AN ABSTRACT OF THE THESIS OF

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Lorraine T. Miller

The purpose of this research was to examine some of the factors which may affect body composition of postmenopausal women. The effect of estrogen, physical activity, diet and lifestyle were examined in 9 women receiving estrogen replacement therapy and 11 women not using this drug. For 3 consecutive days, the subjects collected 24-hour urine samples and recorded their dietary intake. Body fat was estimated by obesity indices based on height and weight and a regression equation based on abdominal skinfold, abdominal circumference and bideltoid diameter (Young, 1964). Lean body mass (LBM) was estimated from urinary excretion of creatinine (Forbes & Bruining, 1976). Physical activity and lifestyle were assessed by a self-administered questionnaire. Age, height, physical activity, diet and

lifestyle were similar for the two groups. Estrogen users were heavier than non-users ($p < 0.05$) and as a group had a higher prevalence of obesity. Percent body fat and LBM also tended to be higher in the estrogen users than in the non-estrogen users. The weight difference between the two groups was already present at age 25 years and persisted through the subsequent 30-year period. All 20 subjects maintained their weight between ages 25 and 35 years, thereafter, increasing in weight significantly ($p < 0.05$) by decade through age 55 years. For all 20 subjects no correlation was found between energy intake and any measure of obesity or body fatness. Obesity was unrelated to energy consumption. Physical activity did not correlate significantly with any estimate of body composition. Energy intake showed an inverse correlation with hours spent watching television ($r = -0.82$, $p < 0.002$). Nutrient intake for most women was adequate; however, calcium intake in women not receiving estrogen replacement therapy may be insufficient.

Factors Influencing Body Composition of Postmenopausal Women

by

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INTRODUCTION

The evaluation and prediction of body composition is important in nutritional assessment. According to a review by Garrow (1982), the first quantitative studies of body composition as indicative of nutritional status were made about 85 years ago. Analyzing the bodies of child cadavers, German physicians found that water made up a larger portion of body weight in malnourished children than in well nourished ones. Between 1945 and 1956, body composition data on adult cadavers were obtained. Although these cadavers varied considerably in fat content, their fat-free tissues had a fairly constant composition of about 73% water, 20% protein and about 69 mmol of potassium per kg. Brozek and Keys (1950), two other pioneers in the field of body composition, stated: "The final, indeed the only basic, criterion of nutritional status in regard to calories must be the body itself."

The percentage of persons over the age of 65 years is rapidly growing in the U.S. Living longer than men, women make up a large portion of the aged population. Thus it is important to understand the physiological changes associated with aging, especially among older

women, since this knowledge may provide a means of improving health and quality of life during the later years.

Information on the body composition of older women is sparse. Body composition, which is not the same for men and women, changes throughout the lifespan. In both sexes, however, lean body mass (LBM), bone density and height decrease, while body fat increases with advancing age.

To prevent bone loss associated with declining estrogen production, estrogen replacement therapy is often prescribed for postmenopausal women. While it is known that estrogen plays a role in preventing bone demineralization (Lindsay et al., 1980; Aloia et al., 1983; Drinkwater et al., 1984; Marshall et al., 1984), it is not known whether estrogen supplementation in postmenopausal women influences body composition in other ways. In two groups of postmenopausal women who were matched for age, height and weight, the ones receiving estrogen replacement therapy for 9 years tended to maintain or lose weight (mean loss of 0.7 kg), while the group receiving the placebo for the same length of time gained an average of 3 kg (Lindsay et al., 1980). These results suggest that estrogen replacement therapy in postmenopausal women may influence body composition.

Studies using rats have found that estrogen decreases body fat and total body weight of oophorectomized rats (Wade & Gray, 1979; Tarttelin & Gorski, 1973; Ramirez, 1981).

Current interest in the effect of exercise on health and prevention of cardiovascular disease (Kramsch et al., 1981) has led to increased research on the effect of physical activity on body composition. Some studies suggest that increasing physical activity can increase LBM while decreasing body fat (Behnke et al., 1942; Brozek, 1952; Wilmore, 1983). Many of these studies have compared athletes to sedentary individuals, however, without considering the influences of nutrition, stature, race and individual variability (Forbes, 1985).

Bowman and Rosenberg (1982) expressed the concern that age-related decreases in energy intake may increase the risk of nutritional deficiencies in older persons. The Ten State Nutrition Survey and the Health and Nutrition Examination Survey (HANES) have shown that persons 50 years of age and older consume far less total food than younger adults (Young, 1982), suggesting that their nutrient intake may be inadequate. Reduced food intake by older persons may not be due to decreased appetite alone, but may also be self-imposed to prevent weight gain. It is well known that in adults, weight

gain (mostly due to an increase in fat) results from an excess of energy intake in relation to expenditure (physical activity, basal metabolism). While the dietary intake of persons over 65 years has been investigated (Kohrs et al., 1980; Bowman & Rosenberg, 1982; Kohrs, 1982), research concerning the nutrient and energy intake of postmenopausal women under 65 years is lacking.

The purpose of the research reported in this thesis was to examine the effect of estrogen replacement therapy, physical activity, energy intake and lifestyle on body composition of postmenopausal women. We also assessed the nutritional adequacy of diets consumed by these women. Twenty postmenopausal women ranging in age from 46 to 64 years participated in this investigation. Nine women were receiving estrogen replacement therapy while the remaining 11 were not. Body composition was estimated by various indices based on height and weight: skinfold, circumference and diameter measurements which were used in estimating percentage of body fat, and urinary creatinine excretion to estimate LBM. Three-day dietary intakes were recorded by each subject to estimate energy and nutrient intakes. Physical activity and some suggestions of lifestyle were determined by questionnaire.

REVIEW OF LITERATURE

Influences of Sex and Age on Body Composition

In humans, body composition changes with aging even when body weight remains the same. With advancing age height declines, bone mass diminishes, body water and lean body mass (LBM) decrease, and adiposity (body fat) increases. These alterations result in decreased body density in the aged individual.

Changes in body composition do not occur uniformly with advancing years. Research by Young et al. (1963) on older women indicated that mean body density and body fat content remained the same in women until about age 40. After 40, body fatness, as measured by underwater weighing and skinfold thicknesses, increased by 23.1% in the fifth decade, 46.0% in the sixth and 55.3% in the seventh.

The influence of age on body composition is different for the two sexes. Young et al. (1963) observed that young women are about two and one-half times fatter than young men. Compared to younger persons of the same sex, however, women in their seventh decade had increased 55.3% in body fat while men had increased 175.0%. With each decade of advancing age, Young et al. also found a decrease in total body water and a decline

of urinary excretion of creatinine, an indicator of LBM (Forbes & Bruining, 1976).

Forbes and Reina (1970) found that the rate of decline in LBM in the later years was greater in males than in females. Estimating LBM by measuring ^{40}K in a whole body counter, Forbes and Reina (1970) in a longitudinal study found that by ages 65-70 years the average male has 12 kg less LBM than at age 25 years and the average female as only 5 kg less. That young adult men have a larger LBM than women to begin with must be considered when looking at these findings.

Height loss is also different between men and women. The average height loss from young adulthood to old age is about 4.9 cm for women and about 2.9 cm for men. Since most men are taller than women, these numbers represent an even greater sex difference in height loss with age (Bowman & Rosenberg, 1982).

Examining body composition in a longitudinal study of Swedish women, Noppa et al. (1980) observed the following:

1. A significant ($p < 0.05$) reduction in mean body height of 0.04 cm per year. The rate of decline is greatest in individuals over 50 years of age.
2. A significant ($p < 0.05$) increase in body weight of 0.23 kg per year. The greatest increases

occur before age 44 while only insignificant increases occur after age 60.

3. An increase in subcutaneous fat.

Comparing the fat distribution in young and middle-aged women, Pollock et al. (1975) found that body fat appears to shift with age from the thigh and gluteal regions to the thoracic trunk. Pollock et al. also observed that middle-aged women were heavier than young women. Since LBM and height were similar between the two groups, Pollock et al. concluded that the added body weight of older women was due to increased fat.

Bowman and Rosenberg (1982), who summarized data from various anthropometric studies, found that weight increased consistently with age for both sexes. In most studies weight reached a maximum at 34-54 years in men and 55-65 years in women and decreased, thereafter, more slowly in women than men.

The Influence of Estrogen on Body Composition

In a normal non-pregnant female of child-bearing age, most of the estrogen is produced by the ovaries. Of the six or more natural estrogens that have been isolated from plasma, beta-estradiol, estrone and estriol are present in the largest quantities. Beta-estradiol and estrone can be converted to estriol, mainly in the

liver. The chief function of estrogens is to cause growth and proliferation of cells related to reproduction (Guyton, 1983).

As women approach menopause, the amount of estrogen produced endogenously falls off (Guyton, 1983). Estrogen deficiency is thought to be a more significant cause of postmenopausal bone loss than aging itself (Richelson et al., 1984). Bone mass declines rapidly for 3 to 5 years after menopause, and estrogen replacement therapy is often prescribed for peri- and postmenopausal women to prevent the increased bone loss associated with declining estrogen production. Estrogen prevents or retards postmenopausal bone loss by reducing bone resorption (Chestnut, 1984).

Examining the relationship between bone mass and estrogen, Drinkwater et al. (1984) designed a study to determine if exercise protected young, hypoestrogenic, amenorrheic, female athletes from bone loss. Compared to eumenorrheic athletes, the mineral density of the lumbar vertebrae and venous estradiol levels were significantly ($p < 0.01$) lower in the amenorrheic athletes. The authors did not suggest that these results negate the positive value of exercise in prevention of bone loss, but rather that they imply an interaction between the effects of estrogen and exercise on specific areas of the skeleton.

Lindsay et al. (1980) examined 100 oophorectomized women, of whom 58 had been taking an estrogen supplement (mestranol) and 42 had been given a placebo for 9 years. The two groups were similar in height, age, weight and bone mineral content at the beginning of the study. After 9 years of supplementation, 38% of the subjects receiving the placebo lost a mean of 0.9 cm in height while the mestranol treated group lost a negligible amount. The estrogen treated group had significant protection against bone loss, as measured by photon absorptiometry at the midpoint of the radius or third metacarpal. The placebo group had lower central vertebral height. Lindsay et al. concluded that estrogen treatment prevents central and peripheral bone loss and reduces the incidence of vertebral compression in oophorectomized women.

Marshall et al. (1984) concluded that estrogen appears to reduce bone loss in peri- as well as postmenopausal women, the effect being greater in the latter than in the former group. Measuring plasma levels of total calcium, ionized calcium and other indices of bone turnover, Marshall et al. found that these indices were significantly ($p < 0.05$) lower in women receiving ethinyl oestradiol than in untreated women.

While it has been shown that estrogen influences bone density, it is not known whether estrogen supplementation in postmenopausal women influences body composition in other ways. Increasing estrogen production associated with puberty in females coincides with fat deposition in the breasts, hips and thighs. After 9 years of supplementation, the oophorectomized women studied by Lindsay et al. (1980) who received estrogen lost a mean of 0.7 kg while those who received the placebo gained a mean of 3.0 kg. Since this difference in body weight between these two groups is most likely fat, it seems logical to ask whether estrogen replacement therapy influences body adiposity as well as bone density.

