FITNESS, DIETARY PATTERNS, AND HEALTH PERCEPTIONS OF COLLEGE FRESHMEN

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CHAPTER I

RESEARCH PROBLEM

Introduction

The relationship between perceptions and behavior is a fertile area of study. This thesis explored one aspect of this relationship by evaluating the differences in peoples' perception of their diet and fitness and their actual dietary patterns and physical fitness levels in the context of recognized risk factors for cardiovascular disease. The specific cardiovascular risk factors measured were body composition, fat distribution, fat intake, saturated fat intake, cholesterol intake, blood pressure, total blood cholesterol and fitness level. A questionnaire that measured perceptions about appearance, fitness, and health was compared to the measured cardiovascular risk factors to examine the associations and deviations between perception and reality.

High blood cholesterol, high blood pressure, overweight and a sedentary lifestyle are risk factors for cardiovascular disease that can be modified through changes in diet and physical activity (National Cholesterol Education Program, 1990). However, our self-concept and perceptions may have a direct or an intervening influence on our ability to make these modifications in our nutrient intake and physical activity level (Newell et al, 1990; Read et al, 1991; Witte et al, 1991). Thus, self-perceptions may influence the risk of cardiovascular disease and, therefore, merits further study.

An important risk factor for cardiovascular disease is overweight (National Cholesterol Education Program, 1990). However weight alone is not always a valid indicator of health or fitness (Larsson et al, 1981). A person may be overweight according to height and weight tables, but not be overfat when measured by body composition analysis. Conversely, a person may be at a normal weight but still be overfat and at an increased risk of cardiovascular disease. Perhaps more important than either overweight or body composition is fat distribution, which has been shown by recent studies to be a risk factor for cardiovascular disease (Peiris et al, 1989; Donahue et al, 1987). The "apple" shape seen typically in overweight men increases cardiovascular risk, whereas the "pear" shape seen in most women is considered to be a less harmful pattern of fat distribution in relation to cardiovascular disease.

Exercise habits and fitness are important factors in cardiovascular disease risk that were evaluated in this study by a questionnaire and by measurements of strength, flexibility and body composition. Body composition analysis is a useful objective way to evaluate both body fat and physical fitness. The body composition analysis techniques used in this study were underwater weighing, total-body electrical conductance (TOBEC), bioimpedance, and 7-site skinfold thickness measurements. Strength and flexibility were estimated using grip strength and lower back/hamstring flexibility, respectively. These measures were used as objective measures of fitness and fatness to compare to the perceptual measures of fitness and body image estimated by responses to questionnaires.

Diet is also an important factor in the development and expression of cardiovascular disease. In this study, dietary intake was measured using a four-day dietary record and a 1-week food frequency questionnaire. The subjects' recorded intakes were analyzed for nutrient content and compared to the subjects' perception of nutrient intake assessed by questionnaire responses. In addition to affecting body fat and obesity, diet may affect blood cholesterol and blood pressure, which also were measured in this study.

Knowledge of relationships between a person's self perceptions and specific cardiovascular risk factors and diet and exercise behaviors may help us to convert our knowledge of the problem into practical educational materials and workable solutions. As I have seen in both myself and my clients, knowing what the problem is and what to do to change it, is different from actually doing it. Exploration of the dynamics between knowledge and behavior may help us speed up the process of converting knowledge into behavior.

Definition of Terms

overfat: the condition of having excess body fat, higher than 24% body fat for women or higher than 17% body fat for men. This term is more precise than overweight, which fails to specify whether fat or lean tissue contributes to the excess weight.

fat distribution: a description of where body fat is predominantly located on the body

central obesity: having excess body fat stored predominantly in the central, abdominal area of the body.

peripheral obesity: having excess body fat stored predominantly in the hips and thighs, in the periphery of the body.

waist-to-hip ratio: a value used to identify a person's fat distribution pattern. The ratio is calculated by dividing waist circumference by hip circumference.

perception: a person's interpretation of sensory data: sight, smell, touch, taste, sound.

evaluation: a person's value judgement of something, for example: good or bad, too much or not enough, ugly or beautiful. Evaluation is typically accompanied by an emotion.

orientation: a person's extent of investment in an activity or object. People with a high appearance orientation would place importance on how they look, pay attention to their appearance, and engage in lots of "grooming behaviors" to look their best (Cash 1986).

Body Mass Index (BMI): the ratio of weight to height, calculated as kilogram/meter squared. BMI is used as an indicator of obesity for estimating chronic disease risk.

Hypotheses and Research Questions

1. There will be no significant difference between the subjects' fatness perceptions assessed by responses to a questionnaire and body fat level assessed by body composition analysis.
2. There will be no significant association between the subjects' perceptions assessed by responses to a questionnaire and subjects' dietary intake based on macronutrient percent and vitamin and mineral adequacy assessed by diet records.
3. There will be no significant differences between the subjects' physical fitness perceptions assessed by responses to a questionnaire and physical fitness objectively assessed by strength, flexibility, and body composition analysis.
4. There will be no significant associations between the subjects' health perceptions assessed by questionnaire responses and specific cardiovascular risk factors: blood cholesterol, blood pressure, body composition, and fat distribution pattern.
5. There will be no significant gender differences between the subjects' perceptions of appearance, fitness, and health assessed by questionnaire responses of male and female subjects.
6. There will be no significant difference in the nutrient intake between days with and without breakfast.
7. There will be no significant differences in body composition measured by the 4 different body composition methods used in this study.

The hypotheses will be further explored with the following research questions:

In this group of freshmen college students:

1. What are their perceptions of their appearance, fitness, and health?
2. What are their blood cholesterol and blood pressure levels?
3. What are their body fat composition and fat distribution patterns?
4. What are their fitness levels?
5. What are their dietary patterns?
6. What are their meal pattern habits?
7. What percent of the students meet RDA nutrient requirements?
8. Are there relationships between dietary habits and the anthropometric and biochemical measures used in this study?
9. What relationships are there between students' perceptions about themselves and their anthropometric, biochemical, or dietary measures?

Assumptions and Limitations

This study has three primary assumptions and limitations. First, this study assumes that the cardiovascular disease risk factors currently recognized by scientific consensus are true causal factors for cardiovascular disease. Second, this study limits its scope to cardiovascular risk factors that are potentially modifiable through changes in diet and/or exercise. Third, this study limits its scope to cardiovascular risk factors that could be measured within the limits of the available budgetary resources and/or the availible instruments.

An additional limitation was that the subjects were self-selected. Self-selection appeared to solicit female subjects that had lower mean total blood cholesteol levels (163 mg/dl) than the 50th percentile (180 mg/dl) for 20-24 year olds from the National Center for Health Statistics (1986). The self-selection process also appeared to solicit subjects who were more active than expected (mean reported hours of exercise/week was 3.2 in females and 4.2 in males). However not all their behaviors were heart healthy, especially the higher than recommended dietary intake of fat (35% kcal from fat), which indicates that they may face higher cardiovascular risk in the future unless these behaviors are modified.

Another limitation of the study was that two electronic body composition analysis instruments malfunctioned during the 2nd collection period in the Fall. The computer used for the underwater weighing failed during the 2nd collection period because it had been left it in the humid underwater weighing room. Because the TOBEC was on a short term loan to the Wellness Center, the TOBEC measurements proceeded without the underwater weighing. Half-way through the 2nd data collection period the bioimpedance machine malfunctioned. Thus, there was approximately a 2 1/2 week gap between body composition measures using the TOBEC and the body composition analysis measurement with the repaired bioimpedance machine and the repaired underwater weighing computer during the 2nd collection period. However, despite these equipment difficulties, measurements were very consistent before and after the repairs.

Ideally, complete nutrient analyses would be available for all foods. However, many fast food and convenience items (like pizza and vending machine items) had missing values for fiber, fatty acid composition, vitamin A, vitamin B_6, vitamin B_{12}, folacin, pantothenic acid, vitamin E, copper, magnesium, selenium, and zinc in the Food Processor II nutrient data base and no comparable substitute items were available for coding. Because of the large amount of fast food items consumed by the subjects, these missing values may show nutrient intake to be lower than the true values for some of these nutrients.

Another limitation in this study is incomplete data sets. Out of 30 subjects 7 did not complete and return their 4-day diet records, 3 had missing or incomplete data on their 1-week food frequency questionaires, 2 had missing or incomplete data on their questionnaires, and 1 subject failed to show up for the physical and biochemical measures.

Organization of the Research Project

1. Project approved by Oklahoma State University Internal Review Board.
2. Consent forms signed and any questions answered. Appearance, fitness, health, and diet questionnaire and 1-week food-frequency questionnaire administered.
3. Physical measurement data collected and dietary record directions explained.
4. Dietary records completed and turned in.
5. Data analyzed and results sent to subjects.

Organization of the Thesis

Chapter IV is written in journal article format using the guide for authors for the Journal of the American Dietetic Association. The other chapters follow traditional format.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The following literature review will summarize the scientific basis of specific cardiovascular risk factors and the possible influence of self-perceptions, thus behavior, on their expression. The purpose of this review is not to present an exhaustive review of the discussed topics, but rather to provide a scientific context for the current research.

Obesity

This section will review the causes of obesity including fat intake and weight cycling, and the relationship of obesity to cardiovascular disease. The different methods of measuring obesity used in this study and their advantages and disadvantages also will be discussed and the relationship with cardiovascular disease risk will be summarized.

Measurement of Obesity

Obesity can be defined by several different methods. The purpose of this discussion is to compare their respective advantages and disadvantages. Discussion will be limited to those methods employed in this study: body mass index, underwater weighing, total-body electrical conductance, bioimpedance, skinfolds, and waist-to-hip ratio.

Body Mass Index. Body mass index (BMI) is widely used as an indicator of obesity for studies exploring the relationship between obesity and chronic disease risk, including the risk for cardiovascular disease (Bray, 1992; Fehily et al, 1989; Kuczmarski, 1992; Must et al, 1991). A major advantage of BMI is that it is (Garrow, 1988) because it is easily determined from simple anthropometric data (height and weight expressed as kg/m^2). Also, BMI has a large and comprehensive data base (Garrow, 1988). Other researchers have found BMI to be a useful predictor of chronic disease risk (Miscozzi et al, 1989; Spiegelman et al, 1992; Stensland and Margolis, 1990) and this method is recommended by the 1985 National Institutes of Health Consensus Panel for use in patient health evaluations (Stensland and Margolis, 1990).

BMI does have some major disadvantages (Garrow, 1988; Marshall et al, 1990). It does not estimate body fat or lean body mass with accuracy (Garrow, 1988). In a sample of 2,512 men aged 45-59 years of age from the Caerphilly Collaborative Ischaemic Heart Disease Study, the adjustment of BMI for frame size had little effect on the prediction of body fatness calculated from 4-site skinfold thickness with the correlation of body fatness with BMI (r=0.76) being almost identical to the BMI adjusted for wrist diameter (r=0.74), meaning that adjusting BMI for frame size does not increase its ability to estimate body composition (Fehily et al, 1989). BMI also does not accurately estimate body fat when compared to underwater weighing (Smalley et al, 1990), therefore BMI should be used with caution as an indicator of obesity. An additional disadvantage of BMI is that it does not measure fat distribution, an important factor in determining the morbidity and mortality associated with obesity (Garrow, 1988). Another possible problem is that the value of BMI as a predictor of cardiovascular disease is different for younger vs older males and females (Marshall et al, 1990), with a high BMI in younger age groups indicating a higher risk than the same BMI in older adults (Micozzi and Harris, 1990). This comparison by age was done on probability samples from the first and second U.S. National Health and Nutrition Examination Surveys (NHANES I and II) (Micozzi and Harris, 1990). The samples (NHANES I, n=14,371; NHANES II, n=10,722) were composed of males and females aged 25-74 (Micozzi and Harris, 1990). BMIs were more highly correlated with estimates of body fat (arm fat area) in younger than in older males and females, and BMIs were more highly correlated with estimates of lean body mass (arm muscle area) in older than in younger males and females (Micozzi and Harris, 1990). For example, the correlation between BMI and arm fat area decreased from r=0.79 in the 25-34 year old group to r=0.68 in the 65-74 year old group (Micozzi and Harris, 1990). The opposite occurred with the correlation coefficient between BMI and arm muscle area, which increased from r=0.61 in the 25-34 year old group to 0.65 in the 65-74 year old group (Micozzi and Harris, 1990). Therefore, caution should be exercised when interpreting BMI as a risk factor for cardiovascular disease when comparing different age groups. Ideally, age specific cutoff values would be be available for risk assessment.

Underwater Weighing. Underwater weighing is considered to be the "gold standard" of indirect body composition analysis techniques. Other methods of body composition analysis base their prediction equations on the relationship between their measure and body composition as determined by underwater weighing. Underwater weighing assumes that the body is composed of two parts, fat and fat-free, that have different mean densities, 0.900 vs 1.100 g/cc respectively (Lukaski, 1987; Jensen, 1992). These density values have been confirmed by direct chemical analysis of laboratory animals (Lukaski, 1987). The method also assumes a constant hydration level and a constant proportion of bone to muscle in the fat-free body mass (Lukaski, 1987; Jensen, 1992). These last two assumptions theoretically yield a variation in percent body fat of 1 to 2% (0.003-0.005 g/cc) in a healthy population (Lukaski, 1987). In addition, lung volume is accounted for, but gastrointestinal gas volume (50-300 ml) is not (Lukaski, 1987). Disadvantages of underwater weighing are that it is expensive, stationary, requires trained operators, and requires a high degree of subject cooperation.

Total-Body Electrical Conductance. Total-body electrical conductance (TOBEC) is a method of body composition analysis that uses electricity to determine the percent body fat and percent lean body mass. Adipose tissue is nearly devoid of water and electrolytes; thus it impedes the flow of electricity. Lean tissue, however, is a good conductor of electricity because it contains all of the body's fluids and electrolytes. Therefore the accuracy of TOBEC depends greatly on the hydration levels of the subjects. Disadvantages of TOBEC are that it is a very expensive, stationary instrumetn and is reliant on the hydration level of the subject.

TOBEC has the advantages of requiring little subject cooperation and of being accurate, rapid, and noninvasive. It is highly accurate when compared to underwater weighing in humans (Newby et al, 1990; Van Loan and Mayclin, 1987; Van Loan, Segal et al, 1987), and with direct carcass analysis in pigs (Keim et al, 1988). Van Loan and Mayclin (1987) observed the relationship between underwater weighing and TOBEC in 20 male and 20 female subjects aged 18-35 years of age. The correlations between TOBEC values and lean body mass estimated from underwater weighing were all greater than $r=0.95$ (Van Loan and Mayclin, 1987). Keim et al (1988) found highly significant correlations ($p<0.0001$) between TOBEC and direct carcass analysis of fat-free mass ($r=0.980$) and body water ($r=0.979$) in pigs. Other studies have demonstrated equally impressive results with TOBEC, with some of the studies even suggesting that TOBEC may be a method of indirect body composition analysis that is not only equal to, but superior to, underwater weighing (Hergenroeder et al, 1991; Newby et al, 1990; Van Loan, Segal et al, 1987).

Bioimpedance. Bioimpedance is a method of body composition analysis that uses the same properties as TOBEC (electrical conductance in water and fat used to determine the percent of lean body mass and the percent of body fat). Bioimpedance has the following advantages: it is inexpensive, portable, has low technical difficulty, is reliable. is precise (<2%), and is fairly accurate (observed error of 2.7% compared to underwater weighing) (Lukaski et al, 1985; Lukaski, 1987; Jensen, 1992) Bioimpedance has the disadvantage (Lukaski, 1987; Jensen, 1992) of being highly dependent on subject hydration levels, therefore its accuracy relies on subject compliance with measurement protocol regarding timing of eating, drinking, exercise, and medication (Khaled et al, 1988). Also, age related changes in hydration levels will affect the analysis of body composition, with hydration levels of lean tissue generally decreasing with increasing age (Deurenberg et al, 1990; Steen, 1988).

Skinfold Thickness. There are many different body composition equations using skinfolds, however the number of sites commonly measured are 3, 4, or 7 sites (Jackson and Pollack, 1985). The 7-site method measures chest, midaxillary, triceps, subscapular, abdomen, suprailiac, and thigh skinfolds on both males and females (Jackson and Pollack, 1985). Skinfold thickness estimation of body composition is based on the false assumption that one-half of total adipose tissue stores are located subcutaneously (Lukaski, 1987). The method has the advantages of being very inexpensive, portable, rapid and reliable (Lukaski, 1987; Jensen, 1992). However, the accuracy and precision of the method depend greatly on the skill of the operator and the care taken to measure the correct skinfold sites in the proper manner (Lukaski, 1987; Jensen, 1992). Other disadvantages are the variable results found when measuring older persons, persons of different races, and persons who are obese (Lukaski, 1987; Jensen, 1992; Marshall et al, 1990; Steen, 1988).

Waist-to-Hip Ratio. Recent studies have shown that a central pattern of fat distribution is a risk factor for cardiovascular disease, meaning that 'where?' is equally as important as or more important than 'how much?' (Peiris et al, 1989; Donahue et al, 1987). The "apple" shape (large abdomen) seen typically in overweight men increases cardiovascular risk, whereas the "pear" shape (larger hips and thighs) seen in most women is considered to be a less detrimental pattern. Thus, the waist-to-hip ratio can be used as a simple indicator of fat distribution, with a ratio over 0.80 for women or 0.90 for men increasing cardiovascular risk (Barrett-Conner and Khaw, 1989; Bray, 1992; Jensen, 1992; Peiris et al, 1989; Shimokata et al, 1989; Wing et al, 1992). The waist-to-hip ratio has the advantages of being simple, rapid, and can be self-assessed without loss in accuracy or precision.

Body Weight and Cardiovascular Disease

Body Mass Index (BMI) has been used widely as an index of obesity for the classification of cardiovascular disease risk. BMI has been observed to have a consistent positive correlation with blood pressure (Intersalt Cooperative Research Group, 1988; Smith et al, 1988; Spiegelman et al, 1992). In the Scottish Heart Health Study (n=7,000) Smith et al (1988) found the highest correlations for systolic pressure in both men and women were with age (men = 0.221 and women = 0.295) and BMI (men = 0.173 and women = 0.256); whereas for diastolic pressure the strongest correlation was with BMI (men = 0.247, women = 0.259), with age being less important. Spiegelman et al (1992) found that BMI was as good a predictor of diastolic blood pressure as other measures of body fat (underwater weighing and skinfold thickness). BMI and underwater weighing (%BF) were both highly correlated with diastolic blood pressure in men (n=976, partial r_{BMI}=0.34 and partial $r_{\%BF}$=0.30) and in women (n=173, partial r_{BMI}=0.42 and partial $r_{\%BF}$=0.32) (Spiegelman et al, 1992).

Thus, BMI is useful in evaluating obesity's relationship to cardiovascular risk, especially for blood pressure. However, BMI does not accurately estimate body fat when compared to underwater weighing (Smalley et al. 1990).

Body Fat and Cardiovascular Disease

The first tool in a more critical evaluation of obesity is body composition. This is more exact than simple body weight because the actual percent of body fat is determined, thus allowing one to distinguish between a person who is at a normal weight but is overfat versus a person who is overweight due to muscular development or bone density but is not overfat. Folsom et al (1989) found that being overfat increases the risk of cardiovascular disease by demonstrating that percent body fat was positively associated ($p<0.05$) with serum triglycercides, total blood cholesterol, blood pressure. In addition, Klesges et al (1991) found that higher percent body fat, measured by skinfold thickness, was negatively associated ($p<0.001$; men, $r=-0.26$; women, $r=-0.29$) with aerobic and leisure time in adult subjects (221 females and 221 males) involved in a longitudinal study of cardiovascular risk factors in families. Aerobic and leisure time also was negatively associated with waist-to-hip ratio ($p<0.05$; men, $r=-0.22$; women, $r=-0.15$) and negatively associated with blood pressure in women ($p<0.05$, systolic $r=-0.22$, diastolic $r=-0.17$) (Klesges et al, 1991). Analysis of a sample from the First US Health and Nutrition Examination Survey (NHANES I) revealed that total blood cholesterol concentrations were directly associated ($p<0.05$) with body fat and were more strongly associated with central than with peripheral fat distribution (Micozzi et al, 1989).

Fat distribution is the second factor that is emerging as an obesity related risk factor. As discussed previously, abdominal fat has been found to be a cardiovascular risk factor (Bray and Bouchard, 1988; Donahue et al, 1987; Peiris et al, 1989; Shimokata et al, 1989). Men tend to gain fat abdominally, while women tend to gain fat in their hips and thighs (Shimokata et al, 1989). This gender difference in fat distribution is one factor in the lower cardiovascular risk for premenopausal women. However, the general trend is for central fat distribution to increase with age (Shimokata et al, 1989) and in women this trend accelerates post-menopausally, along with an increase in heart disease rate (Shimokata et al, 1989).

Peiris et al (1989) examined 33 healthy premenopausal women for relationships between fat distribution measured by waist-to-hip ratio (WHR), body fat measured by underwater weighing, and cardiovascular risk estimated from blood lipid and blood pressure levels. Significant relationships were found between WHR and triglyceride level ($r=0.63$, $p<0.01$), between WHR and the HDL/Total cholesterol ratio ($r=-0.47$, $p<0.01$), between WHR and both systolic ($r=0.55$, $p<0.01$) and diastolic ($r=0.45$, $p<0.01$) blood pressure, but not between WHR and total cholesterol (Peiris et al, 1989). Significant correlations were also found between body fat and triglyeride level ($r=0.77$, $p<0.01$), between body fat and both systolic ($r=0.38$, $p<0.05$) and diastolic ($r=0.42$, $p<0.05$) blood pressure, but not between body fat and total cholesterol or between body fat and the HDL/Total cholesterol ratio (Peiris et al, 1989). This study showed that both fat distribution and body fat were related to cardiovascular risk factors and fat distribution was more highly correlated to these risk factors than was body fat (Peiris et al, 1989). Folsom et al (1989) also found that central fat distribution was associated with cardiovascular risk factors, being positively associated with systolic blood pressure and serum triglyceride concentration, and negatively associated with high density lipoprotein (HDL) cholesterol.

