the arm circumference and triceps skinfold measurements were considered, however, black girls (7-12 years of age) had consistently larger estimated muscle-bone diameters than whites (Malina, 1968). Similarly, Haider and Wheeler (1980) found that black and hispanic teenage girls had a propensity toward being overweight as evidenced by weight for height data. The observed mean triceps values for blacks were higher than for hispanics, although the differences were not significant. This suggests a racial difference in the patterning of subcutaneous fat deposition on the body and possibly greater muscular development in black girls (Malina, 1971).

Physical Activity

The problem of teenage obesity in the United States is a subject for considerable physiological and psychological study (Storz and Greene, 1983). When dietary energy exceeds energy expenditure, weight is gained. Therefore, inactivity can create and perpetuate the problem of being overweight. In general, teenagers who are overweight have not participated in active sports or exercise as often as teenagers of normal weight (Botvin et al., 1979; Krause and Mahan, 1979). This results in low energy expenditure and may maintain the vicious cycle of inactivity-overweight-embarassment-inactivity (Krause and Mahan, 1979).

Bray, Jordan and Sims (1976) identified factors which affect physical activity. They include the following: current physical fitness, type of daily routine, present living conditions, opportunities for extra exertion and exercise, previous experience with exercise programs, and physical activity level. They suggest that information regarding the circumstances surrounding decreased physical activity may form a basis for effective treatment through behavior modification (Bray, Jordan, and Sims, 1976). Lee (1978) studied physical activity of teenagers in Kentucky and found that a significantly smaller amount of time was spent for sports activity by black girls than by white girls.

In New York, a multi-component weight reduction program that focused on altering eating and exercise patterns of adolescents was studied (Botvin et al., 1979). Significantly more students in the experimental group (exercise, nutrition education, and behavior modification) lost weight and decreased the amount of their body fat compared to the control group (Botvin et al., 1979). Also, significantly

more students in the experimental group shifted from being overweight (130% or more than their ideal weight for height), to being within their normal weight range for their height, age, and sex (Botvin et al., 1979).

Likewise, adults can increase the size of their muscles and reduce the storage deposits of fat by exercise (Sinclair, 1973; Franklin and Rubenfire, 1980). Over a period of time, exercise may alter the shape of the body and its composition (Leon et al., 1979). Reduced physical activity may either cause obesity or it may be a consequence of obesity (Chirico and Stunkard, 1960; Johnson et al., 1982). Conversely, increased physical activity has been demonstrated to be helpful in weight reduction (Leon et al., 1979).

Socioeconomic Status and Educational Level of Parents

Nutritional problems exist in all age, ethnic, and economic groups, but they appear to be most prevalent in young, minority group individuals of low SES, as revealed by the Ten-State Nutrition Survey (TSNS, 1972). In this survey, children from higher income families tended to be taller and heavier, with more advanced skeletal development than children from low income families (TSNS, 1972). During adolescence, this trend reversed itself (Garn and Clark, 1976). Adult women in the Ten-State Nutrition Survey (1972) showed an inverse relationship between income and fatness which originated in late adolescence (Garn and Clark, 1976). Girls from higher income families had thicker fatfold measurements through childhood and early adolescence, but in late adolescence and adulthood, women from lower income levels were more obese. These data suggest that

patterns of obesity tend to be established in early childhood, but they are altered by socioeconomic and cultural factors later in life, related perhaps to differences in energy expenditure and weight control.

In the Kohrs et al. (1979) study, almost one-fifth of the girls 10-16 years old were less than 90 percent average weight. As household income increased, the incidence of underweight increased also. Fewer than half as many women were overweight (16.6 percent) from households in the highest income category compared to households with the lowest income (36.5 percent) (Kohrs et al., 1979). Likewise, in New York City, obesity was six times more prevalent among women of lower SES than among women of upper SES (Moore, Stunkard, and Srole, 1962; Goldbert, Moore and Stunkard, 1965).

In three eastern cities, Stunkard, d'Aquili, Fox, and Filion (1972) found that at age six, 29 percent of the lower class girls were obese, as compared with only three percent of the upper class girls. This class-linked difference persisted through age 18, after falling to a minimum at age 12 when 13 percent of the lower-class and nine percent of the upper class females were obese (Stunkard et al., 1972). Furthermore, obesity was established earlier and increased at a faster rate in poor girls than among upper-class girls (Stunkard et al., 1972). Likewise, they found four times as many underweight women among those of high SES as among those of low SES. At six years of age, 15 percent of the upper class girls were thin, compared to only four percent of the lower class (Stunkard et al., 1972).

DuRant et al. (1980) studied children to determine the prevelance of obesity from lower SES populations. They concluded that white females had the highest prevalence of thinness followed by white males, black females, and black males, respectively. The causes of

these socieconomic differences are probably multiple. Earlier maturation, regular meals, provision of an adequate home, sufficient sleep, and exercise habits are likely to contribute to the difference (Tanner, 1962; Sinclair, 1973).

The influence of education on the prevalence of overweight and obesity follows similar trends. Women who had more than 12 years of education were less likely to be overweight than women who had less than or equal to 12 years of education (Kohrs et al., 1979). Educational attainment, however, may be merely another reflection of average income, because the average income of women with less than or equal to 12 years of education was about $2,000 less than women with more than 12 years of education (Kohrs et al., 1979). The relationship of the incidence of obesity to the type of community where women lived (rural versus metropolitan) was not as strong among women as it was among men; the difference between the regions was the least for girls 10-16 years of age (Kohrs et al., 1979).

Garn and Clark (1976) studied adults and found that among males, those with more than 12 years of education had average fatfold thicknesses which were 10 percent greater than those with eight years or less of education. In females, the opposite trend was observed, those in the higher educational group averaged 20 percent thinner fatfolds than women in the lower education group (Garn and Clark, 1976). An inverse relationship between prevalence of obesity and the level of parental education implies the need for nutritional intervention (Dietz and Gordon, 1981).

Nutrition

Concern has been voiced in recent years over the nutritional quality of the American diet. In the Ten-State Nutrition Survey, adolescents between the ages of 10-16 years had the highest evidence of unsatisfactory nutritional status of any group surveyed (TSNS, 1972). Likewise, when 24-hour dietary recalls were conducted during the 1965 Household Food Consumption Survey, all groups of females over eight years of age had average dietary intakes below the Recommended Dietary Allowance (RDA) for more than one mineral or vitamin (Thomas and Call, 1973). In the 1977 Nationwide Food Consumption Survey, calcium, iron, magnesium, and vitamin B_6 intakes were below the 1974 RDA for teenage girls by seven to 40 percent, but vitamin C consumption was adequate (Pao, 1980). Energy intake in all sex-age groups declined between 1965 and 1977 (Pao, 1980). Among young women and girls, average intakes were five to 10 percent less in 1977, and 10 to 25 percent below the 1974 RDA per age group for energy. Nevertheless, average weights of people in most groups in 1977 were similar to average weights in 1965 (Pao, 1980). Thus, the decrease in energy intake did not appear to be related to weight status. Perhaps a sedentary life style was more common in the 1970's than it was in the 1960's.

A sufficient amount of food is essential for normal growth. Adequate nutrition involves proper energy intake as well as specific nutrients. These are essential for the normal growth of humans, and the need varies with the phase of development. Malnutrition during childhood delays growth, and malnutrition in the years preceding

adolescence delays the appearance of the growth spurt (Tanner, 1962; Chandra, 1981).

Food intake is determined by physiologic needs as well as by psychological factors. The opportunity to eat with peers, omit regular meals and eat at varying intervals, snack, and the increased intake of soft drinks and alcohol, are some of the dietary factors which may result in deficits or excesses of total nutrient intake (Chandra, 1981). Macdonald, Wearring and Moase (1983) found that the adolescent girls with the poorest diets favored skipping meals as a method of weight reduction; hence, the daily energy intake was reduced. Since adolescence is a period of rapid growth and maturation, attention should be focused on the increasing trend toward unwise food restriction patterns (Christakis, 1973; Macdonald, Wearring, and Moase, 1983).

A longitudinal study of gross body composition, body conformation, and food and activity patterns in teenagers showed that mean energy intake for females was 1,950 kcal/day (Hampton, Heunemann, Shapirao, and Mitchell, 1967). The energy intake reported by the "lean" groups was significantly higher than "average", "somewhat obese", and "obese" groups (Hampton et al., 1967, p. 389). These findings were comparable to those of others (Johnson, Burke, and Mayer, 1956; Stefanik, Heald, and Mayer, 1959; Morgan, 1959). However, Hodges and Krehl (1965) found that higher body weight corresponded with higher energy intake.

In an Alabama study (Prothro, Mickles, and Tolbert, 1976), 77 percent of the sample population did not consume the recommended energy intake, and 51 percent consumed less than two-thirds of it. In the 13-19 year old group, energy intakes for nonblack females were 32 percent higher than for black females (Prothro, Mickles, and Tolbert,

1976). In earlier research with girls, mean energy intakes of the "lowest one-third SES level," were significantly lower than for the other two levels (Hampton et al., 1967, p. 389).

CHAPTER III

METHODS AND PROCEDURES

Research Design

A descriptive survey using questionnaires, measurements, and interviews was used to systematically describe the relationships between anthropometric measurements and selected variables. Descriptive research looks at differences or relationships between independent and dependent variables (Isaac and Michael, 1982). The independent variables of this study were physical activity information, demographic data, and dietary information. The dependent variables were anthropometric measurements (weight, height, arm circumference, and triceps skinfold).

Population and Sample

The Southern Regional Research Project S-150, "Nutritional Health of Adolescent Females," was funded by the Agricultural Experiment Station with federal and state funds. Only the data from Oklahoma were used in this study. The subjects were studied from February to May, 1981. The population was adolescent girls enrolled in selected public schools and youth groups within a 70-mile radius of Stillwater, Oklahoma. The subjects were either white or black, single, and not pregnant. Girls with known metabolic disorders, such as diabetes or sickle cell trait, were not utilized as subjects.

Potential participants were contacted through the schools, Girl Scouts, or 4-H clubs. The volunteers for the research and their parents were required to give informed consent for participation. Written and oral information about the study and the procedures were provided to the volunteers. If they agreed to participate, they were given special directions and instructed to meet at the data collection site on designated days, usually Saturdays, where dietary, sociological, anthropometric, and physical activity information were gathered from each volunteer.

One hundred and fifty adolescent females, aged 11.5 to 16.5 years, comprised the sample for this study. Most of the subjects attended school in Stillwater, Tulsa, Perry, or Perkins. Seventy-seven percent of the sample were of the white race and 23 percent were of the black race. Two of the girls classified as black were also part American Indian.

Instrumentation

Instruments and questionnaires which were designed for the S-150 Southern Regional Project, Nutritional Health of Adolescent Females, were used in this study. The instruments were designed to be valid, reliable, and usable. Validity refers to the extent to which the results of an evaluation procedure serves the use for which it was intended (Gronlund, 1976). Reliability is the consistency of measurement, and usability is the practical consideration (Gronlund, 1976).

The instruments were checked by the research team for validity, reliability, and usability during preliminary planning sessions. Content validity was checked by having fellow nutrition experts review

the instruments and make recommendations for revisions or changes. Reliability (consistency) was tested by having the researchers practice taking measurements and conducting interviews with each other until consistency was established. As much as possible, one person collected the same types of data for the duration of the study. The instruments were checked for usability by having group training sessions among the researchers to determine if the instrument's format was usable and practical.

The anthropometric measurements form was developed for recording all body measurements and estimates of clothing (Appendix A). The physical activity questionnaire (Appendix B) was a modification of a questionnaire previously developed and tested (Reiff, Montaye, Remington, Napier, Metzner, and Epstein, 1967). The sociodemographic data form was developed for recording information concerning race, residence, household size, household income, and family background (Appendix C). Twenty-four hour dietary recall forms were adapted from those commonly used in nutrition research (Hampton et al., 1967; Krause and Mahan, 1979; Beal; 1980) (Appendix D).

Training and Standardization

Specific procedures were developed for collecting all data and meetings were held during January, 1981, to train the research team in the methodology. Specific instructions and guidelines were developed for collecting anthropometric and physical activity information. Sociodemographic and dietary recall data forms were reviewed by the researchers until they became familiar with the questionnaires and with procedures for eliciting complete information with probing but not leading questions.

Data Collection

During the spring of 1981 several mornings were spent in data collection sessions. The central places of data collection were a family practice clinic in Tulsa, the Perry High School, and the nutrition laboratory, Department of Foods, Nutrition, and Institution Administration (FNIA), College of Home Economics, Oklahoma State University, Stillwater.

When subjects arrived and registered, all questionnaires were distributed to them. They were then guided to all data collection stations for interviews and measurements. Sociodemographic information and the second dietary interview were usually collected in the subject's home.

Anthropometric Measurements

Equipment

An upright single beam scale (Health-O-Meter)[1] was used to measure body weights and heights. Before weight and height measurements were taken each day, the scales were reset to zero and the height leveler (a right angle bar) was checked for movement ease. The capacity of the scale was 350 pounds.

Arm circumference was measured by using an Ensure Inser-Tape from Ross Laboratory (Zerfas, 1975). The Lange skinfold caliper was used for taking skinfold measurements. A metal calibration block was used for determining the caliper's accuracy (Lange, Inc.).

---

[1]Continental Scale Corporation, Chicago, Illinois.

Procedures

Weight. The subjects were asked to remove shoes and excess clothing (sweaters, coats, and so on) before being weighed. Care was taken by the nutritionist to check off clothing items worn by the subject on the clothing estimate list (Appendix A). The subject was asked to stand upright and face the front of the scale. Her weight was measured carefully and recorded to the nearest one-fourth pound. The subject's weight was converted to kilograms after the total weight of the clothing was subtracted (Appendix A).

Height. The subject was asked to stand straight with heels together, shoulders relaxed, hands and arms loose, eyes looking forward, and head held straight (Hooley, 1980). A right angle bar (leveler) was slid down the height board until the lower surface touched the subject's head, crushing the hair. The height measurement was read to the nearest one-fourth inch, recorded on the data sheet, and converted to centimeters (Appendix A).

Arm Circumference. The subject stood with her right arm flexed at a 90 degree angle at the elbow. The arm was measured using the insertion tape, from the lateral margin of the acromial process of the shoulder to the tip of the olecranon process (elbow tip) (Zerfas, 1975; Burgert, and Anderson, 1979). The midpoint over the triceps was marked with a skin pencil. The arm circumference was measured at this site with the tape in a horizontal plane in light contact with the skin (Zerfas, 1975). A reading was taken to the nearest (0.1 cm) and recorded (Appendix A).

Triceps Skinfold. The triceps skinfold was measured at the upper arm midpoint. With the arm hanging freely, the skinfold was lifted parallel to the long axis of the bone, at approximately one centimeter away from the site of measurement (Frisancho, 1974). The calipers were applied to the midpoint; a reading was taken to the nearest 0.1 millimeter. Two readings were taken on each subject and recorded; if the two readings differed, additional readings were taken until agreement was reached (Appendix A).

Arm Muscle Circumference Measurements. Direct, physical measurement of the arm muscle is not possible, however, it can be calculated. To determine the inner arm circle, which is composed principally of muscle, with a small core of bone, arm muscle circumference was derived by computation as follows (Frisancho, 1974).

$$\begin{array}{lcl} \text{Arm Muscle} & & \text{Arm} \\ \text{Circumference} & = & \text{Circumference} - \lambda\ (\text{Triceps Skinfold}) \\ \text{(mm)} & & \text{(mm)} \qquad\qquad\qquad\qquad\quad \text{(mm)} \end{array}$$

Physical Activity

Physical activity interviews occurred for each of the subjects at a private interview station. All subjects were asked to describe the frequency, duration, and exercise intensity of 20 physical activities they might have participated in (Appendix B). Their responses were recorded as number of times per year, month, or week, and the amount of time per session in minutes spent on each exercise (Appendix B). The overall intensity for the activity was a judgment each girl made; and was described as light, moderate, or vigorous exercise.

Sociodemographic Data

Information such as race and per capita income were obtained from the subject's mother by interview and recorded on form S-1 (Appendix C). The mother was interviewed on the assumption that she would be able to provide a better estimate of family income and other information than the adolescent girl. The interviews usually occurred in the privacy of the subject's home during the spring of 1981.

Dietary Information

Dietary information was obtained through interviews by persons trained in nutrition and dietetics. All the information was recorded on 24-hour intake recall forms (Appendices D and E). On the day of data collection, subjects were asked to recall and describe all foods and beverages and the quantities thereof which they had consumed on the preceding day. A set of food models of paraffin-coated rice and beans, resembling the shapes of food portions, calibrated glasses, a card with various circles and squares, and a ruler were used as visual aids for estimating the sizes of food servings. A second dietary recall was taken at least two weeks before or after the central data collection date in the subject's home. Dietary recalls were taken on weekdays as well as weekends.