Estrogen treatment in rats results in decreased food intake, body weight and adiposity (Wade & Gray, 1979; Tarttelin & Gorski, 1973; Ramirez, 1981). Wade and Gray suggested that the mechanism for these alterations is a hormone-induced change upon specific metabolic tissues which redirects the flow of long-chain fatty acids away from adipose tissue storage depots. Wade and Gray suggested that estrogen may decrease adiposity by decreasing the activity of lipoprotein lipase and that progesterone has the opposite effect. Decreased food intake seen in estrogen treated rats may be due to

increased availability of triglyceride as a metabolic fuel. The lower body weights seen in the oophorectomized women receiving estrogen supplements (Lindsay et al., 1980) suggest that some of the changes seen in body composition of rats receiving estrogen may also be present in these women.

Horwitt et al. (1975) examined the relationship between blood lipid levels in women taking oral contraceptive agents (OCA) which include estrogens. Plasma triglycerides were significantly higher in the OCA users than in the controls and were the highest in the women taking the OCA which contained the largest amount of estrogen.

Hartung et al. (1984) assessed the effect of menopause on plasma high density lipoprotein cholesterol (HDL-C). High density lipoprotein (HDL) is associated with a decreased risk of coronary heart disease. Prior to menopause women seem to be protected from coronary heart disease, possibly due to higher HDL-C levels, which may be related to estrogen production. Hartung et al. observed that compared to premenopausal women, postmenopausal women had higher levels of total cholesterol and low density lipoprotein cholesterol. They also observed that body weight and percent body fat were lower in premenopausal than in postmenopausal

groups, and lower in physically active than in sedentary individuals. Women who exercised had higher HDL-C levels than their more sedentary counterparts, regardless of menopausal status. Hartung et al. concluded that exercise may be important in counteracting the negative effects of menopause on plasma lipids.

Except in relation to osteoporosis and bone mass, there has been no research comparing the body composition of postmenopausal women receiving estrogen replacement therapy to those who are not. In view of the weight difference between women receiving and not receiving estrogen replacement therapy (Lindsay et al., 1980) and the effect of estrogen on lipid metabolism (Wade & Gray, 1979; Horwitt et al., 1975; Hartung et al., 1984), the possibility that estrogen supplementation may affect body composition in postmenopausal women is worth examining.

The Influence of Physical Activity and Lifestyle on Body Composition

In recent years there has been much interest in the benefits of exercise and the corresponding risks associated with a sedentary lifestyle. It is currently believed that a regular exercise program improves overall mental and physical health and reduces the risk of developing cardiovascular disease (Kramsch et al., 1981).

Several investigators (Forbes, 1985; Behnke et al, 1942; Welham & Behnke, 1942; Leon et al., 1979; Womersley et al., 1976) compared the body composition of physically active persons to sedentary individuals. These studies demonstrated the inadequacy of height and weight tables as predictors of obesity. A person who is not excessively fat may possess a body with a high specific gravity due to a large muscle mass. As one would expect, athletic individuals possess a greater lean body mass and less body fat than sedentary individuals. Behnke et al. (1942), who pioneered in the field of body composition, showed that some American football players would have been classified as overweight when evaluated by using standard height and weight charts. These individuals were in fact extremely fit with extraordinarily high muscle mass and very little body fat. This study established the fundamental finding of marked differences in body composition between physically active and sedentary individuals.

Brozek (1952) studied male populations involved in work requiring muscular activity of varying intensity. Comparing the body composition of men engaged in sedentary occupations, he found that, even when body weight was equal, men performing physical work had less fat than men engaged in sedentary work.

Wilmore (1983) summarized 55 studies on body composition which examined alterations which occurred as a result of physical training. Training sessions ranged in duration from 6-104 weeks and consisted of activities such as basketball, skiing, hockey and running. Wilmore found an average loss in relative body fat of 1.6% in the studies he reviewed and concluded that exercise appears to result in moderate losses of weight with small-to-moderate increases in LBM and moderate-to-large decreases in body fat.

Forbes (1985), however, recently questioned the validity of assuming that exercise alters body composition. Forbes pointed out that many of the studies that have been done on body composition of athletes have failed to take into consideration such variables as race, age, stature and nutrition. Forbes reflected on possible reasons for athletes having more lean body mass and less adipose tissue than non-athletes:

> Is the difference the result of training per se, or is it the result of better nutrition? Many athletes train long and hard and eat very well. Is it simply that the athlete is better endowed (to begin with) with regard to muscle mass?

Forbes maintained that male athletes may take androgens which promote a positive nitrogen balance. He also reviewed studies which showed that changes in body composition resulted from vigorous exercise combined with

androgen usage. The response to this type of program was dramatic, with significant increases in LBM and loss of body fat. A dose response to androgens was also noted.

Forbes (1985) conducted a longitudinal study on two male and four female athletes. None of the subjects were taking drugs of any kind. Subjects participated in such activities as running, swimming and weight lifting. At the end of the study, the men had gained an average of 2.9 kg total body weight and 3.2 kg LBM, and the women gained an average of 0.5 kg total body weight and 2.2 kg LBM. Forbes concluded that without androgen usage, physical training can only produce modest alterations in body composition. However, he suggested the necessity for further research, commenting that: ". . . the possibility remains that long-term sustained and vigorous exercise could significantly augment the lean body mass."

In addition to affecting lean body mass and fat, exercise influences bone density. From their studies, Krolner et al. (1983) concluded that involutional bone loss which occurs with aging may be the result of decreased physical activity. They suggested that physical exercise prevents spinal osteoporosis in women by inhibiting involutional bone loss from the lumbar vertebrae.

The effect of exercise on body composition of the obese has been a topic of great interest recently. Increased physical activity, along with or without a decreased energy intake, enhances weight loss and favorable changes in body fat and blood lipid levels in obese individuals. Lewis et al. (1976) investigated the effects of exercise on body composition of obese middle-aged women. When these relatively sedentary women increased their physical activity by walking and bicycling without significantly altering their food intake, they significantly reduced their total body weight and body fat.

Leon et al. (1979) examined the effects of a vigorous walking program on the body composition of obese college men. After 16 weeks of participation the subjects significantly reduced their total body weight and body fat. Their lean body weight increased slightly but not significantly. No attempt was made to alter the diets of the participants.

Comparing the responses of pre- and postmenopausal women to exercise, Cowan and Gregory (1985) observed that the older women achieved the same benefits from exercise as the younger women. These benefits included improved submaximal exercise capacity (measured by oxygen consumption) and small decreases in body weight and fat.

Adams and deVries (1973) also found that older women benefitted from increased physical activity. Their study of women aged 52-79 years showed that a 3-month exercise program including calisthenics and jog-walk activities yielded some positive and no negative results. Compared to sedentary controls, in the exercise group, resting heart rate decreased significantly and body weight was reduced.

More studies are needed regarding the effects of exercise on body composition. Particularly important is to learn whether maintaining a certain level of physical activity throughout life can forestall some of the changes that occur in body composition with advancing age such as increasing adiposity, declining LBM and loss of bone density.

Techniques for Estimating Body Composition

A number of techniques are available for assessing body composition. These include ^{40}K counting, hydrostatic weighing, electrical conductivity, neutron activation analysis, urinary creatinine excretion and anthropometry. (For more information on various methods see: Brozek & Keys, 1950; Damon & Goldman, 1964; Katch & Katch, 1980; Lohman, 1981; Lukaski et al., 1981; Lohman, 1984.) Most techniques for assessing body composition

are based on the assumption that the body consists of two chemically distinct compartments: fat and fat-free. From total body weight, fat-free mass can be calculated by subtracting the fat mass and vice versa (Lukaski et al., 1981).

Fat differs from fat-free mass in that it contains relatively little water and has a low potassium content and a density of about 900 kg/m^3. In contrast, fat-free mass has a water content of about 720 g/kg and a density of about 1098-1105 kg/m^3. The concentration of potassium in fat-free tissue is about 62-69 mmol/kg in men and about 55-63 mmol/kg in women. These values are used to estimate body composition (Garrow, 1982).

The simplest and most frequently used techniques for estimating body composition involve anthropometry. The most widely used measurements are height (H) and weight (W). Various indices based on these two measurements are used to estimate obesity. These include W/H, W/H^2 (Quetelet index), W/H^3 (Rohrer index), $W^{1/3}H$ (Ponderal index), and relative weight, which is the observed weight divided by a standard reference weight. Watson et al. (1979), who compared different obesity indices as predictors of body fat, found W/H and W/H^2 to be the best predictors of body fat when compared to body fat as determined by total body water calculations.

Body measurements taken with a tape measure and a skinfold caliper are also easily obtained. Methods for estimating body composition which are based on these measurements, therefore, are attractive for practical reasons. Womersley and Durnin (1977) stated that skinfold and densitometric methods of estimating body fat are probably on the same order of accuracy.

Regression Equations Based on Anthropometry

Except for chemical analysis, there are no absolute techniques for measuring body composition in living persons; all methods involve making certain assumptions. Currently, two methods commonly used as "standards" are ^{40}K counting and underwater weighing. For calculating LBM the ^{40}K technique assumes the relative constancy of the potassium content and volume of extracellular fluid of lean tissue. Underwater weighing assumes the specific gravities of lean and fat tissues and uses equations to convert density to the percentage of body mass which is fat. Neither of these methods directly measures body composition, but development of regression equations from anthropometric data requires that some value be accepted as a standard for validation (Dugdale & Griffiths, 1979).

Jackson et al. (1980) stated that body composition equations tend to be specific for a population, varying with age and sex. Using a step-wise statistical process, Young (1964) formulated regression equations to predict specific gravity in older women. Equations were developed on three different bases using skinfold thicknesses and percentage standard weight (a total of 13 variables); body diameters, body circumferences, percent standard weight, weight and height (15 variables); and using skinfold thicknesses, diameters, circumferences, percent standard weight, weight and height (27 variables). Young concluded that the best equation was based on a combination of skinfolds, circumferences and diameters:

$$\text{specific gravity} = 1.00713 - .0005253X_2 - .0007297X_{15} + .0024155X_{18}$$

where X_2 = abdominal skinfold (mm), X_{15} = abdominal circumference (cm), and X_{18} = deltoid diameter (cm). Specific gravity is converted to percent body weight as fat by the Rathbun-Pace formula:

$$\text{percent fat} = 100 \left(\frac{5.548}{\text{sp. gr.}} - 5.044\right)$$

(as cited by Young, 1964). The correlation between specific gravity determined by underwater weighing and

specific gravity predicted by this equation was 0.8212 with a standard deviation of differences of 0.0082. Since this equation using 3 variables gave results which did not differ significantly from equations using 25 variables, Young concluded that it would be the equation of choice for estimating body composition in women 40 to 70 years of age. Young obtained her data from a population of 62 women whose mean age was 53.0 $\pm$ 8.4 years.

Urinary Excretion of Creatinine

Most of the body's source of creatinine is creatine phosphate in skeletal muscle. The supply of creatine phosphate is low in fatigued muscle and elevated in resting muscle. The reaction mediated by the enzyme creatine phosphokinase to form ATP from creatine phosphate and ADP allows muscle to generate a limited amount of ATP under anaerobic conditions.