Weight Cycling and Cardiovascular Disease

Weight cycling, referred to in the popular press as 'Yo-Yo Dieting', increases cardiovascular disease risk and total mortality risk (Lissner et al, 1991). Weight cycling may promote the development of abdominal fat by shifting fat deposition from the thighs and hips to the abdomen, thus increasing cardiovascular risk (Jeffery et al 1992). It also may contribute to risk by contributing to obesity via a decreased metabolic rate, however this theory is more controversial (Graham et al, 1990; Lissner et al, 1991; Prentice et al, 1992). In addition to resulting in excess body fat, weight cycling itself, independent of the degree of obesity, increases risk of cardiovascular morbidity and mortality in both men and women (Lissner et al, 1991; Wannamethee and Shaper, 1990). An analysis of the Framingham population concluded that subjects with a highly variable weight had a higher total mortality (men p=0.005, women p=0.01), higher coronary heart disease mortality (men p=0.009, women p=0.009), and higher coronary heart disease morbidity (men p=0.0009, women p=0.006) (Lissner et al, 1991). Multivariate analysis excluded obesity and weight trends over time as confounding factors, thus weight cycling is an independent risk factor (Lissner et al, 1991). Moreover the relative risk from weight fluctuation (1.27 to 1.93) is comparable to the risk associated with obesity alone in relation to total mortality, cardiovascular disease, and coronary heart disease (Lissner et al, 1991). This leads to the possibility that the risk of obesity may not outweigh the risk of weight cycling, so maintaining a higher weight may be healthier than engaging in unsuccessful dieting efforts to achieve a lower weight.

Causes of Obesity

Major factors theorized to contribute to obesity are positive energy balance, age, genetics, increased percent of calories from fat, and decreased physical activity (Bray, 1989; Bray, 1992; Després et al, 1992; Miller et al, 1990; Klesges et al, 1991). In 1992 Bray et al reported on the importance of the different causes of obesity using a rating scale of 1=not important to 10=extremely important (Bray et al, 1992). The mean rating scores in descending order were; genetic factors (7.3), physical inactivity (6.4), weight cycling (5.8), depression (5.8), metabolic defect (5.1), willpower (4.7), carbohydrate craving (4.8), and fat cell defect (3.9) (Bray et al, 1992). Diet and physical activity are the two modifiable causal factors of obesity that will be addressed in this review.

Diet and Obesity. The main dietary factors contributing to the development of obesity are excess dietary fat and a high percent of calories from fat (Miller et al, 1990; Prewitt et al, 1991; Slattery et al, 1989; Tucker and Kano, 1992).

Miller et al (1990) studied the relationships between body fat and diet composition. The researchers found a positive association ($p<0.001$) between percent kcal from fat and percent body fat measured by underwater weighing (Miller et al, 1990). Subjects classified as obese consumed 35% of kcal from fat whereas subjects classified as lean consumed only 29% of kcal from fat (Miller et al, 1990). Percent body fat was not related to energy intake when expressed as kcal per kg lean body mass (Miller et al, 1990).

Prewitt et al (1991) studied the changes in body composition (measured by underwater weighing) and energy intake in women fed high-fat (37% kcal) and low-fat (20% kcal) diets. The researchers applied strict screening criteria to a pool of 121 premeopausal women aged 20-48, and selected 18 subjects for the 24-week study. The high-fat diet was served the first 4 weeks and the low-fat diet was served the remaining 20 weeks. Weight was maintained at ±1 kg of initial weight by adjusting kcal intake during both test diets. Despite increasing kcals to 119% of the kcal level consumed to maintain weight during the high-fat diet period ($p<0.0001$), subjects decreased in weight by a mean of 2.8% ($p<0.0001$) at the end of the low-fat diet period. Subjects also decreased fat weight by 11.3% ($p<0.0001$) and increased lean body weight by 2.2% ($p<0.0149$) (Prewitt et al, 1991).

Slattery et al (1989) explored the associations between body fat and its distribution with dietary intake in 5115 young black and white adults aged 18 to 30 years who are participants in the ongoing national collaborative study on Coronary Artery Risk Development in Young Adults (CARDIA). Carbohydrate intake was inversely associated with body mass index in males ($p=0.02$). Increased waist-to-hip ratio (WHR) was positively associated with total kcal intake in women. Increased WHR was inversely associated with percent kcal from carbohydrate in whites, and inversely associated with grams of crude fiber per 1000 kcal in all groups except black men. The WHR tended ($p<0.15$) to be positively associated with the percent of kcal from fat in all groups except black women.

Tucker and Kano (1992) found that the intake of dietary fat was related positively to percent body fat measured by skinfold both with ($p=0.033$) and without ($p=0.0003$) controlling for other risk factors (age, total energy intake, total exercise time/week, years of regular exercise, intake of other macronutrients, and smoking) in 206 adult women (Tucker and Kano, 1992). Relationships between protein and carbohydrate intake and percent body fat measured by skinfolds disappeared when the confounding variables listed above were controlled for (Tucker and Kano, 1992).

These studies suggest that dietary fat may play a causal role in obesity beyond its contribution to the energy content of the diet. Another important factor in the incidence of obesity is physical activity, which will be discussed next.

Physical Activity and Obesity. Physical activity is an important factor in obesity prevention, healthy weight loss and weight maintenance (Cunningham, 1991; Klesges et al, 1991; Miller et al, 1990; Slattery et al, 1989) Cunningham (1991) reviewed the effect of lean body mass on resting energy expenditure and concluded that there is a positive correlation between these two variables over a wide range of body weights, meaning that increasing or maintaining lean body mass through physical exercise will increase or preserve the rate of energy metabolism, thus aiding in the prevention and treatment of obesity (Cunningham, 1991).

Miller et al (1990) evaluated the relationship of percent body fat estimated by underwater weighing and an eating and exercise behavior questionnaire in faculty, staff and student voluteers from Indiana University (males n=107; female n=109; 18-71 years old) (Miller et al, 1990). Leanness and exercise were positively correlated ($p<0.001$) in this study. Obese males ($r=-0.44$, $p<0.001$) and obese females ($r=-0.39$, $p<0.001$) scored lower in exercise behavior than their lean counterparts (Miller et al, 1990).

Slattery, McDonald et al (1989) explored the associations between physical activity, body fat and its distribution, and dietary intake in 5115 young black and white adults aged 18 to 30 years who are participants in the ongoing national collaborative study on Coronary Artery Risk Development in Young Adults (CARDIA). The researchers found that total physical activity was inversely associated ($p<0.01$) with skinfold thickness in all groups. Physical activity was also inversely associated with waist-to-hip ratio in all subjects except white women (Slattery, McDonald et al, 1992).

In summary, the major modifiable contributing factors to fat accumulation and distribution are the intake of fat and the level of physical activity (Bray, 1989; Bray, 1992; Miller et al, 1990).

Physical Fitness

As discussed previously, exercise plays an essential role in obesity prevention and treatment. For this reason alone exercise is considered a valuable tool for the reduction of cardiovascular disease, however exercise has heart health benefits beyond its role in obesity prevention and treatment.

Measurement of Physical Fitness

The American Alliance of Health, Physical Education, Recreation and Dance (AAHPERD) defines five health-related physical fitness components: 1) cardiovascular-respiratory function, 2) body composition, 3) flexibility, 4) muscular strength, and 5) muscular endurance (Williams, 1985). Based on this evaluation of physical fitness components, one simple method to evaluate fitness is to measure body fat levels (Williams, 1985), which researchers have found to be closely related to other fitness measures (Faria and Faria, 1991; Tucker and Kano, 1992). Cardovascular endurance, measured by maximal oxygen uptake, was inversely related to body fat measured by underwater weighing in 38 firemen (Faria and Faria, 1991); while cardiovascular endurance measured by exercise recovery heart rate, was significantly related to percent body fat measured by skinfolds in 206 adult women (Tucker and Kano, 1992).

Activity Level and Cardiovascular Disease

While a sedentary lifestyle is a risk factor for cardiovascular disease, physical activity is a positive factor for reducing cardiovascular risk (National Cholesterol Education Program, 1990; Paffenbarger et al, 1993; Sandvik et al, 1993). Moderate, regular aerobic exercise increases cardiovascular fitness and aises HDL-cholesterol as well as controling high blood pressure and excess body weight (National Cholesterol Education Program, 1990). The health benefits of activity occurs at moderate levels of activity, as well, for example a two mile walk in less than 30 minutes, three times a week (Duncan et al, 1991). Increasing activity above this moderate fitness level results in diminishing returns for effort, because the major drop in risk occurs between the sedentary and the moderately active, with about four times less risk for women and three times less risk for men (Blair et al, 1989).

Activity is helpful not only because it burns calories and helps lose weight and maintain weight loss, but it may even compensate for other cardiovascular risk factors such as high blood cholesterol and low HDL cholesterol (Blair et al, 1989; Paffenbarger et al, 1993; Sandvik et al, 1993). Thus, a person with high blood cholesterol but high fitness apparently has a lower cardiovascular risk than a person who has low blood cholesterol but low fitness (death rates of 27 vs 68 per 10,000 person-years respectively) (Blair et al, 1989). Leon et al (1987) studied heart attack mortality in 12,138 high risk men. He found that middle-aged men who were involved in 14-45 minutes of light activity a day were one-third less likely to die of heart attacks than their sedentary peers (Leon et al, 1987). Slattery, Jacobs et al (1989) looked at the effects of leisure-time physical activity on coronary heart disease mortality in about 3,000 railroad workers. Sedentary subjects, those expending less than 250 kcal per week in their free time, had a 30-40% higher risk of dying from coronary heart disease than those expending 1,000 to 2,000 kcal per week in their free time (Slattery, Jacobs et al, 1989).

Hubert et al (1987) examined 8 years of prospective longitudinal data on the young adult offspring of the Framingham Heart Study cohort, and identified an inactive lifestyle as one of the risk factors for coronary artery disease (Hubert et al, 1987). The subjects (397 men and 497 women) were 20-29 years of age at the beginning of the study. After adjustment for all other factors, a simple self-assessment of physical activity or activity change was positively associated with changes in HDL cholesterol ($p \leq 0.05$) in women and was negatively associated with the total cholesterol/HDL ratio ($p \leq 0.05$) and with changes in VLDL cholesterol ($p \leq 0.01$) in men (Hubert et al, 1987). This study suggests that the exercise habits and behaviors developed during young adulthood have a substantial effect on lipid and lipoprotien profiles in men and women (Hubert et al, 1987).

Thus, moderate activity is an important facor in cardiovascular disease risk reduction. Until recently research has primarily shown this relationship with aerobic type exercise, however strength training has also been shown to cause a decrease in certain cardiovascular risk factors, as will be discussed next.

Strength and Cardiovascular Disease

Strength training may confer a number of positive benefits. Strength training has been shown to cause healthy changes in body composition, primarily by increasing muscle mass and decreasing total body fat and percent body fat (Ullrich et al, 1987; Wood et al, 1988). Increased muscle mass may help a person reach and maintain a lower, more healthful weight by increasing BMR (Cunningham, 1991; Williams, 1985). Cardiovascular risk factors such as high blood pressure and high serum lipid levels may be favorably modified by strength training (Williams, 1985; Ullrich et al, 1987; Verrill et al 1992). Researchers found that participants in an eight-week weight-training program experienced an increase in HDL cholesterol (the "good cholesterol") of 14% from 38.8 to 44.1 mg/dl, and an 8% drop in LDL cholesterol levels (the "bad cholesterol") from 132 to 121 mg/dl (Ullrich et al, 1987). Improvement in muscular strength also may help prevent common injuries such as lower back pain (Williams, 1985).

Diet and Cardiovascular Disease

Scientific consensus supports the role of diet in cardiovascular disease etiology, prevention, and treatment (National Cholesterol Education Program, 1990). U.S. Dietary Guidelines for the prevention of cardiovascular disease are to limit total fat intake to 30% or less of calories, saturated fat to 10% or less of calories, cholesterol to 300 mg or less per day, sodium to 2400 mg or less per day and to increase complex carbohydrate and fiber intake through the consumption of whole grains, fruits, and vegetables (USDA and USDHHS, 1990; National Cholesterol Education Program, 1990). Nutrients with less consensus in relationship to cardiovascular risk are calcium, magnesium, vitamin E, vitamin C, carotene, copper, zinc, and chromium (Smith, 1989).

Lipids

Lipids are one of the primary influences on blood lipid levels. In this section information drawn from two recent comprehensive review articles will be discussed (Gurr, 1992; McNamara, 1992).

Lower total blood cholesterol, a lower LDL:HDL ratio, and a higher apo A-I:apo B ratio are considered desirable changes for the reduction of cardiovascular risk (McNamara, 1992). Dietary cholesterol and the amount and type of fat influence these factors (Gurr, 1992; McNamara, 1992). The lipids discussed in this section will be dietary cholesterol, saturated fatty acids (SFA), monunsaturated fatty acids (MUFA), trans fattty acids (TFA), polyunsaturated fatty acids (PUFA), and ω-3 fatty acids.

Cholesterol. Some epidemiological studies suggest that dietary cholesterol is positively associated with blood cholesterol, but since foods that contain cholesterol often also contain saturated fat as well, the separate effect of cholesterol is difficult to determine from these studies (Gurr, 1992). Animal studies have shown mixed results, with some species, like rabbits, being very sensitive to dietary cholesterol intake and other species, like rats, being relatively insenitive to dietary cholesterol intake (Gurr, 1992). Similarly mixed results have been found in humans, leading to the conclusion that there are hypo- and hyper-responders to dietary cholesterol intake (Gurr, 1992). Generally, studies have shown little or no effect of added cholesterol intake on blood cholesterol levels (Gurr, 1992); however, since the cholesterol and saturated fat content in foods are possitively associated, the reccomendation to decrease cholesterol intake still has value for the reduction of cardiovascular risk in the general population.

Saturated Fatty Acids. Numerous epidemiological studies have demonstrated a positive relationship between increased SFA intake and increased total blood cholesterol levels and increased cardiovascular disease mortality both between and within different populations (Gurr, 1992; McNamara, 1992). Although SFA as a group have been classified as hypercholesterolemic, individual SFA have varying effects on blood cholesterol levels, effects that have not been well studied (McNamara, 1992). Stearic acid has a neutral effect on blood cholesterol levels since it can be converted into oleic acid (a MUFA) in vivo and medium or short chain SFA (≤10 carbons) are absorbed directly into the portal circulation and exert no hypercholesterolemic effect in animals or humans

(McNamara, 1992). However, the differences in cholesterolemic effects between the different SFA may not be of much practical significance since the major SFA in most diets is palmitic acid, which is a highly hypercholesterolemic fatty acid when substituted for MUFA, PUFA, or carbohydrate in the diet (McNamara, 1992). A decrease in SFA may be the primary causal factor in decreasing blood cholesterol levels, rather than the increase in unsaturated fatty acids, PUFA and MUFA, however there is evidence that unsaturated fatty acids may exert unique effects (Gurr, 1992).

Monounsaturated Fatty Acids. There is convincing evidence that the subsitution of MUFA for SFA in the diet decreases LDL while maintaining HDL levels (Gurr, 1992; McNamara, 1992). Most studies have found that MUFA decreased blood cholesterol as well as PUFA when either were substituted for SFA (Gurr, 1992). Diets containing high levels of MUFA may reduce atherosclerosis by two mechanisms, a lowering of LDL concentrations and the production of an LDL particle that is resistant to oxidative modification (McNamara, 1992). Oxidized LDL is theorized to be an initiating factor in atherogenesis (Gurr, 1992; Stringer et al, 1989; Wissler, 1991).

Trans Fatty Acids. Although naturally occuring unsaturated fatty acids are predominantly cis in their configuration, the hydrogenation of of fat results in substantial formation of trans fatty acids, thus there has been an increased intake of TFA in recent years due to the increased use of hydrogenated fats in food products, with the range of U.S. intake being 8 to 10 g TFA per day with elaidic acid (trans 18:1) being the major TFA in the American diet (McNamara, 1992).

The possible impact of TFA on cardiovascular disease risk is a controversial one (Gurr, 1992; McNamara, 1992). Early studies indicated that TFA had a neutral effect on blood lipid levels, however some recent studies have found that TFA increased cardiovascular risk by increasing the LDL:HDL ratio and by decreasing the apo A-I:apo B ratio (McNamara, 1992). One hypothesis for these changes is the similarity in structure between TFA and SFA. Both tend to be esterified into the first position of membrane phospholipids and both have higher melting points due to their ability to pack together into cystalline arrangements (Gurr, 1992; McNamara, 1992). However, this does not explain the decreased HDL levels seen in some studies with TFA but not with SFA (Gurr, 1992; McNamara, 1992). Based on current knowlegde, it seems prudent to limit the intake of TFA, however it is too soon to make definite recommendations regarding their intake.

Polyunsaturated Fatty Acids. Dietary intake of PUFA may reduce blood cholesterol by three mechansims; lowering of LDL apo B levels, increasing lipoprotein membrane fluidity, and increasing LDL degradation (McNamara, 1992). Increased membrane fluidity may enhance LDL receptor function and/or number, with LDL binding, uptake, and degradation being similarly enhanced (McNamara, 1992). PUFA reduce blood cholesterol when substituted isocalorically for SFA (Gurr, 1992; McNamara, 1992). Studies have both shown no effect and a negative effect on HDL levels from increased PUFA intake. These varying results are apparently due to the different amounts of total fat and PUFA in the different studies, since HDL levels appear to be primarilly influenced by the total fat intake of the diet, with PUFA decreasing HDL only when composing a large proportion of the diet (greater than 12-13% kcal or with a P:S ratio over 1.0) (Gurr, 1992; McNamara, 1992).

ω-3 Fatty Acids. The ω-3 fatty acids, primarily eicosapentanoic acid and docosahexanoic acid, are a type of PUFA prevalent in fatty fish, which epidemiological studies have found to lower risk of cardiovascular disease (McNamara, 1992). The decreased cardiovascular risk in populations who consume large amounts of these fish is due to the effect w-3 fatty acids have on decreasing the blood's clotting tendency and decreasing blood triglyceride levels (McNamara, 1992). Increased ω-3 fatty acid intake causes alterations in eicosanoid metabolism (prostaglandins) that result in altered platelet interactions and macrophage metabolism that in turn result in decreased tendency of the blood to clot and a decrease in the number and size of atherosclerotic lesions (McNamara, 1992).

Fiber

Fiber may influence a number of factors related to cardiovascular disease; blood clotting factors, obesity, and hormones like insulin (Anderson and Siesel, 1990); however, this discussion will focus on fiber's influence on blood lipid levels.

Insoluble fiber and soluble fiber are the two kinds of fiber. Insoluble fibers include cellulose, certain hemicelluloses, and lignin, and are found primarilly in wheat, most other grains, and vegetables (Anderson et al, 1987). Insoluble fibers slow down the breakdown of starch, delay the absorption of glucose, increase fecal bulk, and speed up intestinal transit (Anderson et al, 1987). Soluble fibers include pectin, gums, storage polysaccharides, and certain hemicelluloses (Anderson et al, 1987). Oat bran, other grains like rye, legumes, fruit like apples and oranges, and certain vegetables are very good sources of soluble fiber (Anderson et al, 1987; Anderson and Gustafson, 1988; Anderson and Siesel, 1990).

Although insoluble fibers may decrease blood cholesterol levels indirectly by displacing high fat foods in the diet (Anderson et al, 1987), apparently it is the soluble fibers that have the major effect on blood cholesterol levels because they bind to bile salts and increase cholesterol excretion (Anderson and Gustafson, 1988; Anderson and Siesel, 1990; Behall, 1990). Many studies have demonstrated decreased LDL (8% to 29% decrease), decreased total cholesterol levels (5% to 32% decrease), and maintained or increased HDL levels (0% to 9% increase) with increased intakes of soluble fiber from oats or beans (Anderson and Gustafson, 1988; Anderson et al, 1984; Anderson et al, 1990;

Zhang et al, 1992), psyllium (McCall et al 1992) or gums (Behall, 1990; Landin et al, 1992).

In conclusion, fiber can decrease blood cholesterol levels by displacing high fat foods in the diet and by decreasing the reabsorption of cholesterol through the binding of bile acids by soluble fiber (Anderson and Gustafson, 1988). However, other nutrients found in a high fiber diet confound the study of fiber's effect on cardiovascular disease because they also may have beneficial effects on cardiovascular risk. These nutrients will be discussed next.

Antioxidants

One of the initiating factors in atherosclerosis may be oxidized low density lipoproteins (LDL) (Gurr, 1992; Stringer et al, 1989; Wissler, 1991). Antioxidant nutrients may prevent this lipid oxidation (Frei, 1991; Gurr, 1992; Wissler, 1991) and reduce the number and size of lesions that develope (Gey et al, 1987; Verlangieri and Bush, 1992) as well as protect the synthesis of prostacyclin, a prostaglandin with known antiplatelet and vasodilatory effects (Simon, 1992; Verlangieri and Bush, 1992).

Vitamin E. Vitamin E has a controversial history regarding its role in cardiovascular disease. Epidemiological studies have indicated that persons with higher blood levels of vitamin E have a lower risk of cardiovascular disease (Olson, 1973). The recently proposed mechanism for this action is that vitamin E, an antioxidant, prevents the lipid oxidation that may percipitate atherosclerosis (Wissler, 1991)

Pronczuk et al (1992) compared the plasma vitamin E, total cholesterol, and fatty acid profiles of 79 vegetarians and 79 age and sex matched nonvegetarians. Total plasma cholesterol was significantly lower in vegetarians than in nonvegetarians. Vegetarians also had lower cardiovascular risk based on their blood lipid fatty acid profile (higher linoleic:oleic acid ratio). The fatty acid profile was positively correlated ($r=0.72$, $p<0.001$)

with the plasma vitamin E:cholesterol molar ratio. The vitamin E:cholesterol molar ratio was higher in vegetarians (27% of vegetarian males and 11% of vegetarian females) than in nonvegetarians. This study suggests that the nutrient intake of vegetarians may protect them from lipid peroxidation, a possible initiating event in atherosclerosis.

Verlangieri and Bush (1992) studied the effects of vitamin E supplementation both as a preventative agent and as a therapeutical agent on experimentally induced primate atherosclerosis. The 3-year study on 24 male monkeys (M. fascicularis) measured the degree of atherosclerosis (expressed as average percent stenosis) in a prevention group, a therapeutical regression group, and two control groups while on an atherogenic diet. Plasma vitamin E concentration was negatively correlated ($r=-0.45$, $p<0.002$) with atherosclerosis (percent stenosis). The prevention group, which received vitamin E supplements throughout the study, had less atherosclerosis (61% stenosis) than the control group (87% stenosis). The therapeutic regression group, which received vitamin E supplements after atherosclerosis had developed for 12 months, experienced a regression of atherosclerosis from 33% to 8% ($p<0.05$) 8 months after the vitamin E supplementation began. At the end of the 3-year study the regression group had less atherosclerosis (18% stenosis) than the control groups (87% stenosis). The researchers concluded that while vitamin E does not totally prevent atherosclerosis, it does appear to decrease the severity and decrease the rate of disease progression. In addition, vitamin E may regress existing lesions. Proposed mechansims for these effects are the antioxidant effects of vitamin E on the prevention of LDL oxidation and subsequent formation of atherosclerosis and also vitamin E's protection of prostacyclin synthesis, a prostaglandin with antiplatelet and vasodilatory effects (Verlangieri and Bush, 1992).