Physical Activity Interview Validation

To confirm the measurement of physical activity, by use of an interview format; 4-H teenagers were contacted in Perkins, Oklahoma. After giving informed consent (Appendix F), they were interviewed using the S-150 physical activity recall form (Appendix B). Each subject was

sent home with a three-day physical activity diary (Appendix G) and a postpaid envelope to return the forms. Data from both forms were compared, coded, categorized, and correlated for agreement in determining the validity of physical activity measurements using the interview format.

Data Analysis

Preparation of Data

All data except dietary were coded, checked, and verified by research personnel and keypunched on 80-column cards for electronic data processing. Forms had been designed for direct coding with minimal computation. When computations were necessary, a second person double-checked the computations prior to coding or keypunching.

Dietary Coding and Calculation

Dietary intake from both 24-hour food recalls were changed from food measurements to food weight. Then the quantity of energy, and other nutrients in the diet of each subject was calculated using the Nutritional Analysis System (NAS), a computerized data bank in Baton Rouge, LA (NAS, LSU). Each girl's diet was analyzed by the computer and a mean value was obtained from the two dietary interviews for each dietary component.

The mean, standard deviation, and range of energy intake from all subjects were computed. The energy intake of each subject was expressed as a percentage of the Recommended Dietary Allowance (RDA) (NRC, 1980). All subjects were categorized into three groups according to their RDA energy percentage: marginal to adequate energy intake, above or equal to two-thirds the RDA; low energy intake, between one-third and two-thirds the RDA; and very low energy intake, below one-third the RDA.

Physical Activity

Responses to the physical activity interview were scored by using the actual amount of time per week each girl reported spending physical activity which she perceived as light, moderate, or vigorous exercise. When calculating this score, each activity was weighted as a level of intensity characteristic of that activity as well as the participation intensity each individual reported. These descriptions were used to categorize the exercise: light exercise (LEX), moderate exercise (MEX), and vigorous exercise (VEX). A weighted ratio of 1:2:4, was used in the summation equation to yield total exercise time (TEX) per subject. This equation is similar to Cooper's Aerobic Point System (Cooper, 1982).

$$\text{Total Exercise (TEX)} = 1(\text{LEX}) + 2(\text{MEX}) + 4(\text{VEX})$$

Race

Females from two races (white and black) were represented in this study. This information was recorded and coded directly on form S-1 (Appendix D). Frequency distributions and percentages were compiled for each race.

Socioeconomic Status and Educational Level of Parents

Socioeconomic status (total and per capita income) was obtained from the subject's mother by interview and recorded on form S-1 (Appendix C). Per capita income was obtained by dividing the total annual income by the number of people it supported. For data analysis, per capita income was divided into three groups: under $4500, between

$4500 and $6500, and over $6500. Frequency distributions and percentages were compiled for each income level. The education level of each parent and their occupational status were recorded on the S-1 (Appendix C). Several categories were used to describe their educational and occupational status.

Anthropometric Measurements

Anthropometric measurements (height, weight, triceps skinfold, arm circumference, and muscle circumference) were used as dependent variables in this study. Weight for height (WTFHT) was determined by expressing the weight of each girl as a percentage of the median weight (50th percentile) for girls of the same height in the HANES I survey (NCHS, 1973). Relative height (RHT) was determined by expressing the height of each subject as a percentage of the median height (50th percentile) for subjects of the same age in the HANES I survey (NCHS, 1973).

Statistical Methods

Descriptive statistics such as the mean, standard deviation, range, and frequency distribution of several variables were calculated for the population of girls studied. Charts and plots were assembled to illustrate portions of the data via diagrams.

Pearson Product-Moment Correlation Coefficients were calculated to determine the relationships among several variables, including SES, parental education, physical activity, anthropometric measurements, and race (SAS Intro. Guide, 1983). Ranks were calculated for the weight, height, skinfold, weight for height, arm circumference, and physical activity data. Spearman rank-order correlation coefficients were determined for those variables (SAS User's Guide, 1982).

Frequencies were evaluated by using the chi-square test to determine the significance of any association between selected independent and dependent variables. T or F tests were used to identify the significant differences in sample means due to various independent variables such as race, dieting habits, parental education level, SES, and tobacco use (SAS User's Guide, 1982). Multiple regression analysis was used to study the relationships among antropometric measurements and energy intake, physical activity, and a number of other independent variables (SAS User's Guide, 1982).

CHAPTER IV

RESULTS AND DISCUSSION

The data used in this study were a subset of the data generated in the S-150 Regional Nutrition Project, Nutritional Health of Adolescent Females in Eight Southern States. The major objective of this study was to determine whether a relationship existed between physical activity levels and body weight and body composition, estimated from anthropometric measurements. Other researchers found that exercise in adults resulted in a reduction of body weight and body fat stores (Lewis et al., 1976; Leon et al., 1979; Franklin and Rubenfire, 1980). In this study, the author attempted to examine the exercise patterns of adolescent females and determine the extent to which physical activity or weight maintenance programs are being practiced among teenagers in our sample. The effects of other variables such as race, age, dieting habits, SES, energy intake, and educational level of parents, were studied to determine and account for their effects on body composition.

Description of Sample

General Information

The majority of the respondents were white, less than 15 years of age, had reached menarche, did not use tobacco, lived in a major or minor urban area, and resided in a traditional two-parent household

(Table I). Approximately half the group admitted to drinking alcohol which is surprising since 78 percent of the girls were less than 15 (Table I).

Anthropometric measurements and body composition categories are recorded in Table II. Weight and height data reflect the smoothed percentile curves established by the National Center for Health Statistics (NCHS, 1976, 1977), per age and sex group. Almost 30 percent of the sample had skinfolds that equaled or exceeded 22.0 mm, which is equal to the 85th percentile based on national norms (Frisancho, 1974). Arm muscle circumference calculations indicated that our sample exceeded the national 50th percentile per age and sex group by a large margin; 71.2 percent had arm muscle circumferences above 180 mm which is the national median (Frisancho, 1974). This may indicate our group is advanced in both muscle and adipose tissue development. Mean weight for height and mean relative height data indicate that the girls are very close to the national 50th percentile; 101.0 and 99.9 percent, respectively (Table II). About one fourth of the group was underweight ($\leq$ 90 percent weight for height) and over one fifth of the group was either overweight ($\geq$ 110 percent) or obese ($\geq$ 120 percent weight for height) (Table II). A plot of height vs. weight is located in Appendix H.

A summary of the physical activity data is located in Table III. Everyone participated in some type of light or medium intensity exercise each week, but about one-third of the sample (34.5 percent) did not participate in any type of vigorous exercise. The group mean for time spent in physical activity categories/week is also shown in Table III; the total time for LEX, MEX, and VEX equals 22.7 hours per

TABLE I

GENERAL CHARACTERISTICS OF OKLAHOMA ADOLESCENT FEMALES

Characteristic	Response Category	N[1]	Percent
Race	White	115	76.7
	Black	35	23.3
Age	< 156 months (< 13 years)	53	35.3
	156-179 (13-15 years)	64	42.7
	≥ 180 (≥ 15 years)	33	22.0
Menstruation	Yes	101	69.2
	No	45	30.8
Tobacco	No	133	91.7
	Yes	12	8.3
Alcohol	No	76	52.1
	Yes	70	47.9
Residence	Major Urban ≥ 100,000	58	38.7
	Minor Urban ≥ 25,000 - 100,000	56	37.3
	< 2500, rural, non-farm	19	12.7
	< 2500, rural, farm	17	11.3
Family Type	Father, Mother, Siblings	117	78.0
	Father, Mother, Siblings and Other Relatives	3	2.0
	Father, Mother, Siblings and Other Non-Relatives	1	0.7
	Father or Mother and Siblings	27	18.0
	Father or Mother, Siblings and Non-Relatives	2	1.3

[1]N varies because of nonresponse.

TABLE II

BODY COMPOSITION AND ANTHROPOMETRIC MEASUREMENTS
OF OKLAHOMA ADOLESCENT FEMALES

Measurement	Response Category	N[1]	Percent
Weight	< 40.0 kg	19	13.0
	40.0-49.9	42	28.8
	50.0-59.9	63	43.1
	60.0-69.9	14	9.6
	70.0-80.0	8	5.5
Mean Weight = 51.6 kg			
Height	< 150 cm	19	13.0
	150.5-159.9	67	45.9
	160.-169.9	56	38.4
	≥ 170.0	4	2.7
Mean Height = 158.2 cm			
Skinfold	≤ 10.0 mm	12	8.2
	10.1-21.9	92	63.0
	≥ 22.0	42	28.8
Mean Skinfold = 18.8 mm			
Arm Circumference	≤ 20.8 cm	7	4.8
	20.9-24.9	45	30.8
	≥ 24.0	94	64.4
Mean Arm Circumference = 25.4 cm			
Arm Muscle Circumference	< 180 mm	42	28.8
	180-219	85	58.2
	≥ 220	19	13.0
Mean Arm Muscle Circumference = 195.2 mm			
Weight for Height (WTFHT)	< 90	37	25.3
	91-109	78	53.4
	110-119	12	8.2
	≥ 120	19	13.1
Mean Weight for Height = 101.0			
Relative Height (RHT)	< 95	13	8.9
	96-105	125	85.6
	≥ 106	8	5.5
Mean Relative Height = 99.9			

[1]N varies because of nonresponse.

TABLE III

PHYSICAL ACTIVITY LEVELS OF OKLAHOMA ADOLESCENT FEMALES IN HOURS PER WEEK

Characteristics	Response Category	N[1]	Percent
Light Exercise (LEX)	≤ 3.4 hours/week	53	36.5
	3.5 - 14.0	42	29.0
	≥ 14.1	50	34.5
Mean LEX = 10.4 hours/week			
Medium Exercise (MEX)	≤ 3.4 hours/week	48	33.1
	3.5 - 13.9	62	42.8
	≥ 14.0	35	24.1
Mean MEX = 9.2 hours/week			
Vigorous Exercise (VEX)	0 hours/week	50	34.5
	0.1 - 3.0	46	31.7
	3.1 - 7.2	24	16.6
	≥ 7.3	25	17.2
Mean VEX = 3.1 hours/week			
Total Exercise (TEX)	≤ 20.8 hours/week	46	31.7
	20.9 - 62	65	44.8
	≥ 62.1	34	23.5
Mean TEX = 41.2 hours/week			

[1]N varies because of nonresponse.

week (group means) or approximately 3 hours and 13 minutes per day (total group means).

The majority of the respondents lived in households with five or fewer family members and had fewer than three siblings (Table IV). The occupations of the father followed typical trends: most were employed by a business, or had a profession or a white collar job, rather than service or farm occupation. One-third of the fathers in the sample, however, held blue collar jobs (Table IV). Fewer blue collar positions and more service and white collar occupations were held by the mothers. Over one-third of the fathers (35.4 percent) and 22 percent of the mothers reported graduating from college and/or graduate school (Table IV). This is probably because our sample was drawn from a 70-mile radius of Stillwater. Per capita income averaged $5916 in 1981, and the range was $800 - $20,000. The standard of living would of course be dependent on the number of persons living in and out of the household that the income supported.

Slightly under half the group (42.4 percent) had dieted to lose weight and most of them dieted based on a self-recommended program, rather than one recommended by a physician (Table V). Approximately one-third of the group (32.8 percent) went on a weight reduction diet three or more times during the year, and the diet usually lasted less than one month. Slightly over half the group (52.8 percent) thought they were too heavy and 42.4 percent were trying to lose weight (Table V) at the time of the interview.

Three-fourths of the group (76.0 percent) consumed less than the 1980 Recommended Dietary Allowance (NRC, 1980) for energy for their age group (11-16 years) (Table VI). This trend possibly reflects the

TABLE IV

SOCIODEMOGRAPHIC CHARACTERISTICS OF OKLAHOMA ADOLESCENT FEMALES

Characteristic	Response Category	N[1]	Percent
Total Number of Individuals Currently Living in Household	2-3	30	20.0
	4	54	36.0
	5	33	22.0
	6 or more	33	22.0
N=150			
Range: 2-13			
Total Number of Siblings	≤ 3	119	79.3
	4-6	21	14.0
	≥ 7	10	6.7
N=150			
Range: 0-13			
Father's Occupation	Unemployed	3	2.1
	Professional	28	19.9
	Proprietor	6	4.3
	Business	15	10.6
	White Collar	22	15.6
	Blue Collar	47	33.3
	Service	13	9.2
N=141	Farm	7	5.0
Father's Education	0-5 years	1	0.7
	6-8	3	2.1
	9-11	11	7.6
	High School	28	19.4
	Technical or Vocational	9	6.3
	Some College	41	28.5
	College Graduate	25	17.4
N=144	Graduate Degree	26	18.0
Mother's Occupation	Unemployed	1	0.9
	Professional	12	10.4
	Proprietor	7	6.1
	Business	6	5.2
	White Collar	60	52.2
	Blue Collar	3	2.6
	Service	22	19.1
N=115	Other	4	3.5
Mother's Education	0-5 years	1	0.7
	6-8	3	2.0
	9-11	11	7.3
	High School	43	28.7
	Technical or Vocational	16	10.7
	Some College	43	28.6
	College Graduate	24	16.0
N=150	Graduate Degree	9	6.0

TABLE IV (Continued)

Characteristic	Response Category	N[1]	Percent
Per Capita Income (PCINC)	< $4500	47	32.0
	$4500-$6500	47	32.0
N=147	≥ $6501	53	36.0
Mean PCINC = $5916			
Range = $800-$20000			

[1]N varies because of nonresponse.

TABLE V

DIETING INFORMATION QUESTIONS AND RESPONSES OF OKLAHOMA ADOLESCENT FEMALES

Question	Response	N[1]	Percent
Have you ever been on a weight reduction diet?	Yes	61	42.4
	No	83	57.6
Who recommended the weight reduction diet?	Physician	4	6.6
	Mother	12	19.7
	Self	44	72.1
	Media	1	1.6
Have you been on a weight reduction diet within the past year?	Yes	53	86.9
	No	8	13.1
How many times each year do you go on a weight reduction diet?	Never	5	8.2
	Once	18	29.5
	Twice	18	29.5
	3-5 x	11	18.0
	6-25 x	9	14.8
How long does the diet usually last?	< one month	37	62.7
	1-3 months	19	32.2
	≥ 4 months	3	5.1
Have you ever been on a diet to try to gain weight?	Yes	14	9.7
	No	130	90.3
Have you tried to gain weight within the past year?	Yes	9	69.2
	No	4	30.8
Are you presently trying to _____ weight?	Gain	7	4.8
	Lose	61	42.4
	Neither	76	52.8
Do you think your weight is now _____?	Too Light	7	4.8
	About Right	61	42.4
	Too Heavy	76	52.8

[1]N varies because of nonresponse.

large proportion of girls who were dieting to lose weight. Only four percent of the group consumed less than 100 grams of carbohydrate per day, but 18 percent of the sample consumed over 106 grams of fat on the days they were interviewed (Table VI).

TABLE VI

ENERGY, CARBOHYDRATE, PROTEIN, AND FAT INTAKE OF OKLAHOMA ADOLESCENT FEMALES

Nutrient	Response	N[1]	Percent
Carbohydrate	≤ 100 grams/day	6	4.0
	100 - 200	59	39.3
	≥ 201	85	56.7
Mean Carbohydrate = 216 grams/day			
Protein	≤ 60 grams/day	69	46.0
	61 - 90	63	42.0
	≥ 91	18	12.0
Mean Protein = 64 grams/day			
Fat	≤ 80 grams/day	78	52.0
	81 - 105	45	30.0
	≥ 106	27	18.0
Mean Fat = 82 grams/day			
Energy	≤ 733 kcal/day	1	0.7
	734 - 1467	42	28.0
	1468 - 2199	71	47.3
	≥ 2200	36	24.0
Mean Energy Intake = 1845 kcal/day			

[1]N varies because of nonresponse.

Comparison of Key Variables by Race and Age

White girls decreased their observed mean energy, protein, fat, and carbohydrate intakes as they grew older (Table VII). Black girls did not follow this trend. The observed mean energy, protein, fat, and carbohydrate intakes did not vary by more than 137 kcal irrespective of age or by more than 24 grams for the protein, fat, and carbohydrate intakes from year to year for black girls (Table VII).