Creatine is synthesized mainly in the liver and kidney from the amino acids arginine, glycine and methionine in a two-step reaction sequence: transamidination of glycine and arginine to form guanidoacetic acid and ornithine, followed by methylation of guanidoacetic acid by S-adenosylmethionine to form creatine. Creatine subsequently is transported to the

muscle tissue where it is taken up actively. In muscle, both creatine and creatine phosphate are nonenzymatically dehydrated to form creatinine, creatine phosphate being dehydrated twice as fast as creatine. Creatinine formed in muscle is cleared from the body and excreted in the urine. Daily creatinine formation and excretion occur at a relatively constant rate of about 1.7% of the total creatine pool daily (Heymsfield et al., 1983).

To relate urinary creatinine excretion to muscle mass, Heymsfield et al. (1983) outlined four assumptions:

1. Creatine is located almost totally within skeletal and smooth muscle.
2. The total creatine pool and the average concentration of creatine per kg of muscle remains constant in a person who is on a creatine-free diet.
3. Creatine is converted nonenzymatically and irreversibly to creatinine at a constant daily rate.
4. Once formed, creatinine undergoes renal excretion at a constant rate.

Forbes and Bruining (1976) assessed the validity of relating urinary creatinine excretion to lean body mass in man. Their subjects consisted of 21 adults and 13 children ranging in age from 8 to 71 years. To account for daily fluctuation in creatinine excretion, three

consecutive, complete 24-hour urine collections were obtained from each subject. Lean body mass determined by ^{40}K was used as the standard for comparison. A correlation coefficient of 0.9878 was obtained between ^{40}K and urinary creatinine excretion for all subjects. The standard deviation was 2.57 kg of LBM. Forbes & Bruining found that the relationship between urinary creatinine excretion and LBM was linear over a wide range of creatinine values and that age and sex had no major influence. An equation for relating urinary creatinine excretion to LBM was developed by least squares regression:

$$\text{LBM (kg)} = 7.38 + 0.02908 \text{ creatinine (mg/d)}$$

The variability of daily urinary creatinine excretion makes it necessary for the 3-day consecutive urine collections when utilizing urinary creatinine excretion for estimation of LBM (Greenblatt et al., 1976). The subjects' diets should remain relatively constant. Individuals must be free of renal disease and acute infection and must not have suffered a major injury in the recent past. Subjects must not be severely malnourished or have excessive muscle atrophy.

METHODS

Subjects

Twenty postmenopausal women aged 46-64 years were recruited from the OSU faculty and the community. Postmenopause is defined here as cessation of menstruation for at least one year, or that the subject had an oophorectomy at least one year prior to the study. Nine of the women had been taking estrogen supplements, and the remaining 11 women had not been receiving estrogen replacement therapy for at least 6 months prior to this study. The subjects were in good health and free from liver, kidney or metabolic disease as determined by questionnaire. To participate in the study subjects signed an informed consent which was approved by the Oregon State University Human Subjects Committee. A copy of the informed consent can be found in the Appendix.

Table 1 describes the estrogen replacement therapy of the nine women who were using this drug. Most of the subjects (78%) were receiving 0.625 mg/day of estrogen on the 1st through the 25th days of each month. Fifty-six percent of the estrogen users were also taking 10 mg of progesterone daily from the 15th through the 25th days of each month. Length of estrogen use ranged from 10 months to 132 months with a mean of 66.1 $\pm$ 42.2 months.

Table 1

Length of Use and Daily Dosage of Estrogen and Progesterone*

Subjects	Estrogen mg/day	Progesterone mg/day	Months of Use
1	0.3	0	102
2	0.625	10	15
3	0.625	10	96
4	0.625	10	36
5	0.625	10	79
6	0.625	10	83
7	0.625	0	10
8	0.625	0	132
9	0.20	0	42
$\bar{X}$	0.542 ± .167	5.6 ± 5.3	66.1 ± 42.2

* Estrogen was taken on days 1-25 and progesterone, when used, was taken on days 15-25 each month.

Determination of Activity Levels and Lifestyle

Subjects completed a questionnaire which was designed to obtain a profile of their dietary habits, activity level and lifestyle. The Survey Research Center provided assistance in designing the questions and format of the questionnaire. Information obtained from the questionnaire was subsequently used in statistical analyses to determine if differences in the subjects' diet, physical activity and lifestyle were related to their body composition. A copy of the questionnaire can be found in the Appendix.

Dietary History

Subjects recorded a complete 3-day dietary history. Forms were provided for recording amount of food eaten, as well as preparation and type of food consumed. Daily dietary intakes were analyzed for nutrient content using the Ohio State Nutrient Data Base (Schaum et al., 1973). Nutritional adequacy of the diets was assessed by comparing nutrient intakes with the Recommended Dietary Allowances (RDA) (RDA, 1980) for females 51 years of age and older.

Estimation of Percent Body Fat

To avoid inter-observer error, one researcher recorded and performed all body measurements. The method described by Young (1964) and Young et al. (1961) was used. Height was recorded to the nearest 0.50 cm with the subjects standing feet flat (shoes removed), eyes looking straight ahead and the back in contact with the wall. Weight was recorded to the nearest 0.50 kg. Subjects, wearing light street clothes and no shoes, were weighed in the morning after an overnight fast.

Body diameters were measured with a broad blade anthropometer. Bideltoid diameter was measured at the most lateral protrusions of the acromial processes with the elbows held next to the body. Wrist diameter was measured between the styloid processes of the radius and ulna, and elbow breadth was measured between the condyles of the humerus. Diameters were recorded to the nearest 0.1 cm.

Circumferences were measured to the nearest 0.1 cm using a plastic measuring tape. Sites measured included: waist (2 cm above umbilicus), abdomen (at the level of the umbilicus), upper arm (midpoint of the humerus), thigh (just below the gluteal fold) and buttocks (level of greatest rearward protrusion).

A Lange skinfold caliper (Cambridge Scientific Industries, Cambridge, Md.) exerting a constant pressure of 10 g/mm^2 was used to measure skinfold thickness. Measurements were taken on the right side of the body and recorded to the nearest 0.1 mm. Two measurements were taken at each site. If these two values were not within 1.0 mm, a third measurement was made. Averages of the two (or three) values were used in later calculations. Five skinfold sites were measured; triceps (over the triceps muscle midway between the tip of the acromial process of the scapula and the tip of the elbow), biceps (over the biceps brachii muscle), subscapular (below the tip of the scapula), suprailiac (on the midaxillary line) and abdomen (just to the right of the umbilicus).

The equation proposed by Young (1964) was used to estimate specific gravity and body fatness. This equation was chosen because it was developed for women of the same age range as in the present study. The equation is:

$$\text{sp. gr.} = 1.00713 - .0005253X_2 - .0007297X_{15} + .0024155X_{18}$$

where X_2 = abdominal skinfold (mm), X_{15} = abdominal circumference (cm), and X_{18} = bideltoid diameter (cm). Conversion of specific gravity to percent body weight as fat was made using the Rathbun-Pace equation:

$$\text{percent fat} = 100 \left(\frac{5.548}{\text{sp. gr.}} - 5.044\right)$$

(as cited by Young, 1964).

Obesity Indices

Three indices of obesity were computed on the basis of height (H) in meters, and weight (W) in kilograms. Body Mass Index (BMI), W/H^2, W/H and relative weight (observed weight as a percentage of standard reference weight). Standard reference weights used in calculating relative weight were obtained from the 1983 Metropolitan Life Insurance Co. height and weight tables (as presented by Weigley, 1984) with appropriate adjustments made for shoe heel height.

Urinary Creatinine Excretion

Three complete, consecutive, 24-hour urine collections were obtained from each subject. Creatinine concentration was determined employing the Jaffe reaction in a Technicon Autoanalyzer. The Jaffe reaction is based on development of a colored compound from creatinine and alkaline picric acid. The amount of creatinine was determined by comparing the color development of the

urine samples to that of several concentrations of creatinine standards (Pino et al., 1965; Bonsnes & Taussky, 1945). Lean body mass was estimated from urinary creatinine excretion using the equation of Forbes & Bruining (1976):

$$LBM\ (kg) = 7.38 + 0.02908\ creatinine\ (mg/d)$$

Blood Analysis

On the day that body measurements were made blood was also drawn from fasting subjects by a certified medical technologist. Plasma vitamin B-6, hematocrit and hemoglobin values were determined for each subject. These results will be reported by Harris (1986).

Study Design

Data from the 20 subjects were collected over a 4-week period. Day one consisted of meeting with the subjects to provide general information and instruction for recording dietary intake and collecting urine. Informed consent was obtained at this time. On days two, three and four, the subjects recorded their dietary intakes and collected 24-hour urine samples. Urine was brought every morning to the Department of Foods and

Nutrition Research Lab where it was mixed, measured and frozen that same day. Subjects fasted from 10:00 p.m. of day four until blood was drawn the following morning. On day five, blood samples were drawn and body measurements were taken. Subjects were provided with breakfast after these measurements were completed. Results of blood analyses will be reported by Harris (1986).

Statistical Analyses

Data are expressed as means $\pm$ standard deviation. A regression model was used for most analyses (Dixon & Massey, 1983). To determine the significance of weight change with age an analysis of variance was performed. A significance level of $p < 0.05$ was used. A t-test for comparison of means was used to determine if there were differences between values for the estrogen users compared to the non-estrogen users (Bowen & Starr, 1982).

RESULTS

Description of Subjects

Data including age, height, weight and obesity indices (W/H, W/H^2, relative weight) for the subjects are given in Table 1. The average age of the subjects was 56.2 $\pm$ 4.0 years with a range from 46 to 64 years. The 9 estrogen users did not differ significantly in age or height from the 11 non-estrogen users. As a group, however, the estrogen users were significantly ($P < 0.05$) heavier than the non-estrogen users; the mean weights of the estrogen users and non-users were 77.8 $\pm$ 13.8 kg and 66.3 $\pm$ 8.9 kg, respectively. Mean W/H values also differed significantly (p 0.05) between the two groups with values of 47.1 $\pm$ 9.3 kg/m and 40.0 $\pm$ 5.0 kg/m for the estrogen users and non-users, respectively. Although the means for W/H^2 and relative weights were higher for the estrogen users than for the non-estrogen users, these differences were not statistically different.

Compared to relative weights of 120% or greater as indicative of obesity, five (56%) of the estrogen users and four (36%) of the non-users were obese. Inspection of Table 2 shows that the ranges in weight, W/H, W/H^2 and relative weight were much wider for the group using estrogen than for the group using no estrogen.

Table 2

Descriptive Data of Subjects

Subject	Age	Height	Weight	W/H	W/H^2	Relative Wt.*
Estrogen Users	years	cm	kg	kg/m	kg/m^2	%
1	58	157.5	78.1	49.7	31.5	138
2	53	163.3	107.7	66.1	40.3	181
3	53	165.3	74.5	45.2	27.3	122
4	57	159.5	82.0	51.4	32.3	141
5	55	172.0	57.3	33.3	19.4	88
6	52	171.0	69.1	40.4	23.7	109
7	46	164.0	85.4	52.1	31.7	141
8	63	169.5	73.6	43.4	25.6	116
9	55	173.5	72.7	41.9	24.2	112
$\bar{X} \pm$ SD	54.7 ± 4.7	166.2 ± 5.6	77.8† ± 13.8	47.1† ± 9.3	28.4 ± 6.2	127.6 ± 26.6

* Calculated using 1983 Metropolitan Life Insurance Co. height and weight tables (as cited by Weigley, 1984).