<u>Vitamin C.</u> In a 1992 review, Simon summarized the research on vitamin C and cardiovascular disease. Human studies have demonstrated an inverse correlation between vitamin C intake and cardiovascular disease mortality (Simon, 1992). A sub-population

that may be particularly helped by increased vitamin C intake are those with a total cholesestrol level over 200 mg/dl and vitamin C unsaturated tissues (Simon, 1992). Decreased LDL and blood pressure and increased HDL were associated with increased plasma ascorbic acid in a cross-sectional analysis of three Boston area samples (Jacques, 1992).

There are several possible reasons for vitamin C's proported effect on lowering cardiovascular disease risk (Simon, 1992). Lipid peroxidation may be the initiating event in atherogenesis, and vitamin C may act directly and/or synergistically with other antioxidants (ie. vitamin E) to prevent the oxidation of blood lipids (Chobanian, 1992; Frei, 1991; Simon, 1992). Vitamin C is a highly reactive antioxidant that is very effective in reducing oxidants before they can cause damage to lipoproteins (Frei, 1991). Vitamin C also recycles oxidixed vitamin E back to the active form of vitamin E, enabling it to protect lipids from oxidation once more (Kagan et al, 1992).

Like vitamin E, vitamin C also protects the synthesis of prostacyclin, a prostaglandin with known antiplatelet and vasodilatory effects, effects which influence the development and expression of atherogenesis (Simon, 1992).

Vitamin C functions as a regulator of cholesterol's catabolism into bile acids and is an influencing factor in lipid regulation in the guinea pig, rabbit, and rat. A similar role in humans is possible but unproven so far (Simon, 1992).

Thus, although the evidence for the association between vitamin C and cardiovascular disease is largely circumstantial, when taken in total it is suggestive of an association that warrents further study.

Minerals

Essential minerals may play a number of roles in cardiovascular disease because they are often required as cofactors for a multitude of different enzymes in a wide variety of metabolic roles. The purpose of this review is to provide both a background and a springboard to information regarding the possible connections between cardiovascular disease and magnesium, copper, zinc, and chromium.

Magnesium. The relationship between magnesium and cardiovascular disease has not received much attention in recent years. However two reviews offer an intriguing lood at the possibilities (Seelig and Heggveit, 1974; Wester, 1987). Epidemiological studies have found an inverse relationship between cardiovascular disease and water hardness, with calcium and/or magnesium considered to be the possible protective factors (Seelig and Heggtveit, 1974; Wester, 1987). One extensive statistical analysis found that water's magnesium concentration explained more of the variation in cardiovascular death rate than either total water hardness or calcium concentration (Seelig and Heggtveit, 1974; Wester, 1987). Accident victims from soft water areas had lower coronary magnesium levels and more evidence of prior cardiovascular disease than did their peers from hard water areas (Seelig and Heggtveit, 1974). Additional proof that magnesium, not calcium, is the protective factor in water comes from a study of rabbits on atherogenic diets, which were completely protected from atherosclerosis by distilled water with added magnesium but were not protected by distilled water with added calcium (Seelig and Heggtveit, 1974). Animal studies suggest that a chronic magnesium deficiency may contribute to cardiovascular disease (Wester, 1987) by accelerating damage to blood vessel walls, with cellular loss of magnesium being a basic biochemical mechanism in the genesis of many types of lesions (Seelig and Heggtveit, 1974). Several human studies have associated potentially life-threatening arrhythmias with magnesium deficiency (Seelig and Heggtveit, 1974; Wester, 1987). Perhaps the most significant research, however, are the studies demonstrating increased survival rates in heart attack patients given magnesium injections (Seelig and Heggtveit, 1974; Wester, 1987). A British study with 2,300 subjects reported 1-month mortality of 7.8% for the magnesium treated patients vs 10.3% mortality in the salt-water placebo group, a 24% decrease in mortality (Seelig and Heggtveit, 1974). Magnesium has not had a consistent effect on serum lipids, possibly due to differences in initial magnesium status in the studies' subjects (Seelig and Heggtveit, 1974).

Magnesium may improve blood flow by widening arteries or by reducing the risk of blood clots, as well as protecting the heart muscle cells from damage during a heart attack and reducing the risk of arrhythmias (Seelig and Heggtveit, 1974). Researchers have suggested several possible mechanisms for magnesium's anticlotting action; increased fibrinolysis (clot catabolism), platelet membrane stabilization, the competition of magnesium with calcium for clotting factors, increased retention of cellular potassium,and increased vasodilation (Seelig and Heggtveit, 1974; Wester, 1987). Excess vitamin D may exaberate the effects of magnesium defeciency and increases magnesium needs (Seelig and Heggtveit, 1974; Wester, 1987) and this raises the possibility that the consumption of vitamin D fortified milk without a balancing intake of magnesium rich vegetables and grains may produce a sufficient degree of magnesium defeciency to explain some of the cardiovascular disease incidence in the Western world.

The possibility that a chronic dietary insufficiency of magnesium may contribute to the development of cardiovascular disease cannot be excluded, however human research is complicated by the body's homeostatic mechanisms for magnesium, so despite the promising research discussed previously, most experts still consider magnesium's benifits for heart disease to be unproven (Seelig and Heggveit, 1974; Wester, 1987). However, magnesium is a very safe mineral to consume and many individuals may benifit by increasing their intake (Wester, 1987). The USDA reports that half of women consume less than 70% of the RDA for magnesium (300 mg/day) (Seelig and Heggtveit, 1974) and US males have been estimated to be about 30% lower in magnesium than the RDA of 350 mg/day (Wester, 1987). Good sources of magnesium are whole grains, leafy green vegetables, beans, seeds, and nuts and increasing the intake of these foods is consistent with dietary recommendations for the reduction of cardiovascular disease (USDA and

USDHHS, 1990; National Cholesterol Education Program, 1990). Refining and cooking may significantly decrease the magnesium content of foods; refined flour has 80 to 96% less magnesium than whole wheat flour, brown rice may lose more than 80% of its magnesium when it is polished, refined sugar is devoid of magnesium, and vegetables may lose more than 50% of their magnesium content when boiled (Wester, 1987). Researchers estimate that water contains 0 to over 15 µg/mL and may provide up to 27% of daily magnesium intake, depending on water hardness and dietary habits (Wester, 1987).

Copper and Zinc. Copper defeciency is known to increase blood cholesterol and triglyceride levels in rats (Klevey, 1973). Klevey (1973) theorized that it was the ratio of zinc to copper that was vital, with a high zinc/copper ratio being associated with elevated blood cholesterol levels. Klevey's hypotheses has been confirmed in rat studies (Katya-Katya et al, 1984; Sinthusek and Magee, 1984) but the results in human research has been mixed.

Research by He et al (1992) on the relations of serum zinc and copper to serum lipid levels in a population-based sample of 399 chinese men found that serum copper was inversely related to HDL (r=-0.21), while the zinc/copper ratio showed a positive relationship to HDL (r=0.19). These correlations remained significant after adjustments for confounding factors (age, body mass index, physical activity, tobacco smoking and dietary cholesterol, fat, and fiber). After adjustment for the confounding factors, multivariate analysis revealed a significant negative association between serum copper and total blood cholesterol. Higher serum copper was associated with decreased total and HDL cholesterol, however no significant relationship was found between serum copper and LDL levels, Serum zinc had no significant relationship with any of the lipids measured. McMaster et al (1992) also demonstrated a positive relationship between serum copper and blood cholesterol levels. It is difficult to interpret these results because serum copper and serum zinc are not directly related to the dietary intake of copper and zinc, because of intervening homeostatic mechanisms.

Chromium. Chromium functions as part of a glucose-tolerance factor which aids insulin's action in the body, thus inadequate chromium may result in elevated insulin levels and impaired glucose tolerance (Anderson and Kozlovsky, 1985), which may be a risk factor for cardiovascular disease (Stout, 1991). Chromium may influence cardiovascular disease through its impact on blood glucose control in the body (Anderson and Kozlovsky, 1985). In rats, chromium deficiency resulted in increased blood cholesterol, and chromium supplementation caused lowered blood cholesterol (Schroeder et al, 1971).

Inadequate chromium status may result from either decreased intake or increased excretion. Decreased chromium intake may result from consuming a highly refined diet (Anderson and Kozlovsky, 1985). Anderson and Kozlovsky (1985) reported the daily average (n=7 days) dietary chromium intake levels in the self-selected diets of 32 subjects (10 males, 22 females, 25-65 years old) to be about 25 μg/day, which is half of the minimum recommended level of 50 μg/day (National Research Council, 1989.). Increased chromium excretion may result from excess sugar intake (Anderson and Kozlovsky, 1985) and excess physical exercise or stress (Anderson et al 1982).

Diet and Blood Pressure

Electrolytes

Diet impacts blood pressure (Hypertension Prevention Trial Research Group, 1990), with nutrients of concern being potassium, sodium, magnesium, calcium, and lipids. Individually, these nutrients have conflicting effects on blood pressure. Sodium restriction, for example, appears to have little effect on blood pressure except in individuals (an estimated 6% of the population) with salt sensitive hypertension (Hypertension Prevention Trial Research Group, 1990). However, in the general population evidence for a major effect of sodium is weak. Evidence suggests that potassium intake has positive effects in reducing blood pressure (Intersalt Cooperative Research Group, 1988; Clinical Nutrition Cases, 1988). A high potassium diet may make sodium restrictions more successful (Feldman, 1990; Clinical Nutrition Cases, 1988) and makes a high sodium diet less damaging but it does not reduce the need for hypertensive medication in hypertensive patients (Grimm et al, 1990). A diet low in calories and sodium and high in potassium may help reduce high blood pressure (Hypertension Prevention Trial Research Group, 1990; Clinical Nutrition Cases, 1988).

Calcium

Epidemiological studies generally support a link between calcium and blood pressure (McCarron et al, 1991; Gruchow et al, 1988). Calcium supplementation may decrease blood pressure, primarily in those who are salt sensitive (Cerrato, 1988), but also in normotensive humans (Lyle et al, 1987). Calcium supplements (1500 mg) significantly decreased blood pressure in normotensive white and black men (Lyle et al, 1987). Caution must be exercised however since a high calcium intake (above 800 mg) can harm individuals with high serum renin or high ionized calcium levels (Cerrato, 1988).

Magnesium

Magnesium supplementation may also decrease blood pressure, but only in magnesium deficient persons (Zemel et al, 1990). Supplements given to magnesium adequate mild hypertensives had no significant effect on blood pressure (Zemel et al, 1990).

Antioxidants

Antioxidant nutrients may influence blood pressure by protecting the synthesis of prostacyclin, a prostaglandin with vasodilatory effects, from inhibition by peroxides (Pronczuk et al, 1992; Salonen et al, 1988; Simon, 1992; Verlangieri and Bush, 1992). Salonen et al (1988) observed inverse associations between both plasma vitamin C levels ($p=0.0008$) and serum selenium levels ($p=0.0017$) and resting blood pressure in Finnish men ($n=722$, 54 years old) examined as part of the Kuopio Ischaemic Heart Disease Risk Factor Study. Decreased blood pressure has been associated ($p<0.05$) with increased plasma ascorbic acid in other studies (Jacques, 1992; Moran et al, 1993) but not with selenium or antioxidant nutrients other than vitamin C (Jacques, 1992; Moran et al, 1993); These studies are suggestive of an association between antioxidants, particularly vitamin C, and blood pressure, however results are preliminary and the subject requires further research.

Lipids

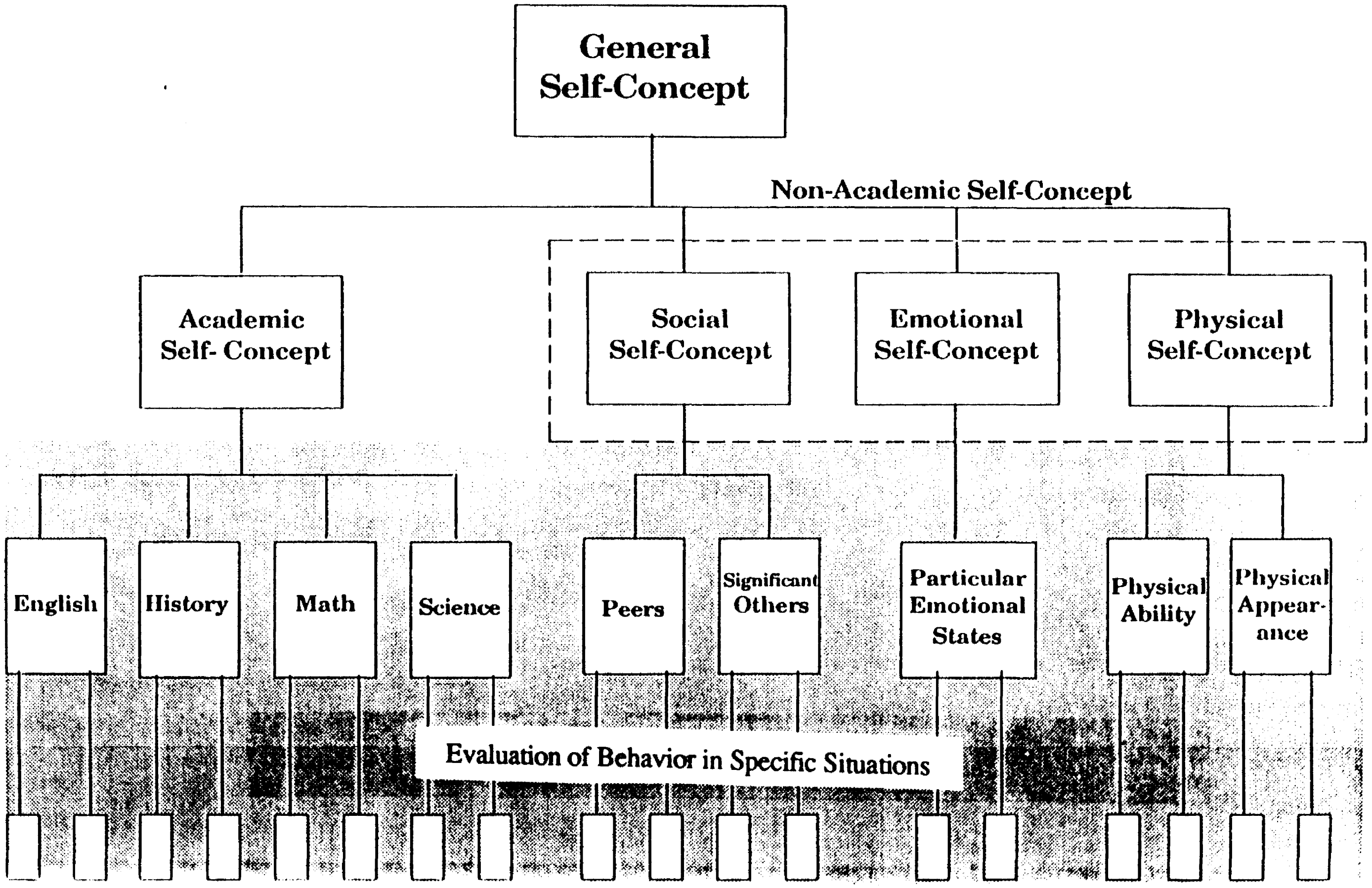
In a 1989 review, Sacks concluded that although population studies suggest that low-fat diets or substituting unsaturated fat intake for saturated fat intake decrease blood pressure, there is little convincing clinical evidence that the amount and type of dietary fats affects blood pressure in persons with normal or mildly elevated blood pressure (Sacks, 1989). The low blood pressure vegetarian populations generally consume less fat and saturated fat, however many other nutrients in their diet differ from a non-vegetarian diet and this confounds the relation between dietary fats and blood pressure (Sacks, 1989). More significant results have been achieved with pharmacologic doses of ω-3 fatty acids (Knapp, 1989). A 50 ml dose of fish oil, a good source of ω-3 fatty acids, decreased blood pressure in men with mild hypertension (Knapp and Fitzgerald, 1989; Kestin et al, 1990).

Self-perceptions

Improvement in self-concept and self-perceptions is valued for its role in facilitating desirable changes in behavior (Marsh, 1989). In a 1989 review of self-concept research, Marsh concluded that self-concept is multidimensional and hierarchically organized (see figure 2, page 37), and becomes increasingly differentiated with age. Marsh also concluded that there is no evidence for gender differences in overall self-concept at any age level, however there are gender differences in specific components of self-concept, some favoring boys and others favoring girls (Marsh, 1989). These gender differences tend to be consistent with the traditional gender stereotypes; for example females tend to score higher in verbal and congeniality/sociability self-concept while males tend to score higher in math and physical ability self-concept. In addition males tend to score higher in appearance self-concept than females (Marsh,1989).

Measurement of Self-Perceptions

Self-concept, self-image and self-perception are terms that have been used somewhat interchangeably in the literature. Self-concept is defined as how the individual knows himself or herself and includes attributes that the person perceives he or she possesses as well as the perception of how others view him or her. Self-concept is theorized to have four parts (Figure 1, page 37): academic self-concept, social self-concept, emotional self-concept and physical self-concept that may be further divided into sub areas



Sonstoem and Morgan. Exercise and self-esteem: rationale and model.
Med Sci Sports Exerc 1989;21(3):329-37.

Figure 1. Heirarchical Stucture of Self-Concept

(Sonstroem and Morgan, 1989; Marsh, 1989). Because self-concept is multidimensional, an instrument measuring only overall self-concept would be too general for use in studying the relationship between body images and cardiovascular risk factors. A person may have a moderately good overall self-concept because of having such high self-concepts in academics, social, and/or emotional areas that it masks the reality of a poor physical self-concept. For this reason a multidimensional instrument was used in this study; the Multidimensional Body-Self Relations Questionnaire (see questionnaire in appendix) (Cash et al, 1986).

The Multidimensional Body-Self Relations Questionnaire (MBSRQ) was developed principally by Thomas F. Cash, Ph.D., Professor of Psychology, Old Dominion University, Norfolk, Virginia 23529-0267, Phone: (804) 683-4213. This 69-item questionnaire contains the 54-item short form (BSRQ-S) of the original 140-item BSRQ (Winstead and Cash, 1984), the 9-item Body Areas Satisfaction Scale (BASS), plus 6 weight-related items. The MBSRQ was developed on the basis of conceptual, empirical and psychometric criteria as described below. The MBSRQ was administered in July 1985 through a nationwide readership survey of Psychology Today magazine and the results were reported in the April 1986 issue (Cash, 1986). From this survey of approximately 30,000 respondents, 2,000 respondents were randomly selected and stratified by the sex and age distribution of the U.S. population. This database permitted further assessment of the psychometric properties of the BSRQ.

The theory behind this instrument is that body image is a self-attitude comprised of three psychological dimensions concerning three somatic domains of the body. The three psychological dimensions or dispositions toward one's body are affective ("Evaluation"), cognitive ("Attention/Importance"), and behavioral ("Action" or "Activity"). The three somatic domains are physical aesthetics ("Appearance"), physical competence ("Fitness"), and biological integrity ("Health"). Thus body-image is composed of a 3 x 3 conceptual matrix. On conceptual and empirical grounds, the Attention/Importance and Action subscales were combined as "Orientation" to make a 2 x 3 matrix that yields 6 subscales: Appearance Evaluation, Appearance Orientation, Fitness Evaluation, Fitness Orientation, Health Evaluation, and Health Orientation. Factor analytic scoring produced the same 6 subscales plus an additional, seventh subscale termed "Illness Orientation". Other subscales included in the MBSRQ are the Body Areas Satisfaction Scale (BASS) and the Weight Preoccupation Scale. The BASS is similar to the Appearance Evaluation subscale, except that it allows the examination of discrete areas of the body's appearance rather just an overall composite score. The Weight Preoccupation Scale is the mean of four items: Fat Anxiety, Weight Vigilance, Self-Classified Weight, and Dieting/Restraint. The Fat Anxiety scale estimates one's emotional apprehension or discomfort about being or becoming overweight, with high scores indicating high fat anxiety. The Weight Vigilance scale estimates the 'weight watching', the degree of awareness of small changes in weight, with high scores indicating higher weight vigilance. The Self-Classified Weight scale estimates how one perceives and labels one's weight, from very underweight to very overweight, with high scores indicating a higher self-perceived body weight. The Dietary Restraint scale estimates the degree of weight-control dieting and fasting, with higher scores indicating more dieting behavior and attitudes.

Self-Perceptions and Dietary Intake

Newell et al (1990) researched self-concept as a factor in the quality of diets of 160 adolescent girls. Self-concept was measured by the Tennessee Self Concept Scale, midarm circumference and triceps skinfold thickness were measured to estimate body fat level, and dietary intake was estimated from a 24-hour recall and a food frequency questionnaire. The subjects had Physical Self-Concept scores which were more than one standard deviation below the 50th percentile, reflecting a poor opinion of physical appearance, which is common in adolescent girls because they want their appearance to resemble fashion models or actresses and are disappointed when it does not.

Witte et al (1991) studied the relationships between self-concept, measured by questionnaire, and nutrition-related behavior, assessed by 3-day diet records, in 153 women aged 18 to 35 years. The researchers found that several self-concept scores influenced nutrient intakes and eating patterns in young women (Witte et al, 1991). The "Body Size" dissatisfaction score was negatively correlated ($p \leq 0.05$) with carbohydrate intake and snack kcal content and positively correlated with the protein:kcal ratio, associations consistent with efforts to lose weight (Witte et al, 1991). The self-concept scores "Super Person" and "Do Your Own Thing" had a negative correlation ($p \leq 0.05$) with good nutrient intake and eating patterns (Witte et al, 1991). The "Super Person" may believe that nothing can hurt them and so ignore health and nutrition advice, while the "Do Your Own Thing" person may be too interested in seeking out fun activities to concern themselves with what they eat. The self-concept score "Traditional" and higher scores in nutrition knowledge and attitudes scores were positively correlated with good nutrient intake and eating patterns. A "Traditional" person was more likely to eat meals regularly (3 times/day) and appeared to heed nutritional advice to increase calcium intake (Witte et al, 1991). The research demonstrated that aspects of self-concept influenced nutrient intake and may have influenced peoples' receptivity to nutrition and health messages. These authors recommend that tailoring nutritional messages for different self-concept orientations (ie. "Super Person") may be more effective than the traditional approach of only targeting groups according to their nutrient needs and demographic characteristics (Witte et al, 1991).