TABLE VII

COMPARISON OF MEAN ENERGY, PROTEIN. FAT, AND CARBOHYDRATE INTAKES BY RACE AND AGE

Race	Age[1] (years)	N	Mean Energy[2] (kcal)	Mean Protein[2] (grams)	Mean Fat[2] (grams)	Mean Carbohydrate[2] (grams)
White	12	44	2040.7	73.2	89.2	241.7
	14	44	1699.8	61.5	74.8	199.1
	16	27	1624.6	54.8	73.0	190.1
Black	12	9	1852.3	61.9	87.1	208.3
	14	20	1989.1	61.3	91.8	232.2
	16	6	1978.3	68.2	87.8	232.8

[1]12 = less than 156 months, 14 = 156-180 months, and 16 = 180-199 months.

[2]Two-day 24-hour recall average.

The group means for anthropometric measurements and exercise levels by race are shown in Table VIII. The observed means are similar for all measurements across both races, although blacks had higher levels of mean exercise time in all categories.

Figure 1 shows the relationship between weight for height and age. On the horizontal axis is age in years, and on the vertical axis is percentage. If the subject was overweight (weight for height $\geq$ 110), or obese, (weight for height $\geq$ 120), a "1" was placed on the bar chart, and if the subject was normal weight or below normal weight (weight for height < 110, a "2" was placed on the chart. The percentage of girls who were overweight or obese (code 1) increased from ages 11 and 12 to a peak at age 13 and then decreased steadily to a very low percentage at age 15 and finally increased at 16 years of age. The subjects gain in weight between the ages of 11 - 13 is probably because of hormonal and physiological changes (Frisch, 1980). The decline in obesity and overweight after age 13 is probably because of intentional weight reduction dieting. Dwyer, Feldman, and Mayer (1967) found that dieting was associated with rising levels of body fat and that the average age when dieting started was between 14 and 15 years. The increase in weight at age 16 may be due to unsuccessful dieting or it may be due to further maturation. Kelly, Patten, and Johannes (1982) found that adolescent females were deeply preoccupied with eating, dieting, and body weight.

Validation of Physical Activity Recall Data

Habitual energy expenditure and activity patterns have been investigated using a variety of methods including exercise diaries,

TABLE VIII

COMPARISON OF MEAN ANTHROPOMETRIC MEASUREMENTS AND EXERCISE LEVELS BY RACE

	Race	
	White (Mean ± S.D.)	Black (Mean ± S.D.)
Anthropometric Measurements	N = 112	N = 34
Weight	51.0 ± 10.4 kg	53.6 ± 9.6 kg
Height	158.2 ± 7.1 cm	158.4 ± 5.1 cm
Triceps Skinfold	19.3 ± 7.3 mm	17.2 ± 6.4 mm
Arm Circumference	25.3 ± 3.5 cm	25.8 ± 3.1 cm
Weight for Height	100.2 ± 15.8	104.0 ± 15.6
Exercise Levels	N = 111	N = 34
Light Exercise	10.2 ± 10.1 hours/week	11.0 ± 12.0 hours/week
Medium Exercise	8.5 ± 8.9 "	11.8 ± 10.8 "
Vigorous Exercise	2.9 ± 4.0 "	3.6 ± 6.0 "
Total Exercise	38.9 ± 28.4 "	49.0 ± 3.9 "

1 = overweight (weight for height $\geq$ 110)
obese (weight for height $\geq$ 120)

2 = normal or below normal weight
(weight for height < 110)

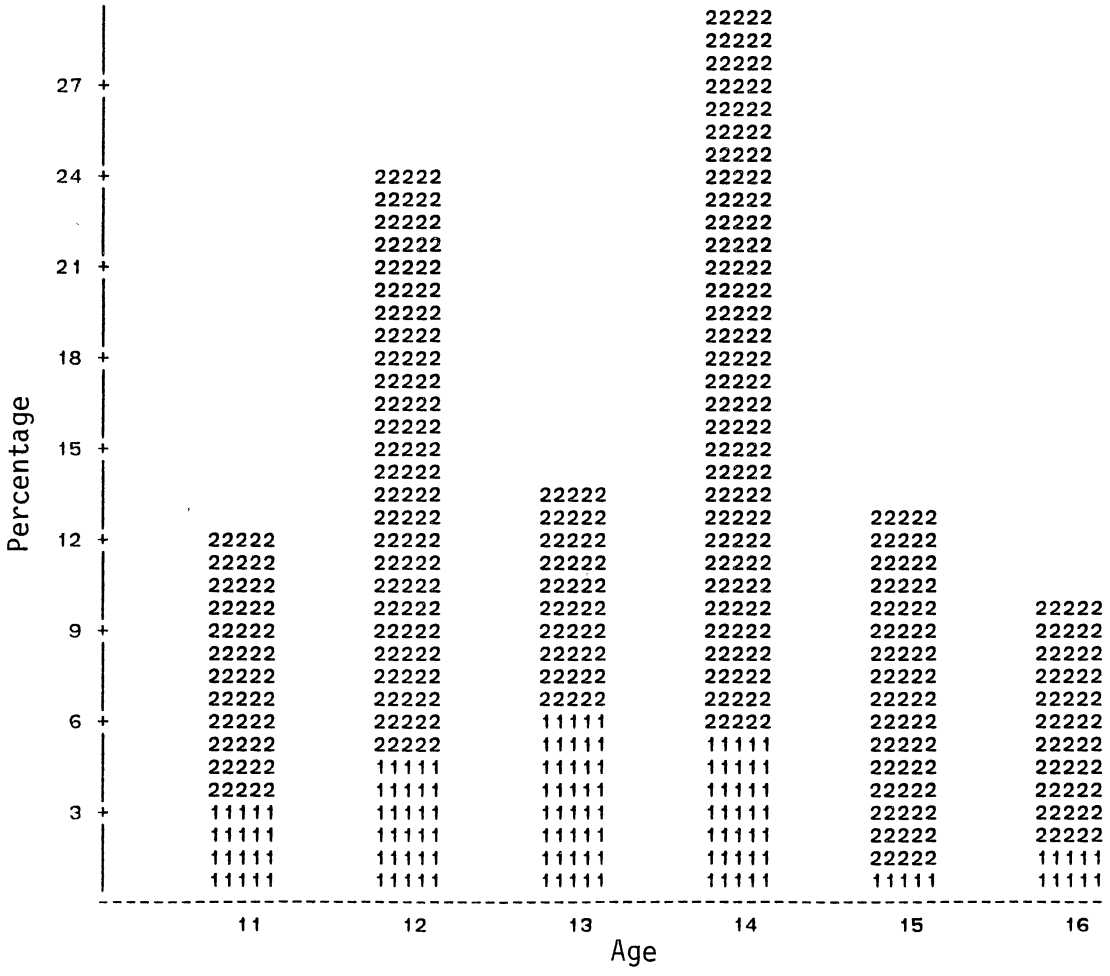


Figure 1. Weight for Height and Age vs. Weight Status (Overweight or Obese vs. Underweight or Normal Weight)

recalls, exercise log books or journals, and self-administered questionnaires (Bouchard, Tremblay, Leblanc, Lortie, Savard, and Thericult, 1983). Indirect calorimetry is also available to measure the energy cost of daily activities, but it has little usefulness in large population studies because of the time and equipment involved (Bouchard et al., 1983). Questionnaires, diaries, and interviews may not reach the same precision as indirect calorimetry, but they can discriminate between individuals of different energy expenditure levels (Buskirk and Mendex, 1980).

Several researchers have developed daily energy expenditure records for estimating the amount and the pattern of daily energy expenditure (Gwinup, 1975; Baecke, Burema, and Frijters, 1982; Baecke, Van Staveren, and Burema, 1983; Bouchard et al., 1983; Forbes, 1985). Reliability studies of three-day activity records were conducted by Bouchard et al. (1983) and they found that daily records were highly reproducible (intraclass correlation coefficient = .96). Also, they found that activity levels of high intensity were reported more accurately than low intensity activities. The reason for this may be that persons who engage in intense sports do so regularly (Taylor, Jacobs, and Schucker, 1978; Bouchard et al., 1983).

Perkins, Oklahoma Club 4-H Correlation Study

Ten girls in the Perkins, Oklahoma 4-H Club were contacted and asked to keep an activity diary for three days (Appendix G). They were also interviewed using the physical activity recall form (Appendix B). The diary which our subjects used was almost identical to the energy expenditure record used by Bouchard et al. (1983). Data from both forms were compared, coded, categorized (light, medium,

or vigorous exercise) and correlated for agreement in determining the reliability of physical activity records.

The raw data and the correlation coefficients are shown in Table IX. The correlation coefficient between the medium and vigorous activities on the diary and the interview was $r = .72$, which is significant at the $p = .02$ level. The correlation for light intensity exercise (diary vs. interview) was low and not significant, $r = .14$. This is in agreement with Taylor, Jacobs, and Schucker (1978) and Bouchard et al. (1983); they found that high intensity physical activities were reported more accurately than low intensity activities. The correlation coefficient for total exercise levels was intermediate ($r = .27$) and not significant (Table IX).

Correlation of Selected Variables

Correlations among several of the studies anthropometric and exercise variables are listed in Table X. Most of the anthropometric measurements are significantly and positively related to each other, except height and weight for height which are not significantly correlated. Triceps skinfold measurements are independent of height (Seltzer and Mayer, 1965). The exercise and anthropometric variables are often correlated negatively with each other which is consistent with current exercise physiology recommendations. Total exercise is correlated positively and significantly with light, medium, and vigorous exercise (LEX, MEX, and VEX). LEX, MEX, and VEX are components of TEX.

The relationship among select variables and anthropometric measurements are listed in Table XI. As the girls grow older, they

TABLE IX

RAW DATA AND CORRELATION COEFFICIENTS FOR PHYSICAL ACTIVITY DIARIES AND INTERVIEWS FROM THE PERKINS, OKLAHOMA 4-H CLUB

Subject Number	Mean Light Intensity Exercise (Diary)	Mean Light Intensity Exercise (Interview)	Mean Medium and Vigorous Intensity Exercise (Diary)	Mean Medium and Vigorous Intensity Exercise (Interview)
01	90 minutes/day	8.2 minutes/day	292 minutes/day	25.6 minutes/day
02	172	0.6	32	.2
03	188	83.7	57	17.1
04	172	34.0	218	30.0
05	222	10.9	29	10.2
06	143	12.2	57	4.6
07	205	42.5	213	23.4
08	132	27.1	47	3.3
09	32	41.7	40	2.6
10	88	12.1	236	6.5

Correlation coefficients and probability > |R| under the null hypothesis that rho = 0.

	Light Ex. Inter.	Med. & Vig. Ex. Inter.	Total Ex. Inter.
Light Ex. Diary	r = 0.14	r = 0.29	r = 0.22
Med. & Vig. Ex. Diary	r = -0.13	r = 0.72*	r = 0.16
Total Ex. Diary	r = -0.04	r = 0.83*	r = 0.27

*Significant at the p = .02 level.

TABLE X

CORRELATION COEFFICIENTS FOR ANTHROPOMETRIC MEASUREMENTS AND EXERCISE VARIABLES

Variable	Weight	Height	WTFHT	Triceps Skinfold	Arm Muscle Circ..	Arm Circ.	LEX	MEX	VEX	TEX
Weight										
Height	0.60***									
Weight for Height	0.81***	0.07 ns								
Tr. Skinfold	0.68***	0.28***	0.63***							
Arm Muscle Circumference	0.66***	0.19*	0.68***	0.14 ns						
Arm Circumference	0.88***	0.31***	0.87***	0.75***	0.76***					
Light Exercise	-0.07 ns	-0.20*	0.06 ns	-0.18*	0.26**	0.05 ns				
Med. Exercise	0.13 ns	0.03 ns	0.14 ns	0.10 ns	0.14 ns	0.16*	0.24**			
Vig. Exercise	-0.12 ns	-0.003 ns	-0.16 ns	-0.13 ns	-0.03 ns	-0.11 ns	0.10 ns	0.06 ns		
Total Exercise	-0.01 ns	-0.05 ns	0.02 ns	-0.08 ns	0.16 ns	0.06 ns	0.54***	0.72***	0.65***	--

Note: ns = not significant; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$.

grow taller, heavier, and develop more muscle and adipose tissue (Table XI), as illustrated by significant arm muscle and arm circumference measurements. There was a negative relationship between age and light exercise, and between age and energy intake. Perhaps the older girls start driving cars, and walk and bike ride less for transportation, thus explaining the decline in light exercise. They also may become more weight conscious and intentionally begin dieting. There was no relationship between energy intake and the exercise variables. Some researchers have speculated that sedentary individuals eat less than their physically active counterparts (Mayer, 1968; Krause and Mahan, 1979). There was, however, a significant and a negative relationship between energy intake and height, weight, skinfold, arm, and arm muscle circumference. Based on these data, as energy intake increased, height, weight, skinfold, arm, and arm muscle circumference values decreased. This is in agreement with Baecke, Van Staveren, and Burema (1983) who found that the fatter women ate less food than the lean women, yet there was no difference in their habitual physical activity.

Several demographic correlation coefficients are illustrated in Table XII. Both mothers' and fathers' educational level is positively related to per capita income (Table XII). Energy intake is significantly and negatively related to per capita income. This is in agreement with Kohrs et al. (1979) and DuRant et al. (1980); they found that social factors were stronger determinants of the prevalence of obesity than genetic or biochemical factors. If obesity is related to energy intake this finding may be important and will have implications for dieting and diet counseling.

TABLE XI

CORRELATION COEFFICIENTS FOR SELECTED VARIABLES AND ANTHROPOMETRIC MEASUREMENTS

	Variable	
	Age	Energy
Height	0.54***	-0.20*
Weight	0.41***	-0.37***
Skinfold	0.23**	-0.28***
Arm Circumference	0.26**	-0.40***
Arm Muscle Circumference	0.16*	-0.32***
WTFHT	-0.002 ns	-0.30***
LEX	-0.19*	-0.01 ns
MEX	0.05 ns	0.04 ns
VEX	0.01 ns	0.10 ns
TEX	-0.02 ns	0.07 ns
Energy	-0.23**	--

Note: ns = not significant; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$.

TABLE XII

CORRELATION COEFFICIENTS AMONG DEMOGRAPHIC VARIABLES AND ENERGY INTAKE

Variable	Mother's Education	Father's Education	Number Living in Household	Per Capita Income
Energy	-0.07 ns	-0.11 ns	0.05 ns	-0.16*
Mother's Education	--	0.50***	-0.10 ns	0.30***
Father's Education		--	-0.05 ns	0.26**

Note: ns = not significant; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$.

t Tests for Several Characteristics

The t-test was used to determine whether a significant difference existed between two groups for several variables. Race, tobacco use, and the effects of weight altering diets were examined.

Race

No significant difference was found between blacks and whites for the following variables: height, weight, skinfold, arm circumference, weight for height, light, medium, vigorous, or total exercise levels, tobacco use, or energy intake. There was a significant difference at the $p \leq .05$ level for alcohol usage ($t = 1.99$). The black girls in the sample drank significantly less alcohol than white girls. Three demographic variables (education of parents and per capita income) for the two races are summarized in Table XIII. These results reflect national education and socioeconomic trends showing that whites attain higher educational levels and earn more money per capita than blacks (TSNS, 1972).

TABLE XIII

t TESTS FOR FATHERS' AND MOTHERS' EDUCATION AND PER CAPITA INCOME FOR TWO RACES (WHITES AND BLACKS)

Variable	t Value	Probability Level
Fathers' Education	$t = 3.17$	$p \leq 0.002$
Mothers' Education	$t = 3.21$	$p \leq 0.002$
Per Capita Income	$t = 3.25$	$p \leq 0.002$

Tobacco

No significant difference was found between smokers and non-smokers for light, medium, vigorous, or total exercise. This is surprising since it is generally agreed that smokers find exercise more difficult. The adolescent girls in the sample may not have smoked long enough, however, to cause impairment in their physical activity levels.

There was a significant difference between the smokers' and non-smokers' alcohol intake. The smokers' drank significantly more alcohol than the non-smokers ($p \leq 0.002$). Tobacco use had no significant effect on mean energy intake, or anthropometric measurements (height, weight, skinfold, arm circumference, weight for height, or relative height).

Weight Altering Diets

The data were analyzed to determine if dieting to lose or gain weight would have an effect on energy nutrients, anthropometric measurements, or physical activity. Question 1 (Appendix E) was: Have you ever been on a weight reduction diet? and Question 6 (Appendix E) was: Have you ever been on a diet to try to gain weight? Based on the replies to these questions several variables were examined (Tables XIV and XV).

The dieters did consume significantly less energy than the non-dieters and they weighed significantly more (Table XIV). Interestingly, the dieters were also taller and had larger arm circumference and triceps skinfold measurements than the non-dieters. There were no significant differences in physical activity levels between dieters and non-dieters (Table XIV).