† significant difference between means of estrogen users and of non-users, $P < 0.05$.

Table 2 (continued)

Descriptive Data of Subjects

Subject Non-estrogen Users	Age years	Height cm	Weight kg	W/H kg/m	W/H^2 kg/m^2	Relative Wt* %
10	57	164.3	78.6	47.8	29.1	129
11	58	168.5	60.9	36.1	21.4	98
12	61	157.5	68.6	43.6	27.7	121
13	54	171.0	62.7	36.7	21.5	99
14	55	165.0	65.9	39.9	24.2	108
15	54	173.0	55.4	32.0	18.5	85
16	55	160.5	70.0	43.6	27.2	120
17	57	170.5	69.5	40.8	23.9	109
18	58	177.5	82.7	46.6	26.3	122
19	58	162.5	62.3	38.3	23.6	105
20	64	152.0	53.2	35.0	23.0	98
$\bar{X} \pm$ SD	57.4 ± 3.0	165.7 ± 7.4	66.3† ± 8.9	40.0† ± 5.0	24.2 ± 3.1	108.5 ± 13.3
Total group $\bar{X} \pm$ SD	56.2 ± 4.0	166.1 ± 6.5	71.5 ± 12.5	43.2 ± 7.9	26.2 ± 5.1	117.0 ± 22.0

* Calculated using 1983 Metropolitan Life Insurance Co. height and weight tables (as cited by Weigley, 1984).

† significant difference between means of estrogen users and of non-users, $P < 0.05$.

Table 3 presents the data on skinfold thicknesses measured at five sites. The sum of the five skinfolds, which varied four-fold, among the 20 subjects was higher for the estrogen users (153.2 $\pm$ 50.6 mm) than for the non-estrogen users (125.1 $\pm$ 21.8 mm). This difference was not statistically significant. Of the five skinfold measurements, the ones taken at the biceps and abdomen were inclined to be the thickest among the 20 subjects.

Body circumferences (Table 4) of the women using estrogen tended to be larger than those of the women not using this drug. Compared to the data obtained from the non-users, the coefficients of variability of each of the five body circumferences were higher in the estrogen users. The means of the two groups' body diameters (Table 5) were comparable.

Table 6 shows the means of each subject's 3-day excretion of urinary creatinine. Also included in Table 6 are data on the subjects' LBM (calculated from urinary creatinine [Forbes & Bruining, 1976]), specific gravity (calculated from a regression equation proposed by Young, 1964, based on abdominal circumference, abdominal skinfold and bideltoid diameter), and percent body fat (calculated from the specific gravity based on the aforementioned regression equation). LBM and percent fat, respectively, were slightly higher in the estrogen

Table 3

Skinfold Measurements, in Millimeters,* of Individual Subjects

Subject	Triceps	Biceps	Subscapular	Abdominal	Suprailiac	Sum
Estrogen Users						
1	23.0	22.0	30.6	39.6	44.6	159.8
2	50.0	48.5	37.5	48.0	49.5	233.5
3	40.0	34.5	38.5	42.5	40.5	196.0
4	25.5	23.0	31.0	43.4	36.5	159.3
5	18.5	7.5	11.5	11.0	11.5	60.0
6	25.0	14.0	22.0	35.0	25.0	121.0
7	49.0	29.0	33.5	41.0	35.0	187.5
8	35.0	28.6	19.5	33.0	25.5	141.6
9	30.5	15.5	19.5	32.5	22.0	120.0
$\bar{X} \pm SD$	32.9 ± 11.4	24.7 ± 12.3	27.1 ± 9.3	36.2 ± 10.7	32.3 ± 12.1	153.2 ± 50.6

* Mean skinfold thickness measured twice at each site with a Lange skinfold caliper.

Table 3 (continued)

Skinfold Measurements, in Millimeters,* of Individual Subjects

Subject	Triceps	Biceps	Subscapular	Abdominal	Suprailiac	Sum
Non-estrogen Users						
10	40.0	27.0	33.0	40.0	30.0	134.0
11	24.0	18.0	16.3	28.5	18.0	104.8
12	27.5	30.5	25.5	28.5	30.5	142.5
13	28.5	15.0	22.0	20.5	25.0	111.0
14	25.0	20.0	20.0	27.5	25.0	117.5
15	19.5	11.0	10.0	20.0	15.5	76.0
16	29.0	24.5	23.5	28.0	30.0	135.0
17	36.3	23.0	20.0	28.0	25.0	132.3
18	35.0	19.0	24.5	42.5	33.5	154.5
19	26.6	20.5	22.5	33.5	23.5	126.6
20	29.0	24.5	24.0	39.0	25.0	141.5
$\bar{X} \pm$ SD	29.1 $\pm$ 5.9	21.2 $\pm$ 9.1	21.9 $\pm$ 5.7	30.5 $\pm$ 7.4	25.5 $\pm$ 5.4	125.1 $\pm$ 21.8
Total group						
$\bar{X} \pm$ SD	30.8 $\pm$ 8.8	22.8 $\pm$ 9.1	24.2 $\pm$ 7.8	33.1 $\pm$ 9.3	28.6 $\pm$ 9.4	137.7 $\pm$ 39.2

* Mean skinfold thickness measured twice at each site with a Lange skinfold caliper.

Table 4

Circumference Measurements, in Centimeters,* of Individual Subjects

Subject	Thigh	Arm	Waist	Buttocks	Abdominal
Estrogen Users					
1	70	35	80	111	84
2	74	34	109	134	115
3	64	35	97	106	101
4	93	34	105	103	105
5	51	26	66	88	71
6	60	27	72	104	78
7	74	34	80	121	82
8	65	29	79	107	85
9	61	29	78	101	82
$\bar{X} \pm$ SD	68.0 $\pm$ 11.4	31.4 $\pm$ 3.6	85.1 $\pm$ 14.9	108.3 $\pm$ 13.0	89.2 $\pm$ 14.4

* Values to nearest centimeter

Table 4 (continued)

Circumference Measurements, in Centimeters,* of Individual Subjects

Subject	Thigh	Arm	Waist	Buttocks	Abdominal
Non-estrogen Users					
10	63	32	96	106	102
11	62	26	78	104	82
12	58	31	86	87	91
13	59	28	81	102	85
14	65	30	79	100	84
15	54	23	65	89	69
16	60	28	71	101	75
17	59	30	83	99	87
18	61	30	82	107	87
19	56	28	74	88	79
20	51	28	73	82	78
$\bar{X} \pm SD$	58.9 ± 4.1	28.5 ± 2.5	78.9 ± 8.3	96.8 ± 8.7	83.5 ± 8.7
Total group $\bar{X} \pm SD$	63.0 ± 9.5	29.9 ± 3.3	81.7 ± 11.8	102.0 ± 12.0	86.1 ± 11.7

* Values to nearest centimeter.

Table 5

Diameter Measurements, in Centimeters, of Individual Subjects

Subject	Deltoid	Wrist	Elbow
Estrogen Users			
1	39.4	5.5	5.5
2	46.5	5.5	6.0
3	41.0	5.2	5.5
4	40.0	5.0	6.0
5	39.9	5.5	6.4
6	40.0	5.2	6.5
7	40.8	5.0	6.2
8	40.5	4.5	6.0
9	40.5	6.0	6.4
$\bar{X} \pm$ SD	40.9 $\pm$ 2.1	5.3 $\pm$ 0.4	6.1 $\pm$ 0.4

Table 5 (continued)

Diameter Measurements, in Centimeters, of Individual Subjects

Subject	Deltoid	Wrist	Elbow
Non-estrogen Users			
10	41.0	5.2	5.2
11	38.0	5.0	5.0
12	41.0	5.5	6.0
13	40.5	5.0	6.0
14	39.8	5.0	6.0
15	37.0	5.0	5.5
16	40.0	6.0	5.0
17	41.0	5.0	6.0
18	41.0	5.0	6.0
19	40.0	5.2	6.0
20	39.0	5.0	4.5
$\bar{X} \pm$ SD	39.8 $\pm$ 1.3	5.2 $\pm$ 0.3	5.6 $\pm$ 0.7
Total group $\bar{X} \pm$ SD	40.3 $\pm$ 1.8	5.2 $\pm$ 0.4	5.8 $\pm$ 0.6

Table 6

Creatinine Excretion and Estimates of LBM, Specific Gravity and Percent Body Fat of Subjects

Subject	Creatinine* g/day	LBM† kg	Sp Gr‡	% Fat§
Estrogen users				
1	0.93 ± 0.06	34.4	1.020	39.4
2	1.16 ± 0.02	41.2	1.010	44.7
3	0.58 ± 0.02	24.3	1.010	44.8
4	0.98 ± 0.14	35.8	1.004	48.2
5	1.00 ± 0.22	36.5	1.046	26.0
6	1.36 ± 0.13	47.0	1.028	35.1
7	1.09 ± 0.06	39.1	1.024	37.4
8	0.83 ± 0.06	31.4	1.026	36.5
9	1.01 ± 0.10	36.7	1.028	35.2
$\bar{X}$ ± SD	0.99 ± 0.22	36.3 ± 6.3	1.022 ± 0.013	38.6 ± 6.7

* Values represent $\bar{X}$ ± SD of three, 24-hour, consecutive urinary creatinine excretions.

† LBM (kg) = 7.38 + 0.02908 creatinine (mg/d) (Forbes & Bruining, 1976)

‡ Sp gr calculated from abdominal circumference, abdominal skinfold and bideltoid diameter using regression equation proposed by Young (1964).

§ Percent fat was calculated from sp gr using the Rathbun-Pace equation (as cited by Young, 1964).

Table 6 (continued)

Creatinine Excretion and Estimates of LBM, Specific Gravity and Percent Body Fat of Subjects

Subject	Creatinine* g/day	LBM† kg	Sp Gr‡	% Fat§
Non-estrogen users				
10	0.97 ± 0.03	35.5	1.011	44.5
11	0.61 ± 0.01	25.2	1.024	37.3
12	0.93 ± 0.02	34.4	1.025	36.9
13	0.62 ± 0.04	25.5	1.032	33.1
14	1.01 ± 0.13	36.7	1.028	35.5
15	0.66 ± 0.06	26.7	1.036	31.3
16	0.86 ± 0.03	32.4	1.034	32.0
17	0.81 ± 0.05	30.8	1.028	35.3
18	0.99 ± 0.04	36.1	1.020	39.3
19	1.02 ± 0.13	37.0	1.029	35.0
20	0.87 ± 0.03	32.7	1.024	37.4
$\bar{X}$ ± SD	0.85 ± 0.15	32.1 ± 4.5	1.026 ± 0.007	36.1 ± 3.7
Total group $\bar{X}$ ± SD	0.91 ± 0.19	34.0 ± 5.6	1.024 ± 0.010	37.2 ± 5.2

* Values represent $\bar{X}$ ± SD of three, 24-hour, consecutive urinary creatinine excretions.

† LBM (kg) = 7.38 + 0.02908 creatinine (mg/d) (Forbes & Bruining, 1976)

‡ Sp gr calculated from abdominal circumference, abdominal skinfold and bideltoid diameter using regression equation proposed by Young (1964).