Rucinski (1989) explored the relationship of body image, assessed by questionnaire, and dietary intake, measured by 3-day diet record, of competitive ice skaters: 17 males aged 16-26 years and 23 females aged 13-22 years. Ice skating is a sport in which thinness is stressed, therefore a test designed to assess behaviors and attitudes common in anorexia nervosa (the Eating Attitudes Test (EAT)) was used. Higher EAT scores mean that subjects have more anorexic thought patterns and behaviors. Intake of all nutrients appeared to decrease as EAT scores increased. In females EAT scores were negatively correlated with intakes of energy ($r=-0.549$, $p<0.01$), iron ($r=-0.387$, $p<0.05$), and thiamin ($r=-0.472$, $p<0.05$). In males, no significant correlations were found. Apparently, male and female skaters had different views of the ideal body frame and that the concern for body image was an influential variable on dietary intake in female ice skaters.

Read et al (1991) researched the relationship of use of vitamin and mineral supplementation to certain psychologic factors in 505 adults enrolled in the RENO (Relationship of Energy, Nutrition and Obesity to cardiovascular risk factors) Diet Heart Study. The three psychological instruments used were the Levenson Locus of Control Test (LOC), the Nutrition Attitude Survey (NAS), and the General Well-Being Schedule (GWBS). The LOC test rates the degree to which one perceives events in one's life to be determined internally by choice or to be determined externally by chance or by "powerful" others. The NAS test has four subscales, "dietary inefficacy"-feeling helpless about unhealthy eating habits, "nutrition concern"-awareness of nutrition/disease connection and willing to make dietary changes, "meat preference"-feeling that it's not a meal without meat, and "food exploration"-willing to try new foods. The GWBS simply measures how people judge their emotional well-being. Supplement use was not significantly related to any of the global instruments (GWBS, LOC) used in this research; however, supplement users tended ($p<0.10$) to score higher in "nutrition concern" and lower in "meat preference". Obese subjects felt more ($p<0.01$) helpless about their ability to make dietary changes and were more likely ($p<0.01$) to feel that chance and the influence of powerful others determined events in their life than did the normal weight subjects. Although women felt more helpless about their ability to make dietary changes than the men

($p<0.01$), they were more concerned about nutrition ($p<0.05$), and demonstrated a lower meat preference than the men did ($p<0.01$).

Self-Perceptions and Physical Fitness

Brodie et al (1988) examined how gender and different body composition categories influenced the self-perception of health and fitness in indoor sports participants in the United Kingdom. Body composition was estimated by BMI calculated from self-reported height and weight. The 'excellent' and 'good' self-perceived fitness categories did not have significantly different BMIs, so they were combined as the 'good/excellent' group. Comparing the self-perception fitness categories by BMI, the 'good/excellent', 'fair', and 'poor' fitness groups had significantly different BMIs with a higher BMI being found in each respective self-perceived fitness categories (Brodie et al, 1988). The study had four conclusions: 1) indoor sports participants rated their health and fitness highly, but their fitness less so than their health; 2) as adiposity increases, health and fitness perception decreases ($p<0.001$); 3) perceptions of health were better for women than for men of the same age; and perceptions of fitness were better for men than for women of the same age (Brodie et al, 1988). In summary the authors concluded:

> Individual perceptions of health and fitness are clearly multi-factorial but the hypothesis that those groups with poorer perceptions have greater adiposity is well demonstrated. This is an important finding from the perspective of health promotion because the association between obesity and lack of health and fitness is an educational message with appears to be appreciated. This analysis cannot directly substantiate that body composition is a factor in perceiving health and fitness, but the differences shown between adiposity groupings provide a basis for that suggestion.
> (Brodie et al, 1988)

Miller et al (1990) evaluated the relationship of percent body fat estimated by underwater weighing and a eating and exercise behavior questionnaire. Most subjects were faculty, staff and students (107 males, 109 females) from Indiana University (Miller et al, 1990). Obese males and females scored lower (males, $r=-0.26$, $p<0.005$; females, $r=-0.36$, $p<0.001$) than normal weight subjects in the eating score measuring eating cue responses (Miller et al, 1990). Both obese males ($r=-0.44$, $p<0.001$) and obese females ($r=-0.39$, $p<0.001$) scored lower in exercise behavior than their lean counterparts and leanness and exercise were positively related to each other ($p<0.001$) (Miller et al, 1990).

Psychological benefits may result from regular physical exercise, both aerobic and weight training (Sonstoem and Morgan, 1989; Tucker, 1987). Most young adults use exercise as a means to improve their physical appearance and to feel psychologically better about themselves (Sonstoem and Morgan, 1989; Tucker, 1987). Tucker (1987) demonstrated that weight training appears to improve ($p<0.05$) the body concepts of college males after 8-week of weight training and in a randomized study, running and weight lifting were equally effective in improving the self-concept of clinically depressed women (Ossip-Klein et al, 1989).

The psychological benefits of exercise may have other health benefits as well. Studies have shown that active, fit people are less likely to smoke than those who are sedentary and less fit. A ten-year study of Canada Life Assurance's corporate-fitness program found that among the most active group there were no smokers, although 78% of them had been smokers at the beginning of the study in 1978 (Shephard, 1992). The moderately active group had equally impressive results. Although 90% of the group had been smokers at the beginning of the study, only 3% of the moderately active group remained smokers by the end of the study in 1988 (Shephard, 1992). Dannenberg et al (1989) confirmed that fewer cigarettes were smoked per day by adult subjects (1,598 men and 1,762 women aged 20-69) in higher physical activity levels ($p<0.01$) than subjects in the lowest physical activity level.

In conclusion, research supports the theory that self-perceptions influence health behaviors, including dietary intake and physical activity, however the literature is not consistant in regards to which instrument is used to measure perceptions. This is a concern in the psychological sciences, with the general consensus being that the use of multidemensional and/or multilple instruments is the best strategy to use at this point. Hopefully future research will pinpoint and clarify the relevant psychological dimensions for measuring the aspects of self-perception and self-concept that influence health behavior.

CHAPTER III

METHODOLOGY

Subjects

Thirty subjects, 16 females and 14 males, were solicited through flyers posted on bulletin boards on campus and through information presented at residence hall meetings. Subjects volunteered during either Spring 1992 (n=19, 7 males, 12 females), or Fall 1992 (n=11, 7 males, 4 females). The subjects' average age was 18.6 years old, with a range of 18 to 20 years of age. The study was approved by the Internal Review Board at Oklahoma State University.

At the initial meeting the subjects were informed about the nature and purpose of the study and gave written consent. After signing the consent form the self-perception questionnaire and the 1-week Food Frequency Questionnaire were administered and the subjects were given the following directions both verbally and in writing to follow before returning to the Wellness Center for their physical and biochemical measurements and 4-day diet record instructions:

1. Do not consume any caffeinated beverages (coffee, tea, colas, mountain dew, etc) for 12 hours beforehand.
2. Do not eat or exercise within four hours of the data collection period.
3. Drink plenty of fluid the day before and day of testing, but stop drinking at least two hours before testing begins.
4. Wear shorts and T-shirt. (Bring a swimsuit if doing underwater weighing).

The following measurements were taken on the day of testing: weight, height, waist circumference, hip circumference, wrist circumference, 7-site skinfolds, bioimpedance, TOBEC, underwater weighing (for 11 subjects), grip strength, flexibility, blood pressure, and total blood cholesterol. The subjects were given instructions for the 4-day diet records after the measurements were completed.

Instrumentation and Procedures

Questionnaires

Each subject completed a 101 item questionnaire composed of the 67 item Multidimensional Body-Self Relations Questionnaire (Cash et al, 1986), and the 10 item Dietary Restraint questionnaire (Ruderman, 1986). The remaining questions were compiled by the author to address additional fitness and dietary habits and perceptions.

The food frequency questionnaire (FFQ) used in this study was a 1-week food frequency questionnaire modified from Willett's 1-year food frequency questionnaire (Eck and Willett, 1991; Eck et al, 1991). This questionnaire was used to assess short-term intake in a time-efficient manner. The Food Frequency Questionnaire (FFQ) was also compared to the four-day dietary records because the food frequency questionnaire could be classified as a perceptual measure due to its reliance on the recall of the subject. The FFQ was analyzed by entering the subjects stated 1-week intake using uniform codes and then dividing by 7 to acquire a one day average nutrient intake. A copy of the food frequency questionnaire can be found in the appendix. The food frequency questionnaire (Eck and Willet, 1991) was analyzed using Food Processor II (ESHA Research, 1990). The Food Processor II program calculated the following dietary components: food weight, water weight, kcal, protein, carbohydrate, fiber, total fat. saturated fat, monounsaturated fat, polyunsaturated fat. cholesterol, carotene, retinol. total vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, folacin, pantothenic acid. vitamin C. vitamin E, calcium, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, zinc, percent of calories from protein, percent of calories from carbohydrate, and percent of calories from fat.

Height and Weight

The subjects were weighed on a beam balance scale with no shoes and only light clothing (shorts and T-shirt). Weight was recorded in pounds to the nearest 1/4 pound. The subjects height, also measured without shoes, was measured using the sliding ruler attached to the balance beam scale. Height was recorded in inches to the nearest 1/4 inch.

Body Mass Index

Body Mass Index (BMI) is calculated as weight in kilograms divided by height in meters squared (kg/m^2). The BMI is a used as an indice of obesity. Health risks increase as BMI increases. The Panel on Energy, Obesity, and Body Weight Standards (Jéquier, 1987) have set up the following standards for obesity classification using the BMI. These standards were used to classify the BMI results of this study:

Classification of Obesity by Body Mass Index (kg/m^2)

Classification	BMI
Desirable range	20-25
Grade I obesity	25-29.9
Grade II obesity	30-40
Grade III obesity	>40

Frame Size

The wrist circumference was measured in inches with a narrow tape around the smallest part of the right hand wrist distal to the styloid process of radius and ulna (around the finger side of the 'wristbone'). Wrist circumference was used to estimate frame size by "r" value (Grant, 1980). The "r" value is calculated by dividing height in centimeters by wrist circumference in centimeters. Frame size was then determined by comparison to the following standards (Grant, 1980):

Frame Size by "r" Value

Men		**Women**
"r" value	**Frame size**	**"r" value**
> 10.4	small	> 11.0
9.6-10.4	medium	10.1-11.0
< 9.6	large	< 10.1

Body Composition

Four methods were used to estimate body composition: 7-site skinfold, bioimpedance, TOBEC, and hydrostatic. The following standards were used to categorize the results:

Body Composition Classifications

Woman % body fat	Classification	Men % body fat
14.0-16.9	Very low fat	7.0-9.9
17.0-19.9	Low fat	10.0-12.9
20.0-23.9	Average fat	13.0-16.9
24.0-26.9	Above average fat	17.0-19.9
27.0-29.9	Very high fat	20.0-24.9
30.0 and higher	Obese	25.0 and higher

Underwater Weighing. The first method used to estimate body composition was underwater weighing, using an AD-4321 A/B weighing indicator manufactured by Vacumed, a division of Vacumetrics Inc., A & D Company, Ltd., A & D Engineering, Inc., 5770 Nicolle Street, Ventura, CA 93003, Phone: (800) 235-3333, Fax: (805) 654-8759. The water pH and chlorine concentration was tested and adjusted using the BioGuard Spa Plus™ Test Kit, the BioGuard® SpaGuard® pH increaser (100% sodium carbonate) and pH decreaser (88% sodium bisulfate, 12% inert ingredients), and BioGuard® SpaGuard® Chlorinated Concentrate (62% available chlorine) for spas, hot tubs, and pools manufactured by Bio-Lab, Inc., Decatur, GA 30031. The pH was adjusted to fall within the ideal range of 7.2 to 7.8. The chlorine concentration was maintained within the ideal range of 1.0 to 2.0 ppm. The temperature was maintained within 25-35°C. Residual lung capacity was estimated from functional volume capacity (FVC) measured on the Spiro Analyzer ST-90 manufactured by Futuremed™, a division of Future Impex Corporation, 2076 Deer Park Avenue, Deer Park, NY 11729, Phone: (516) 242-1616. The FVC was measured using the following procedures:

1. Age entered in years, height in inches, gender (M or F), and race.
2. Cardboard tube put into mouth piece.

3. Subjects instructed to form a complete seal around the the cardboard tube with their mouths, and to breath normally for 2 to 3 breaths and then take a very deep breath and blow it out as hard and completely as possible (within 1-2 seconds) and finish by inhaling again.
4. After the subject had heard and understood the instructions the measurement was taken.
5. The FVC measurement was repeated 3 times. The highest FVC was recorded for input into the underwaterweighing program for the estimation of residual lung volume.

After the FVC was obtained, the subject changed into a bathing suit and entered the underwaterweighing tank where the following procedures were followed:

1. Subject data was entered: age, gender, height, weight, and FVC.
2. Water temperature in degrees Celsius was entered.
3. The subject fastened the weighted belt around the waist and sat back into the harness hanging from the weighing indicator.
4. Subject emptied lungs by exhaling before submerging completely under the water, where any remaining air should be exhaled.
5. The measurement was taken when the reading has stabilized (10 to 15 seconds).
6. The subject then surfaced.
7. The measurement was repeated 2 to 3 times to increase accuracy.

Total-Body Electrical Conductivity. Total-body electrical conductivity (TOBEC), also called an electromagnetic scan (EM-Scan), also was used to estimate body composition. The instrument used was EM-Scan Model HA-2, DJ Medical Instrument Corporation, 3420 Constitution Drive, Springfield, IL 62707, Phone: (217) 793-3666, Fax: (217) 793-3489. The TOBEC was calibrated before each data collection with a standard designed to produce a constant signal. The calibration device, a copper wire loop encased in Plexiglass, was centered at the top of the cart with the copper wire loop coaxial to the magnetic field. A test run was then initiated and the instrument adjusted to give the appropriate constant signal (phase average = 215 ± 4). Detector output was checked to adjust the phase to 3000. All subjects were measured by the author using the following procedures:

1. Subjects had an accurate and current height and weight and followed the subject protocol to ensure proper hydration levels.
2. Subjects lay down on their backs on top of a thin, flat cart which rolls on top of the supporting platform going through the measuring chamber. The subjects' head should be toward the chamber against the top of the cart. The subjects' arms were to the side away from the body with thumbs up. Legs were apart so that skin was not touching skin.
3. Subjects must remove all metal that encompasses the body: watches, necklaces, belts, hair bands.
4. No calculators or beepers are allowed.
5. After procedures and precautions have been followed the subject may be scanned.

Bioimpedance. The third method used to estimate body composition was bioimpedance using Biodynamics Model 310 Body Composition Analyzer, Chattanooga Corporation, P.O. Box 4287, Chattanooga, TN 37405, (615) 870-2281. Subjects were measured two times with different sets of electrodes and the results were averaged. Subjects were measured by the author and an experienced graduate student using the following procedures:

1. Subjects lied down on their back with right hand and foot exposed. Subject were told to relax with hands, palms down, at least six inches from sides and feet at least six inches apart

2. Four sensor pads were placed on the right wrist, hand, ankle, and foot. The wrist sensor pad was positioned near the subject's wrist with the edge of the pad located at the crease formed between the arm and hand while the hand is flexed back toward the subject's head (dorsiflexion). With the wrist relaxed, the hand's sensor pad was positioned in the center of the right hand close to the knuckles. The ankle sensor pad was positioned on top of the subject's right ankle with the edge of the pad located at the crease formed between the leg and foot while the foot was flexed back toward their head (dorsiflexion). The foot was relaxed and the foot's sensor pad was positioned on the center of the right foot near the base of the toes.
3. Sensor cables were attached, red clips were attached to the wrist and ankle sensor pads and the black clips to the hand and foot.
4. The measurement was then taken by activating the machine. The bioimpedance machine was self-calibrated and required the input of height, weight, gender, age, and frame size.

7-site Skinfold. The 7-site skinfold (Jackson and Pollack, 1985) measures fat at the tricep, subscapular, suprailium, chest/pectoral, abdomen, thigh, and axilla. All subjects were measured by the same person using a Lange Skinfold Caliper manufactured by Cambridge Scientific Industries, P.O. Box 265, Cambridge, MD 21613, Phone (800) 638-9566 or (301) 228-5111. The body composition equations used and the skinfold sites measured (see Figure 1, page 13) were the following:

Males body density = 1.112 - 0.00043499 (sum of seven skinfolds) + 0.00028826 (age)

Female body density = 1.0970 - 0.00046971 (sum of seven skinfolds) + 0.00012828 (age)

Percent body fat = (495/body density - 450) x100

Triceps: a vertical fold on the posterior midline of the upper right arm, halfway between the acromion and the olecranon processes, with arm held freely to the side of the body.

Subscapular: an angular fold taken at a 45 degree angle 1-2 cm below the inferior angle of the scapula

Pectoral: Men: a diagonal fold taken one half of the distance between the anterior axillary line and the nipple. Women: a diagonal fold taken a third of the distance between the anterior axillary line and the nipple.

Mid Axilla: a vertical fold taken at the mid point on the midaxillary line.

Suprailium: an oblique fold taken in line with the natural angle of the iliac crest taken in the anterior axillary line immediately superior to the iliac crest.

Abdominal: a vertical fold taken at a distance of 2 cm to the right side of the umbilicus.

Thigh: a vertical fold on the anterior midline of the thigh, midway between the proximal border of the patella and the inguinal crease (hip). The fold should be measured while the subject's weight is resting on the opposite leg.

Waist-to-Hip Ratio

The waist circumference was measured with the subject's abdomen relaxed at the narrowest circumference between the chest and hips of females and one inch above the umbilicus of males. The hip circumference was measured at the largest circumference around the buttocks with the heels together. These two measurements were used to calculate the Waist-to-Hip Ratio (WHR) by dividing waist circumference by hip circumference. In men, a greater risk of heart disease and stroke above a WHR of 0.90 (Lohman, 1988). In women, the risk of heart disease and stroke increases sharply above 0.80 (Lohman, 1988).

Strength

Strength was estimated by measuring static grip strength of each hand using a D-type grip dynamometer manufactured by Takei & Company, Ltd. Shinagawa-ku, Tokyo

142, Japan; Phone: 786-4111~4; Cable: Takekikico Tokyo; Telex: 2466196 Takei J. The following procedures were followed (Fitness Canada, 1986):

1. Subject dried their hands. The gripping mechanism of the dynometer was adjusted so that the second joint of the hand fits snugly under the handle. The dynometer was gripped between the fingers and the palm at the base of the thumb.
2. The hand being tested was held out in front of the body, free from contact with the body. The subject bent slightly forward from the waist and kept the arm in a slightly flexed position from the elbow joint.
3. An all out gripping of the dynamometer occurred for two to three seconds. Subjects tried to keep the arm still, not swinging or pumping.
4. Two to three trials was done on each hand and the best measurement was recorded in kg and compared to the following standards (Fitness Canada, 1985).

Norms for Sum of Right and Left Grip Strengths (kg) for 5-19 years of age

Male	Classification	Female
≥113	Excellent	≥71
103-112	Above Average	64-70
95-102	Average	59-63
84-94	Below Average	54-58
≤83	Poor	≤53

Flexibility

Flexibility was estimated by measuring lower back and hamstrings flexibility using the FLEX-TESTER; Country Technology, Inc. P.O. Box 87, Gays Mills, WI 54631, Phone: (608) 735-4718, FAX: (608) 735-4859. The following directions were followed:

1. Subject sat on the floor, knees together, legs flat on the floor, feet against the foot plate of the FLEX-TESTER.
2. Finger tips were placed against the finger plate with middle fingers placed directly over each other, palms down.
3. With legs straight, but not locked, the subjects reached forward with shoulders square, arms fully extended, head down, stretching forward as far as possible without bouncing.
4. The procedure was repeated three times and the furthest reach was recorded in inches.
5. The results were evaluated very poor, poor, fair, very good, or excellent using the following values from Corbin and Lindsey (1985).

Flexibility Classifications

Male(inches)	**Rating**	**Female (inches)**
≥23	Excellent	≥24
20-22	Very Good	21-23
6-19	Fair	16-20
11-15	Poor	11-15
≤12	Very Poor	≤12

<u>Blood Pressure</u>

Blood pressure was measured by experienced personnel after the subject sat quietly for five minutes. The PyMaH Trimline sphygmomanometer and Pre-gaged ® Balanced ™ adult cuffs from PyMaH Corporation, Somerville, New Jersey were used to measure blood pressure in mm Hg. The sphygomanometer was pumped up to 200 mm Hg prior to blood pressure readings. If this pressure was inadequate a higher pressure was used. The acceptable range used for blood pressure was assumed to be 120 ± 10 over 80 ± 10 mm Hg, with a diastolic blood pressure of 90 to 104 classified as mild, 105 to 114 as moderate, and 115 or higher classified as severe hypertension. (Joint National Committee, 1988).

Total Blood Cholesterol

Blood cholesterol was estimated from a fingerstick blood sample using the following instruments and procedures:

1. Site Selection: a site was chosen at the side and end of a finger where there is adequate tissue thickness and fewer nerve endings. Blood was not drawn from the thumb.
2. Site Preparation: the site was cleaned with an alcohol swab and then dried thoroughly using a sterile gauze pad to avoid hemolysis caused by any residual alcohol.
3. Skin Puncture: a skin-puncture lance was used to puncture to a depth adequate for blood flow, 2.0 to 2.4 mm. The lance used was the B-D long point micro lance sterile single use blood lancet Becton-Dickinson, Division of Beckon, Dickinson and Company, Rutherford, New Jersey 07070.
4. Specimen Collection: The first drop of blood was wiped away to avoid contamination from excess tissue fluid. The puncture site was held downward and when another drop of blood appeared the tip of a VISION capillary tube was touched to it, drawing it up into the tube through capillary action. The tube was filled to the line. If necessary gentle pressure was exerted on the surrounding tissue to enhance blood flow. However, care was taken to avoid squeezing the site hard enough to cause any hemolysis or tissue fluid contamination.
5. Specimen Testing: the capillary tube was inserted into the test pack, keeping the test pack flat. The blood samples were analyzed using a Cholesterol kit from Abbott

Vision ™, Abbott Laboratories, Abbott Park, IL 60064. The specimens were analyzed within 10 minutes of collection on VISION Analyzer, from Abbott Laboratories, Abbott Park, IL 60064.

6. Puncture Treatment: After the blood sample was collected, a sterile cotton ball was applied to the puncture site with a slight pressure until the bleeding stopped.

7. Total Cholesterol values were compared to values from the Lipid Research Clinics Program reference values for hyperlipidemia and hypolipidemia in NIH Publication No. 80-1527 (1980).