TABLE XIV

t TESTS FOR THE ENERGY NUTRIENTS, ANTHROPOMETRIC MEASUREMENTS, AND PHYSICAL ACTIVITY FOR DIETERS VS. NON-DIETERS[1]

Variable	Mean ± S.D.	t Value	Probability Level
Mean Energy Intake			
Dieters	1695 kcal ± 520 kcal	-2.95	$p \leq 0.004$
Non-Dieters	1988 ± 673		
Mean Protein Intake			
Dieters	59.3 g ± 20.5 g	-2.42	$p \leq 0.02$
Non-Dieters	68.8 ± 25.5		
Mean Fat Intake			
Dieters	75.8 g ± 25.5 g	-2.32	$p \leq 0.03$
Non-Dieters	88.6 ± 37.4		
Mean Carbohydrate Intake			
Dieters	196.9 g ± 69.4	-2.90	$p \leq 0.005$
Non-Dieters	233.5 ± 78.6		
Weight			
Dieters	56.4 kg ± 9.9 kg	5.5	$p \leq 0.0001$
Non-Dieters	47.9 ± 8.7		
Height			
Dieters	160.4 cm ± 5.0 cm	3.5	$p \leq 0.0007$
Non-Dieters	156.6 ± 6.8		
Skinfold			
Dieters	22.6 mm ± 7.6 mm	6.3	$p \leq 0.0001$
Non-Dieters	15.9 ± 5.2		
Arm Circumference			
Dieters	26.9 cm ± 3.6 cm	5.00	$p \leq 0.0001$
Non-Dieters	24.3 ± 2.8		
Weight for Height			
Dieters	106.5 ± 17.5	3.91	$p \leq 0.0001$
Non-Dieters	96.6 ± 12.7		
Relative Height			
Dieters	100.4 ± 3.6	1.40	ns
Non-Dieters	96.6 ± 12.7		

TABLE XIV (Continued)

Variable	Mean ± S.D.	t Value	Probability Level
Total Exercise			
Dieters	42.4 hours/week ± 33.7	0.36	ns
Non-Dieters	40.5 ± 29.9		
Vigorous Exercise			
Dieters	11.0 hours/week ± 11.9	0.60	ns
Non-Dieters	9.9 ± 9.6		
Medium Exercise			
Dieters	10.4 hours/week ± 10.3	1.23	ns
Non-Dieters	8.4 ± 8.8		
Light Exercise			
Dieters	11.0 hours/week ± 11.9	0.60	ns
Non-Dieters	9.9 ± 9.6		

[1]N = 61 dieters, 83 non-dieters; ns = not significant.

TABLE XV

t TESTS FOR ENERGY NUTRIENTS, ANTHROPOMETRIC MEASUREMENTS, AND PHYSICAL ACTIVITY FOR THOSE WISHING TO GAIN WEIGHT VS. NOT GAIN WEIGHT[1]

Variable	Mean ± S.D.	t Value	Probability Level
Mean Energy Intake			
Gain Weight	2476.5 kcal ± 971.2	4.04	$p \leq 0.0001$
Do Not Wish to Gain	1797.5 ± 545.0		
Mean Protein Intake			
Gain Weight	87.6 g ± 40.3	3.95	$p \leq 0.0001$
Do Not Wish to Gain	62.3 ± 20.2		
Mean Fat Intake			
Gain Weight	118.4 g ± 56.5	4.40	$p \leq 0.0001$
Do Not Wish to Gain	79.4 ± 27.7		
Mean Carbohydrate Intake			
Gain Weight	268.9 g ± 100.8	2.67	$p \leq 0.009$
Do Not Wish to Gain	212.5 ± 72.1		
Weight			
Gain Weight	44.9 kg ± 6.1	-2.62	$p \leq 0.01$
Do Not Wish to Gain	52.2 ± 10.2		
Height			
Gain Weight	155.7 cm ± 6.3	-1.48	ns
Do Not Wish to Gain	158.4 ± 6.7		
Skinfold			
Gain Weight	14.7 mm ± 5.3	-2.28	$p \leq 0.03$
Do Not Wish to Gain	19.2 ± 7.2		
Arm Circumference			
Gain Weight	23.6 cm ± 2.1	-2.17	$p \leq 0.04$
Do Not Wish to Gain	25.6 ± 3.4		
Weight for Height			
Gain Weight	93.2 ± 12.6	-1.93	ns
Do Not Wish to Gain	101.6 ± 15.8		
Relative Height			
Gain Weight	98.9 ± 3.3	-1.14	ns
Do Not Wish to Gain	100.0 ± 3.5		

TABLE XV (Continued)

Variable	Mean ± S.D.	t Value	Probability Level
Total Exercise			
Gain Weight	51.3 hours/week ± 39.0	1.25	ns
Do Not Wish to Gain	40.2 ± 30.6		
Vigorous Exercise			
Gain Weight	4.9 hours/week ± 6.9	1.55	ns
Do Not Wish to Gain	2.9 ± 4.3		
Medium Exercise			
Gain Weight	10.0 hours/week ± 7.2	0.32	ns
Do Not Wish to Gain	9.2 ± 9.7		
Light Exercise			
Gain Weight	11.6 hours/week ± 10.6	0.45	ns
Do Not Wish to Gain	10.2 ± 10.6		

[1]N = 14 (gain weight), 130 (do not wish to gain weight); ns = not significant.

Our results are comparable to Dwyer, Feldman, and Mayer (1967), in which they found that about 61 percent of their sample had been on diets to lose weight, yet only 15.2 percent had high triceps skinfold measurements. Likewise, most of the subjects in the Storz and Greene study (1983) were either within or under the average range for body weight. Yet most of the subjects wanted to lose weight (Storz and Greene, 1983) and they used a greater number of negative than positive adjectives to describe their appearance (Storz and Greene, 1983). Kelly, Patten, and Johannes (1982) reported that a high percentage of teenage girls (33.2 percent) saw themselves as overweight, yet only 5.1 percent of the sample was overweight according to weight for height standards.

Macdonald, Wearring, and Moase (1983) found that the girls in their study were concerned with their bodily appearance and were frequently on weight reduction diets. Their dieting behavior was a reflection of their dissonance with their actual vs. desired body size (Macdonald, Wearring, and Moase, 1983). Findings in this study are in agreement with these researchers and indicate that a high incidence of dissatisfaction with physical appearance exists among teenage girls.

Approximately five percent of our sample was trying to gain weight (Table V). Girls who were trying to gain weight did consume significantly more energy than girls who did not want to gain weight (Table XV). They also were lighter, and had smaller arm circumference and triceps skinfold measurements. There were no significant differences in height, weight for height, relative height, or any of the exercise levels (Table XV). Dwyer, Feldman, and Mayer (1967) also found that five percent of the girls in their sample wanted to gain weight. These girls were categorized in the "lean group" ($\leq$ 11 mm

triceps skinfold) (Dwyer, Feldman, and Mayer, 1967). Their comparisons between dieters and nondieters revealed that height per se was not the critical factor for choosing to gain or lose weight. Likewise, the findings in this study indicated no significant differences in height between the girls wanting to gain weight vs. not gain weight. Rather, the measurements which contributed to general bulk were the ones that were significantly important (weight, skinfold, and arm circumference) (Table XV).

Chi-Square Analysis

Chi-square analysis was conducted on the frequency or category data. The frequencies observed in this study did not differ significantly from the expected population frequencies. Several categories were examined or created from the data set. Race, age, energy, exercise, arm muscle circumference, weight for height, and skinfold were all examined and none of the variables proved significant.

Spearman's Correlation Coefficient Rho

The data in this study were sorted and ranked by weight, weight for height, skinfold, and total exercise. General trends were apparent when the data were ranked. For example, the subjects with the lowest total exercise ranks (ranks 1-12) had some of the highest ranks for weight for height, weight, arm circumference, and skinfold (Appendix I). A Spearman's correlation coefficient test was run on the data ranks. The results are located in Table XVI.

TABLE XVI

SPEARMAN'S CORRELATION COEFFICIENTS FOR ANTHROPOMETRIC MEASUREMENTS AND EXERCISE VARIABLES

Variable	Weight	Height	WTFHT	Skinfold	Arm Circ.	TEX	MEX	LEX
Weight								
Height	0.66***							
Weight for Height	0.76***	0.10 ns						
Skinfold	0.64***	0.30***	0.58***					
Arm Circumference	0.86***	0.36***	0.84***	0.72***				
Total Exercise	-0.01 ns	-0.06 ns	0.02 ns	-0.08 ns	0.07 ns			
Vigorous Exercise	-0.13 ns	-0.06 ns	-0.14 ns	-0.19*	-0.10 ns	0.62***		
Medium Exercise	0.09 ns	-0.04 ns	0.14 ns	0.10 ns	0.17*	0.73***	0.19*	
Light Exercise	-0.15 ns	-0.18*	-0.5 ns	-0.28***	-0.05 ns	0.48***	0.12 ns	0.20*

Note: ns = not significant; * = $p \leq 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.001$.

The Spearman correlation coefficients for ranks (Table XVI) are similar to the Pearson correlation coefficients for the continuous data (Table X). Nearly all of the anthropometric measurements were significantly and positively related to each other, except height and weight for height which were not significantly correlated. The exercise and anthropometric variables were correlated negatively and were not significant. Perhaps the girls have not been exercising long enough for the exercise to have an influence on body composition or the girls had relatively homogeneous exercise patterns as Baecke, Van Staveren, and Burema (1983) suggested. Triceps skinfold and vigorous exercise and triceps skinfold and light exercise were, however, negatively and significantly correlated, but there were no significant differences among any of the exercise levels and weight for height.

Analysis of Variance

Analysis of variance was used to investigate the effects of several variables on exercise and anthropometric measurements. Duncan's multiple range test was used to test for significant differences between means.

Total and Vigorous Exercise

Total and vigorous exercise levels were categorized into three groups (high, medium, and low). Total exercise and vigorous exercise were considered the independent variables in the analysis of variance, and weight, skinfold, weight for height, and arm circumferences were considered the dependent variables. There were no significant differences in any of the anthropometric measurements for the three

total and vigorous exercise levels. Modest alterations in body composition have been reported from exercise programs by other researchers (Lewis et al., 1976; Botvin et al., 1979). Additional studies are needed on the biological effects of vigorous, sustained exercise and training in adolescents.

Energy

Mean daily energy intake was divided into three groups (high, medium, and low), the divisions were based on the following caloric levels: $\geq$ 2200 kcal/day, high; 1468-2109 kcal/day, medium; less than or equal to 1467 kcal/day, low. The results of the analysis of variance procedure and the Duncan's multiple range tests are shown in Tables XVII and XVIII.

The subjects who had the lowest energy intakes also had the highest triceps skinfold, weight for height, and arm circumference measurements (Table XVIII). Those with the highest daily energy intakes weighed the least (Table XVIII). If these trends continue through adulthood, weight reduction diets may be contraindicated.

Age

The sample was divided by age (A12, less than 13 years of age; A14, 13 or 14 years; and A16, 15 or older) and analyzed for differences in energy intake, skinfold, weight for height, and total exercise levels. The results for the analysis of variance procedure and the Duncan's multiple range test are in Tables XIX and XX.

TABLE XVII

ANALYSIS OF VARIANCE PROCEDURE FOR THREE LEVELS OF ENERGY INTAKE FOR WEIGHT, WEIGHT FOR HEIGHT, SKINFOLD, AND ARM CIRCUMFERENCE MEASUREMENTS

Dependent Variable	Source	df	SS	MS	F value	Prob. > F[1]
Weight	Model	2	1,239.01	619.51	6.32	0.002
	Error	143	14,012.74	97.99		
	Total	145	15,251.75			
Weight for Height	Model	2	3,047.80	1,523.9	6.56	0.0019
	Error	143	33,205.95	232.21		
	Total	145	36,253.75			
Skinfold	Model	2	496.15	248.07	5.16	0.007
	Error	143	6,875.97	48.08		
	Total	145	7,372.12			
Arm Circumference	Model	2	201.97	100.99	9.77	0.0001
	Error	143	1,477.97	10.33		
	Total	145	1,679.94			

[1]Probability of > F.

TABLE XVIII

DUNCAN'S MULTIPLE RANGE TESTS FOR WEIGHT, WEIGHT FOR HEIGHT, SKINFOLD, AND ARM CIRCUMFERENCE MEASUREMENTS AT THREE LEVELS OF ENERGY INTAKE

Dependent Variable	Means (Energy Intake)[1]		
Weight	47.41 (high)	51.58 (medium)	55.44 (low)
Weight for Height	96.42 (high	99.25 (medium)	108.12 (low)
Skinfold	16.56 mm (high)	18.45 mm (medium)	21.54 mm (low)
Arm Circumference	24.08 cm (high)	25.11 cm (medium)	27.21 cm (low)

[1]Means which are underlined are not significantly different at the .05 level.

TABLE XIX

ANALYSIS OF VARIANCE PROCEDURE FOR THREE LEVELS OF AGE FOR ENERGY INTAKE, SKINFOLD, WEIGHT FOR HEIGHT, AND TOTAL EXERCISE

Dependent Variable	Source	df	SS	MS	F value	Prob. > F[1]
Energy Intake	Model	2	2,416,767	1,208,383	3.18	0.04
	Error	147	55,919,130	380,402		
	Total	149	58,335,897			
Skinfold	Model	2	576.54	288.3	6.07	0.003
	Error	143	6,795.58	47.5		
	Total	145	7,372.12			
Weight for Height	Model	2	1,199	599.4	2.45	0.09 ns
	Error	143	35,055	245.1		
	Total	145	36,254			
Total Exercise	Model	2	837.84	418.9	0.42	0.66 ns
	Error	142	140,918.94	992.4		
	Total	144	141,756.78			

[1]Probability of > F.

TABLE XX

DUNCAN'S MULTIPLE RANGE TESTS FOR ENERGY INTAKE, SKINFOLD, WEIGHT FOR HEIGHT, AND TOTAL EXERCISE AT THREE AGE LEVELS

Dependent Variable	Means (Age)[1]		
Energy	1689 kcal (A16)	1790 kcal (A14)	2009 kcal (A12)
Skinfold	16.09 mm (A12)	19.76 mm (A16)	20.51 mm (A14)
Weight for Height	98.3 (A16)	98.6 (A12)	104.3 (A14)
Total Exercise	38.6 hours/week (A14)	42.6 hours/week (A12)	44.3 hours/week (A16)

[1]Means which are underlined are not significantly different.

In this study, there was a steady, progressive decrease in energy intake with advancing age in teenage girls. The 12-year old girls ate the most per day (2009 kcal), but not significantly more than the 14-year old girls (Table XX). There were no significant differences in weight for height or total exercise time by the three age categories examined here. Nevertheless, triceps skinfold differences existed, indicating physiological changes were occurring with age rather than altered physical activity patterns.

Father's and Mother's Education

There were no significant differences among the eight educational levels of the fathers and the weight ($F = 1.75$) and skinfold measurements ($F = 0.60$) among their daughters. There were significant differences among the eight educational levels of the mothers and the weights of their daughters ($F = 2.21$). Hence, the data were examined more closely, and since there were so few mothers in the sample who had less than 11 years of education, the lower categories were collapsed into one group. Likewise, the two upper categories (college graduate and graduate degree) were combined to produce an even distribution of N. The results are in Tables XXI and XXII.

Significant differences were observed for skinfold and weight for height measurements among the groups of subjects (Table XXI). The same ascending order was noted for the means for both skinfold and weight for height. Girls who had mothers with college or graduate school educations weighed the least, had the smallest skinfolds, and the lowest weight for height measurements, although not significantly different from several of the other educational levels (Table XXII).

TABLE XXI

ANALYSIS OF VARIANCE PROCEDURE FOR VARIOUS LEVELS OF MOTHER' EDUCATION FOR SKINFOLD, WEIGHT, AND WEIGHT FOR HEIGHT MEASUREMENTS AMONG THEIR DAUGHTERS

Dependent Variable	Source	df	SS	MS	F value	Prob. > F[1]
Skinfold	Model	4	750	187.5	3.99	0.004
	Error	141	6,622	47.0		
	Total	145	7,372			
Weight	Model	4	968	242.0	2.39	0.054 ns
	Error	141	14,284	101.3		
	Total	145	15,252			
Weight for Height	Model	4	2,501	635.2	2.61	0.04
	Error	141	33,753	239.4		
	Total	145	36,254			

[1]Probability of > F.