§ Percent fat was calculated from sp gr using the Rathbun-Pace equation (as cited by Young, 1964).

group (36.3 $\pm$ 6.3 kg and 38.6 $\pm$ 6.7%) than in the non-estrogen group (32.1 $\pm$ 4.5 kg and 36.1 $\pm$ 3.7%). This was not unexpected, as the estrogen users as a group weighed significantly more ($p < 0.05$) than the non-estrogen users. Furthermore, body weight was significantly correlated ($p < 0.05$; $r = 0.48$) with creatinine excretion. Having more muscle mass than lighter persons, heavier persons will excrete more creatinine in urine. None of the other variables tested (age, estrogen usage, percent body weight as fat, activity level, amount of aerobic exercise, sum of skinfolds or the three obesity indices) showed any significant correlation with excretion of urinary creatinine.

The sum of the skinfolds measured correlated significantly with percent body weight as fat ($p < 0.001$, $r = 0.76$) which was not surprising as skinfold thickness provides an indication of body fatness. None of the other variables tested including estrogen usage and activity level showed any significant correlation with percent body weight as fat. Relative weight, but neither of the other two obesity indices, showed a significant correlation with sum of skinfolds ($p < 0.05$, $r = 0.88$). This suggests that relative weight is the best predictor of body fatness of the three indices used in this study.

Relative weight and height correlated significantly with the obesity index W/H^2 ($p < 0.0001$, $r = 0.99$). W/H and weight correlated significantly with relative weight ($p < 0.0001$, $r = 0.99$). Watson et al. (1979) stated that the best indices are those which show a low correlation with height and a high correlation with weight and other measurements of body fatness. From this is would appear that relative weight is a better index of body fat and obesity than W/H^2.

In the self-administered questionnaire, the subjects were asked to recall their previous body weights. The results, presented in Figure 1, indicate that both groups of women maintained their weight fairly well between the ages of 25 and 35 years. Thereafter, a significant ($p < 0.05$) increase in weight occurs with each decade up to age 55 years. There was a tendency for women who were overweight at an early age to remain overweight and increase weight with advancing age. Women who reported weights close to recommended weights for their height appeared to gain less weight through the years.

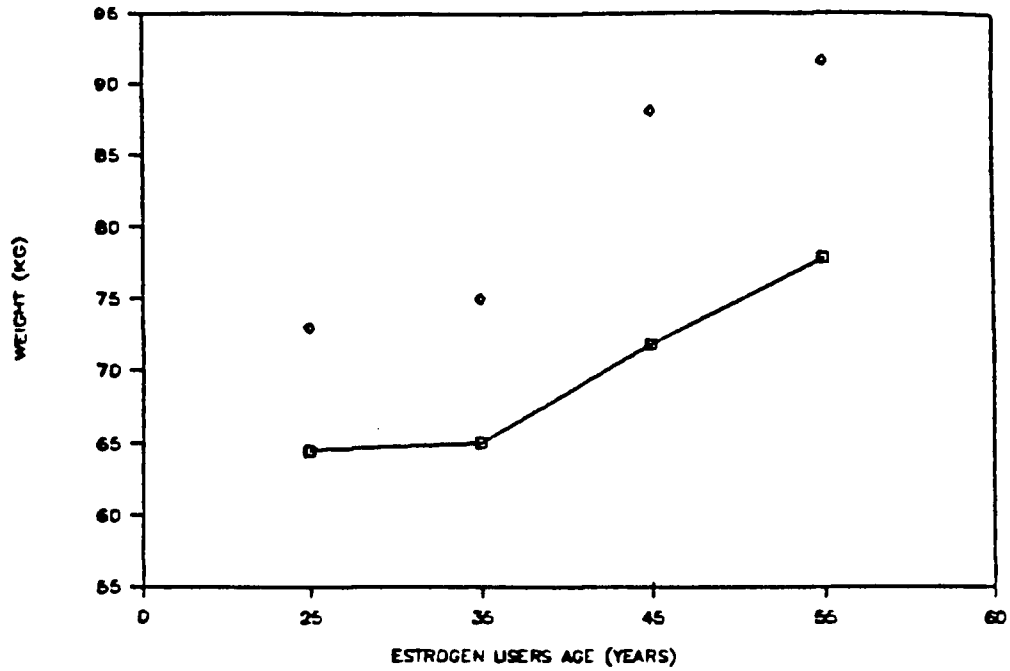
From age 25 to 55 years the estrogen users as a group weighed more than the non-estrogen users. After having maintained their weight between the ages of 25 to 35 years, the estrogen users as a group gained weight at a faster rate than the non-users from age 35 to 55

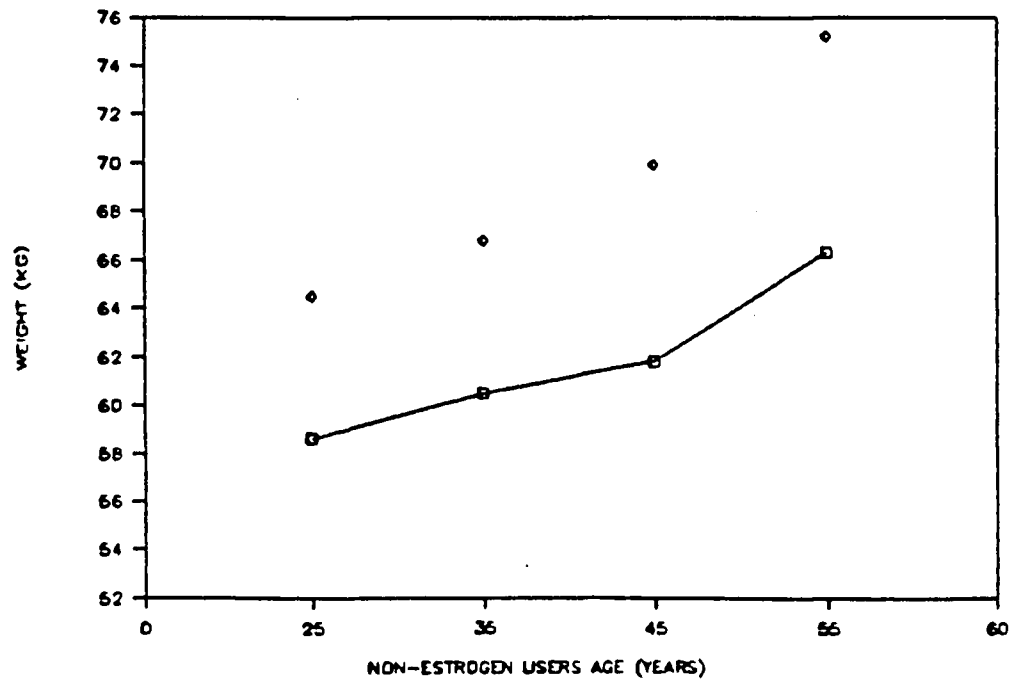
Figure 1

Body Weights at Different Ages of Estrogen Users and Non-estrogen Users

Fig. 1 shows mean body weights (kg) at different ages of estrogen and non-estrogen users. Each point on a line represents the group's mean weight at that age. Points above the line represent the mean + one standard deviation. After age 35, for both groups weight increased significantly ($p < 0.05$) with each decade through age 55 years (or present age if younger than 55).

Figure 1


95
90
85
80
75
70
65
60
55
WEIGHT (KG)
0
25
35
45
55
60
ESTROGEN USERS AGE (YEARS)


76
74
72
70
68
66
64
62
60
58
56
54
52
WEIGHT (KG)
0
25
35
45
55
60
NON-ESTROGEN USERS AGE (YEARS)

years. Note that for each time period the coefficient of variability of the estrogen users' weight is greater than that of the non-users.

Nutrient Intake and Dietary Habits

Table 7 presents the subjects' nutrient intakes calculated from their 3-day dietary histories. The average daily intakes of the 20 subjects exceeded 67% of the RDA for the calculated nutrients. Four subjects had a mean daily consumption of vitamin A of less than 67% of the RDA (2624 IU, 1190 IU, 2023 IU, 2016 IU), and one subject had a mean daily calcium intake (467 mg) that was less than 67% of the RDA.

Table 7 does not include the contributions of nutritional supplements taken by nine of the subjects. Of the nine women using nutritional supplements, seven were using calcium, four were using multivitamin preparations and three were taking vitamin C. Some of the nine women used more than one supplement. The subject who had a vitamin A intake of 2624 IU was consuming a multivitamin supplement containing this nutrient. The other eight subjects who used nutritional supplements had mean daily nutrient intakes which exceeded 67% of the RDA of the selected nutrients.

Table 7

Average Daily Intake of Selected Nutrients by Postmenopausal Women*

Nutrient	Mean ± S.D.	Range	Persons < (.67) RDA†	RDA†
Energy (kcal)	1695 ± 319.6	1091-2296	-	1400-2200
Fat (gm)	64.6 ± 17.9	31-105	-	-
Protein (gm)	69.1 ± 14.5	43.4-103.5	0	44
Carbohydrate (gm)	208 ± 48.0	135-313	-	-
Calcium (mg)	952 ± 375.2	467-1942	1	800
Phosphorus (mg)	1125 ± 299.3	687-1950	0	800
Iron (mg)	11.2 ± 2.7	6.8-16.5	0	10
Vit. A (IU)	7306 ± 4329.4	1190-15,325	4	4000
Thiamine (mg)	1.1 ± 0.34	0.72-1.84	0	1.0
Riboflavin (mg)	1.7 ± 0.54	1.1-2.9	0	1.2
Niacin (mg)	20.4 ± 4.0	14.3-31.8	0	13
Vit. C (mg)	137.2 ± 56.0	46.0-239.0	0	60

* Calculated from the mean 3-day dietary intakes from each of the 20 postmenopausal female participants in this study. Supplements are not included in these values

† RDA (RDA 1980) for females 51 years of age and older

Seventy percent (14) of the women reported that they frequently consumed between meal snacks. Ninety-five percent (19) of the subjects regularly ate three meals per day, never skipping meals. Only one subject reported eating two meals per day. Seventy-five percent (15) of the subjects consumed most of their daily calories between 5:00 and 7:00 p.m., 10% (2) between 2:00 p.m. and 5:00 p.m., 10% (2) before 11:00 a.m., and 5% (1) after 7:00 p.m. Eleven subjects (55%) occasionally watched television while eating meals, 5 (25%) never and 4 (20%) almost always watched television while eating meals. These factors had no effect on body weight or obesity indices according to the results of regression analysis.

Mean intake of alcohol was 3.6 $\pm$ 3.4 servings (1 serving = 1 oz. hard liquor, 5 oz. wine or 12 oz. beer) per week with three subjects never consuming alcohol and three consuming 10 or more servings per week. Caffeine consumption averaged 4.0 $\pm$ 2.4 servings (1 serving = 8 oz. caffeine-containing beverage) per day, consisting mostly of coffee. All but one subject reported regular consumption of caffeinated beverages.