Risk level associated with total blood cholesterol levels

Age	**Cholesterol Levels (mg/dl)**		
(years)	**Low Risk**	**Moderate**	**High Risk**
2-19	<170	170-185	>185

Dietary Measures

Diet was assessed using a 4-day dietary record. The subjects also were asked to fill out a 24-hour dietary recall that was not included with dietary data for the study but was used for instruction purposes only. Graduated food models were used to instruct the subjects on portion sizes. Bean models constructed of dried beans and paraffin were used to illustrate 2 cup, 1 cup, 1/2 cup, 1/3 cup, 1/4 cup, 2 Tbsp, 1 Tbsp, and 1 tsp portion sizes (Moore, 1967) The bean models have the advantage over other food models because they are non-biasing (Moore, 1967). Cardboard boxes were used to illustrate 3 oz, 2 oz and 1 oz meat/cheese portions (Posner, 1992). One cup and 1/2 cup beverage models were used to illustrate liquid measures. The author reviewed the 24-hour dietary recall with each subject and suggested corrections, additions, and modifications. Directions for the 4-day dietary records accompanied this review and were as follows:

1. Record the kind and amount of food as you consume it, do not delay in recording intake.
2. Record the time you begin eating each meal or snack.
3. Include brand names, restaurant names, etc.
4 Include everything consumed, including condiments, beverages, water, gum, candy.
5. Record four consecutive days. Include one weekend day.
6. Eat as usual. Do not attempt to modify your diet.

The four-day dietary records were analyzed using Food Processor II. (ESHA Research, 1990). The Food Processor II program calculated the following dietary components: food weight, water weight, kcal, protein, carbohydrate, fiber, total fat, saturated fat, monounsaturated fat, polyunsaturated fat, cholesterol, carotene, retinol, total vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, folacin, pantothenic acid, vitamin C, vitamin E, calcium, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, zinc, percent of calories from protein, percent of calories from carbohydrate, and percent of calories from fat.

Pilot Study

Five volunteers participated in a trial run of the procedures to sort out any logistical problems of time, space, personnel and procedures. At this time it was decided that underwater weighing was too time consuming to include in the study. Underwater weighing was later put back into the study to compare the TOBEC method to underwater weighing for a subsample (n=11) of the subjects.

Data Analysis

Because the spring 1992 and fall 1992 groups were not significantly different in any of the anthropometric variables, the two groups were combined and treated as one group. The only two variables that approached significance were height (p=0.053) and weight (p=0.105), which is explained by the greater proportion of males in the second group, with the Spring 1992 group having 7 males and 12 females, while the Fall 1992 group had 7 males and only 4 females.

Results were analyzed using the 4th edition of the Statistical Analysis System (Statistical Analysis System Institute, 1990). Means and standard deviation was calculated for all data. Frequency distributions were calculated for frame size, grip strength rating, flexibility rating, and nutrient intake. Simple and stepwise regression were calculated for blood cholesterol, blood pressure, body composition measures, and the self-perception subscales. Pearson's correlation was performed between 4-day dietary record nutrients and the corresponding nutrients from the Food Frequency Questionnaire. Pearson's Correlation was also done for blood pressure, blood cholesterol, and body composition measures. Variable means were analyzed for differences (based on gender, breakfast consumption, and weekend dietary intake) using ANOVA, Least Significant Difference, and Duncan's multiple comparison.

CHAPTER IV

Journal Article

Title: Fitness, dietary patterns, and health perceptions of college freshmen

Key words: fat, cholesterol, body composition, fitness, self-perception

Word Count: Abstract: 250

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Abstract

This study explored the relationship between perceptions and reality, focusing on specific cardiovascular risk factors: obesity, body composition, fat distribution, dietary total and saturated fatty acids, cholesterol, blood pressure, total blood cholesterol and physical activity. These risk factors were compared with perceptions measured by an appearance, fitness, health, and diet perception questionnaire to examine the associations between them.

Thirty subjects, 16 females and 14 males, volunteered for the study which was approved by the Internal Review Board at Oklahoma State University. Measurements taken were: weight, height, body mass index, waist-to-hip ratio, total-body electrical conductance, grip strength, flexibility, blood pressure, and total blood cholesterol. Diet was assessed using a 4-day dietary record and a 1-week food frequency questionnaire. In

addition each subject completed a questionnaire measuring appearance, fitness, healthy, and diet perceptions.

Subjects perceived being leaner as being fitter, healthier, and more attractive. Subjects underestimated fatness and overestimated fitness ($p<0.05$). Females tended to be more preoccupied with their weight ($p=0.09$), appearance ($p=0.06$), and scored higher in dietary restraint ($p=0.0003$) than males. Subjects were health oriented, yet their diets resembled the "typical American diet", too high in fat and too low in complex carbohydrates (35% of kcal from fat, 49% of kcal from carbohydrate, and only 12 grams of fiber/day). The relationship between self-perceptions and behavioral outcomes is an important one for health promotion. Exploration of the dynamics between knowledge and behavior may help speed up the process of converting knowledge into behavior.

Introduction

The relationship between perceptions and behavior is a fertile area of study that has great potential for aiding the application of nutritional knowledge by expediting the conversion of nutritional knowledge into human behavior, and by making health promotional campaigns more effective. The purpose of this study was to determine the associations of appearance, fitness, and health, and diet perceptions with measured cardiovascular risk factors modifiable by diet or activity. The specific modifiable cardiovascular risk factors measured were obesity, body composition, fat distribution, dietary fat, dietary saturated fat, dietary cholesterol intake, blood pressure, total blood cholesterol, and fitness level.

High blood cholesterol, high blood pressure, obesity, and a sedentary lifestyle are risk factors for cardiovascular disease that can be modified through changes in diet and physical activity (1). Our self-concept and perceptions may influence our nutrient intake and physical activity (2-5), which in turn may influence the risk of having cardiovascular disease.

Obesity has been established as a risk factor for cardiovascular disease (1). However, weight is not always a valid indicator of health or fitness (6). A person may be overweight according to the height and weight tables, but not be overfat when measured by body composition analysis. Conversely a person may be at a normal weight but still be overfat and at an increased risk of cardiovascular disease. Recent studies have shown that fat distribution is more highly correlated with the risk of cardiovascular disease than is obesity alone (7-9). These studies also have concluded that body fat distribution is an independent and predictive risk factor for cardiovascular disease with central obesity (abdominal area) being more detrimental to cardiovascular health than peripheral obesity (hip and thigh area) (7-9).

Body composition is a useful objective measure of both body fat and physical fitness. Body composition was used as an objective measure of fitness and fatness to compare to the perceptual measures estimated by the Multidimensional Body-Self Relations Questionnaire (MBSRQ) (10).

Diet is an important factor in the development and expression of cardiovascular disease (1). Nutrients of primary importance are the amount and kind of fat, cholesterol, and electrolytes (1). In this study dietary intake was objectively measured using a four-day diet record and a 1-week food frequency questionnaire (11).

Methods

Thirty freshmen subjects (16 females, 14 males, mean age 18.6 years old) were solicited through flyers posted on bulletin boards around campus and through information presented at residence hall meetings. The study was approved by the Internal Review Board at Oklahoma State University.

At the initial meeting the subjects were informed about the nature and purpose of the study and gave written consent. After signing the consent form each subject completed a questionnaire composed of the 1-week food frequency questionnaire, the 69 item Multidimensional Body-Self Relations Questionnaire (10), the 10 item Dietary Restraint questionnaire (12), and additional questions compiled by the author to address fitness and dietary habits and perceptions. The primary instrument used to assess body image and perceptions was the Multidimensional Body-Self Relations Questionnaire (MBSRQ) developed principally by Thomas F. Cash, Ph.D., Professor of Psychology, Old Dominion University, Norfolk, Virginia 23529-0267, Phone: (804) 683-4213. The subjects were then given the following directions both verbally and in writing to follow before returning to the Wellness Center for their physical and biochemical measurements and 4-day diet record instructions.

1. Do not consume any caffeinated beverages (coffee, tea, colas, mountain dew, etc) for 12 hours beforehand.
2. Do not eat or exercise within four hours of the data collection period.
3. Drink plenty of fluid the day before and day of testing, but stop drinking at least two hours before testing begins.
4. Wear shorts and T-shirt.

The following measurements were taken on the day of testing: weight, height, body mass index, waist-to-hip ratio, total-body electrical conductance (TOBEC), grip strength, flexibility, blood pressure, total blood cholesterol. The subjects were given instructions for the 4-day diet records after the measurements were completed.

Weight and height were measured to the nearest 1/4 inch or pound on a beam balance scale while the subject was in T-shirt, shorts, and socks. The BMI was then calculated as kg/m^2.

The waist-to-hip ratio was used as an indicator of fat distribution. The waist circumference was measured with the subject's abdomen relaxed at the narrowest circumference between the chest and hips of females and one inch above the umbilicus of males. The hip circumference was measured at the largest circumference around the buttocks with the heels together.

Body composition was determined by total-body electrical conductivity (TOBEC), also called an electromagnetic scan (EM-Scan). The instrument used was EM-Scan Model HA-2, DJ Medical Instrument Corporation, 3420 Constitution Drive, Springfield, IL 62707, Phone: (217) 793-3666, Fax: (217) 793-3489. The TOBEC was calibrated before each data collection with a standard designed to produce a constant signal.

Strength was estimated by measuring static grip strength of both hands using a D-type grip dynamometer manufactured by Takei & Company, Ltd. Shinagawa-ku, Tokyo 142, Japan.

Flexibility was estimated by measuring lower back and hamstrings flexibility using the FLEX-TESTER; Country Technology, Inc. P.O. Box 87, Gays Mills, WI 54631.

Blood pressure was measured by experienced personnel after the subject sat quietly for five minutes. The PyMaH Trimline sphygmomanometer and Pre-gaged ® Balanced ™ adult cuffs from PyMaH Corporation, Somerville, New Jersey were used to measure blood pressure in mm Hg.

Total blood cholesterol was estimated from a fingerstick blood sample. The blood samples were analyzed using a Cholesterol kit from Abbott Vision ™, Abbott Laboratories, Abbott Park, IL 60064. The specimens were analyzed within 10 minutes of collection on VISION Analyzer, from Abbott Laboratories, Abbott Park, IL 60064.

Dietary data was collected using two methods. The first is a 1-week food frequency questionnaire (FFQ) (11). The FFQ was analyzed on Food Processor II by entering the week's intake using uniform codes, then dividing by 7 to get the mean daily intake. The second method used for dietary analysis was a 4-day dietary record using graduated food models to instruct the subjects on accurate portion sizes (14; 15). The 4-day diet records also were analyzed on Food Processor II (13).

Statistical analysis was performed using SAS (16). Means and standard deviations were calculated for all data. Frequency distributions were calculated for blood cholesterol, grip strength rating, flexibility rating, and nutrient intake. Simple and stepwise regression were calculated for blood cholesterol, blood pressure, body composition measures, and the self-perception subscales. Pearson's Correlation was calculated between 4-day dietary record nutrients and the corresponding nutrients from the FFQ. Pearson Correlation was calculated between blood pressure, blood cholesterol, and body composition measures. Variable means were analyzed for gender differences using ANOVA, Least Significant Difference, and Duncan's multiple comparison.

Results and Discussion

Stepwise regression was used to determine which variables were most important in explaining the subjects' perception (Table 1, page 66 and Table 2, page 67). The inclusion of blood cholesterol and blood pressure in the models is interesting because subjects are unable to directly perceive them. However this can be partially explained by the fact that both variables have a colinear relation with body composition, the visible factor in the prediction models. The Waist-to-Hip Ratio (WHR) did not appear in any of the prediction models. This is not surprising because only one male and one female had an excessive WHR (>0.80 for females, >0.90 for males). Among an obese subject group, WHR would be more likely to appear as an influence on their self-perceptions.

Appearance Evaluation was best estimated by three variables: body composition (TOBEC), Grip Strength, and Blood Cholesterol (Table 1, page 66). Thus, persons who are leaner and stronger evaluate their appearance more positively. No significant differences were found between the appearance evaluations of females and males.

Table 1: Stepwise Regression Models[a] of the Multidimensional Body Self Relations Questionnaire Subscales

Variable	Coefficients	Prob>F
APPEARANCE EVALUATION: 43% of the variance explained		
Intercept	7.08	0.0001
Body Composition (TOBEC)	-0.06	0.0128
Grip strength	-0.22	0.0368
Blood Cholesterol	-0.01	0.0542
APPEARANCE ORIENTATION: 23% of the variance explained		
Intercept	4.43	0.0001
Body Composition (TOBEC)	-0.05	0.0563
Sex	0.79	0.0138
FITNESS ORIENTATION: 12% of the variance explained		
Intercept	4.72	0.0001
Body Composition (TOBEC)	-0.04	0.0755
HEALTH EVALUATION: 40% of the variance explained		
Intercept	5.09	0.0001
Body Composition (TOBEC)	-0.05	0.0245
Blood cholesterol, gender difference	-0.01	0.0251
Diastolic blood pressure, gender difference	0.03	0.0076
HEALTH ORIENTATION: 43% of the variance explained		
Intercept	5.31	0.0001
Blood cholesterol	-0.01	0.0015
Systolic blood pressure, gender difference	-0.01	0.0453
Flexibility, gender difference	0.50	0.0095

[a] An indicator variable was used to designate gender: 1 for females and 0 for males.

Table 2: Stepwise Regression Models[a] of the Multidimensional Body Self Relations Questionnaire Subscales of Body Areas and Muscle Tone

Variable	Coefficient	Prob>F
LOWER TORSO: 19% of the variance explained		
Intercept	4.45	0.0001
Thigh skinfold	-0.08	0.0224
MID TORSO: 46% of the variance explained		
Intercept	4.53	0.0001
Abdominal skinfold	-0.11	0.0001
UPPER TORSO: 46% of the variance explained		
Intercept	5.89	0.0004
Tricep skinfold	-0.07	0.1874
Exercise Duration	-0.41	0.1208
MUSCLE TONE: 35% of the variance explained		
Intercept	0.17	0.8396
Grip Strength	0.31	0.0219
Exercise Efficacy	0.60	0.0026

[a] An indicator variable was used to designate gender:
1 for females and 0 for males.

Appearance Orientation was estimated best by two variables: body composition (TOBEC) and gender (Table 1, page 66), thus females and leaner individuals oriented more toward their appearance. Females had a higher appearance orientation than males (p=0.057). A person with a high appearance orientation would place importance on how they look, pay attention to their appearance, and engage in lots of "grooming behaviors" to look their best (10). Females also tended to be more preoccupied with their weight than males (p=0.09). The females' preoccupation with their weight emerges from their high appearance orientation, since thinness in females is considered attractive in our society. Another behavioral pattern accompanying the high appearance orientation is dietary restraint. Females were significantly more restrained in their eating than males (p=0.003), meaning that females are more likely to alternate between being restrictive and being uncontrolled in their food intake in a pattern similar to the bulimic or compulsive eating pattern. For example, if one ate one cookie many might feel they had irreparably broken their diet and so would proceed to eat the entire package of cookies. Females are more likely to exhibit this behavior than males. This behavior can lead to weight cycling, which may increase abdominal fat deposits and increase cardiovascular risk (8).

Body Area Satisfaction Scores were examined for relationships between a subject's anthropometric variables and their satisfaction or dissatisfaction with different areas and aspects of their body (Table 2, page 67). Satisfaction with the lower torso (buttocks, hips, thighs, and legs) was best estimated by thigh skinfold thickness. Persons with leaner legs had greater satisfaction with their lower torso. Overall, females tended (p=0.13) to be more dissatisfied with their lower torso than males, reflecting a dissatisfaction with their natural female reproductive and lactational fat deposits in the hips and thighs, and an unrealistic desire for the lean lower torso typical of males. Satisfaction with the mid torso (waist and stomach) was best predicted by the abdominal skinfold. Persons with leaner stomachs had greater satisfaction with their mid torso. No difference in mid torso satisfaction was found between males and females. Satisfaction with the upper torso (chest area, shoulders, arms) was best predicted by tricep skinfold and typical exercise duration. Thus persons with leaner arms and who typically exercised for shorter duration had greater satisfaction with their upper torso. This means that subjects who disliked their upper torso spent more time exercising, perhaps to improve their appearance. Exercising to improve appearance is a common motivator (17; 18). Those who already felt satisfied did not have this motivation and so exercised less.

Satisfaction with muscle tone was best estimated by grip strength and exercise efficacy (the confidence that one can exercise regularly). Thus persons who are stronger and have confidence in their ability to exercise regularly are most satisfied with their muscle tone. Fitness efficacy (confidence that one can exercise regularly) was not significantly different between males and females. A 5 point scale was used; 1=not at all confident, 5=completely confident. Both females and males averaged 3.6 ± 1.1. Efficacy ratings have been found to predict future behavior (17). Therefore, one could speculate that strength building exercise increases the confidence that one can exercise regularly. If so, then weight training would be a valuable tool for increasing exercise behaviors.

Fitness Evaluation was not related to any of the anthropometric or biochemical measures taken. No differences were found between the fitness evaluations of females and males. This contrasts research by who compared BMI between different self-perceived fitness categories (excellent or good, fair, and poor) in indoor sports participants (5). They found that the group with highest fitness rating (excellent or good) had the lowest mean BMI. The different fitness groups had significantly ($p \leq 0.05$) different BMIs, with the 'poor' fitness category being the fattest (having the highest BMI) (5). There was a discrepancy between objectively measured fitness and the subjects' perception of their fitness. The 1 to 5 point scale used to objectively assess their fitness was termed "Fitness Score" and was determined by taking the average of their grip strength rating, flexibility rating, and body composition (TOBEC) classification times two:

Fitness Score = mean (grip strength + flexibility + (TOBEC class x 2))

The subjects' perception of their fitness (mean Fitness Evaluation=4.2; 5 is highest) was significantly higher than their actual fitness (mean Fitness Score=2.4; 5 is highest). This may be due to a commonly believed fitness myth that if you're thin then you are fit, not realizing that you can be thin but still be overfat and unfit. Another possibility is that the subjects focus on only one aspect of fitness, like strength, and ignored aspects of less importance to them.

Fitness Orientation was best predicted by body composition, measured by TOBEC (Table 1, page 66). Leaner individuals had higher fitness orientations; devoting more time, attention, and effort to fitness. The subjects' fitness orientation (mean Fitness orientation=3.7) was significantly ($p \leq 0.05$) higher than their actual fitness (mean Fitness score=2.4). This means that subjects might have overstated their commitment and involvement in fitness, or it simply means they were only committed toward one aspect of fitness, like endurance, and ignored flexibility (most males) or strength (some women). No gender differences were found between the Fitness Orientations scores of females and males. There also were no differences in mean hours of exercise per week, mean fitness efficacy scores (confidence that you can exercise regularly) or mean strength scores; however, there was a significant gender difference for mean flexibility scores ($p=0.003$), the females were much more flexible than males.

Females (n=14) reportedly exercised from 0 to 15 hours a week, mean = 3.2 ± 3.6 hours/week. Males (n=14) reportedly exercised 0 to 9 hours a week, mean=4.4 ± 2.8 hours/week. There was no significant difference in mean reported exercise hours/week between males and females, however the large standard deviations make analysis difficult.

Health Evaluation was best predicted by body composition, gender difference in blood cholesterol, and gender difference in diastolic blood pressure (Table 1, page 66). Thus leaner individuals (males and females) and females with lower blood cholesterol and higher diastolic blood pressures evaluated their health more highly. No gender differences were found in Health Evaluation scores between females and males.

Health Orientation was best predicted by blood cholesterol, gender difference in systolic blood pressure and the gender difference in flexibility. Females with greater flexibility and lower systolic blood pressures had higher health orientation scores. Leaner individuals also had higher health orientation scores. No gender differences were found in health orientations between females and males.

The mean nutrient intakes are listed in Table 3, page 75. The subjects dietary intake was comparable to the typical American diet when compared to the U.S. Dietary Goals (Table 4, page 73). Mean percent fat kcal intake was 35% of calories, above the 30% level recommended in the U.S. Dietary Goals, while the mean percent carbohydrate kcal intake of 49% was below the recommended 58%. (Table 4, page 73).

Gender differences in nutrient intake adequacy were found for several nutrients (Table 5, page 74). Differences ($p \leq 0.05$) were observed for vitamin C, iron, and pantothenic acid, for which fewer females than males were adequate (Table 5, page 74).

Based on the 4-day diet records, subjects ate breakfast 64% of the time and mean meal frequency was 3.5 times per day. No significant differences were observed in eating frequency or breakfast consumption between genders. Eating breakfast resulted in the consumption of significantly ($p \leq 0.05$) more cholesterol than non-breakfast days. In addition eating breakfast resulted in a significantly higher level of adequacy in vitamin C, vitamin A, and vitamin B_{12}. Some of the typical items consumed for breakfast by the subjects were orange juice with one or more of the following items: eggs, bacon, sausage, hashbrowns, doughnuts, and biscuits and gravy. These items explain the observations of higher cholesterol intake (eggs, bacon, sausage), vitamin B12 adequacy (sausage), vitamin A adequacy (fortified margarine used to fry eggs or spread on bread items), and higher vitamin C adequacy (habit of consuming orange juice with breakfast).