TABLE XXII

DUNCAN'S MULTIPLE RANGE TESTS FOR SKINFOLD, WEIGHT, AND WEIGHT FOR HEIGHT MEASUREMENTS AT VARIOUS LEVELS OF MOTHER'S EDUCATION

Dependent Variable	Means (Mother's Education)[1]				
Skinfold	15.8 (Col. or Grad.)	18.5 (≤ 11)	18.5 (HS)	19.5 (Tech. or Voc.)	24.1 (Some College)
Weight	47.8 kg (Col. or Grad.)	49.4 (≤ 11)	52.2 (Some College)	52.9 (HS)	56.4 (Tech. or Voc.)
Weight for Height	93.9 (Col. or Grad.)	100.5 (≤ 11)	102.0 (HS)	103.0 (Tech. or Voc.)	108.0 (Some College)

[1]Means which are underlined are not significantly different.

Garn, Bailey, Cole, and Higgins (1977) reported similar results, women with the highest educational background averaged 20 percent thinner fat folds than women in the lower education group. Further research is needed to clarify the relationship of parental education to prevalence of obesity in children or adolescents. If educational background does impart an inverse relationship to the prevalence of obesity, this carries clear implications for the need to be alert to groups at risk for the development of obesity.

Father's and Mother's Occupation

There were no significant differences among the various occupational levels of either parents for weight for height or skinfold measurements of their daughters. Existing information in the literature does not clarify the effects of economic or social status on behaviors resulting in obesity (Dietz and Gordon, 1981).

Per Capita Income

There were no significant differences among three levels of income (high, > $6500; medium, $4500-6500; or low, < $4500), for weight for height, weight, skinfold, or arm circumference measurements. Perhaps any true relationship is concealed by the per capita function. Households with large incomes may not even rank in the top one-third, when per capita is considered. For example, whenever there are several family members, irrespective of their ages, per capita income decreased. Likewise, households with low incomes may appear falsely large whenever it is a one-parent, one-child home.

General Linear Model Multiple Regression

In multiple regression, the values of a dependent variable are described in terms of one or more independent variables (SAS User's Guide, 1982). The goal of the analysis is to account for the changes in the dependent variable. If a single measure fails to account for most of the change, then the dependent variable probably depends on two or more independent variables (SAS Intro. Guide, 1983). Multiple regression techniques are particularly effective in decision making concerning which of several measures should be included in selection tests (Isaac and Michael, 1982). R^2 measures how much variation in the dependent variable can be accounted for by the model.

Stepwise Regression

Many variables contribute to body composition measurements. The goal is to provide an equation that has an R^2 close to one and to find a test that is economical or one that uses only a few independent variables (SAS Intro. Guide, 1983). Stepwise regression is a procedure or an attempt to search for the "best" model by introducing the independent variables one by one (SAS Intro. Guide, 1983). Stepwise regression was performed on each of the following dependent variables: skinfold, weight for height, weight, and arm circumference. The results are located in Tables XXIII through XXVI. Less than five independent variables in all cases "explained" 24-37 percent of the variance of the four body composition measurements.

Tables XXIII through XXVI show the relationship among skinfold, weight for height, weight, arm circumference, and various dietary, exercise, and demographic characteristics of the subjects. Skinfold

TABLE XXIII

STEPWISE REGRESSION PROCEDURE FOR THE DEPENDENT VARIABLE, SKINFOLD[1]

	Independent Variable	R^2
Step 1	Age	0.10
Step 2	Tobacco Use	0.15
Step 3	Energy Intake	0.19
Step 4	Vigorous Exercise (VEX)	0.22
Step 5	Medium Exercise (MEX)	0.24

[1]None of the other variables met the 0.15 significance level necessary for entry into the model.

TABLE XXIV

STEPWISE REGRESSION PROCEDURE FOR THE DEPENDENT VARIABLE, WEIGHT FOR HEIGHT[1]

	Independent Variable	R^2
Step 1	Energy Intake	0.14
Step 2	Medium Exercise (MEX)	0.19
Step 3	Vigorous Exercise (VEX)	0.23
Step 4	Age	0.25
Step 5	Father's Occupation	0.27

[1]None of the other variables met the 0.15 significance level necessary for entry into the model.

TABLE XXV

STEPWISE REGRESSION PROCEDURE FOR THE DEPENDENT VARIABLE, WEIGHT[1]

Independent Variable		R^2
Step 1	Menstruation	0.26
Step 2	Energy Intake	0.34
Step 3	Medium Exercise (MEX)	0.36
Step 4	Family Type	0.38

[1]None of the other variables met the 0.15 significance level necessary for entry into the model.

TABLE XXVI

STEPWISE REGRESSION PROCEDURE FOR THE DEPENDENT VARIABLE, ARM CIRCUMFERENCE[1]

Independent Variable		R^2
Step 1	Energy Intake	0.21
Step 2	Medium Exercise (MEX)	0.27
Step 3	Tobacco Use	0.30
Step 4	Father's Occupation	0.33
Step 5	Vigorous Exercise (VEX)	0.35

[1]None of the other variables met the 0.15 significance level necessary for entry into the model.

appeared to be negatively related to vigorous exercise and energy intake according to the beta regression coefficients. In addition, skinfold tended to be positively related to age, tobacco use, and medium exercise levels. Medium exercise was not statistically significant at the 0.05 level.

Weight for height was negatively related to age, vigorous exercise, and energy intake. Age was not statistically significant at the 0.05 level. Weight for height was positively related to father's occupation and medium exercise.

Weight was negatively related to menstruation (absence of menarche) and energy intake, and weight was positively related to medium exercise levels. Family type and weight were negatively, but not significantly related.

Arm circumference was positively related to medium exercise, and negatively related to energy intake. Vigorous exercise was negatively related to arm circumference, but the relationship was not significant at the 0.05 level. Father's occupation and tobacco use were positively, but not significantly, related to arm circumference.

Baecke, Van Staveren, and Burema (1983) reported that the energy intake of females was negatively related to body fat percent and positively related to lean body mass, but energy intake was not significantly related to any index of habitual physical activity (work, sport, or leisure time index). Multiple regression analysis of total energy intake (kcal/day) on body fat percent, lean body mass, and indices of habitual physical activity in females yielded an R^2 of 0.13 (Baecke, Van Staveren, and Burema, 1983).

Likewise, Kromhout (1983) found that energy intake was inversely related to the sum of skinfolds in middle-aged men in the Netherlands. The independent variables (energy, fat, and alcohol) together "explained" 44 percent (R^2) of the variance in the sum of skinfolds.

Hypotheses Testing

Summary of Testing Hypothesis 1

The researcher failed to reject the null hypothesis: there were no significant differences among various levels of physical activity and body weight, height, triceps skinfold, and arm circumference measurements of adolescent females based on analysis of variance tests. Although a negative and a significant relationship existed between light exercise and triceps skinfold ($r = -0.18$, $p \leq .05$), positive relationships existed between medium exercise and arm circumference ($r = 0.16$, $p \leq .05$) and between light exercise and arm muscle circumference ($r = 0.26$, $p \leq .05$).

Summary of Testing Hypothesis 2

The researcher rejected the null hypothesis that a comparison of peer rankings for triceps skinfold, weight, arm circumference, and body weight for height measurements (ranks) were not significant. Spearman's correlation coefficient test for ranks indicated that many anthropometric variables were positively and significantly correlated.

Summary of Testing Hypothesis 3

The researcher failed to reject the null hypothesis: two methods of estimating physical activity did lead to the classification of

subjects in the same activity category for medium and vigorous exercise levels. Physical activity interviews and diaries among subjects produced a strong and a positive correlation coefficient ($r = 0.72$, $p \leq .02$).

Summary of Testing Hypothesis 4

The researcher rejected the null hypothesis that there were no significant differences in body composition measurements and dietary intake (energy) based on the analysis of variance tests. The t test also indicated that the subjects who were dieting to lose weight ate less food and had significantly larger skinfold, arm circumference, weight for height, weight, and height measurements than those who were not dieting to lose weight. Likewise, the subjects who were dieting to gain weight ate more food and had significantly smaller skinfold, weight, and arm circumference measurements than those who were not dieting to gain weight.

The researcher failed to reject the null hypothesis: there were no significant differences between body composition measurements and the following variables: race, mother's occupation, father's occupation, father's education, and per capita income based on analysis of variance tests.

overweight (greater than or equal to 110 percent of weight for height) or obese (greater than or equal to 120 percent of weight for height).

Approximately one-third the group went on a weight reduction diet three or more times during the year and the diet usually lasted less than one month. Slightly over half the group thought they were too heavy and 42.4 percent were trying to lose weight at the time of the interview. Three-fourths of the group consumed less than the 1980 RDA for energy for their age group.

Everyone participated in some type of light or medium intensity exercise each week, but about one-third of the sample did not participate in any type of vigorous exercise. The exercise and anthropometric variables were generally correlated negatively with each other which is consistent with current exercise physiology theory. There was a significant and negative relationship between energy intake and anthropometric measurements (height, weight, skinfold, arm circumference, arm muscle circumference, and weight for height). As the energy intake increased, all the anthropometric measurements decreased. Likewise, there was significant and a negative relationship between energy and per capita income.

No significant difference was found between blacks and whites for height, weight, skinfold, arm circumference and weight for height, tobacco use, energy intake, or light, medium, vigorous, or total exercise levels. Black girls drank significantly less alcohol than the white girls drank. The parents of the black girls had significantly less education ($p \leq 0.002$) and less per capita income than the white girls ($p \leq 0.002$).

The subjects who were on weight reduction diets consumed significantly less energy than the non-dieters and they weighed significantly more. The dieters were also taller and had larger arm circumferences and triceps skinfold measurements than the non-dieters. There were no significant differences in physical activity levels.

Girls who were trying to gain weight did consume significantly more energy than girls who did not want to gain weight. They also were lighter and had smaller arm circumference and triceps skinfold measurements. There were no significant differences in height, weight for height, relative height, or exercise levels in girls trying to gain weight vs. those not trying to gain weight.

General trends were apparent when the data were ranked; the subjects with the lowest total exercise ranks had some of the highest ranks for weight for height, weight, arm circumference, and skinfold measurements. The Spearman correlation coefficients were significantly and positively related to each other; except height and weight for height which were not significantly correlated. Triceps skinfold and vigorous exercise and triceps skinfold and light exercise were negatively and significantly correlated, but there were no significant differences between any of the exercise levels and weight for height.

The subjects who had the lowest energy intakes also had the highest triceps skinfold, weight for height, and arm circumference measurements. Those with the highest daily energy intakes weighed the least. There was a steady, progressive decrease in energy intake with advancing age in teenage girls, but there were no significant differences in weight for height, or total exercise time by the various age categories examined.

Multiple regression was used to account for the changes in the dependent variable. R^2 was moderate (24-38 percent) for skinfold, weight for height, weight, and arm circumference. The following independent variables were the most useful in explaining the variance: age, tobacco use, menstruation, family type, medium or vigorous exercise, father's occupation, and energy intake.

Conclusions

The researcher made the following conclusions on the basis of this study:

1. There were no significant differences among three levels of physical activity (high, medium, or low) and body weight, height, triceps skinfold, and arm circumference measurements of adolescent females.

2. A comparison of peer rankings for triceps skinfold, weight, arm circumference, and body weight for height measurements were equivalent.

3. Two methods of estimating physical activity (interview and diary) did lead to the classification of subjects in the same activity category for medium and vigorous exercise levels.

4. There were significant differences in body composition measurements and dietary intake (energy). Subjects who were dieting to lose weight ate less food and had significantly larger skinfold, arm circumference, weight for height, weight, and height measurements than those who were not dieting to lose weight. The subjects who were dieting to gain weight, ate more food and had significantly smaller skinfold, weight, and arm circumference measurements than those who were not dieting to gain weight.

5. There were no significant differences between body composition measurements and the following variables: race, mother's occupation, father's occupation, father's education, and per capita income.

Recommendations for Research

The researcher recommended the following areas for further research.

1. A larger sample would provide more data about the typical exercise and eating patterns of adolescent girls.

2. Longitudinal studies of adolescent girls and young women should be conducted to investigate the changes in exercise levels with increasing age.

3. An investigation of whether or not the intensity of exercise had an influence on body weight and body composition.

4. Two or more skinfold measurements (triceps and subscapular) should be studied to determine if racial differences do exist between blacks and whites.

LITERATURE CITED

Baecke, J. A. H., Burema, J., and Frijters, J. E. R.: A short questionnaire for the measurement of habitual physical activity in epidemiological studies. Am. J. Clin. Nutr. 36: 936, 1982.

Baecke, J. A. H., Van Staveren, W. A., and Burema, J.: Food consumption, habitual physical activity, and body fatness in young Dutch adults. Am. J. Clin. Nutr. 37: 278, 1983.

Beal, V. A.: Nutrition in the Life Span. 1st ed. New York: John Wiley and Sons, 1980.

Boas, F.: The growth of children. Science, 19: 256, 1892.

Botvin, G. J., Cantlon, A., Carter, B. J., and Williams, C. L.: Reducing adolescent obesity through a school health program. Journal of Pediatrics 95(6): 1060, 1979.

Bouchard, C., Tremblay, A., Leblanc, C., Lortie, G., Savard, R., and Theriault, G.: A method to assess energy expenditure in children and adults. Am. J. Clin. Nutr. 37: 461, 1983.

Bray, G. A., Jordan, H. A., and Sims, E. A.: Evaluation of the obese patient. J. Am. Med. Assoc. 235(14): 1487, 1976.

Brownell, K. D.: The psychology and physiology of obesity: Implications for screening and treatment. J. Am. Diet. Assoc. 84: 406, 1984.

Brozek, J., Grande, F., Anderson, J. T., and Keys, A.: Densitometric analysis of body composition: Revision of some quantitative assumptions. Ann. NY Acad. Sci. 110: 113, 1963.

Bullen, B. A., Reed, R. B., and Mayer, J.: Physical activity of obese and non-obese adolescent girls appraised by motion picture sampling. Am. J. Clin. Nutr. 14: 211, 1964.

Burgert, S. L. and Anderson, C. F.: An evaluation of upper arm measurements used in nutritional assessments. Am. J. Clin. Nutr. 32: 2135, 1979.

Buskirk, E. R.: Obesity: A brief overview with emphasis on exercise. Fed. Proc. 33: 1948, 1974.

Buskirk, E. R. and Mendex, J.: Energy: Caloric requirements. In: Alfin-Slater, R. B. and Kritchevsky, D., eds. Nutrition and the Adult-Macronutrients. New York: Plenum Press, 1980.

Buzina, R. D. and Urema, K.: Selection of minimum anthropometric characteristics to assess nutritional status. Nutrition and Malnutrition. Identification and Measurement. 49: 271, 1973.

Byrd, R. J., Smith, D. P., and Shackleford, C. B.: Jogging in middle-aged men: Effect on cardiovascular dynamics. Arch. Phys. Med. Rehabil. 55: 301, 1974.

Chandra, R. K.: Nutrition in adolescence. Nutrition Research 1: 147, 1981.

Chirico, A. M. and Stunkard, A. J.: Physical activity and human obesity. New Engl. J. Med. 263: 935, 1960.

Christakis, G.: Dietary methodologies. Am. J. Public Health 63: 11, 1973.

Cooper, K. H.: The Aerobics Program for Total Well-Being. 1st ed. New York: Bantam Books, Inc., 1982.

Davenport, C. B.: Anthropometry and Anthroposcopy. 1st ed. Cold Spring Harbor, NY: Waverly Press, 1927.

Dietz, W. H.: Obesity in infants, children and adolescents in the United States I. Identification, Natural History, and Aftereffects. Nutrition Research 1: 117, 1981.

Dietz, W. H. and Gordon, J. E.: Obesity in infants, children, and adolescents in the United States II. Causality. Nutrition Research 1: 193, 1981.

Dugdale, A. E., May, G. M. A., and O'Hara, M. O.: Ethnic differences in the distribution of subcutaneous fat. Ecology of Food and Nutrition 10: 9, 1980.

DuRant, R. H., Martin, D. S., Linder, C. W., and Weston, W.: The prevalence of obesity and thinness in children from a lower socioeconomic population receiving comprehensive health care. Am. J. Clin. Nutr. 33: 2002, 1980.

Dwyer, J. T., Feldman, J. J. and Mayer, J.: Adolescent dieters: Who are they? Am. J. Clin. Nutr. 20: 1045, 1967.

Fineberg, S. K.: The realities of obesity and fad diets. Nutr. Today 7: 23, 1972.

Forbes, G. B.: Body composition as affected by physical activity and nutrition. Fed. Proc. 44: 343, 1985.

Franklin, B. A. and Rubenfire, M.: Losing weight through exercise. J. Am. Med. Assoc. 244(4): 377, 1980.

Frisancho, A. R.: Triceps skinfold and upper arm muscle size norms for assessment of nutritional status. Am. J. Clin. Nutr. 27: 1052, 1974.