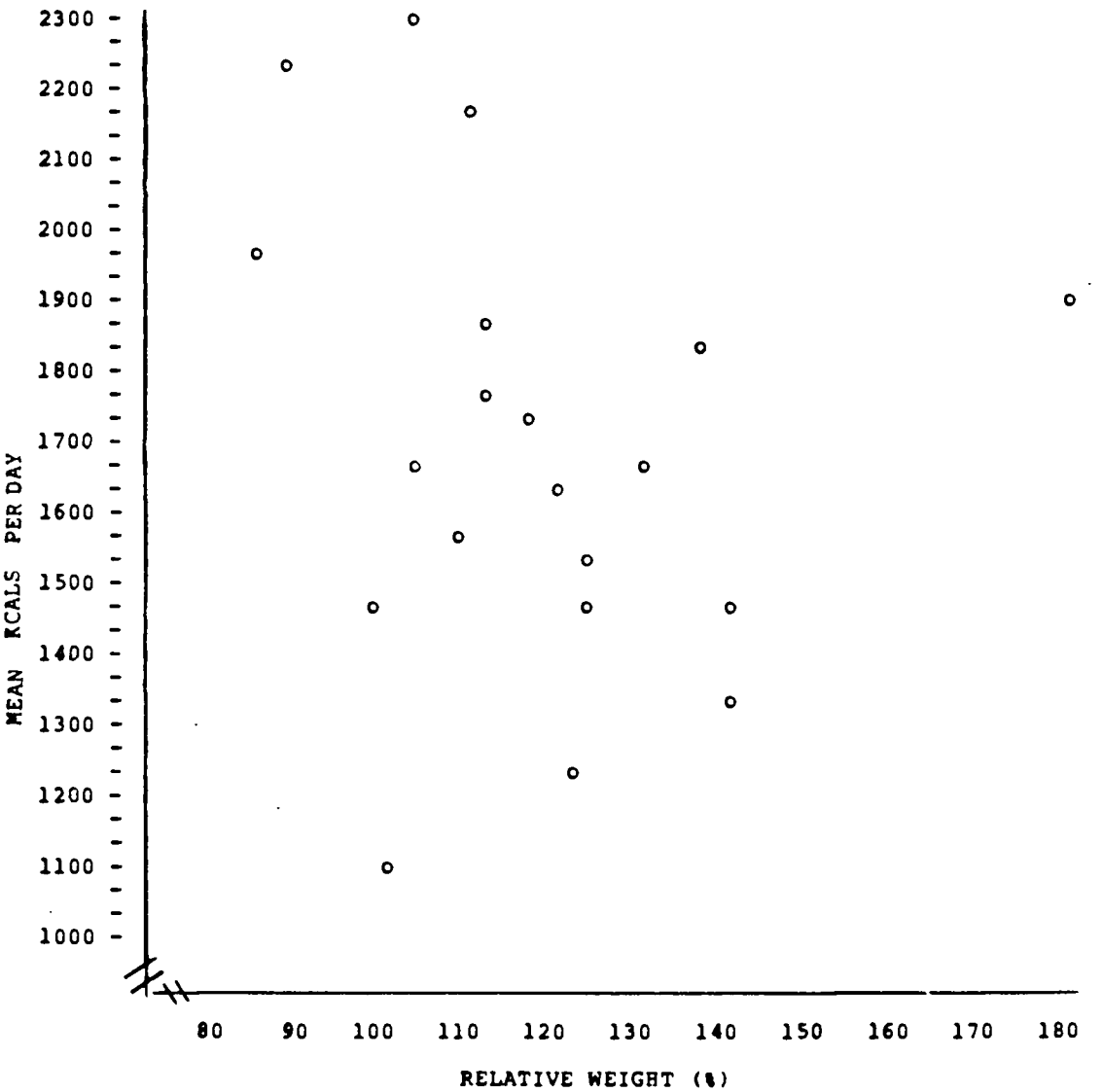
Figure 2 shows the relationship between the subjects' relative weight and average daily energy consumption. Subject 15, for example, who had the lowest relative weight (85%) of the 20 subjects and an energy

Figure 2

Relationship Between Energy Consumption
and Relative Weight

Fig. 2 compares the mean daily energy intake to relative weight for each subject. Energy consumption did not significantly correlate with relative weight or any other estimate of obesity. Energy intake was not significantly different for estrogen users compared to non-users.

Figure 2


2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
MEAN KCALS PER DAY
80
90
100
110
120
130
140
150
160
170
180
RELATIVE WEIGHT (%)

intake of 1978 kcals, was consuming more energy than subject 2, who had the highest relative weight (181%) and an energy intake of 1903 kcal. Apparently obesity cannot be explained simply on the basis of caloric intake. The three subjects with the highest daily energy intakes, 2227, 2172 and 2296 kcals, had relative weights of 88%, 109% and 99%, respectively.

Regression analysis failed to reveal any significant relationship between the obesity indices (W/H, W/H^2, relative weight) and kcal consumption. Weight, height, sum of skinfolds and percent body weight as fat also failed to correlate significantly with energy intake. The possibility exists that some subjects may have modified their eating habits on the days they recorded their dietary intakes.

Physical Activity/Lifestyle

Subjects described their physical activity level and lifestyle by responding to a questionnaire. Seventy percent (14) of the subjects described themselves as moderately active, while 20% (4) said they were sedentary and 10% (2) said they were very active. Participation in aerobic activity ranged from 0-1 days per week for 20% (4) of the subjects to more than 6 days per week for 40% (8) of the subjects. Thirty-five percent (7) reported

4-5 days participation per week, and 5% (1) reported participation 2-3 days per week.

Three women smoked cigarettes; several others had smoked previously. Subjects worked outside the home an average of 31.6 $\pm$ 20.3 hours per week with a range from 0-60 hours per week. Eleven women worked full-time (40 hours or more/week), and six worked 20 hours/week or less. Three women were homemakers. Forty-five percent (9) of the women watched more than six hours of television per week while 55% (11) watched six hours or less per week.

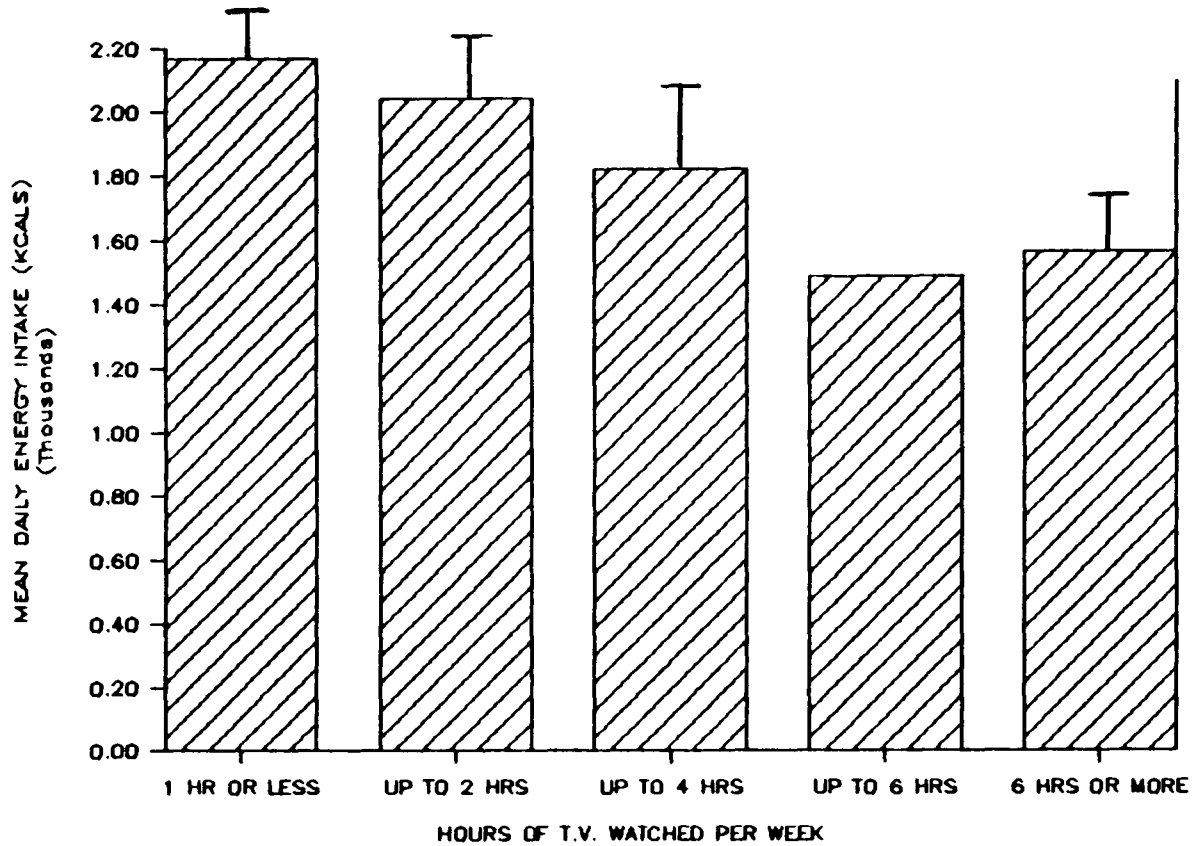
The hours of weekly television viewing was the only variable to correlate significantly with the number of calories consumed daily ($p < 0.002$, $r = -.82$). This inverse relationship is shown in Figure 3. Actual time spent watching television may have been estimated with greater accuracy by the inclusion of more time periods, particularly for the nine women who placed themselves in the 6+ hours/week category.

Figure 3

Relationship Between Energy Consumption
and Time Spent Watching Television

Fig. 3 shows the inverse relationship between mean daily energy intake and hours of weekly television viewing ($r = -0.82$, $p < 0.002$). Each rectangle represents the mean kcal intake for the respondents in that category of television viewing. Standard deviation bars representing mean + one standard deviation are shown above the rectangle. Number of subjects in each category, from least to greatest amount of time viewing television, are 3, 2, 5, 1 and 9, respectively.

Figure 3


MEAN DAILY ENERGY INTAKE (KCALS)
(Thousands)
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1 HR OR LESS
UP TO 2 HRS
UP TO 4 HRS
UP TO 6 HRS
6 HRS OR MORE
HOURS OF T.V. WATCHED PER WEEK

DISCUSSION

The Influence of Estrogen on Body Composition

The results of a study by Lindsay et al. (1980), which showed that after nine years of supplementation, postmenopausal women receiving estrogen replacement therapy weighed significantly less than those women receiving placebos during this time, were cited to support the hypothesis that estrogen replacement therapy may affect body composition. Additional support for this hypothesis were the findings of Wade & Gray (1979) who showed that estrogen reduced body weight and body adiposity in oophorectomized rats.

Contrary to the results of the study by Lindsay et al. (1980) the estrogen users in this study, compared to the non-users, were heavier ($p < 0.05$) (Table 2). Obesity indices (W/H; $p < 0.05$), skinfold thicknesses and body circumferences also tended to be higher for the estrogen users compared to the non-users, indicating that this additional weight may be due to body fat (Tables 2, 3 and 4). LBM as measured by urinary creatinine excretion was slightly higher in the estrogen users than the non-users (Table 6). These differences between the two groups were not always statistically significant due to the large inter-individual variation and the small number of subjects in each group.