Table 3: Nutrient Intake[a]: Overall Means and Gender Differences

Item	**Overall Means (n=23)**	**Female Means (n=10)**	**Male Means (n=13)**	**P***
kcal	2443±798	1997±381	2786±874	0.0001***
Protein, g	87±29	75±14	97±34	0.0001***
Carbohydrate, g	301±92	246±51	344±96	0.0001***
Fiber, g	12.1±5.7	11±4	13±7	0.7528
Total Fat, g	97±35	81±22	110±38	0.3985
Saturated Fat, g	34±12	29±7	38±14	0.5494
Monounsaturated Fat, g	34±13	26±8	40±13	0.2390
Polyunsaturated Fat, g	14±6	11±5	16±6	0.7092
Cholesterol, mg	311±199	234±90	370±241	0.5438
Carotene, RE	362±451	461±553	287±359	0.1509
Vitamin A, RE	334±185	344±169	326±203	0.3104
Vitamin A, total RE	862±612	1020±741	741±489	0.0548*
Thiamin, mg	1.55±0.50	1.30±0.21	1.74±0.58	0.5395
Riboflavin, mg	2.03±0.75	1.78±0.20	2.22±0.95	0.8106
Niacin, mg	22±10	16.1±3.6	25.8±10.7	0.3444
Vitamin B_6, mg	1.42±0.50	1.28±0.49	1.55±0.52	0.1082
Vitamin B_{12}, µg	3.55±1.73	2.89±0.94	3.95±2.02	0.3224
Folacin, µg	320±91	206±58	242±94	0.7518
Pantothenic Acid, mg	4.4±2.1	3.5±1.0	5.0±2.5	0.6883
Vitamin C, mg	91±58	91±53	91±64	0.6208
Vitamin E, mg	8.2±3.7	8.7±5.0	7.7±2.4	0.1924
Calcium, mg	916±457	865±221	956±585	0.2979
Copper, mg	1.08±0.36	0.98±0.35	1.16±0.37	0.6975
Iron, mg	14.6±5.5	11.6±3.2	16.9±5.9	0.2934
Magnesium, mg	253±94	218±54	280±110	0.9857
Phosphorus, mg	1312±484	1112±238	1466±573	0.7872
Potassium, mg	2610±945	2273±592	2869±1099	0.9995
Selenium, µg	79±38	71.3±27.6	85.3±45.0	0.9941
Sodium, mg	39994±1407	3581±1250	4311±1486	0.5231
Zinc, mg	9.8±3.3	8.21±1.98	11.03±3.72	0.8237
Percent Protein	15±3	15±2	14±4	0.7725
Percent Carbohydrate	49±7	49±6	50±8	0.3523
Percent Fat	35±5	36±6	35±5	0.3311

[a] Means expressed as mean±standard deviation
* Females and males significantly different at p≤0.05
** Females and males significantly different at p≤0.01
*** Females and males significantly different at p≤0.001

Table 4: Nutrient Intake[a] Compared to Recommended Values[b]

Nutrient	**Mean[a] (n=23)**	**Goals**
Protein % Calories	14.6 ± 3.2	12%
Carbohydrate % Calories	49.4 ± 6.9	58%
Fat % Calories	35.1 ± 5.1	≤30%
Saturated Fat % Calories	12.5±2.3	≤10%
Monounsaturated Fat % Calories	12.4±2.0	≤10%
Polyunsaturated Fat % Calories	5.2±1.4	≤10%
Cholesterol, mg	311 ±199	≤300 mg
Fiber, g	12 ± 0.7	20-30 g
Sodium, mg	3993 ± 1407	≤2400 mg

[a]Means expressed as mean±standard deviation
[b]Recommended values based on U.S. Dietary Goals

Table 5: Nutrient Intake Adequacy[a/b]: Overall Means and Gender Differences

Nutrient	Mean	Percent of Subjects Adequate (n=23)	Percent of Females Adequate (n=10)	Percent of Males Adequate (n=13)	p
Protein, g	87.2 ± 29.2	100%	100%	100%	0.999
Vitamin A, total, RE	862 ± 612	43%	50%	38%	0.600
Thiamin, mg	1.55 ± 0.50	96%	100%	92%	0.393
Riboflavin, mg	2.03 ± 0.75	91%	100%	85%	0.212
Niacin, mg	21.6 ± 9.6	91%	90%	92%	0.854
Vitamin B_6, mg	1.42 ± 0.50	74%	70%	76%	0.723
Vitamin B_{12}, μg	3.55 ± 1.73	96%	100%	92%	0.393
Folacin, μg	230 ± 91	91%	90%	92%	0.854
Pantothenic acid, mg	4.36 ± 2.07	35%	10%	54%	0.029*
Vitamin C, mg	91.2 ± 58.4	74%	50%	92%	0.013**
Vitamin E, mg	8.17 ± 3.66	61%	70%	54%	0.454
Calcium, mg	916 ± 457	52%	50%	54%	0.863
Copper, mg	1.08 ± 0.36	48%	30%	62%	0.146
Iron, mg	14.6 ± 5.5	87%	70%	100%	0.035*
Magnesium, mg	253 ± 94	65%	60%	69%	0.663
Phosphorus, mg	1312 ± 484	91%	100%	85%	0.212
Selenium, μg	79.2 ± 38.3	83%	90%	77%	0.435
Zinc, mg	9.8 ± 3.3	48%	40%	54%	0.532

[a] Means expressed as mean±standard deviation
[b]Adequacy based on meeting at least 66% of The Recommended Dietary Allowances (1986) or 2/3 of midpoint of safe and adequate range estimate
*Females and males significantly different at $p \leq 0.05$
** Females and males significantly different at $p \leq 0.01$
***Females and males significantly different at $p \leq 0.001$

Subjects appeared to be accurately assessing their typical eating patterns using the Food Frequency Questionnaire (FFQ) because the FFQ and the 4-day Food Record were significantly correlated ($p \leq 0.05$) in their measurement of the following nutrients: calories, protein, total fat, saturated fat, monounsaturated fat, cholesterol, thiamin, riboflavin, niacin, vitamin B_{12}, folacin, vitamin C, calcium, copper, magnesium, phosphorus, and potassium (Table 6, page 76). Nutrients not correlated were estimated to be higher with the FFQ than with the 4-day diet record (Table 6, page 76). Similar results were found by researchers comparing food frequency questionnaires (daily, weekly, monthly) with a 3-day diet record (19).

Implications

Researching the relationships between self-perceptions and behavior outcomes is important for health promotion. The discrepancies between a person's perception of the problem and the objective assessment of that problem will affect their action or inaction, attention to health messages, their motivation to change, and their success at making changes. Failure to perceive a problem may lead to ignoring health messages, failing to seek help, failing to make changes, and/or to failing at making permanent changes. If the problem is not perceived it does not exist to the person. A person's perceptions may overestimate or underestimate objective reality. In anorexia the distortion leads the subject to overestimate their fatness and develop maladaptive starvation eating habits. In this subject group the tendency was to underestimate one's fatness and overestimate fitness, thus failing to perceive increased cardiovascular risk and in turn failing to take action to change the behavior(s).

Table 6: Correlation between Mean Nutrient Intakes[a] for the 1-week Food Frequency Questionnaire and the 4-day diet record

Nutrient	FFQ Mean	4-day Mean	r	p*
Weight, g	2314±1037	2488±907	0.40	0.0668
Water, g	1813±897	1976±785	0.36	0.1048
kcal	2466±905	2443±798	0.51	0.0148*
Protein, g	100±42	87±29	0.43	0.0437*
Carbohydrate, g	307±119	301±92	0.35	0.1133
Fiber, g	16.9±7.6	12.1±5.7	0.25	0.2610
Total Fat, g	98±40	97±35	0.56	0.0065*
Saturated Fat, g	37±15	34±12	0.60	0.0029*
Monounsaturated Fat, g	36±15	34±13	0.45	0.0342*
Polyunsaturated Fat, g	16±9	14±6	0.35	0.1064
Cholesterol, mg	296±150	311±199	0.58	0.0048*
Carotene, RE	567±692	362±451	0.19	0.3932
Vitamin A, RE	436±315	334±185	0.56	0.0063*
Vitamin A, total RE	1041±844	862±612	0.22	0.3309
Thiamin, mg	1.58±0.62	1.55±0.50	0.55	0.0083*
Riboflavin, mg	2.02±0.82	2.03±0.75	0.63	0.0016*
Niacin, mg	26±13	22±10	0.43	0.0435*
Vitamin B_6, mg	2.06±0.98	1.42±0.50	0.35	0.1145
Vitamin B_{12}, μg	4.56±2.51	3.55±1.73	0.57	0.0061*
Folacin, μg	276±187	230±91	0.60	0.0298*
Pantothenic Acid, mg	4.9±1.9	4.4±2.1	0.36	0.0990
Vitamin C, mg	135±88	91±58	0.48	0.0233*
Vitamin E, mg	13.5±11.2	8.2±3.7	0.16	0.4700
Calcium, mg	929±379	916±457	0.61	0.0028*
Copper, mg	1.21±0.63	1.08±0.36	0.49	0.0207*
Iron, mg	13.6±6.7	14.6±5.5	0.24	0.2889
Magnesium, mg	281±125	253±94	0.48	0.0254*
Phosphorus, mg	1307±546	1312±484	0.50	0.0173*
Potassium, mg	3090±1196	2610±945	0.47	0.0277*
Selenium, μg	102±43	79±38	0.34	0.1270
Sodium, mg	2492±925	3994±1407	0.19	0.3933
Zinc, mg	11.3±4.5	9.8±3.3	0.29	0.1896
Percent Protein	16±3	15±3	0.13	0.5672
Percent Carbohydrate	49±5	49±7	0.07	0.7662
Percent Fat	35±5	35±5	0.12	0.5992

[a]Means expressed as mean±standard deviation
*linear correlation significantly different from zero at $\alpha = 0.05$

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CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Anthropometric and Biochemical Conclusions

The anthropometric values found in this study (Table 1, page 80) were similar to those found in other research for height, WHR, BMI, and body composition in young adult females and males (Folsom et al, 1989; Slattery et al, 1989)

The mean female height (64.2") compares well to the mean height of 65.1" obtained by Folsom et al (1989) from 1,288 females with a mean age of 25.4 years. The mean height of males was 69.2", comparing well to the mean height of 70.1 inches obtained by Folsom et al (1989) from 1,152 males with a mean age of 25.4 years.

The mean weight of females was 129.1 pounds, about 10 pounds lower than the mean weight of 138.8 pounds obtained by Folsom et al (1989) from 1,288 females with a mean age of 25.4 years. The mean weight of males was 175.3 pounds, comparing well to the mean weight of 169.4 pounds obtained by Folsom et al (1989) from 1,152 males with a mean age of 25.4 years.

Mean BMI in this study was typical for the females and higher than average for the males. Females' mean BMI was 22.2 kg/m2, while the mean BMI was 23.1 kg/m2 for both Folsom et al (1989) and Slattery et al (1989). Males mean BMI was 25.7 kg/m2, higher than the mean BMIs of 24.2 and 24.3 kg/m2 obtained by Folsom et al (1989) and Slattery et al (1989) respectively.

Table 1: Anthropometric and Biochemical Variables[a]: Overall Means and Gender Differences

Variable	Overall Means	Female Means	Male Means	p
Age	18.5 ± 0.57	18.6±0.6	18.5±0.5	0.1153
Number of subjects	30	16	14	--
Height, inches	66.5 ± 0.5	64.2±3.0	69.2±1.7	0.0002***
Weight, pounds	149.8±5.4	129.1±15.1	175.3±37.0	0.0017**
Waist-to Hip Ratio	0.78±0.06	0.729±0.03	0.837±0.04	0.0001***
Body Mass Index, kg/m^2	23.7±4.0	22.1±2.4	25.7±4.8	0.0435*
TOBEC[b], % body fat	23.9±6.5	27.4±4.9	19.6±5.6	0.0146*
Bioimpedance, % body fat	19.5±7.9	24.1±4.7	14.3±7.6	0.0146*
7-site Skinfold, % body fat	14.6±	18.1±3.2	11.0±5.3	0.0081**
Blood Cholesterol, mg/dl	163.9±32.0	164.2	160.3	0.8129
Systolic Blood Pressure, mm Hg	113 ± 11	108±10	119±11	0.0913
Diastolic Blood Pressure, mm Hg	72 ± 9	72±8	73±10	0.7472
Grip Strength Rating[c]	2.5 ± 1.5	2.1±1.6	3.0±1.3	0.1359
Flexibility Rating[d]	3.4 ±1.1	3.9±0.9	2.8±1.0	0.0026**

[a] Means expressed as mean±standard deviation
[b] Total-body electrical conductance
[c] Grip strength is based on a 1 to 5 scale where 5 indicates the greatest strength
[d] Flexibility is based on a 1 to 5 scale where 5 indicates the greatest flexibility
*Females and males significantly different at $p \leq 0.05$
** Females and males significantly different at $p \leq 0.01$
***Females and males significantly different at $p \leq 0.001$

The mean female WHR of 0.729 compares favorably to the 0.73 obtained by Folsom et al (1989) from 1,288 females with a mean age of 25.4 years, as well as the WHR of 0.726 obtained by Slattery et al (1989) from 1,286-1,306 females, 18-30 years old. The mean male WHR of 0.837 compares favorably to the 0.84 obtained by Folsom et al (1989) from 1,152 males with a mean age of 25.4 years, as well as the WHR of 0.839 obtained by Slattery et al (1989) from 1,157-1,171 males, 18-30 years old.

The mean percent body fat of 27.4 for females was similar to the 29.0 percent body fat obtained by Folsom et al (1989) from 1,288 females aged 25.4 years old. The mean percent body fat of 19.6 for males was similar to the 18.3 percent body fat obtained by Folsom et al (1989) from 1,152 males aged 25.4 years old.

Blood Cholesterol

No differences were observed between male and female subjects for blood cholesterol (mean = 163.9 mg/dl) (Table 1, page 80). Mean blood cholesterol levels in females were lower than (164.2 vs 180 mg/dl) the 50th percentile for 20-24 year old females (National Center for Health Statistics, 1986). The mean blood cholesterol levels in males were also lower than (160.3 vs 176 mg/dl) the 50th percentile for 20-24 year old males (National Center for Health Statistics, 1986). Although the group mean was low, 27.6% of the subjects had a blood cholesterol level in the high risk category for their age group (Table 2, page 82).

For blood cholesterol, 77% of the variance was explained by two variables that accompanied increased blood cholesterol; body composition (bioimpedance), and systolic blood pressure, and two factors that decreased blood cholesterol; monounsaturated fat, grip strength rating, and body composition (7-site skinfold) (Table 3, page 83). Strength training has been ignored in the past when addressing the exercise requirements for

Table 2: Frequency Distribution of Blood Cholesterol, Frame Size, Grip Strength, and Flexibility Classification

Variable	Category	Frequency	Percent[a]
Blood	Low Risk	18	62.1%
Cholesterol	Moderate Risk	3	10.3%
n=29	High Risk	8	27.6
Frame Size	Small	6	21.4%
n=28	Medium	18	64.3%
	Large	4	14.3%
Grip Strength	Excellent	5	17.2%
n=29	Above Average	4	13.8%
	Average	2	6.9%
	Below Average	8	27.6%
	Poor	10	34.5%
Flexibility	Excellent	5	17.2%
n=29	Very Good	9	31.0%
	Fair	9	31.0%
	Poor	5	17.2%
	Very Poor	1	3.4%

[a] Percent of total subjects, both male and female

Table 3: Stepwise Regression Models[a] for Total Blood Cholesterol

Variable	Coefficient	Prob
Total Blood Cholesterol: 49% of the variance explained		
Intercept	150.23	0.0001
Bioimpedance	3.06	0.0011
Skinfold	-0.06	0.0082
Grip Strength	-9.29	0.0318
Total Blood Cholesterol: 64% of the variance explained		
Intercept	15.97	0.7659
Bioimpedance	3.04	0.0433
Skinfold	-0.06	0.0038
Systolic Blood Pressure	1.20	0.0177
Grip Strength	-10.81	0.0068
Total Blood Cholesterol: 74% of the variance explained		
Intercept	40.58	0.4035
Monounsaturated Fat	-1.00	0.0247
Bioimpedance	2.53	0.0010
Skinfold	-0.07	0.0006
Systolic Blood Pressure	1.44	0.0030
Grip Strength	-13.41	0.0008
Total Blood Cholesterol: 86% of the variance explained		
Intercept	32.84	0.3657
Monounsaturated Fat	-2.30	0.0002
Niacin	1.75	0.0020
Bioimpedance	1.91	0.0017
Skinfold	-0.06	0.0003
Systolic Blood Pressure	1.64	0.0001
Grip Strength	-16.14	0.0001

[a] An indicator variable was used to designate gender: 1 for females and 0 for males.

preventing and treating cardiovascular disease. But these results, along with other research, point out the positive impact of muscular strength on cardiovascular risk factors (Ullrich et al, 1987). Naturally, a more gradual and cautious approach should be taken with subjects undergoing cardiac rehabilitation (Verrill et al, 1992).

Blood Pressure

Using Stepwise regression systolic blood pressure was best estimated by two variables: Body Mass Index (BMI) and magnesium adequacy (Table 4, page 85). Subjects that had higher BMI's and lower magnesium intakes had higher systolic blood pressures. The relationship between BMI and blood pressure is a well established one (Smith et al, 1988; Intersalt Cooperative Research Group, 1988; Hypertension Prevention Trial Research Group, 1990). What is more interesting, however, was that none of the body composition measures (like TOBEC) appeared early in the stepwise regression equations. This may mean that it is shear body mass, regardless of its composition, that determines blood pressure. Speigelmann et al (1992) also found that BMI was as good a predictor of blood pressure as body coposition estimated by underwater weighing. Therefore, it is possible that gaining 5 pounds of muscle will increase blood pressure just as gaining 5 pounds of fat will (provided there are no other changes in body weight). Magnesium deficiency is likely in the subjects with higher systolic blood pressures, as Zemel et al (1990) has shown that only magnesium deficient persons respond to magnesium supplementation with decreases in blood pressure.

Diastolic blood pressure was best estimated by Body Mass Index, saturated fat, polyunsaturated fat, vitamin E adequacy, and calcium intake (Table 4, page 85). Thus, subjects that had higher BMI's, higher saturated fat intake, lower polyunsaturated fat intake, higher vitamin E adequacy, and lower intake of calcium had higher diastolic blood pressures. The fatty acid intake profile suggests negative effects from consuming more

Table 4: Stepwise Regression Models[a] for Blood Pressure

Variable	Coefficient	Prob
Systolic Blood Pressure: 46% of the variance explained		
Intercept	93.67	0.0001
BMI	1.26	0.0121
Magnesium adequacy	-11.78	0.0184
Diastolic Blood Pressure: 75% of the variance explained		
Intercept	48.61	0.0001
Saturated Fat	0.57	0.0027
Polyunsaturated Fat	-1.16	0.0003
Calcium	-0.01	0.0009
Vitamin E Adequacy	7.59	0.0123
Body Mass Index	1.21	0.0004
Female Systolic Blood Pressure: 97% of the variance explained		
Intercept	91.06	0.0001
Monounsaturated Fat	-0.85	0.0002
Pantothenic Acid	-2.84	0.0060
Body Composition, TOBEC	1.95	0.0001
Female Diastolic Blood Pressure: 94% of the variance explained		
Intercept	73.93	0.0001
Polyunsaturated Fat	-1.05	0.0010
Niacin	1.85	0.0005
Selenium	-0.26	0.0003
Male Systolic Blood Pressure: 97% of the variance explained		
Intercept	114.90	0.0001
Niacin	-0.40	0.0056
Vitamin B_6	24.47	0.0001
Magnesium	-0.20	0.0001
Zinc	3.03	0.0001
Male Diastolic Blood Pressure: 98% of the variance explained		
Intercept	3.14	0.6051
Fiber	-0.62	0.0021
Carotene	-0.02	0.0003
Pantothenic acid	3.55	0.0001
Calcium adequacy	-11.06	0.0003
Body Mass Index	2.77	0.0001

[a] An indicator variable was used to designate gender: 1 for females and 0 for males.

saturated fat and less polyunsaturated fat. This pattern also has emerged in many population studies but has not been demonstrated convincingly in clinical studies (Sacks, 1989). In these subjects, increased calcium intake decreased diastolic blood pressure. This finding has been confirmed by Lyle et al, (1987) who demonstrated significantly decreased blood pressure in normotensive white and black men taking daily 1500 mg supplements of calcium.

No differences were observed between male and female subjects for blood pressure (mean = 112/72 mmHg) (Table 1, page 80). However, different prediction equations were obtained for systolic and diastolic blood pressures for females and males (Table 4, page 85).

Systolic blood pressure in females was best explained by monounsaturated fat intake, pantothenic acid intake, and body composition (TOBEC) (Table 4). Thus females that had higher body fats and consumed less monounsaturated fat and less pantothenic acid had higher systolic blood pressures. Systolic blood pressure in males was best estimated by niacin intake, vitamin B_6 intake, magnesium intake, and zinc intake (Table 4). Thus males with lower intakes of niacin and magnesium and higher intakes of vitamin B_6 and zinc had higher systolic blood pressures.

Diastolic blood pressure in females was best estimated by polyunsaturated fat intake, niacin intake, and selenium intake (Table 4). Thus females with lower intakes of polyunsaturated fat and selenium and a higher intake of niacin had higher diastolic blood pressures. Diastolic blood pressure in males was best estimated by fiber intake, carotene intake, pantothenic acid intake, calcium adequacy, and BMI (Table 4). Thus males with lower fiber intake, lower carotene intake, lower calcium adequacy, and higher pantothenic acid intake and higher BMIs had higher diastolic blood pressures.

Correlation analysis revealed significant positive correlations ($p \leq 0.05$) between systolic blood pressure and diastolic blood pressure ($r=0.62$), systolic blood pressure and Body Mass Index ($r=0.46$), systolic blood pressure and Waist-to-Hip Ratio ($r=0.42$), and a negative correlation of systolic blood pressure with the subjective importance of daily fruit and vegetable intake ($r=-0.38$, $p \leq 0.05$). This means that as the importance of daily fruit and vegetable intake decreases, blood pressure increases. This concurs with the literature on increased dietary antioxidants and lower blood pressure (Jacques, 1992; Moran et al, 1993) and lower blood pressure in vegetarians (Sacks, 1989).

Body Composition

A significant difference was observed between methods of body composition analysis (Table 5, page 88). The 7-site skinfold yielded the lowest estimates (mean body fat=14.6%), TOBEC the highest (mean body fat=23.9%), and bioimpedance fell midway between them (mean body fat=19.5%). Other researchers have also found that body composition analysis methods (underwater weighing, bioimpedance and skinfolds) varied considerably depending on the method and/or equations used (Fuller and Elia, 1989; Rammohan and Aplasca, 1992; Schols et al, 1991)

TOBEC, however, was the more accurate method in this study because it was not significantly different from underwater weighing (Table 5, page 88), the 'gold standard' of body composition techniques (Heymsfield and Waki, 1991). In addition, Stepwise regression showed that TOBEC explained 88% of the variance in underwater weighing (Table 6, page 89). Because TOBEC was most like underwater weighing, the TOBEC values were used for all analyses and comparisons using body composition. BMI and all four of the body composition analysis methods showed that the males were leaner ($p \leq 0.05$) than females (Table 1, page 80). This was what was expected (Folsom et al, 1989; Lukaski, 1987).

The possibility that the simpler, less costly methods like skinfold and bioimpedance will underestimate body fat is an important consideration in body composition studies.

Table 5: Comparison* of Body Composition Methods to Determine Percent Body Fat

Method	n	Mean Percent Body Fat*
Underwater Weighing	9	23.52 [a]
TOBEC	11	23.95 [a]
Bioimpedance	10	19.84 [b]
7-site Skinfold	11	14.55 [c]

*Methods followed by the same letter are not significantly different at the 0.05 level

Linear Regression Equations:
(x= percent body fat determined by underwater weighing method)

TOBEC = -0.66 + 0.972 (±0.133) x $r^2 = 0.88$

Bioimpedance = -8.07 + 1.166 (±0.510) x $r^2 = 0.43$

7-site Skinfold = -11.49 + 1.052 (±0.162) x $r^2 = 0.86$

Table 6: Stepwise Regression Models[a] for Body Composition Methods

Variable	Coefficient	Prob
UNDERWATER WEIGHING:		
88% of the variance explained		
Intercept	3.32	0.2788
TOBEC	0.91	0.0002
UNDERWATER WEIGHING:		
94% of the variance explained		
Intercept	6.31	0.0437
TOBEC	0.54	0.0248
Skinfold	0.40	0.0497
UNDERWATER WEIGHING:		
98% of the variance explained		
Intercept	10.33	0.0022
TOBEC	0.41	0.0132
Skinfold	0.50	0.0036
Flexibility	- 0.86	0.0145
TOBEC: 77% of the variance explained		
Intercept	8.60	0.0001
Skinfold	1.01	0.0001

[a] An indicator variable was used to designate gender: 1 for females and 0 for males.