Frisch, R. E.: Pubertal adipose tissue: Is it necessary for normal sexual maturation? Evidence from the rat and human female. Fed. Proc. 39(7): 2395, 1980.

Garn, S. M.: Growth, Body Composition and Development of Obese and Lean Children. In Winick, M., ed. Childhood Obesity. New York: John Wiley and Sons, 1975.

Garn, S. M. and Clark, D. C.: Trends in fatness and the origins of obesity. Pediatr. 57: 443, 1976.

Garn, S. M., Bailey, S. M., Cole, P. E., and Higgins, I. T. T.: Level of education, level of income, and level of fatness in adults. Am. J. Clin. Nutr. 30: 721, 1977.

Garrett, H. L., Pangle, R. V., and Mann, G. V.: Physical conditioning and coronary risk factors. J. Chron. Dis. 19: 899, 1966.

Goldbert, P. B., Moore, M. E., and Stunkard, A. J.: Social factors in obesity. J. Am. Med. Assoc. 192: 1039, 1965.

Gray, G. E. and Gray, L. K.: Anthropometric measurements and their interpretation principles, practices, and problems. J. Am. Diet. Assoc. 77: 534, 1980.

Gronlund, N. E.: Measurement and Evaluation in Teaching. 3rd ed. New York: Macmillan Publishing Co., Inc., 1976.

Gwinup, G.: Effect of exercise alone on the weight of obese women. Arch. Intern. Med. 135: 676, 1975.

Hager, A.: Nutritional problems in adolescence. Nutr. Rev. 39(2): 89, 1981.

Haider, S. Q. and Wheeler, M. S.: Dietary intake of low socioeconomic black and hispanic teenage girls. J. Am. Diet. Assoc. 77: 677, 1980.

Hamill, P. V. V., Drizd, T. A., Johnson, C. L., Reed, R. B., Roche, A. F., and Moore, W. M.: Physical growth: National Center for Health Statistics percentiles. Am. J. Clin. Nutr. 32: 607, 1979.

Hammond, W. H.: Measurement and interpretation of subcutaneous fat, with norms for children and young adult males. Brit. J. Prevent. Social Med. 9: 201, 1955.

Hampton, M. C., Huenemann, R. L., Shapirao, L. R., and Mitchell, B. W.: Caloric and nutrient intakes of teen-agers. J. Am. Diet. Assoc. 50: 385, 1967.

Health and Nutrition Examination Survey, National Center for Health Statistics.: Preliminary findings of the first health and nutrition examination survey, United States, 1971-1972: Anthropometric and clinical findings. Rockville, MD: National Center for Health Statistics, 1975. Series: United States Dept. of Health, Education, and Welfare. DHEW Publ. No. (HRA) 75-1219-2.

Himes, J. H., Roche, A. F., and Webb, P.: Fat areas as estimates of total body fat. Am. J. Clin. Nutr. 33: 2093, 1980.

Hodges, R. E. and Krehl, W. A.: Nutritional status of teenagers in Iowa. Am. J. Vlin. Nutr. 17: 200, 1965.

Hooley, R. A.: Clinical nutritional assessment: A perspective. J. Am. Diet. Assoc. 77: 682, 1980.

Isaac, S. and Michael, W. B.: Handbook in Research and Evaluation. 2nd ed. San Diego, CA: Edits Publ., 1982.

Johnson, C. C., Stone, M. H., Afredo-Lopez, S., Hebert, J. A., Kilgore, L. T., and Byrd, R. J.: Diet and exercise in middle-aged men. J. Am. Diet. Assoc. 81: 695, 1982.

Johnson, M. L., Burke, B. S., and Mayer, J.: Relative importance of inactivity and overeating in the energy balance of obese high school girls. Am. J. Clin. Nutr. 4: 37, 1956.

Kelly, J. T., Patten, S. E., and Johannes, A.: Analysis of self-reported eating and related behaviors in an adolescent population. Nutrition Research 2: 417, 1982.

Keys, A. and Brozek, J.: Body fat in adult man. Physiol. Rev. 33: 245, 1953.

Kohrs, M. B., Wang, L. L., Eklund, D., Paulsen, B., and O'Neal, R.: The association of obesity with socieconomic factors in Missouri. Am. J. Clin. Nutr. 32: 2120, 1979.

Krause, M. V. and Mahan, L. K.: Food, Nutrition and Diet Therapy. 6th ed. Philadelphia: W. B. Saunders Co., 1979.

Kromhout, D.: Energy and macronutrient intake in lean and obese middle-aged men (The Zutphen Study). Am. J. Clin. Nutr. 37: 295, 1983.

Lange Skinfold Caliper and Calibration Block, Cambridge Scientific Industries, Inc., Cambridge, Maryland.

Lee, C. J.: Nutritional status of selected teenagers in Kentucky. Am. J. Clin. Nutr. 31: 1453, 1978.

Leon, A. S., Conrad, J., Hunninghake, D. B., and Serfass, R.: Effects of a vigorous walking program on body composition, and carbohydrate and lipid metabolism of obese young men. Am. J. Clin. Nutr. 32: 1776, 1979.

Lewis, S. Haskell, W. L., Wood, P. D., Manoogian, N., Bailey, J. E., and Peretra, M.: Effects of physical activity on weight reduction in obese middle-aged women. Am. J. Clin. Nutr. 29: 151, 1976.

Lowenstein, M. F. and Phillips, J. F.: Evaluation of arm circumference measurements for determining nutritional status of children and its use in an acute epidemic of malnutrition: Owerri, Nigeria following the Nigerian wat. Am. J. Clin. Nutr. 26: 226, 1973.

Macdonald, L. A., Wearring, G. A., and Moase, O.: Factors affecting the dietary quality of adolescent girls. J. Am. Diet. Assoc. 82: 260, 1983.

Malina, R. M.: Patterns of development in skinfolds of Negro and white Philadelphia children. Human Biology 38: 89, 1966.

_____.: Growth, maturation, and performance of Philadelphia Negro and white elementary school children. Ph.D. thesis, Univ. of Pennsylvania, 1968.

_____.: Skinfolds in American Negro and white children. J. Am. Diet. Assoc. 59: 34, 1971.

Mallick, M. J.: Health hazards of obesity and weight control in children: A review of the literature. Am. J. of Pub. Health 73(1): 78, 1983.

Martin, E. A. and Beal, V. A.: Roberts Nutrition Work with Children. Chicago: University of Chicago Press, 1978.

Mayer, J.: Overweight Causes, Cost, and Control. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1968.

_____.: Obesity. In Goodhart, R. S., and Shils, M. E., eds. Modern Nutrition in Health and Disease. 5th ed. Philadelphia: Lea & Febiger, 1973.

_____.: Obesity during childhood. In Winick, M., ed. Childhood Obesity. New York: John Wiley and Sons, Inc., 1975.

McKigney, J. I.: Physical growth of ethnic groups comprising the United States population. Am. J. Clin. Nutr. 28: 1071, 1975.

Meyer, E. E. and Neumann, C. G.: Management of the obese adolescent. Pediatr. Clin. North. Am. 24: 123, 1977.

Moore, M. E., Stunkard, A. J., and Srole, L.: Obesity, social class, and mental illness. J. Am. Med. Assoc. 181: 962, 1962.

Morgan, A. F., ed.: Nutritional Status USA. Calif. Agr. Exper. Stat. Bull. 769, 1959.

Morgan, K. J., Johnson, S. R., and Stampley, G. L.: Children's frequency of eating, total sugar intake, and weight/height stature. Nutrition Research 3: 635, 1983.

National Center for Health Statistics.: Height and weight of youths 1-17 years. U.S. Vital and Health Statistics. Series 11 No. 124, NHEW Pub. No. (HSM) 73-1606. Health Service and Mental Health Administration. Washington: U.S. Government Printing Office, 1973.

_____.: NCHS Growth Charts, 1976. Monthly Vital Statistical Report, Vol. 25, No. 3, Suppl. (HRA) 76-1120. Rockville, MD: Health Resources Administration, 1976.

_____.: NCHS Growth Curves for Children 0-18 years. United States Vital and Health Statistics. Series 11 No. 165. Health Resources Administration. Washington: U.S. Government Printing Office, 1977.

National Research Council Food and Nutr. Bd.: Recommended Dietary Allowances, 8th rev. ed. Washington: 1980.

Nutritional Analysis System, Department of Experimental Statistics, Louisiana State University, Baton Rouge, LA.

O'Brien, R., Girshik, M. A., and Hunt, E. P.: Body measurements of American boys and girls for garment and pattern construction. Washington: U.S. Dept. of Agriculture. (Miscellaneous Pub. No. 454), 1941.

Pao, E. M.: Nutrient consumption patterns of individuals, 1977 and 1965. Family Economics Review, 16, 1980.

Prader, A., Tanner, J. M., and von Harnack, G. A.: Catch-up growth following illness or starvation. J. Pediat. 62: 646, 1963.

Prothro, J., Mickles, M., and Tolbert, B.: Nutritional status of a population sample in Macon County, Alabama. Am. J. Clin. Nutr. 29: 94, 1976.

Rathbun, E. N. and Pace, N.: Studies on body composition. I. The determination of total body fat by means of the body specific gravity. J. Biol. Chem. 1958: 667, 1945.

Reed, R. B. and Stuart, H. C.: Patterns of growth in height and weight from birth to eighteen years of age. Pediatrics 24: 904, 1959.

Reiff, G. C., Montoye, J. H., Remington, R. D., Napier, J. A., Metzner, H. L., and Epstein, F. H.: Assessment of physical activity by questionnaire and interview. In Karronen, J. J. and Barry, A. K., eds. Phytical Activity and the Heart. Springfield, MO: Charles C. Thomas Co., 1967.

Roberts, L. J.: Nutrition Work with Children. Chicago: University of Chicago Press, 1935.

SAS Institute Inc.: SAS User's Guide. Statistics, 1982 ed. Cary, NC: SAS Institute, Inc., 1982.

SAS Introductory Guide.: SAS Institute Inc. Revised ed. Cary, NC: 1983.

Sanders, B. S.: Environment and Growth. 1st ed. York, PA: Warwick and York, Inc., Maple Press Co., 1934.

Schemmel, R.: Assessment of obesity. In Schemmel, R., ed. Nutrition, Physiology and Obesity. Boca Raton, FL: CRC Press, Inc., 1980.

Scott, R. B., Ferguson, A. D., Jenkins, M. S., and Cutter, F. F.: Growth and development of Negro infants. V. Neuromuscular patterns of behavior during the first year of life. Pediatrics. 16: 24, 1955.

Seltzer, C. C. and Mayer, J.: A simple criterion of obesity. Postgrad. Med. 38: 101A, 1965.

Sinclair, D.: Human Growth After Birth. 2nd ed. Southampton, England: London Oxford University Press, Camelot Press, Ltd., 1973.

Stefanik, P. A., Heald, F. R., and Mayer, J.: Caloric intake in relation to energy output of obese and non-obese adolescent boys. Am. J. Clin. Nutr. 7: 55, 1959.

Storz, N. S. and Greene, W. H.: Body weight, body image, and perception of fad diets in adolescent girls. J. of Nutr. Ed. 15: 15, 1983.

Stuart, H. C. and Meredith, A. V.: Use of body measurements in the school health program. Am. J. Public Health 36: 1365, 1946.

Stunkard, A., d'Aquili, E., Fox, S., and Filion, R. D. L.: Influence of social class on obesity and thinness of children. J. Am. Med. Assoc. 221(6): 579, 1972.

Tanner, J. M.: Growth at Adolescence. 2nd ed. Oxford, England: Blackwell Scientific Publications, Alden Press, 1962.

Tanner, J. M. and Whitehouse, R. H.: Standards for subcutaneous fat in British children. Brit. Med. J. 1: 446, 1962.

Tanner, J. M., Whitehouse, R. H., Marshall, W. A., and Carter, B.S.: Prediction of adult height from height, bone age, and occurrence of menarche, at ages 4 to 16 with allowance for midparent height. Arch. Dis. in Childh. 50: 14, 1975.

Tanner, J. M., Whitehouse, R. H., and Takaishi, M.: Standards from birth to maturity for height, weight, height velocity, and weight velocity. British children. Parts I and II. Arch. Dis. Child. 41: 454, 1966.

Taylor, H. L., Jacobs, D. R., and Schucker, B.: A questionnaire for the assessment of leisure time physical activities. J. Chronic. Dis. 31: 741, 1978.

Ten-State Nutrition Survey 1968-1970, I.: Historical Development, II. Demographic Data, III. Clinical Anthropometry, Dental, IV. Biochemical, V. Dietary and highlights. DHEW Publs. Nos. (HSM) 72-8130, 72-8131, 72-8132, 72-8133, and 73-8134, 1972.

Thomas, J. A. and Call, D. L.: Eating between meals--A nutrition problem among teenagers? Nutr. Rev. 31(5): 137, 1973.

U.S. Dept. of HEW: Ten-State Nutrition Survey, 1968-1970. DHEW Public. No. (HSM) 72-8130, 72-8131, and 72-8133. Supt. of Documents. Washington: U.S. Government Printing Office, 1972.

Ward, G. M., Krzywicki, H. J., Rahman, D. P., Quaas, R. L., Nelson, R. A., and Consolazio, D. F.: Relationship of anthropometric measurements to body fat as determined by densitometry, potassium-40, and body water. Am. J. Clin. Nutr. 28: 162, 1975.

Wetzel, N.C.: Physical fitness in terms of physique, development and basal metabolism with a guide to individual progress from infancy to maturity: A new method for evaluation. J. Am. Med. Assoc. 116: 1187, 1941.

Womersley, J. and Durnin, J. V.: A comparison of the skinfold method with extent of 'overweight' and various weight-height relationships in the assessment of obesity. Br. J. Nutr. 38: 271, 1977.

Zack, P. M., Harlan, W. R., Leaverton, P. E., and Cornoni-Huntley, J.: A longitudinal study of body fatness in childhood and adolescence. The Journal of Pediatrics 95(1): 126, 1979.

Zerfas, A. J.: The insertion tape: A new circumference tape for use in nutritional assessment. Am. J. Clin. Nutr. 28: 782, 1975.

APPENDIX A

ANTHROPOMETRIC MEASUREMENTS FORM

Anthropometric Measurements

NOTE: Ask subject to remove shoes and all heavy outer garments.

1. Birthdate _____ _____ _____
   Month Day Year

2. Weight _____lbs. / 2.2 = _____ kg
   Record weight in pounds

3. Clothing Estimate _____ grams
   (Note clothing list in #7)

4. Height _____

5. Arm Circumference _____ cm

6. Triceps Skinfold _____ mm

7. Check the clothing items worn when subject was weighed in order to obtain clothing estimate. Calculate and record in #3.

   Clothing List:

   Bra: Natural (25 g) Padded (40 g)

   Panties: Nylon (18 g) Cotton (20 g)

   Slip: Full (110 g) Half (80 g)

   Socks: Footlets (30 g) Short Socks (35 g) Knee Socks (50 g)

   Sheer Hose: Knee Length (25 g) Panty Hose (60 g)

   Slacks: Polyester (250 g) Cotton (360 g) Jeans (440 g)

   Skirt: Light (250 g) Medium (360 g) Heavy (420 g)

   Blouse: Light (100 g) Medium (190 g) Heavy (280 g)

   Sweater: Light (320 g) Medium (390 g) Heavy (440 g)

   Belt: Light (60 g) Medium (100 g) Heavy (140 g)

   Other: List and weigh similar items

_____

APPENDIX B

PHYSICAL ACTIVITY FORM

Subject No. _____

Date _____

Exercise/Activity Levels

Directions: The following set of information needs to be asked for EACH activity which the subject has participated in during the past year.

Frequency (Yearly basis)

1. Once or twice a year
2. Monthly
3. Weekly

Seasonally (Monthly)

1. Yes, less than or equal to 6 months
2. No, more than 6 months

Number of Days/Week

(Answer only if frequency is weekly, by recording the appropriate number of days.) _____

Duration/Day _____ minutes

Intensity

1. Light (Not tiring, or no sweating)
2. Moderate (Somewhat tiring or sweating)
3. Vigorous (Tiring to exhasuting, or profuse sweating)

Example:

1. Baseball or softball

   Frequency _____

   Seasonally _____

   # of days/week _____

   Minutes _____

   Intensity _____

2. Basketball

3. Bicycling

4. Dancing

5. Gymnastics

6. Swimming
7. Water Skiing
8. Golfing
9. Soccer
10. Walking
11. Tennis
12. Running
13. Ice Skating
14. Roller Skating
15. Hiking or Mountain Climbing
16. Bowling
17. Calisthenics
18. Farming or Gardening
19. Volleyball
20. Snow Skiing

APPENDIX C

SAMPLE QUESTIONS FROM SOCIODEMOGRAPHIC FORM

Subject No. _____

Date _____

Sociodemographic Background Information

Respondent's relation to subject _____

**Note to interviewer: If subject does not live with parent(s) and/or guardian(s) she may possibly be the respondent. Change wording of items appropriately.