A BMI (W/H^2) value greater than 27.0 is considered indicative of obesity (Zeman, 1983). In this study 5 of the 9 estrogen users (56%) and 3 of the 11 non-estrogen users (27%) would be considered obese by this standard. Using a relative weight value of 120% or more as the standard for obesity the numbers remain the same for the estrogen users and increase by one (4 of 11) to 36% obesity in the non-estrogen group. The average BMI value for the entire group was 26.2 $\pm$ 5.1 indicating a propensity toward obesity for the group. The mean BMI value for the estrogen users was 28.4 $\pm$ 6.2 and for non-users, 24.2 $\pm$ 3.1 Relative weight was also higher in estrogen users than non-users with mean values of 127.6 $\pm$ 26.6% and 108.5 $\pm$ 13.3%, respectively. This indicates that as a group the estrogen users were considered to be above ideal weight while the non-users as a group were within ideal weight ranges for their heights. Individually there was greater range in weights in the estrogen group (57.3 kg - 107.7 kg) than in the non-estrogen group (53.2 kg - 82.7 kg).

The estrogen users and non-users in this study were matched for age and height (Table 2). No significant differences in energy intake, physical activity or lifestyle existed between estrogen users and non-users. In the present study, the nine estrogen users had a mean

weight of 77.8 ± 13.8 kg whereas the non-estrogen users weighed an average of 66.3 ± 8.9 kg (p 0.05). However, this weight difference between the two groups appears to be unrelated to estrogen use since even at age 25 years the nine women presently using estrogen were heavier (64.5 ± 8.5 kg) than the 11 women who are not using estrogen (58.6 ± 5.9 kg). The occurrence of weight gain with advancing age was found to be significant for all 20 subjects ($p < 0.05$) (Figure 1). The results showed that the women maintained their weight fairly well between the ages of 25 and 35 years but, thereafter, a significant ($p < 0.05$) increase in weight occurred with each decade through age 55. The estrogen users as a group had been heavier throughout the years and tended to gain more weight with advancing years than the non-estrogen users. However, there was also greater variation among the nine women who presently use estrogen; standard deviations for body composition measurements were consistently higher in this group than in the 11 women who are not estrogen users. A larger subject population might have eliminated some of the effect of individual variability. In this study, weight gain with advancing age may be a more significant factor influencing weight than any effect that might have been due to estrogen.

In the present study the dosage and length of estrogen usage were not controlled. Although eight out of the nine estrogen users (Table 1) were taking a daily dose of 0.625 mg estrogen, length of use ranged from 10 months to 11 years. Of the nine estrogen users in this study, six were also taking progesterone (Table 1). The effects of progesterone on body composition in rats are opposite to those seen as a result of estrogen usage (Wade & Gray, 1979). Five of the women in this study who had gained weight after beginning estrogen replacement therapy gave reasons for this weight change. Two women gained weight after quitting smoking. Three other women in this group cited health problems, including leg injuries and surgery, which had required them to reduce their physical activity. Obviously there were factors here which would have masked any alteration in body weight due to estrogen replacement therapy alone. Further studies should be conducted using larger subject populations.

The study by Lindsay et al. (1980) was conducted in a population of 100 women who were evenly matched in height and weight. The study was longitudinal in nature, followed for 9 years, and included a control group (placebo) as well as a treatment group (estrogen). A study of similar design could be used to assess the

influence of estrogen on body composition in women. However, some problems do exist. Research indicates that estrogen supplementation without progesterone may increase the risk of developing endometrial cancer (HHS Publication No. (FDA) 81-3114, 1981). The ethics involved in a human study on the effects of estrogen in postmenopausal women are complex. This issue complicates developing an effective study design for examining the influence of estrogen on body composition in humans.

One woman in this study reported some interesting information concerning her weight changes with varying doses of estrogen. Following an oophorectomy at age 35 years, she received 1.25 mg of estrogen daily for 4 years. After 4 years her estrogen dosage was cut in half, and at this point she began gaining weight. Her weight had remained constant during the time she was taking 1.25 mg of estrogen daily. This information appears to support the effect of estrogen on weight reported by Lindsay et al. (1980).

Description of Subjects

The subjects in the present study are compared to middle-aged female subjects from two previous studies summarized in Table 8. The subjects in the present study are about 10 years older than the subjects in the studies

Table 8

Body Composition of Middle-aged Women: Data from Three Studies

	Pollock et al. 1975	Young et al. 1963	Present Study
N	60	88	20
Age (years)	44.7 ± 5.7	47.7 ± 10.8	56.2 ± 4.0
Height (cm)	165.9 ± 5.1	162.9 ± 6.5	166.1 ± 6.5
Weight (kg)	61.2 ± 8.4	62.0 ± 8.6	71.5 ± 12.5
% Fat	29.8 ± 6.7*	36.4 ± 8.9*	37.2 ± 5.2†
LBM (kg)	42.6 ± 3.7*	41.2 ± 2.4‡	34.3 ± 5.4‡
Creatinine (g/day)		1.16 ± 0.08	0.91 ± 0.19
Skinfolds (mm)			
triceps	22.2 ± 6.5	27.6 ± 7.8	30.8 ± 8.8
subscapular	17.3 ± 7.4	17.3 ± 7.8	24.2 ± 7.8
abdominal	29.6 ± 11.6	28.5 ± 11.2	33.1 ± 9.3
suprailiac	17.3 ± 9.1	20.6 ± 10.7	28.6 ± 9.4
Circumferences (cm)			
abdominal	71.8 ± 6.1	87.7 ± 10.5	86.1 ± 11.7
waist	82.7 ± 9.2	--	81.7 ± 11.8
buttocks	97.5 ± 7.0	99.1 ± 6.7	102.0 ± 12.0
thigh	57.6 ± 4.7	57.4 ± 4.4	63.0 ± 9.5
arm	28.6 ± 2.6	28.9 ± 3.0	29.9 ± 3.3
Diameters (cm)			
wrist	5.2 ± 0.3	4.9 ± 0.6	5.2 ± 0.4
bideltoid	41.8 ± 2.0	39.0 ± 2.2	40.3 ± 1.8

* estimated by underwater weighing

† estimated from regression equation based on abdominal circumference, abdominal skinfold and bideltoid diameter (Young, 1964)

‡ calculated from creatinine data

of Young et al. (1963) and Pollock et al. (1975) (Table 8). The trend of increasing adiposity and declining LBM with age is evident when comparing the results of these studies. The subjects in the present study (mean age of 56.2 $\pm$ 4.0 years) have more adipose tissue than the subjects in the study by Young et al. (mean age of 47.7 $\pm$ 10.8 years) or Pollock et al. (mean age of 44.7 $\pm$ 5.7 years). This is evident from the larger skinfold and circumference measurements, and decreased creatinine excretion and LBM found in the present study. The average percentage of body fat in the present group was close (37.2 $\pm$ 5.5%) to that of the subjects of Young et al. (36.4 $\pm$ 8.9%) and higher than that of the subjects of Pollock et al. (29.8 $\pm$ 6.7%). These results are difficult to compare, however, as different techniques were used to assess percent body fat and LBM in these studies. Young and Pollock and their associates estimated body composition by underwater weighing. In the present study we estimated body composition using a combination of three body measurements in a regression equation to estimate body fat and creatinine excretion to estimate LBM. Young et al. also measured creatinine excretion, so LBM calculated from their subjects' creatinine excretion was used for comparison to the present study.

Creatinine excretion was lower (0.91 ± 0.19 g/day) in the present study compared to that (1.16 ± 0.08 g/day) in the study by Young et al. Normal range of daily creatinine excretion is 0.8-1.8 g/day (Zeman, 1983). There are few reports of urinary creatinine excretion, particularly for populations of older women. Normal creatinine excretion values of 0.91 g/day (60 year old female subject) and 1.19 g/day (49 year old female subject) were reported by Forbes and Bruining (1976). Forbes and Bruining also reported data from other studies on creatinine including a range of 0.520-1.520 g/day in a group of 104 females and a range of 0.160-1.520 g/day in a study of 29 males and 26 females (including children).

LBM estimated by creatinine excretion averaged 34.3 ± 5.6 kg in the present study, 41.2 ± 2.4 kg in the study by Young et al. and 42.6 ± 3.7 kg when estimated from underwater weighing in the study by Pollock et al. This trend of decreased LBM in the older subjects is expected. Frisancho (1984) reported that from age 35-39 years onward there is a decline of about 6-8% per decade in LBM as estimated by potassium dilution and creatinine excretion. Forbes and Reina (1970) reported LBM values (estimated by ^{40}K) of women at 45 years to be 39 kg; 55 years, 39 kg; and 65-70 years, 35 kg.

Four of the subjects in the present study had urinary creatinine excretion values which fell below the normal range of 0.8-1.8 g/day (Zeman, 1983): 0.581, 0.611, 0.644 and 0.624. One of these subjects was a vegetarian, and the other three had protein intakes (43.4 g/day, 59.3 g/day, 61.5 g/day, respectively) that were lower than the average daily protein intake for the group (69.1 $\pm$ 14.5 g/day). This may, in part, reflect the influence of diet on urinary creatinine excretion. Heymsfield et al. (1983) reported that average daily dietary intake of creatine and creatinine replaces from one-third to one-half the daily urine loss of creatinine. According to Heymsfield et al., the average daily American diet includes about 700 mg creatine and 37 mg creatinine. Heymsfield et al. also found that creatinine excretion decreases with advancing age, partly due to decreased consumption of meat. The women in this study tended to use meat as a condiment in mixed dishes rather than as a main dish. Depending upon the amount of meat in the mixed dishes they consumed, this could partly explain the reduced urinary creatinine excretion in this group. Another explanation for the lower urinary creatinine values obtained in the present study may have been that urine samples were inadequately mixed prior to creatinine assay. Mixing the thawed samples on the

vortex mixer may have been insufficient (J. Riddlington, personal communication).

Relationship Between Energy Intake and Obesity

Comparing the energy intake with the subjects' relative weights provided some interesting results. Among subjects with a relative weight of less than 120% the average kcal intake per day was 1804 ± 342 (Figure 2). The nine women whose relative weight exceeded 119% had an average daily kcal intake of 1561 ± 202. Subject 15 had the lowest relative weight of 85%, yet with an energy consumption of 1978 kcal she was consuming more energy than subject 2, who had the highest relative weight of 181% and an energy intake of 1903 kcal. The 3 subjects with the highest energy intakes, 2227, 2272 and 2296 kcals, had relative weights of 88%, 109% and 99%, respectively. These results correspond with findings of a 1983 study (Anonymous, 1983), which showed that an obese person can maintain an abnormally expanded fat compartment with approximately the same energy intake as a thin person. Five previous studies which were summarized by Anonymous (1983) have shown that obese women maintained their weight with energy intake from 700-4550 kcals per day and normal weight women with intake from 900-3600 kcals per day.

Range of food intake by obese and non-obese persons measured in these five clinics was not significantly different. It was concluded that variations in individual ease of fatty acid storage and mobilization from fat cells and variations in energy conservation are present in persons. Obviously obesity cannot be explained simply on the basis of energy intake. This may explain why in the present study regression analysis failed to reveal any significant relationship between energy intake and any of the obesity indices (W/H, W/H^2 or relative weight) as well as weight, height, sum of skinfolds and percent body weight as fat. The possibility does exist that subjects may modify their eating habits somewhat when recording daily food intake; however, previous research shows that obese persons can maintain body composition with energy intakes that are comparable to or lower than energy intakes of thin persons (Anonymous, 1983).