Surprisingly, the 7-site skinfold method very consistently underestimated percent of body fat by a significant degree when compared to TOBEC (mean of 8.6% body fat according to the regression equation, Table 6, page 89). The underestimation of body fat with the skinfold method was more pronounced in the higher fat subjects. This result could be due to measuring slightly off from the specific correct sites, so that the largest fat deposits are not measured or by not grasping the entire fat layer . These results indicate that if technicians learn to do skinfolds on lean, athletic persons (whose skinfold body fat estimate more closely approximates underwater weighing) they may have difficulty measuring higher fat subjects.

Of the females, only 1 of the 16 measured had a Waist-to-Hip Ratio (WHR) greater than 0.80. Of the males, only 1 of the 13 measured had a WHR greater than 0.90. However, the trend is for WHR to increase with age (Shimokata et al, 1989), so the subjects' WHR may increase (indicating an increase in abdominal fat) in the future, which would be accompanied by an increase in cardiovascular risk. Significant positive correlations ($p \leq 0.05$) were found between WHR and BMI ($r=0.75$), and between WHR and systolic blood pressure ($r=0.62$). Trends in correlations were found between WHR and total fat intake ($r=0.34$, $p=0.107$), between WHR and monounsaturated fat intake ($r=0.34$, $p=0.111$), and between WHR and fiber intake ($r=0.35$, $p=0.107$).

Dietary Conclusions

The mean nutrient intakes are listed in Table 7, page 91. When the subjects dietary intake was compared to the U.S. Dietary Goals (Table 8, page 92), it was found to be typical of the American diet-high in fat and low in carbohydrate and fiber (National Cholesterol Education Program, 1990). The subjects mean dietary intake was 35% percent of kcal from fat and 49% of kcal from carbohydrate and a mean fiber intake of only 12 grams per day (Table 2). White and Klimis-Tavantzis (1992) found similar results in their

Table 7: Nutrient Intake[a]: Overall Means and Gender Differences

Item	Overall Means (n=23)	Female Means (n=10)	Male Means (n=13)	P*
kcal	2443±798	1997±381	2786±874	0.0001***
Protein, g	87±29	75±14	97±34	0.0001***
Carbohydrate, g	301±92	246±51	344±96	0.0001***
Fiber, g	12.1±5.7	11±4	13±7	0.7528
Total Fat, g	97±35	81±22	110±38	0.3985
Saturated Fat, g	34±12	29±7	38±14	0.5494
Monounsaturated Fat, g	34±13	26±8	40±13	0.2390
Polyunsaturated Fat, g	14±6	11±5	16±6	0.7092
Cholesterol, mg	311±199	234±90	370±241	0.5438
Carotene, RE	362±451	461±553	287±359	0.1509
Vitamin A, RE	334±185	344±169	326±203	0.3104
Vitamin A, total RE	862±612	1020±741	741±489	0.0548*
Thiamin, mg	1.55±0.50	1.30±0.21	1.74±0.58	0.5395
Riboflavin, mg	2.03±0.75	1.78±0.20	2.22±0.95	0.8106
Niacin, mg	22±10	16.1±3.6	25.8±10.7	0.3444
Vitamin B_6, mg	1.42±0.50	1.28±0.49	1.55±0.52	0.1082
Vitamin B_{12}, µg	3.55±1.73	2.89±0.94	3.95±2.02	0.3224
Folacin, µg	320±91	206±58	242±94	0.7518
Pantothenic Acid, mg	4.4±2.1	3.5±1.0	5.0±2.5	0.6883
Vitamin C, mg	91±58	91±53	91±64	0.6208
Vitamin E, mg	8.2±3.7	8.7±5.0	7.7±2.4	0.1924
Calcium, mg	916±457	865±221	956±585	0.2979
Copper, mg	1.08±0.36	0.98±0.35	1.16±0.37	0.6975
Iron, mg	14.6±5.5	11.6±3.2	16.9±5.9	0.2934
Magnesium, mg	253±94	218±54	280±110	0.9857
Phosphorus, mg	1312±484	1112±238	1466±573	0.7872
Potassium, mg	2610±945	2273±592	2869±1099	0.9995
Selenium, µg	79±38	71.3±27.6	85.3±45.0	0.9941
Sodium, mg	39994±1407	3581±1250	4311±1486	0.5231
Zinc, mg	9.8±3.3	8.21±1.98	11.03±3.72	0.8237
Percent Protein	15±3	15±2	14±4	0.7725
Percent Carbohydrate	49±7	49±6	50±8	0.3523
Percent Fat	35±5	36±6	35±5	0.3311

[a] Means expressed as mean±standard deviation
* Females and males significantly different at p≤0.05
** Females and males significantly different at p≤0.01
*** Females and males significantly different at p≤0.001

Table 8: Nutrient Intake[a] Compared to Recommended Values[b]

Nutrient	Mean[a] (n=23)	Goals
Protein % Calories	14.6 ± 3.2	12%
Carbohydrate % Calories	49.4 ± 6.9	58%
Fat % Calories	35.1 ± 5.1	≤30%
Saturated Fat % Calories	12.5±2.3	≤10%
Monounsaturated Fat % Calories	12.4±2.0	≤10%
Polyunsaturated Fat % Calories	5.2±1.4	≤10%
Cholesterol, mg	311 ±199	≤300 mg
Fiber, g	12 ± 0.7	20-30 g
Sodium, mg	3993 ± 1407	≤2400 mg

[a]Means expressed as mean±standard deviation
[b]Recommended values based on U.S. Dietary Goals

analysis of 3-day diet records completed by 97 adolescents. Both males and females consumed a diet with a mean of 36% of the calories from fat and low fiber intake (females 6±4 g fiber/day, males 11 ± 8 g fiber/day) (White and Kimis-Tavantzis, 1992). Gans et al (1992) determined the mean 3-day dietary intake of adolescent males (n=41, aged 14-19) to be 34.4% kcal as fat, 50.2% kcal as carbohydrate, and 14.8% kcal as protein (Gans et al, 1992). Micronutrient intakes were only reported as a mean percent of RDA for the entire group, so comparisons with the current data is not possible.

The percent of subjects inadequate (mean nutrient intake of less than 67% of the RDA) was 48% for calcium, 57% for vitamin A, 13% for iron, and 26% for vitamin C (Table 9, page 94). These values appear to be similar to the results found by Hertzler and Frary (1992) for calcium and vitamin C, but dissimilar for iron. Hertzler and Frary (1992) found that mean nutrient adequacy was less than 70% of the RDA for calcium (45% of subjects), vitamin A (29% of subjects), iron (28% of subjects), and vitamin C (18% of subjects) when 3-day diet records of non-nutrition major college students (n=280) enrolled in a basic nutrition class were analyzed.

Based on the 4-day diet records, subjects ate breakfast 64% of the time and mean meal frequency (including snacks) was 3.5 times per day, with breakfast being the meal most often skipped. Newel et al (1990) also found that breakfast was the meal most often skipped. No significant differences were observed in eating frequency or breakfast consumption between genders. Eating breakfast resulted in the consumption of significantly ($p \leq 0.05$) more cholesterol than on non-breakfast days (Table 10, page 95). In addition eating breakfast resulted in a significantly higher level of adequacy in vitamin C, vitamin A, and vitamin B_{12}. The typical items consumed for breakfast by the subjects were eggs, bacon, sausage, hashbrowns, doughnuts, biscuits and gravy, and orange juice. These

Table 9: Nutrient Intake Adequacy[a/b]: Overall Means and Gender Differences

Nutrient	Mean	Percent of Subjects Adequate (n=23)	Percent of Females Adequate (n=10)	Percent of Males Adequate (n=13)	p
Protein, g	87.2 ± 29.2	100%	100%	100%	0.999
Vitamin A, total, RE	862 ± 612	43%	50%	38%	0.600
Thiamin, mg	1.55 ± 0.50	96%	100%	92%	0.393
Riboflavin, mg	2.03 ± 0.75	91%	100%	85%	0.212
Niacin, mg	21.6 ± 9.6	91%	90%	92%	0.854
Vitamin B_6, mg	1.42 ± 0.50	74%	70%	76%	0.723
Vitamin B_{12}, µg	3.55 ± 1.73	96%	100%	92%	0.393
Folacin, µg	230 ± 91	91%	90%	92%	0.854
Pantothenic acid, mg	4.36 ± 2.07	35%	10%	54%	0.029*
Vitamin C, mg	91.2 ± 58.4	74%	50%	92%	0.013**
Vitamin E, mg	8.17 ± 3.66	61%	70%	54%	0.454
Calcium, mg	916 ± 457	52%	50%	54%	0.863
Copper, mg	1.08 ± 0.36	48%	30%	62%	0.146
Iron, mg	14.6 ± 5.5	87%	70%	100%	0.035*
Magnesium, mg	253 ± 94	65%	60%	69%	0.663
Phosphorus, mg	1312 ± 484	91%	100%	85%	0.212
Selenium, µg	79.2 ± 38.3	83%	90%	77%	0.435
Zinc, mg	9.8 ± 3.3	48%	40%	54%	0.532

[a] Means expressed as mean±standard deviation
[b]Adequacy based on meeting at least 66% of The Recommended Dietary Allowances (1986) or 2/3 of midpoint of safe and adequate range estimate
*Females and males significantly different at $p \leq 0.05$
** Females and males significantly different at $p \leq 0.01$
***Females and males significantly different at $p \leq 0.001$

Table 10: Nutrient Intake Differences between Days With or Without Breakfast

Nutrient	**No Break-fast**	**Break-fast**
kcal	2413	2355
Protein, g	81.0	87.5
Protein Adequacy	97%	98%
Total Fat, g	95.1	94.7
Saturated Fat, g	29.1	35.8
Monounsaturated Fat, g	33.3	33.3
Polyunsaturated Fat, g	15.9	12.5
Cholesterol, mg	230	343 *
Vitamin A, Adequacy	34%	59% *
Thiamin, Adequacy	81%	89%
Riboflavin, Adequacy	91%	95%
Niacin, Adequacy	88%	75%
Vitamin B_6, Adequacy	63%	61%
Vitamin B_{12}, Adequacy	63%	82% *
Folacin, Adequacy	72%	75%
Pantothenic Acid, Adequacy	38%	34%
Vitamin C, Adequacy	50%	73% *
Vitamin E, Adequacy	56%	57%
Calcium, Adequacy	38%	50%
Copper, Adequacy	38%	54%
Iron, Adequacy	69%	66%
Magnesium, mg	69%	66%
Phosphorus, Adequacy	78%	75%
Selenium, Adequacy	69%	79%
Zinc, Adequacy	56%	52%

* Values significantly different at $p \leq 0.05$

items explain the observations of higher cholesterol intake (eggs, bacon, sausage), vitamin B12 adequacy (sausage), vitamin A adequacy (fortified margarine used to fry eggs or spread on bread items), and higher vitamin C adequacy (due to the habit of consuming orange juice at breakfast and only at breakfast). Newell et al (1990) also found that skipping breakfast was associated with low vitamin C intake.

Subjects appeared to be accurately assessing their typical eating patterns using the 1-week Food Frequency Questionnaire (FFQ) because the mean daily intakes of the 1-week FFQ and the 4-day Food Record were significantly correlated ($p \leq 0.05$) in their measurement of the following nutrients: calories, protein, total fat, saturated fat, monounsaturated fat, cholesterol, thiamin, riboflavin, niacin, vitamin B_{12}, folacin, vitamin C, calcium, copper, magnesium, phosphorus, and potassium (Table 11, page 97). Nutrient values that did not correlate were found to be higher for the FFQ than for the 4-day diet record. Bergman et al (1990) found some similar results in their comparison of food frequency questionnaires (daily, weekly, and monthly) and a 3-day diet record. Although the estimates of saturated fat, cholesterol, sodium, and percent of total kcal from fat, protein, and carbohydrate were not significantly different between the food frequency questionnaires and the 3-day diet record the researchers found the the food frequency questionnaires generally resulted in higher estimates for kcal and nutrient intake than the 3-day diet record (Bergman et al, 1990).

Self-Perception Conclusions

Stepwise regression was used to determine which variables were most important in explaining the subjects' perception (Table 12, page 98 and Table 13, page 99). The inclusion of blood cholesterol and blood pressure in the models is interesting because subjects are unable to directly perceived them. However this can be partially explained by the fact that both variables have a colinear relation with body composition, the visible factor

Table 11: Correlation between Mean Nutrient Intakes[a] for the 1-week Food Frequency Questionnaire and the 4-day diet record

Nutrient	FFQ Mean	4-day Mean	r	p*
Weight, g	2314±1037	2488±907	0.40	0.0668
Water, g	1813±897	1976±785	0.36	0.1048
kcal	2466±905	2443±798	0.51	0.0148*
Protein, g	100±42	87±29	0.43	0.0437*
Carbohydrate, g	307±119	301±92	0.35	0.1133
Fiber, g	16.9±7.6	12.1±5.7	0.25	0.2610
Total Fat, g	98±40	97±35	0.56	0.0065*
Saturated Fat, g	37±15	34±12	0.60	0.0029*
Monounsaturated Fat, g	36±15	34±13	0.45	0.0342*
Polyunsaturated Fat, g	16±9	14±6	0.35	0.1064
Cholesterol, mg	296±150	311±199	0.58	0.0048*
Carotene, RE	567±692	362±451	0.19	0.3932
Vitamin A, RE	436±315	334±185	0.56	0.0063*
Vitamin A, total RE	1041±844	862±612	0.22	0.3309
Thiamin, mg	1.58±0.62	1.55±0.50	0.55	0.0083*
Riboflavin, mg	2.02±0.82	2.03±0.75	0.63	0.0016*
Niacin, mg	26±13	22±10	0.43	0.0435*
Vitamin B_6, mg	2.06±0.98	1.42±0.50	0.35	0.1145
Vitamin B_{12}, µg	4.56±2.51	3.55±1.73	0.57	0.0061*
Folacin, µg	276±187	230±91	0.60	0.0298*
Pantothenic Acid, mg	4.9±1.9	4.4±2.1	0.36	0.0990
Vitamin C, mg	135±88	91±58	0.48	0.0233*
Vitamin E, mg	13.5±11.2	8.2±3.7	0.16	0.4700
Calcium, mg	929±379	916±457	0.61	0.0028*
Copper, mg	1.21±0.63	1.08±0.36	0.49	0.0207*
Iron, mg	13.6±6.7	14.6±5.5	0.24	0.2889
Magnesium, mg	281±125	253±94	0.48	0.0254*
Phosphorus, mg	1307±546	1312±484	0.50	0.0173*
Potassium, mg	3090±1196	2610±945	0.47	0.0277*
Selenium, µg	102±43	79±38	0.34	0.1270
Sodium, mg	2492±925	3994±1407	0.19	0.3933
Zinc, mg	11.3±4.5	9.8±3.3	0.29	0.1896
Percent Protein	16±3	15±3	0.13	0.5672
Percent Carbohydrate	49±5	49±7	0.07	0.7662
Percent Fat	35±5	35±5	0.12	0.5992

[a]Means expressed as mean±standard deviation
*linear correlation significantly different from zero at $\alpha = 0.05$

Table 12: Stepwise Regression Models[a] of the Multidimensional Body Self Relations Questionnaire Subscales

Variable	Coefficients	Prob>F
APPEARANCE EVALUATION: 43% of the variance explained		
Intercept	7.08	0.0001
Body Composition (TOBEC)	-0.06	0.0128
Grip strength	-0.22	0.0368
Blood Cholesterol	-0.01	0.0542
APPEARANCE ORIENTATION: 23% of the variance explained		
Intercept	4.43	0.0001
Body Composition (TOBEC)	-0.05	0.0563
Sex	0.79	0.0138
FITNESS ORIENTATION: 12% of the variance explained		
Intercept	4.72	0.0001
Body Composition (TOBEC)	-0.04	0.0755
HEALTH EVALUATION: 40% of the variance explained		
Intercept	5.09	0.0001
Body Composition (TOBEC)	-0.05	0.0245
Blood cholesterol, gender difference	-0.01	0.0251
Diastolic blood pressure, gender difference	0.03	0.0076
HEALTH ORIENTATION: 43% of the variance explained		
Intercept	5.31	0.0001
Blood cholesterol	-0.01	0.0015
Systolic blood pressure, gender difference	-0.01	0.0453
Flexibility, gender difference	0.50	0.0095

[a] An indicator variable was used to designate gender:
1 for females and 0 for males.

Table 13: Stepwise Regression Models[a] of the Multidimensional Body Self Relations Questionnaire Subscales of Body Areas and Muscle Tone

Variable	Coefficient	Prob>F
LOWER TORSO: 19% of the variance explained		
Intercept	4.45	0.0001
Thigh skinfold	-0.08	0.0224
MID TORSO: 46% of the variance explained		
Intercept	4.53	0.0001
Abdominal skinfold	-0.11	0.0001
UPPER TORSO: 46% of the variance explained		
Intercept	5.89	0.0004
Tricep skinfold	-0.07	0.1874
Exercise Duration	-0.41	0.1208
MUSCLE TONE: 35% of the variance explained		
Intercept	0.17	0.8396
Grip Strength	0.31	0.0219
Exercise Efficacy	0.60	0.0026

[a] An indicator variable was used to designate gender: 1 for females and 0 for males.

in the prediction models. The Waist-to-Hip Ratio (WHR) did not appear in any of the prediction models. This is not surprising because only one male and one female had an excessive WHR (>0.80 for females, >0.90 for males). Among an obese subject group WHR would be more likely to appear as an influence on their self-perceptions.

Appearance Evaluation

Appearance Evaluation was best estimated by three variables: body composition (TOBEC), Grip Strength, and Blood Cholesterol (Table 12, page 98). Thus persons who are leaner and stronger evaluate their appearance more positively. No significant differences were found between the appearance evaluations of females and males.

Appearance Orientation

Appearance Orientation was estimated best by two variables: body composition (TOBEC) and gender (Table 12, page 98), thus females and leaner individuals oriented more toward their appearance. Females had a higher appearance orientation than males (p=0.057). A person with a high appearance orientation would place importance on how they look, pay attention to their appearance, and engage in lots of "grooming behaviors" to look their best (Cash 1986). Females also tended to be more preoccupied with their weight than males (p=0.09). The females' preoccupation with their weight emerges from their high appearance orientation, since thinness in females is considered attractive in our society. Another behavioral pattern accompanying the high appearance orientation is dietary restraint. Females were significantly more restrained in their eating than males (p=0.003), meaning that females are more likely to alternate between being restrictive and being uncontrolled in their food intake in a pattern similar to the bulimic or compulsive eating pattern. For example, if a restrained eater ate one cookie they would feel they had irreparably broken their diet and so would proceed to eat the entire package of cookies.

Females are more likely to exhibit this behavior than males. This behavior can lead to weight cycling, which may increase abdominal fat deposits and increase cardiovascular risk. Both male and female subjects stated that they were not on a weight loss diet, however the males (mean=1.1, "definitely not on a weight loss diet") were significantly (p=0.000) more emphatic in their statement than the females (mean=2.2, "not on a weight loss diet").

Body Area Satisfaction Scores

Body Area Satisfaction Scores were examined for relationships between a subject's anthropometric variables and their satisfaction or dissatisfaction with different areas and aspects of their body (Table 13, page 99). Satisfaction with the lower torso (buttocks, hips, thighs, and legs) was best estimated by thigh skinfold thickness. Persons with leaner legs had greater satisfaction with their lower torso. Overall, females tended (p=0.13) to be more dissatisfied with their lower torso than males. Females were dissatisfied with their natural female shape, with its reproductive and lactational fat deposits in the hips and thighs, and unrealistically desired the lean lower torso typical of males. Satisfaction with the mid torso (waist and stomach) was best predicted by the abdominal skinfold. Persons with leaner stomachs had greater satisfaction with their mid torso. No difference in mid torso satisfaction was found between males and females. Satisfaction with the upper torso (chest area, shoulders, arms) was best predicted by tricep skinfold and typical exercise duration. Thus persons with leaner arms and who typically exercised for shorter duration had greater satisfaction with their upper torso. This means that subjects who disliked their upper torso spent more time exercising, perhaps to improve their appearance. Exercising to improve appearance is a common motivator (Sonstroem and Morgan, 1989; Tucker, 1987). Those who already felt satisfied did not have this motivation and so exercised less.

Satisfaction with muscle tone was best estimated by grip strength and exercise efficacy (the confidence that one can exercise regularly). Thus persons who are stronger and have confidence in their ability to exercise regularly are most satisfied with their muscle tone. Fitness efficacy (confidence that one can exercise regularly) was not significantly different between males and females. A 5 point scale was used; 1=not at all confident, 5=completely confident. Both females and males averaged 3.6 ± 1.1. Efficacy ratings have been found to predict future behavior (Sonstroem and Morgan, 1989). Therefore, one could speculate that strength building exercise increases the confidence that one can exercise regularly. If so, then weight training would be a valuable tool for increasing exercise behaviors.

Fitness Evaluation

Fitness Evaluation was not related to any of the anthropometric or biochemical measures taken. No differences were found between the fitness evaluations of females and males. This contrasts research by Brodie et al (1988) who compared self-perceived fitness categories (excellent or good, fair, and poor) by BMI in indoor sports participants. They found that the group with highest fitness rating (excellent or good) had the lowest mean BMI. The different fitness groups had significantly ($p \leq 0.05$) different BMIs, with the 'poor' fitness category being the fattest (having the highest BMI) (Brodie et al, 1988). There was a discrepancy between objectively measured fitness and the subjects' perception of their fitness. The 1 to 5 point scale used to objectively access their fitness was termed "Fitness Score" and was determined by taking the average of their grip strength rating, flexibility rating, and body composition (TOBEC) classification times two:

Fitness Score = mean (grip strength + flexibility + (TOBEC class x 2))

The subjects' perception of their fitness (mean Fitness Evaluation=4.2; 5 is highest) was significantly higher than their actual fitness (mean Fitness Score=2.4; 5 is highest). This may be due to a commonly believed fitness myth that if you're thin then you are fit, not realizing that you can be thin but still be overfat and unfit. Another possibility is that the subjects focus on only one aspect of fitness, like strength, and ignore aspects of less perceived importance to them.