1. Subject's Race

   1 = White 2 = Black

2. Location of Subject's Residence (Record town) _____

   1 = Major urban--Greater than or equal to 100,000
   2 = Minor urban--Greater than or equal to 2,500 and less than 100,000
   3 = Rural, non-farm--Less than 2,500 and non-farming
   4 = Rural, farm--less than 2,500 and farming

3. Where does subject stand in the birth order of her siblings?

   1 = Only child 2 = Oldest 3 = In the middle 4 = Youngest

If the subject is not an only child, ask:

4. How many? Record zero or actual number. _____

   A) Older brothers

   B) Older sisters

   C) Younger brothers

   D) Younger sisters

5. Who lives in the household with subject? (Check the appropriate category and record the actual number.)

_____ Father	_____ Non-related males
_____ Mother	_____ Non-related females
_____ Brother(s)	_____ Grandmother(s)
_____ Sister (s)	_____ Grandfather(s)
_____ Uncle(s)	_____ Male cousin(s)
_____ Aunt(s)	_____ Female cousin(s)
_____ Children of subject	_____ Niece(s)
_____ Husband of subject	_____ Nephew(s)

_____ Mother-in-law
_____ Father-in-law
_____ Guardian(s)
_____ None

**Note: From the information obtained in question 5, determine family type as follows:

If family consists of father and mother, and possibly brother(s) and/or sister(s)

Family Type = 1

If family consists of father and mother, possibly brothers and/or sisters, and in addition other related members

Family Type = 2

If family consists of father and mother, possibly brothers and/or sisters, and in addition non-related members

Family Type = 3

If family consists of father or mother and possibly brothers and/or sisters

Family Type = 4

If family consists of father or mother, possibly brothers and/or sisters, and in addition non-related members

Family Type = 5

If family consists of father or mother, possibly brothers and/or sisters, and in addition non-related members

Family Type = 6

6. What is the total number of persons living in subject's household? (Reply determined by interviewer) _____

**Note: If the father is living, ask questions 7A, B, C, D, E, regardless of whether he lives in the household or not.

7A. Is the subject's biological father employed?

1 = Yes 2 = No

7B. (If employed), is the subject's father employed

1 = full time 2 = part-time

7C. (If employed), what is his occupation? _____

**Note: Refer to Table VII in coding the reply to this question.

Table VII

1 = Professional	5 = Blue Collar
2 = Proprietor	6 = Service
3 = Business	7 = Farm
4 = White Collar	8 = Other

7D. (If not employed) is subject's father

1 = Unemployed 2 = Retired 3 = Student 4 = Homemaker

7E. How many years of schooling has the subject's father completed? (Check the highest level of education completed)

1 = 0 to 5	5 = Technical or vocational school
2 = 6 to 8	6 = Some college
3 = 9 to 11	7 = Completed college
4 = Completed High School	8 = Graduate School

**Note: If the mother is living, ask questions 8A, B, C, D, and E, regardless of whether she lives in the household or not.

8A. Is the subject's biological mother employed outside the home?

1 = Yes 2 = No

8B. (If employed), is subject's mother employed

1 = full time 2 = part-time

8C. (If employed), what is her occupation? _____

**Note: Refer to Table VII in coding the reply to this question.

8D. (If not employed) is subject's mother

1 = Unemployed 2 = Retired 3 = Student 4 = Homemaker

8E. How many years of schooling have you (the mother) completed? (Check the highest level of education completed)

1 = 0 to 5	5 = Technical or vocational school
2 = 6 to 8	6 = Some college
3 = 9 to 11	7 = Completed college
4 = Completed High School	8 = Graduate School

**Note: Please indicate to the respondent that the period for reporting income is the past 12 months. For all of the sources of income listed below, the following codes should be used: 1 = Yes, 2 = No

9. We need to relate information of food habits, meal practices and health to your sources of income. To keep this completely confidential, I would like you to indicate which of the following ways your household received income last year.

   A. Wages, salary and/or bonus

   B. Social Security, Veteran's, Pension (not welfare) or Insurance Payments

   C. Farming

   D. Rental Property

   E. Welfare Payments

   F. Child Support (from divorced parent) or alimony

   G. WIC

   H. Food Stamps

   I. Gifts (friends, relatives)

   J. Business

   K. Odd jobs or any other source

10A. Now that you have mentioned the source(s) of your family income, what is the total (add all sources) before taxes are deducted? You can do this by week, month or year.

   $ _____ weekly

   $ _____ monthly

   $ _____ yearly

**Note: If listed weekly or monthly ask 10B.

10B. How many weeks or months of the year do you make this amount?

   _____ weeks _____ months

11. Given the above information in question 10, what is the subjects total gross family income? (Record actual amount) _____

12. How many people does this income support? (Record actual amount) _____

APPENDIX D

24-HOUR FOOD INTAKE RECALL FORM

FORM D-1b

Subject No. _____ Name _____ Interview at

Date _____ Today is: Sn M Tu W Th F Sa ___ Home

___ School

Tell me, beginning with the time you got up yesterday morning, everything you ate or drank until you went to bed last night.

TIME OF DAY	FOOD & DESCRIPTION	AMOUNT	NO. ITEMS	PLACE

Did you take a supplement yesterday? Yes No

If so, What Kind?	How Many?	Time of Day	Amount/Tablet

How long have you taken this supplement? _____years _____months ____1 mo.

Are you now trying to: _____ Lose weight _____ Gain weight

_____ Maintain present weight

If trying to lose, what method are you using? (Check all that apply)

_____ eating less _____ special diet _____ exercise

_____ medication/pills _____ other (_____)

APPENDIX E

SAMPLE QUESTIONS FROM DIETARY HABITS AND FOOD CONSUMPTION QUESTIONNAIRE

1. Have you ever been on a weight reduction diet?

   1 = Yes 2 = No

   If answer is "No", skip to #6.

2. If yes, was it recommended or decided on primarily by (select one):

   1. Physician
   2. Mother
   3. Father
   4. Self
   5. Girlfriend(s)
   6. Boyfriend(s)
   7. Media

3. Have you been on a weight reduction diet within the past year?

   1 = Yes 2 = No

4. How many times each year to you go on a weight reduction diet?

5. How long does the diet usually last (select one).

   1. Less than one month
   2. One to three months
   3. Four to six months
   4. More than six months

6. Have you even been on a diet to try to gain weight?

   1 = Yes 2 = No

   If answer is "No", skip to #9.

7. Have you tried to gain weight within the past year?

   1 = Yes 2 = No

8. If yes, was it recommended or decided on primarily by (select one):

   1. Physician
   2. Mother
   3. Father
   4. Self
   5. Girlfriend(s)
   6. Boyfriend(s)
   7. Media

9. Are you presently trying to _____ weight?

   1 = Gaim 2 = Lose 3 = Neither

10. Do you think your weight in now (circle one):

    3 = Too Heavy 1 = Too Light 2 = About Right

APPENDIX F

INFORMED CONSENT FORM

INFORMED CONSENT

I volunteer to participate in a study of physical activity and body composition of OK teenagers. I realize that I will be asked questions about my physical activity level and I will keep a physical activity diary for three days. The researchers have my permission to record height, weight, and triceps skinfold measurements.

_____ _____

Signature Date

Address

_____

_____

_____

_____

Telephone

_____

APPENDIX G

ACTIVITY DIARY

ACTIVITY DIARY

Name_____ Age_____

Day_____ Date_____

Directions:

1. Please check (✓) the appropriate column to describe the activity.
2. Draw an arrow (↓) down the column if the activity is the same for greater than five minutes.
3. If two or more activities apply, please record all of them and explain.
4. See the code sheet for examples (page 3).

	sleeping	sitting	standing	working	exercising		sleeping	sitting	standing	working	exercising		sleeping	sitting	standing	working	exercising
12:00 midnight						3:00 a.m.						6:00 a.m.					
12:05						3:05						6:05					
12:10						3:10						6:10					
12:15						3:15						6:15					
12:20						3:20						6:20					
12:25						3:25						6:25					
12:30						3:30						6:30					
12:35						3:35						6:35					
12:40						3:40						6:40					
12:45						3:45						6:45					
12:50						3:50						6:50					
12:55						3:55						6:55					
1:00 a.m.						4:00 a.m.						7:00 a.m.					
1:05						4:05						7:05					
1:10						4:10						7:10					
1:15						4:15						7:15					
1:20						4:20						7:20					
1:25						4:25						7:25					
1:30						4:30						7:30					
1:35						4:35						7:35					
1:40						4:40						7:40					
1:45						4:45						7:45					
1:50						4:50						7:50					
1:55						4:55						7:55					
2:00 a.m.						5:00 a.m.						8:00 a.m.					
2:05						5:05						8:05					
2:10						5:10						8:10					
2:15						5:15						8:15					
2:20						5:20						8:20					
2:25						5:25						8:25					
2:30						5:30						8:30					
2:35						5:35						8:35					
2:40						5:40						8:40					
2:45						5:45						8:45					
2:50						5:50						8:50					
2:55						5:55						8:55					

	sleeping	sitting	standing	working	exercising
9:00 a.m.					
9:05					
9:10					
9:15					
9:20					
9:25					
9:30					
9:35					
9:40					
9:45					
9:50					
9:55					
10:00 a.m.					
10:05					
10:10					
10:15					
10:20					
10:25					
10:30					
10:35					
10:40					
10:45					
10:50					
10:55					
11:00 a.m.					
11:05					
11:10					
11:15					
11:20					
11:25					
11:30					
11:35					
11:40					
11:45					
11:50					
11:55					
12:00 noon					
12:05					
12:10					
12:15					
12:20					
12:25					
12:30					
12:35					
12:40					
12:45					
12:50					
12:55					

	sleeping	sitting	standing	working	exercising
1:00 p.m.					
1:05					
1:10					
1:15					
1:20					
1:25					
1:30					
1:35					
1:40					
1:45					
1:50					
1:55					
2:00 p.m.					
2:05					
2:10					
2:15					
2:20					
2:25					
2:30					
2:35					
2:40					
2:45					
2:50					
2:55					
3:00 p.m.					
3:05					
3:10					
3:15					
3:20					
3:25					
3:30					
3:35					
3:40					
3:45					
3:50					
3:55					
4:00 p.m.					
4:05					
4:10					
4:15					
4:20					
4:25					
4:30					
4:35					
4:40					
4:45					
4:50					
4:55					

	sleeping	sitting	standing	working	exercising
5:00 p.m.					
5:05					
5:10					
5:15					
5:20					
5:25					
5:30					
5:35					
5:40					
5:45					
5:50					
5:55					
6:00 p.m.					
6:05					
6:10					
6:15					
6:20					
6:25					
6:30					
6:35					
6:40					
6:45					
6:50					
6:55					
7:00 p.m.					
7:05					
7:10					
7:15					
7:20					
7:25					
7:30					
7:35					
7:40					
7:45					
7:50					
7:55					
8:00 p.m.					
8:05					
8:10					
8:15					
8:20					
8:25					
8:30					
8:35					
8:40					
8:45					
8:50					
8:55					

	sleeping	sitting	standing	working	exercising
9:00 p.m.					
9:05					
9:10					
9:15					
9:20					
9:25					
9:30					
9:35					
9:40					
9:45					
9:50					
9:55					
10:00 p.m.					
10:05					
10:10					
10:15					
10:20					
10:25					
10:30					
10:35					
10:40					
10:45					
10:50					
10:55					
11:00 p.m.					
11:05					
11:10					
11:15					
11:20					
11:25					
11:30					
11:35					
11:40					
11:45					
11:50					
11:55					

CODES:

SLEEPING - sleeping or reclining, awake

SITTING - talking, watching TV, singing, driving a car, reading, writing, studying, playing records, knitting, crocheting, mending, sewing, typing, tabletop work, eating, personal grooming, dressing, undressing, sitting

STANDING - sweeping, vacuuming, ironing, table tennis, shopping, cooking, baking, washing dishes, washing clothes, restaurant trades, golf, garage work, sailing, horseback riding, walking - slow

WORKING - weeding, hoeing garden, loading/stacking bales, scrubbing floors, cycling, painting walls, dancing, climbing stairs, tennis, walking - fast, walking with a load, skiing

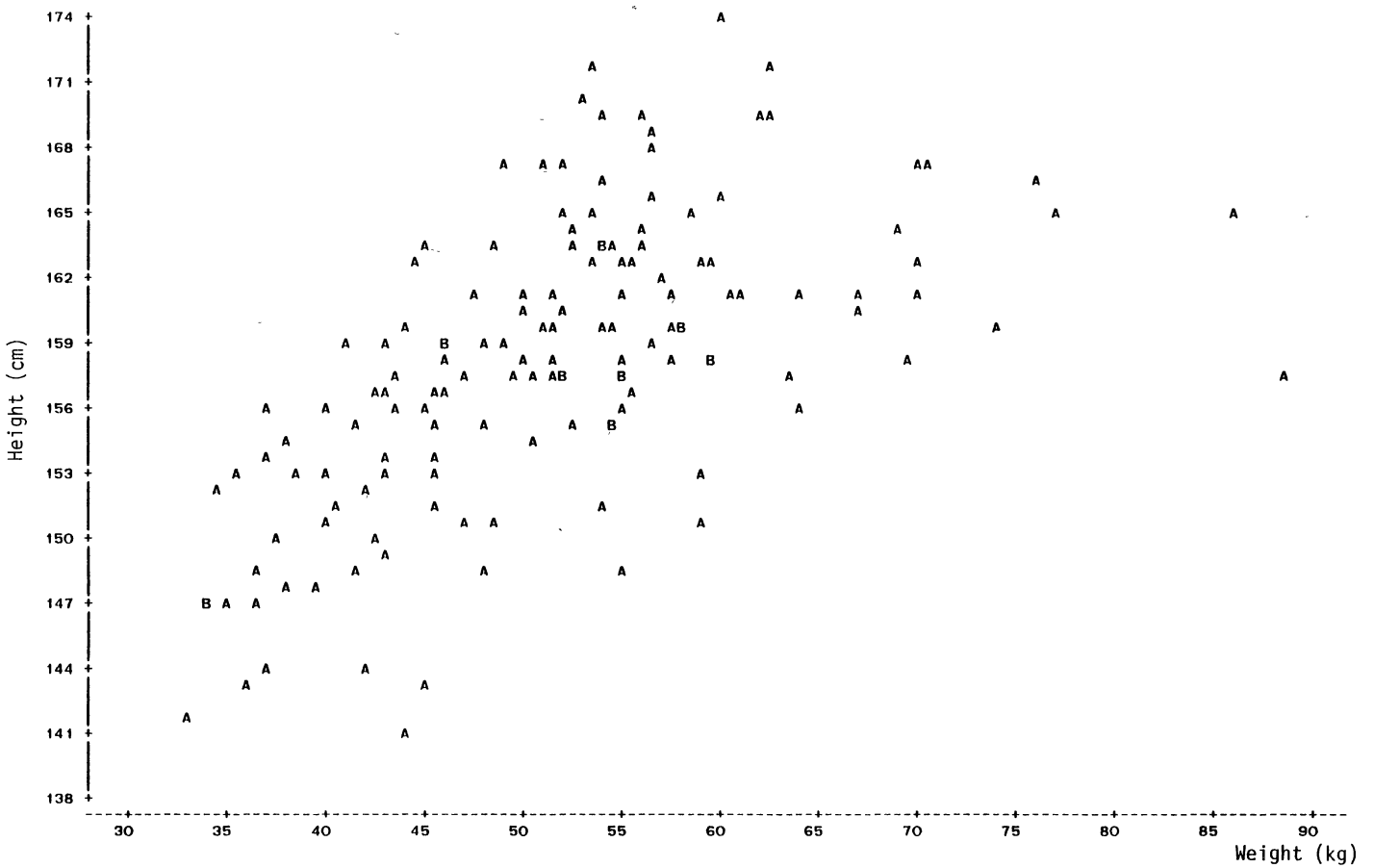
EXERCISING - walking with a load uphill, basketball, swimming, running, football, softball

APPENDIX H

HEIGHT VS. WEIGHT PLOT

HEIGHT DATA VS WEIGHT DATA FOR OKLAHOMA ADOLESCENT FEMALES

PLOT OF HT*WT LEGEND: A = 1 OBS, B = 2 OBS, ETC



NOTE: 4 OBS HAD MISSING VALUES

APPENDIX I

RANKS FOR TOTAL EXERCISE

OBS	SUBJECT	TEX	VFX	MEX	LEX	WT	HT	WTFHT	SKFD	ACIRC
1	23					69 5	71 0	81 5	131 0	119 0
2	70			.						
3	73						.			
4	164									
5	165									
6	28	1 0	53 5	2.0	4 5	139 0	134 5	122.0	142 0	130 0
7	68	2 0	25 5	2 0	30 5	89 5	130.5	54 0	28 0	30 0
8	12	3 0	25 5	2 0	34 0	91 0	43.5	100 0	134 5	104 0
9	21	4 0	25 5	5 0	42 0	98 0	109.0	63 5	124.5	104 0
10	76	5 0	25 5	6 5	50 5	14 5	38.5	11 0	2 0	4 0
11	82	6 0	25 5	8 5	52 0	134 0	93 0	132 5	62 5	91 5
12	156	7 0	25 5	21 0	39 0	76 0	132 0	36 0	88 5	32 5
13	80	8 0	25 5	35 0	16 0	131 0	62 0	135 5	131 0	134 5
14	151	9 0	25 5	28.5	41 0	141 0	134.5	130 5	133 0	137 0
15	148	10 5	25 5	16 0	60 0	85 5	117.5	63 5	52 0	65 5
16	158	10 5	66 5	25 5	18 0	108 0	138 0	63 5	77 0	89 0
17	13	12 0	25 5	18.0	57 0	115 0	89.0	114.0	131 0	96.0
18	64	13 0	25 5	43.0	28 0	43 5	54.0	44.0	35 0	59.0
19	25	14 0	25 5	50 0	11.0	88 0	117.5	71 5	91.5	53 5
20	18	15 0	70 5	21.0	32 5	50 0	75.0	39 5	67 5	50.0
21	4	16 0	25 5	12.5	72.0	109 0	137.0	54 0	85 0	40 5
22	33	17 0	70 5	30.5	38 0	24 0	43.5	27 5	57 5	40 5
23	81	18 0	25 5	41.5	50.5	28 0	54.0	19.5	4 5	12 5
24	66	19 5	25 5	58 0	37 0	101 0	48.5	122 0	45 5	84 5
25	168	19 5	25 5	30 5	70.5	37 0	1.0	126.5	81 0	63 5
26	16	21 0	25 5	63.5	21 5	78 0	43.5	107 5	118.0	87 0
27	84	22 0	66 5	56 0	19.5	11 5	36.0	8 5	74 0	5 0
28	119	23 0	58 0	62 0	24.0	20 0	31.5	27 5	70 5	32.5
29	22	24 0	53 5	68.0	11.0	54.0	79.0	27 5	96.5	59.0
30	8	25 0	25 5	36.5	75.0	111 0	105.0	87 5	137 0	113.5
31	9	26 0	78 5	50 0	14 0	32 5	36.0	27 5	112 5	65 5
32	69	27 0	74 0	54.0	24 0	48 5	54.0	58 0	91 5	55 0
33	98	28 0	25 5	23.5	82.0	29 0	31 5	58 0	19 0	30 0
34	24	29 5	25 5	18.0	85.5	67 0	84 5	71 5	82 0	79.0
35	30	29 5	25 5	46.5	74 0	104 0	117.5	81.5	124 5	112 0
36	15	31 0	74 0	66.0	16.0	105 0	140 5	102 5	78 0	74 5
37	43	32 5	25 5	73 0	54.5	19 0	22 0	39 5	44 0	10 5
38	114	32 5	25 5	12.5	95.0	30 5	79.0	19 5	16.0	14.0
39	65	34 0	25 5	55.0	80.0	4 0	27.5	1.0	54 5	1 5
40	154	35.0	25 5	78.5	45.0	96 0	62.0	110 5	101.5	126.0
41	29	36.0	25 5	77.0	49 0	117 0	125.0	87.5	110 5	108 0
42	90	37 0	74 0	33.5	78 0	25 0	5 5	116.5	4 5	81 0
43	67	39 0	74 0	65.0	57.0	130 0	140.5	102 5	54 5	74 5
44	117	39 0	25 5	8 5	108 0	6 0	31.5	2 5	13 0	3 0
45	142	39.0	25 5	90 0	24 0	121 5	71 0	116.5	107 0	118 0
46	174	41 0	53 5	27.0	97 0	57 5	114.0	14.5	33 0	59 0
47	74	42 0	25 5	32.0	98 0	48 5	79 0	44 0	31 0	38 0
48	153	43 0	86 0	68 0	28 0	32 5	54.0	22.5	37 0	16 0
49	150	44 0	25 5	102 0	11 0	69 5	62.0	94 0	96 5	74 5
50	88	45 0	25 5	39 5	100 5	61 0	62.0	71 5	65 0	79 0
51	157	46 0	66 5	95 0	4.5	99 0	71.0	105 5	99 5	110.5
52	77	47 0	53 5	50 0	100 5	62.5	99 5	36 0	31 0	59.0
53	53	48 5	110 0	6 5	57 0	129 0	145.0	87 5	96 5	104 0
54	96	48 5	101 0	12 5	77 0	93 5	114.0	94 0	16 0	50 0
55	170	50 0	25 5	93.5	69 0	39 0.	114 0	8 5	23 5	45 0
56	78	51 0	83 0	38 0	93 0	127 0	99.5	110 5	59.0	125 0

OBS	SUBJECT	TEX	VEX	MEX	LEX	WT	HT	WTFHT	SKFD	ACIRC
57	89	52 0	25 5	33.5	115 5	55 0	40 5	71 5	107 0	70 5
58	159	53 0	84 0	92 0	11 0	124 0	128.5	87 5	107 0	120.5
59	11	54 5	25 5	57 0	112 5	146 0	62.0	146 0	145 0	146 0
60	149	54 5	25 5	101.0	65 0	126 0	99.5	118 5	99 5	100 0
61	60	56 0	107 5	12.5	76 0	40 5	48.5	44 0	52 0	35 5
62	41	57 0	25 5	68 0	104 5	136 0	121.0	138 0	141 0	136 0
63	54	58 0	93 0	87.5	30 5	38 0	109 0	4 0	23 5	18 0
64	35	59 5	74 0	71 0	90 0	75 0	62.0	94 0	74 0	115 0
65	79	59 5	78 5	99 0	47 0	7 0	3.0	63 5	38 5	21 0
66	5	61 0	25 5	107 0	45 0	92 0	40.5	120 0	139 0	116 5
67	118	62 0	25 5	109 5	19 5	79 0	117.5	81 5	115 0	70 5
68	87	63 5	58 0	52.5	115 5	96 0	99.5	94 0	96 5	94 5
69	115	63 5	101 0	23.5	88.0	5 0	9.0	19 5	14 0	1 5
70	58	65 0	116 0	25.5	35 5	17.0	11.5	63 5	70.5	30 0
71	37	66 0	66 5	89 0	83.5	121.5	109.0	102 5	129.0	130 0
72	83	67 0	69 0	36.5	125.0	73 5	125.0	39 5	119 5	74 5
73	105	68 0	81.5	4.0	131 0	68 0	134.5	49 0	42 5	67 5
74	152	69 0	25 5	85.0	111 0	119 0	31.5	128 5	112 5	140 0
75	7	70 0	109 0	78 5	4 5	85 5	25 0	128 5	116.0	113.5
76	40	71 5	25 5	39 5	135 0	56 0	14.5	124 5	85 0	98 0
77	155	71 5	117 0	46.5	35 5	57 5	20.0	81 5	19 0	47 5
78	121	73 0	105 0	44 5	88.0	66 0	62 0	63 5	12.0	52 0
79	27	74 0	58 0	117.0	26.0	140 0	109.0	134 0	144 0	145 0
80	103	75 0	53 5	76.0	118 0	27 0	18.5	77 5	85 0	59 0
81	19	76 0	101 0	63 5	88.0	14 5	11.5	49 0	28.0	16.0
82	50	77 0	78 5	100.0	83 5	132 0	48.5	138 0	114 0	123 5
83	1	78.5	25 5	70.0	130.0	16 0	31.5	17 0	57 5	21 0
84	172	78 5	78 5	112.0	40 0	137 0	71.0	141.0	91 5	133 0
85	93	80 0	25 5	80.5	126.0	21 0	25.0	44 0	11 0	47 5
86	92	81 0	92 0	103.5	63 0	62 5	71.0	71 5	19 0	59 0
87	47	82 0	99 0	106 0	32.5	125 0	146 0	71 5	128 0	87 0
88	143	83 0	94 5	83.0	94.0	143 0	130.5	141 0	121 0	138.0
89	31	84 0	97 0	28 5	120 5	18 0	48.5	6 0	42.5	6 5
90	146	85 5	130 0	18.0	4.5	45 0	25.0	87 5	40 5	42.5
91	161	85 5	113 5	73 0	73 0	2 5	9.0	14 5	70 5	6 5
92	102	87 0	90 0	44 5	132 5	34 5	48.5	39 5	7 0	21 0
93	94	88 0	98 0	59.5	117 0	30 5	17.0	87 5	3 0	34 0
94	171	89 0	103 5	75.0	99.0	113 0	71.0	105 5	60.0	120 5
95	34	90 0	122 5	48 0	70 5	64 0	93 0	36 0	1 0	59 0
96	51	91 0	86 0	86.0	120.5	47 0	79.0	44 0	38.5	82 5
97	173	92 0	81 5	96 5	124 0	106 0	121.0	71 5	40.5	87 0
98	56	93 5	113 5	21.0	129 0	128 0	140.5	94 0	119 5	127 5
99	169	93 5	103 5	118.0	21.5	59 5	79.0	49 0	70 5	26 0
100	3	95 0	128 0	61.0	67 0	110 0	79.0	114 0	138 0	130.0
101	20	96 0	88.5	126 0	53 0	40 5	4.0	122 0	127 0	84 5
102	107	97 0	122 5	59 5	92 0	26 0	27.5	54 0	23 5	63 5
103	38	98 5	25 5	123.5	96 0	43 5	36 0	77 5	79 5	45 0
104	55	98 5	135 0	52.5	4.5	103 0	54.0	124 5	136 0	123 5
105	52	100 0	88 5	111 0	112.5	10 0	5 5	71 5	31 0	25 0
106	2	101 0	25 5	134.0	4 5	89 5	140 5	33 0	91 5	72 0
107	106	102 0	25 5	130.5	68 0	100 0	14 5	138 0	101 5	101 0
108	14	103 0	118 0	109.5	45 0	22 0	79.0	6 0	56 0	16 0
109	109	104 0	60 0	116 0	128 0	2 5	9.0	14 5	62 5	24 0
110	71	105 0	111 0	91 0	123 0	42 0	31 5	81 5	28 0	50 0
111	26	106 0	129 0	96 5	60.0	36 0	84.5	6 0	76 0	21 0
112	42	107 0	25 5	139.0	11 0	145 0	125.0	145 0	146 0	144 0

OBS	SUBJECT	TEX	VEX	MEX	LEX	WT	HT	WTFHT	SKFD	ACIRC
113	163	108	133.0	93.5	48.0	93.5	89.0	107.5	117.0	104.0
114	101	109	124.0	83.0	107.0	119.0	109.0	110.5	48.5	91.5
115	145	110	86.0	133.0	16.0	133.0	99.5	126.5	110.5	127.5
116	10	111	127.0	80.5	109.5	135.0	99.5	132.5	140.0	141.0
117	46	112	134.0	98.0	64.0	80.0	121.0	49.0	122.0	82.5
118	110	113	132.0	105.0	54.5	82.0	144.0	33.0	66.0	53.5
119	166	114	62.0	138.0	66.0	73.5	62.0	98.5	62.5	91.5
120	44	115	131.0	87.5	104.5	9.0	14.5	27.5	21.0	27.5
121	100	116	137.5	83.0	81.0	13.0	18.5	27.5	8.5	8.5
122	85	117	62.0	125.0	137.0	119.0	22.0	141.0	124.5	134.5
123	75	118	119.5	108.0	109.5	116.0	89.0	102.5	67.5	110.5
124	113	119	115.0	119.0	104.5	34.5	62.0	19.5	48.5	35.5
125	147	120	141.0	41.5	4.5	112.0	84.5	114.0	79.5	116.5
126	120	121	143.0	12.5	4.5	77.0	93.0	11.0	107.0	91.5
127	72	122	140.0	12.5	102.0	71.5	89.0	54.0	48.5	38.0
128	36	123	94.5	120.5	138.0	23.0	14.5	81.5	104.0	79.0
129	167	124	119.5	127.0	85.5	59.5	134.5	27.5	23.5	27.5
130	112	125	91.0	115.0	142.0	8.0	7.0	11.0	10.0	8.5
131	45	126	106.0	132.0	91.0	107.0	128.5	63.5	74.0	122.0
132	59	127	121.0	130.5	28.0	123.0	71.0	130.5	103.0	132.0
133	6	128	53.5	141.0	104.5	51.0	62.0	33.0	35.0	45.0
134	97	129	25.5	136.0	134.0	144.0	125.0	143.0	85.0	143.0
135	104	130	25.5	140.0	127.0	87.0	89.0	94.0	85.0	77.0
136	48	131	62.0	144.0	43.0	102.0	109.0	76.0	134.5	104.0
137	99	132	112.0	129.0	120.5	65.0	38.5	94.0	26.0	42.5
138	86	133	64.0	135.0	136.0	138.0	99.5	135.5	143.0	139.0
139	162	134	125.0	122.0	120.5	84.0	109.0	58.0	52.0	94.5
140	95	135	107.5	113.0	144.0	142.0	84.5	144.0	124.5	142.0
141	32	136	144.0	73.0	79.0	81.0	143.0	22.5	35.0	21.0
142	49	137	96.0	137.0	132.5	53.0	99.5	14.5	48.5	38.0
143	17	138	25.5	145.0	62.0	83.0	125.0	54.0	94.0	69.0
144	111	139	126.0	123.5	141.0	46.0	43.5	49.0	6.0	98.0
145	108	140	137.5	114.0	139.0	96.0	62.0	118.5	88.5	108.0
146	144	141	25.5	142.0	145.0	114.0	99.5	98.5	8.5	98.0
147	57	142	136.0	120.5	143.0	1.0	2.0	27.5	62.5	10.5
148	63	143	139.0	128.0	140.0	52.0	22.0	110.5	45.5	108.0
149	39	144	145.0	103.5	114.0	71.5	99.5	63.5	107.0	67.5
150	91	145	142.0	143.0	60.0	11.5	48.5	2.5	16.0	12.5

VITA 2

LuAnn Laurice Soliah

Candidate for the Degree of

Doctor of Philosophy

Thesis: INFLUENCE OF PHYSICAL ACTIVITY AND OTHER VARIABLES ON BODY COMPOSITION MEASUREMENTS OF ADOLESCENT FEMALES IN OKLAHOMA

Major Field: Food, Nutrition and Institution Administration

Biographical:

Personal Data: Born in Mayville, North Dakota, July 9, 1958, the daughter of Maurice and Eunice Soliah.

Education: Graduated from Hatton High School, Hatton, North Dakota in 1975; Attended Mayville State College, Mayville, North Dakota, 1973 and 1974; received Bachelor of Science degree in Foods and Nutrition (Dietetics) from North Dakota State University, Fargo, North Dakota, in May, 1978; received Master of Science degree from Kansas State University, Manhattan, Kansas in August, 1980; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in May, 1985.

Professional Experience: Research and Teaching Assistant, Department of Foods/Nutrition, Kansas State University, July, 1978 to August, 1980; Quality Control Laboratory, Safeway Foods, Inc., August, 1980 to May, 1981; Consultant Dietitian Medicalogdes, Inc., May, 1981 to present; Graduate Teaching Associate, Department of Foods, Nutrition and Institution Administration, Oklahoma State University, January, 1983 to present.

Professional Organizations: American Dietetic Association, Registered Dietitian, Institute of Food Technologists, Omicron Nu, Phi Kappa Phi, Gamma Sigma Delta, and Phi Upsilon Omicron.

Publications: Soliah, L. L., Newell, G. K., Vaden, A. G., and Dayton, A. D. Establishing the need for nutrition education: II. Elementary teachers: Nutrition knowledge, attitudes, and practices. J. Am. Dietet. A. 83: 447, 1983.

Stone, M. B., Soliah, L. L., and Craig, J. Ascorbic acid content, pH, safety, and acceptability of home-canned tomatoes. Plant Foods for Human Nutrition. 31: 327, 1982.

Food service supervisors clinical nutrition manual. L. Soliah. Copyright, 1982.