Fitness Orientation

Fitness Orientation was best predicted by body composition, estimated by TOBEC (Table 12, page 98). Leaner individuals had higher fitness orientations; devoting more time, attention, and effort to fitness. The subjects' fitness orientation (mean Fitness orientation=3.7) was significantly ($p \leq 0.05$) higher than their actual fitness (mean Fitness score=2.4). This means that subjects might have overstated their commitment and involvement in fitness, or it simply means they were only committed toward one aspect of fitness, like endurance, and ignored flexibility (most males) or strength (some women). No gender differences were found between the Fitness Orientations scores of females and males. There also were no differences in mean hours of exercise per week, mean fitness efficacy scores (confidence that you can exercise regularly) or mean strength scores; however, there was a significant gender difference for mean flexibility scores ($p=0.003$), females were much more flexible than males.

Females (n=14) reportedly exercised from 0 to 15 hours a week, mean = 3.2 ± 3.6 hours/week. Males (n=14) reportedly exercised 0 to 9 hours a week, mean=4.4 ± 2.8 hours/week. There was no significant difference in mean reported exercise hours/week between males and females.

Health Evaluation

Health Evaluation was best predicted by body composition, gender difference in blood cholesterol, and gender difference in diastolic blood pressure (Table 12, page 98).

Thus leaner individuals (males and females) and females with lower blood cholesterol and higher diastolic blood pressures evaluated their health more highly. No gender differences were found in health evaluations between females and males.

<u>Health Orientation</u>

Health Orientation was best predicted by blood cholesterol, gender difference in systolic blood pressure and the gender difference in flexibility (Table 12, page 98). Females with greater flexibility and lower systolic blood pressures had higher health orientation scores. Leaner individuals also had higher health orientation scores. No gender differences were found in health orientations between females and males.

Summary

This group of subjects clearly viewed being leaner as more desirable, attractive, and healthy. However, subjects perceived themselves as leaner and more fit than they actually were, due to mistaking being thin for being fit and lean. The subjects also were health oriented, yet their diets followed a typical American eating pattern, consuming a diet high in fat and low in complex carbohydrates.

Researching of the relationship between self-perceptions and behavior outcomes is important for health promotion and education. The discrepancies between a person's perception of the problem and the objective assessment of that problem will affect their action or inaction, their attention to health messages, their motivation to change, their success at change, and may cause inattention to health messages, failure to seek help, failure to make changes, and/or to failure at making permanent changes (American College of Sports Medicine, 1988; Read et al, 1991). If the problem is not perceived it does not exist to the person. A person's perceptions may overestimate or underestimate objective reality. In anorexia the distortion leads the subject to overestimate their fatness and develop maladaptive starvation eating habits. In this subject group the tendency was to underestimate one's fatness and overestimate fitness, thus failing to perceive increased cardiovascular risk and in turn failing to take action to change the behavior(s).

Although women did not have binge behavior, they revealed a tendency toward binge oriented thought patterns. These thought patterns may be latter expressed if weight is gained and a "Yo-Yo dieting" cycle of weight loss and weight gain begins. This weight cycling may lead to increased cardiovascular risk (Lissner et al, 1991).

A lean appearance is valued and so may help contribute to the achievement of lower body fat, lower blood cholesterol, lower blood pressure, and higher fitness. However, the method of achieving leanness, dieting, may ironically lead to a higher cardiovascular risk due to the deleterious effects of weight cycling, increased central obesity, and binge eating, all of which needs to be further explored.

It appears that dissatisfaction with appearance is a primary motivator for changes in activity and diet. However the problem is that the standards with which people judge themselves may be unrealistic and unachievable, thus ultimately disappointing and unmotivating. Promoting a process orientation rather than an outcome orientation will promote the overall wellness of the public. Focusing attention more on health behaviors, rather than only on health outcomes like a leaner body, will help the public avoid the pitfalls of eating disorders, weight cycling, exercise addiction, and psychological harm.

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APPENDIX

INSTITUTIONAL REVIEW BOARD APPLICATION

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Proposal Title: NUTRITIONAL AND PHYSICAL FITNESS: PERCEPTION VERSUS REALITY

Principal Investigator: Dr. Christa Hanson & Sara Thomas

Date: April 15, 1992 IRB # HE-92-039

This application has been reviewed by the IRB and

Processed as: Exempt [ ] Expedite [XX] Full Board Review [ ]

Renewal or Continuation [ ]

Approval Status Recommended by Reviewer(s):

Approved [XX] Deferred for Revision [ ]

Approved with Provision [ ] Disapproved [ ]

Approval status subject to review by full Institutional Review Board at next meeting, 2nd and 4th Thursday of each month.

Comments, Modifications/Conditions for Approval or Reason for Deferral or Disapproval:

Provisions Received

Signature: Marcia L. Tilley Date: April 15, 1992
Chair of Institutional Review Board

**OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH**

Proposal Title: NUTRITIONAL AND PHYSICAL FITNESS: PERCEPTION VERSUS REALITY

Principal Investigator: Dr. Christa F. Hanson & Sara Thomas

Date: April 9, 1992 IRB # HE-92-039

This application has been reviewed by the IRB and

Processed as: Exempt [ ] Expedite [XX] Full Board Review [ ]

Renewal or Continuation [ ]

Approval Status Recommended by Reviewer(s):

Approved [ ] Deferred for Revision [ ]

Approved with Provision [XX] Disapproved [ ]

Approval status subject to review by full Institutional Review Board at next meeting, 2nd and 4th Thursday of each month.

Comments, Modifications/Conditions for Approval or Reason for Deferral or Disapproval:

The reviewer(s) have the folowing comments which must be addressed prior to approval:

There is a concern about asking a student under the age of 21 if they drink alcohol which would be illegal. The need for the questionnaire to be totally confidential is important. Immediately upon coding the research the questionnaire should be destroyed. Need to specify in the application in number 12 and 13 how, exactly you will make sure this information could not be associated with a specific student.

Example: No names used, questionnaire destroyed upon coding, and have at least 30 subjects or greater.

DO NOT PROCEED WITH THIS STUDY BEFORE RECEIVING FINAL APPROVAL

RETURN RESPONSE TO BETH MCTERAN, 005 LSE, X45700

Signature: Marcia L. Tilley Date: April 9, 1992
Chair of Institutional Review Board

IRB # HE-92-039

APPLICATION FOR REVIEW OF HUMAN SUBJECTS RESEARCH
(PURSUANT TO 45 CFR 46)
OKLAHOMA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD

Title of project (please type): Nutrition and Physical Fitness: Perception Versus Reality

Please attach copy of project proposal.

I agree to provide the proper surveillance of this project to ensure that the rights and welfare of the human subjects are properly protected. Additions to or changes in procedures affecting the subjects after the project has been approved will be submitted to the committee for review.

PRINCIPAL INVESTIGATOR(S): (If student, list advisor's name first)

Christa F. Hanson	Christa F. Hanson
Typed Name	Signature
Sara Thomas	Sara J. Thomas
Typed Name	Signature
Typed Name	Signature

Nutritional sciences	Home Economics
Department	College
416 HE	48290
Faculty Member's Campus Address	Campus Phone Number

TYPE OF REVIEW REQUESTED: [ ] EXEMPT [X] EXPEDITED [ ] FULL BOARD
(Refer to OSU IRB Information Packet or the OSU IRB Brochure for an explanation of the types of review.)

1. Briefly describe the background and purpose of the research.

1. High blood cholesterol, excess body fat, and a sedentary lifestyle are risk factors for cardiovascular disease. Because many people are relatively sedentary, even those who are at appropriate weight for height can more body fat than is desirable, and many people have poor eating habits compared to the US Dietary Goals, the US Dietary Recommendations and the Recommended Dietary Allowances.

The purpose of this study is to evaluate the dietary habits, body composition, blood cholesterol and fitness indices of college freshmen.

2. Who will be the subjects in this study? How will they be solicited or contacted? Subjects must be informed about the nature of what is involved as a participant, including particularly a description of anything they might consider to be unpleasant or a risk. Please provide an outline or script of the information which will be provided to subjects prior to their volunteering to participate. Include a copy of the written solicitation and/or an outline of the oral solicitation.

2. Subjects will volunteer for trial, be OSU freshmen students, and have no medical problems that require chronic medication or special diets. Subjects also should have been at their current weight for at least the past 3 months. Sara Thomas, graduate student and Registered Dietitian, will recruit students.

Advertisements posted in campus residence halls and direct visitation at floor meetings will be used to notify potential subjects. Potential subjects will be given a written summary of all the procedures to be used in the proposed study and will have an opportunity to ask questions privately. Each subject will be interviewed to ensure that they meet the criteria stated above.
(Written outline attached).

3. Briefly describe each condition or manipulation to be included within the study.

3. Each student will fill out a dietary recall and a diet, activity and body-image questionaire. Students will be scheduled for a morning, fasting finger-prick blood cholesterol and blood pressure measurement at the Wellness center that uses the same procedures and personnel as the Wellness Center uses for all students. In addition, they will have their body composition measured using Em-Scan (TOBEC, total body electrical conductance), bioimpedance, and 7-site skinfold, height, weight, wrist, waist and hip circumference, flexibility and grip strength. They will be asked about the food they ate the previous day (24-hour recall) and shown how to record their daily food and beverage intake for the next 4 days. All measurements will be taken at the Wellness Center. Except for the blood cholesterol and blood pressure, which will be done by the laboratory personnel, all other tests and measures will be done by Sara Thomas.

4. What measures or observations will be taken in the study? Include a copy of any questionnaires, tests, or other written instruments that will be used.

4. Data to be collected from the subjects are 1) physical measurements (height, weight, wrist, waist and hip circumference, total blood cholesterol, blood pressure, flexibility, grip strength, and body composition) and 2) questionaires (food frequency, dietary recall, 4-day diet record and a diet, activity and body-image questionaire).
(Description of tests and questionaires are attached.)

5. Will the subjects encounter the possibility of stress or psychological, social, physical, or legal risks which are greater, in probability or magnitude, than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests?
Yes [ ] No [XX] If yes, please describe.

6. Will medical clearance be necessary before subjects can participate due to tissue or blood sampling, or administration of substances such as food or drugs, or physical exercise conditioning?
   Yes [ ] No [X] If so, please describe.

   Note: Refer to the OSU IRB Information Packet for information on the handling of blood and tissue samples.

All students will be 18 years of age or older, and in good health. Measurements will be done at the Wellness center using already approved procedures done by experienced and trained personnel.

7. Will the subjects be deceived or misled in any way? Yes [ ] No [X] If yes, please describe and include an outline or script of the debriefing.

8. Will there be a request for information which subjects might consider to be personal or sensitive? Yes [ ] No [X] If yes, please describe.

9. Will the subjects be presented with materials which might be considered to be offensive, threatening, or degrading?
   Yes [ ] No [X] If yes, please describe.

10. Will any inducements be offered to the subjects for their participation? Yes [X] No [ ] If yes, please describe.
If extra course credits are offered, are alternative means of obtaining additional credits available?

Subjects will not receive any monetary inducements. However, all subjects will receive results of their blood cholesterol, blood pressure, flexibility, grip strength, body composition tests and dietary analyses. Values will be explained to all subjects compared to accepted, typical or recommended levels. These values will give subjects important information about their health status.

11. Will a written consent form be used? Yes [X] No [ ] If yes, please include the form, and if not, please indicate why not and how voluntary participation will be secured.

Note: The OSU IRB Information Packet illustrates elements which must be considered in preparing a written consent form. Conditions under which the IRB may waive the requirement for informed consent are to be found in 45 CFR 46.117 (c), (1) and (2).

12. Will any aspect of the data be made a part of any record that can be identified with the subject? Yes [ ] No [X] If yes, please explain.

13. What steps will be taken to ensure the confidentiality of the data?

13. Each subject will be given a numerical code that will be used on all materials and data in order to maintain confidentiality.

14. Will the fact that a subject did or did not participate in a specific experiment or study be made a part of any record available to a supervisor, teacher, or employer? Yes [ ] No [X] If yes, please explain.

15. Describe any benefits that might accrue to either the subject or society. (See 45 CFR 46, section 46.111 (a) (2)).

To subject: All subjects will receive results of their blood cholesterol and body composition tests and their dietary analyses. Values will be explained to all subjects compared to accepted, typical or recommended levels. These values will give subjects important information about their health status.

To society: The purpose of this experiment is to gain information about eating habits, body composition and blood cholesterol in young adults. The new knowledge gained from this trial should help nutritionists develop new interventions to prevent the development and incidence of obesity and disorders related to it such as cardiovascular heart disease.

E.C. Nelson (Guy DiMopel)   3-13-92
Signature of Head or Chairperson   Date

Department or Administrative Unit   Date

Margaret J. Weber   3-17-92
College/Division Research Director   Date

Checklist for Application Submission

- [✓] Proposal
- [✓] Informed Consent Form/Assent (if appropriate)
- [✓] Instrument(s) (questionnaire, survey, testing, field)
- [✓] Curriculum Vita (not necessary for Exempt review)
- [✓] Departmental/College/Division Signatures

Number of copies to be submitted:

Exempt Review:	2 copies
Expedited Review:	3 copies
Full Board Review:	7 copies

APPROVED 10-13-88

THE FOLLOWING TO BE COMPLETED BY IRB REVIEWER

Date: ______________________________ IRB # ______________________________

IRB ACTION:

[ ] Approved

[ ] Approved with Provision

[ ] Deferred for Revision

[ ] Disapproved

Comments:

Signature: ________________________________ Date: ____________________
IRB Reviewer

Permenant Address:
3029 NW Johnson Ave
Corvallis, OR 97330
(503) 754-7120

SARA L. THOMAS, R.D.

Current Address:
26 N University Pl #8
Stillwater, OK 74075
Home: (405) 744-4693
Work: (405) 744-9355

EDUCATION	*Oklahoma State University* 1990-present. AP-4 program. Estimated graduation date August 1993 with Masters of Science degree in Human Nutrition in the College of Human Environmental Sciences. GPA 3.66.
	Oregon State University 1986-1990, B.S. Home Economics: General and Clinical Dietetics with Highest Scholarship. GPA 3.84.
	Robert Gordon's Institute of Technology 1988-1989 in Aberdeen, Scotland as an Oregon State exchange student. GPA 3.74.
	Philomath High School 1982-1986. GPA 3.91. Philomath, OR.
EMPLOYMENT	
1991-present	*Graduate Assistant in Nutrition*, 20 hours/week, paid. Individual nutrition counceling and group nutrition classes and presentations. Topics include Sports Nutrition, Weight Loss, Lowering Cholesterol, Healthy Eating, Eating Out, Eating Disorders, and Nutrient Supplementation. Assist in cooking demonstrations. Create educational and promotional materials using the Macintosh Computer. Oklahoma State University Wellness Center, Stillwater, OK.
Summer 1991	*Graduate Research Assistant*, 20 hours/ week, paid. Assisted professor with research activites; literature review and retrieval, and data compiltion. Carolynn Ukpaka, PhD, NSCI department, Oklahoma State University.
1990-1991	*Dietetic Intern*, 32 hours/week, unpaid. Clinical, Community, and Food Service Dietitian duties and responsibilities. Taught Cardiac Rehab nutrition classes. Oklahoma State University AP-4 program at St John's Medical Center, Tulsa, OK.
SKILLS	Can analyze body composition using underwater weighing, bioimpedance, EM-scan, Futrex, and skinfold calipers. Can analyze diets using Food Processor II and Nutritionist III. Can use Macintosh Aldus pagemaker, Microsoft Word, and Table Editor computer programs.
ASSOCIATIONS/ ACTIVITIES	American Dietetic Association. National Honor Societies: Phi Eta Sigma, Alpha Lambda Delta, and Phi Kappa Phi.
REFERENCES	Available upon request.

OKLAHOMA STATE UNIVERSITY
WELLNESS CENTER
Thesis for Thomas

CONSENT FORM

I,________________________, hereby authorize or direct Sara Thomas and Christa Hanson, PhD, or associates or assistants of her choosing, to perform the following procedures:

Height and weight
Wrist circumference to determine frame size
Waist and hip circumference to determine waist to hip ratio
Total Blood Cholesterol using finger prick method following standard Wellness center protocol
Blood Pressure using standard Wellness center protocol.
Flexibility using Flex-Tester to see how far you can reach toward your toes when in a sitting position
Grip strength using Grip Dynamometer to measure how strong your grip is on both hands by squeezing the dynamometer with maximal exertion for 2-3 seconds for 2 tries on each hand.

Body composition using 3 methods:

7-site skinfold using calipers to measure the thickness of skinfolds at seven sites: the back of your arm, your back, your upper chest, 3 sites on your abdomen and one on your front upper thigh. The measurement takes 3-5 minutes.

TOBEC: measures body composition while you are passed through a field of safe low dose electromagnetic waves while lying down on a movable bench. The measurement takes 30-40 seconds.

Bioimpedance: measures body composition by passing an electrical current through your body from electrodes placed on your bare feet and hands. You won't feel anything and the low dose of electricity is safe. The measurement takes 3-5 minutes.

You will also be asked to answer a **questionnaire** on your thoughts, feelings and behavior about nutrition and fitness related topics. It will take approximately 45 minutes.

You will also be asked to do a **24 hour dietary recall**, answer a **food frequency questionnaire** and keep a **four day dietary record.**

Each subject will be given a numerical code that will be used on all materials and data in order to maintain confidentiality.

The **total time commitment** for this study is 3-4 hours.

This is done as part of an investigation entitled Nutrition and Fitness: Perception vs Reality.

The purpose of the procedure is to evaluate people's perception of their diet and fitness versus their actual nutrient intake and physical fitness levels in the context of risk and risk reduction for cardiovascular disease.

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

I may contact Sara Thomas at telephone number (405) 744-7091 or 377-3189 should I wish further information about the research. I may also contact LeAnn Prater, University Research Services, 001 Life Sciences East, Oklahoma State University, Stillwater, OK 74078; Telephone (405) 744-5700.

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

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

Signed:____
(Signature of Subject)

I certify that I have personally explained all elements of this form to the subject before requesting the subject to sign it.

Signed: ____
Sara Thomas, R.D..

____
Christa Hanson, PhD, Asst. Prof Nutrition Sci

OKLAHOMA STATE UNIVERSITY
WELLNESS CENTER
Thesis for Thomas

CONSENT FORM

I,_________________________, hereby authorize or direct Sara Thomas and Christa Hanson, PhD, or associates or assistants of her choosing, to perform the following procedures:

Height and **weight**
Wrist circumference to determine frame size
Waist and hip circumference to determine waist to hip ratio
Total Blood Cholesterol using finger prick method following standard Wellness Center protocol
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Grip strength using Grip Dynamometer to measure how strong your grip is on both hands by squeezing the dynamometer with maximal exertion for 2-3 seconds for 2 tries on each hand.

Body composition using 4 methods:

7-site skinfold using calipers to measure the thickness of skinfolds at seven sites: the back of your arm, your back, your upper chest, 3 sites on your abdomen and one on your front upper thigh. The measurement takes 3-5 minutes.

TOBEC: measures body composition while you are passed through a field of safe low dose electromagnetic waves while lying down on a movable bench. The measurement takes 30-40 seconds.

Bioimpedance: measures body composition by passing an electrical current through your body from electrodes placed on your bare feet and hands. You won't feel anything and the low dose of electricity is safe. The measurement takes 3-5 minutes.

Underwater Weight: measures body composition from your density in water. The measurement will be done following standard Wellness Center protocol. You will be asked to exhale all your breath while immersed in a tank of warm water for 10-20 seconds. The measurement will be repeated 2-3 times. Locker rooms and showers are available for changing into and out of swim suits. Total estimated time for this measurement is 10-15 minutes, plus however much time it takes you to change clothes.

You will also be asked to answer a **questionnaire** on your thoughts, feelings and behavior about nutrition and fitness related topics. It will take approximately 45 minutes.

You will also be asked to do a **24 hour dietary recall**, answer a **food frequency questionnaire** and keep a **four day dietary record**.

Each subject will be given a numerical code that will be used on all materials and data in order to maintain confidentiality.

The **total time commitment** for this study is 4-5 hours.

This is done as part of an investigation entitled Nutrition and Fitness: Perception vs Reality.

The purpose of the procedure is to evaluate people's perception of their diet and fitness versus their actual nutrient intake and physical fitness levels in the context of risk and risk reduction for cardiovascular disease.

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

I may contact Sara Thomas at telephone number: (W) 744-9355 or (H) 744-4693 should I wish further information about the research. I may also contact LeAnn Prater, University Research Services, 001 Life Sciences East, Oklahoma State University, Stillwater, OK 74078; Telephone (405) 744-5700.

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

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

Signed:____

(Signature of Subject)

I certify that I have personally explained all elements of this form to the subject before requesting the subject to sign it.

Signed: ____

Sara Thomas, R.D..

____

Christa Hanson, PhD, Asst. Prof Nutrition Sci

Oklahoma State University
Wellness Center
Thesis for Thomas

AGE: ________ **CODE:** ____________

SEX: ________ **DATE:** ____________

HEIGHT: ______inches ________cm

WEIGHT: ______pounds ________kg

WRIST CIRCUMFERENCE: ______

Frame Size: S M L

Waist circumference: ________inches

Hip circumference: ________inches

WAIST TO HIP RATIO: _____

Skinfold Measurements

Tricep______

Back________

Iliac_______

Chest_______

Abd.________

Thigh_______

Mid Ax.______

BODY COMPOSITION:

BMI: ________

TOBEC: ________

BIOIMPEDENCE: ________

7-SITE SKINFOLD: ________

BLOOD CHOLESTEROL: _______mg/dl

BLOOD PRESSURE: _______syst

_______diast

GRIP STRENGTH

Right Hand: _____lb _____kg

%tile: _____

Left Hand: _____lb _____kg

%tile: _____

FLEXIBILITY: _______

%tile: _______

SUBJECT CODE #:________

DATE:

24-hour recall

TIME	Food and Amount

SUBJECT CODE #:__________

DATE:

Day 1

TIME	Food and Amount

SUBJECT CODE #:________

DATE:

Day 2

TIME	Food and Amount

SUBJECT CODE #:________

DATE:

Day 3

TIME	Food and Amount

SUBJECT CODE #:________

DATE:

Day 4

TIME	Food and Amount

VITA

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Master of Science

Thesis: FITNESS, DIETARY PATTERNS AND HEALTH PERCEPTIONS OF COLLEGE FRESHMEN

Major Field: Nutritional Sciences

Biographical:

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Education: Graduated from Philomath High School, Philomath, Oregon, in June, 1986; received Bachelor of Science Degree in General and Clinical Dietetics from Oregon State University at Corvallis in June, 1990; completed requirements for the Master of Science degree at Oklahoma State University in July, 1993.

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