Nutrient Intake of Postmenopausal Women

Compared to the standard of two-thirds of the RDA (RDA, 1980) the nutrient intake of most of the women in the present study was adequate. An inadequate amount (i.e., less than two-thirds of the RDA) of calcium was consumed by one woman, and of vitamin A by four women. Nine women were using nutritional supplements--calcium or

multivitamin and mineral preparations. According to a Consensus Conference on Osteoporosis (1984), however, postmenopausal women who are not receiving estrogen supplements need 1500 mg of calcium per day to maintain calcium balance. Only two of the non-estrogen users in this study were consuming 1500 mg of calcium in their diets. Thus, the remaining nine women not receiving estrogen replacement therapy may be in negative calcium balance and face increased risk of osteoporosis. Further assessment of the calcium intake of postmenopausal women, including balance studies, should be conducted.

The overall dietary intake in this population of postmenopausal women appeared to be adequate. However, these results cannot be interpreted as representative of the intake of most postmenopausal women in this country since these subjects may not be a representative sample. Since three women had advanced degrees in nutrition and all were from an upper socioeconomic class, their diets may reflect better nutrition than is present in the general population of women this age.

The Influence of Physical Activity and Lifestyle on Body Composition

The method of assessing physical activity in this study was by a self administered questionnaire. Subjects

rated themselves as sedentary, moderately active or very active and listed the duration and frequency of their weekly participation in aerobic activities such as walking, jogging, bicycling and aerobic dance. For subsequent statistical analyses a number was assigned to represent the subjects' level of aerobic activity maintained on a weekly basis. This mode of analysis resulted in no significant correlations between activity level and the various measures of body composition investigated.

This does not necessarily mean that physical activity does not affect body composition in postmenopausal women, but rather that the study design for measuring this variable may have been inadequate. A better method for measuring the body composition changes resulting from physical activity would involve a larger number of subjects in a longitudinal study with both treatment and control groups that were matched for age and physical characteristics. Sedentary women would be assigned to either a treatment group which would participate in measured amounts of vigorous physical activity or a control group which would remain sedentary. Following a period of prescribed exercise in the treatment group, both groups would be measured to determine if exercise resulted in body composition changes.

Correlations were sought between the various measurements of body composition and lifestyle variables including hours worked outside the home, television viewing, number of persons in household, and total energy intake and time of day most energy was consumed. The only significant finding was a negative correlation ($r = -0.82$, $p < 0.002$) between hours of weekly television viewing and daily energy consumption (Figure 3). As T.V. watching increased, energy consumption decreased. This may actually reflect an influence of physical activity on energy intake. The more time spent in sedentary activities such as watching T.V., the less time is available for more physically demanding activities. The women watching the least amount of T.V. were consuming the greatest amount of energy, perhaps the result of incresed energy demands due to a more physically active lifestyle.

The Influence of Aging on Body Composition

The findings of a significant increase in weight by decade after age 35 years in this study agree with many previous studies (Forbes & Reina, 1970; Young et al, 1963; Yearick, 1978) which show increasing weight with aging. The influence of aging on body composition should be considered in any body composition studies. Further

research could determine if alterations in lifestyle, diet and physical activity could modify the effects of age on body composition.

SUMMARY AND CONCLUSIONS

This research was undertaken to examine some of the factors which influence the body composition of postmenopausal women. Specifically examined were the effect of estrogen replacement therapy, level of physical activity, and some dietary and lifestyle factors. Additionally, the nutrient intake of postmenopausal women was evaluated for adequacy of intake of specific nutrients and general eating patterns.

Twenty postmenopausal women between the ages of 46 and 64 years participated in this research project. Nine women were receiving estrogen replacement therapy for periods ranging from 10 months to 11 years, and 11 women had not been taking any estrogen. The 20 subjects were in good health and free from any metabolic disease.

For 3 consecutive days, the subjects collected 24-hour urine samples and recorded their complete dietary intake. Subjects were measured for height, weight, skinfold thickness at five sites (triceps, biceps, abdominal, subscapular and suprailiac), body diameters at three sites (elbow, wrist and bideltoid), and body circumferences at five sites (abdominal, upper arm, waist, thigh and buttocks). Body fat was estimated by obesity indices based on height and weight (W/H, W/H^2 and relative weight), and a regression equation based on

abdominal skinfold thickness, bideltoid diameter and abdominal circumference (Young, 1964). LBM was estimated from urinary creatinine excretion (Forbes & Bruining, 1976). Dietary intake was assessed based on the data from the 3-day dietary intakes recorded by each subject. Physical activity and lifestyle were estimated from a self-administered questionnaire.

The estrogen users were heavier than the non-users ($p < 0.05$) and as a group had a higher prevalence of obesity than the non-estrogen users. Skinfold thicknesses, body circumferences and LBM also tended to be higher among estrogen users compared to the non-estrogen users. Height, age, physical activity and lifestyle did not differ significantly between the two groups. As a group the estrogen users were heavier from age 25 through age 55 years when compared to the weights of the non-estrogen users during this 30-year period. All 20 subjects maintained weight between ages 25 and 35 years; thereafter, a significant increase ($p < 0.05$) in weight occurred by decade through age 55.

For all 20 subjects no correlation was found between energy intake and any measure of obesity or body fatness. Obesity was unrelated to energy consumption. Energy intake showed an inverse correlation with hours spent watching television ($r = -0.82$, $p < 0.002$).

Nutrient intake for most women was adequate; however, women not receiving estrogen replacement therapy may not be consuming enough calcium.

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APPENDIX

Department of Foods & Nutrition

Oregon State University

INFORMED CONSENT

Vitamin B-6 Status and Body Composition of Postmenopausal Estrogen Users

The purpose of this research is (a) to determine the effect of estrogen replacement therapy on vitamin B-6 status in postmenopausal women and (b) to determine some of the factors affecting body composition of postmenopausal women. Vitamin B-6 status will be measured by dietary intake of vitamin B-6, plasma vitamin B-6 and urinary excretion of vitamin B-6; body composition will be determined by skinfold and circumference measurements, underwater weighing and urinary excretion of creatinine.

If I agree to participate in this investigation, I will keep an accurate record of foods and beverages I consume for three consecutive days. On these same three days, I agree to collect complete 24-hr urine specimens in the containers provided for me by the investigators. For recording my diet and collecting urine, I will follow the detailed instructions that are provided for me. On the fourth day, I consent to have a registered medical technologist obtain 20 ml (equivalent to 4 teaspoons) of blood from a vein in my forearm between 7 and 9 o'clock in the morning. I will not have eaten or drunk anything except water from 10 o'clock the evening before to the time my blood is drawn the following morning. At the time blood is drawn, I will complete a questionnaire including questions about my age, use of estrogen, use of prescription and non-prescription drugs, nutrient supplements and alcohol, dietary habits and amount of exercise. After breakfast I consent to having skinfold and circumference measurements made at several sites on my body. I also consent to having my height and weight measured ~~and having my lean body weight determined by underwater weighing~~. I understand that to participate in this investigation, I should not have taken a vitamin supplement for at least 2 weeks.

I understand that there may be some slight discomfort when the medical technologist draws blood from my arm. There may be a slight bruise at the site of needle entry. There are no risks involved in collecting urine, recording my diet, ~~underwater weighing~~ and having anthropometric measurements made.

I know that I will receive no direct benefits from volunteering to participate in this research.

I have been assured that any information obtained from me in connection with this study will remain confidential.

I understand that I am free to withdraw from this study at any time.

All of my questions regarding this investigation have been answered.

If I have any additional questions later, I will contact Dr. Lorraine Miller, Janet Harris or Susan Worley at 754-3561. I have been given a copy of this form for my records.

Subject	Date
Witness	Date

NUTRITIONAL SURVEY OF POSTMENOPAUSAL WOMEN

Please answer the following questions as completely and as honestly as possible. If you need more space than that which is provided, please continue your answer on page five or on the back of the page. If you do not wish to answer a question, draw a line through it. If you do not understand a question, please ask for assistance. The accuracy of this study depends upon you. All information is confidential. Thankyou for your cooperation!

NAME _____ DATE _____

1. Have you been taking estrogens regularly for the last six months? (Circle one number)
   1 NO
   2 YES → 1a. How many months have you been taking estrogens continuously?
   _____MONTHS

   1b. What is the complete brand name of the estrogens you are taking? (Include a label if possible. Be sure to remove your name from label.)
   _____BRAND NAME

   1c. Have you switched estrogen brands any time during the last six months? (Circle one number)
   1 NO
   2 YES → 1d. Please list the other estrogen brands you have taken during the past six months and give number of months taken for each.

BRAND NAME	MONTHS TAKEN

   1e. Please indicate whether or not you are taking estrogens for each of the following reasons. (Circle one number for each reason)

REASON	YES, A REASON	NO, NOT A REASON
a. hot flashes.....	1	2
b. to prevent/retard osteoporosis.	1	2
c. other (please specify_____ _____)	1	2

   1f. Since you started using estrogens, has your weight stayed the same, increased, or decreased? (Circle one number)
   1 STAYED THE SAME
   2 INCREASED
   3 DECREASED → 1g. By about how many pounds has your weight increased or decreased?
   _____POUNDS

2. Have you been taking progestogens regularly for the last six months? (Circle one number)
   1 NO
   2 YES → 2a. How many months have you been taking progestogens continuously?
   _____MONTHS

   2b. What is the complete brand name of the progestogens you are taking? (Include a label if possible. Be sure to remove your name from label.)
   _____BRAND NAME

3. Are you presently on a special diet? (Circle one number)
   1 NO
   2 YES → 3a. Briefly describe this diet:_____
   _____

4. Do you smoke cigarettes? (Circle one number)
   1 NO
   2 YES
   → 4a. How many cigarettes do you smoke per day?
   _____CIGARETTES PER DAY

5. Do you ever drink alcoholic beverages? (Circle one number)
   1 NO
   2 YES
   → 5a. About how many servings (equivalent to 1 ounce of liquor, 4 ounces of wine, or 10 ounces of beer) do you consume per week?
   _____SERVINGS PER WEEK

6. Do you drink coffee, tea, or soft drinks containing caffeine? (Circle one number)
   1 NO
   2 YES
   → 6a. How many cups per day?
   _____CUPS PER DAY

7. Do you have a history of medical problems? (Circle one number)
   1 NO
   2 YES
   → 7a. Briefly describe your medical problems:_____
   _____

8. Are you presently using any prescription drugs other than estrogens?
   1 NO
   2 YES
   → 8a. In the table below, please list the presription drugs you are taking, the dosage, the number of pills you take per day, and the number of months you have been taking them.

PRESCRIPTION NAME	DOSAGE	NUMBER OF PILLS PER DAY	NUMBER OF MONTHS TAKEN

9. Have you been using any supplements such as vitamins or minerals regularly for the last six months? (Circle one number)
   1 NO
   2 YES
   → 9a. In the table below, please list the supplements you are taking, the dosage, the number of pills you take per day, and the number of months you have been taking them.

SUPPLEMENT NAME	DOSAGE	NUMBER OF PILLS PER DAY	NUMBER OF MONTHS TAKEN

10. Circle the word(s) below that you feel best describes your lifestyle.
    1 SEDENTARY
    2 MODERATELY ACTIVE
    3 VERY ACTIVE

11. Do you regularly engage in physical activity? (Circle one number)
    1 NO
    2 YES → 11a. In the table below, please describe the type of activity you engage in, the number of minutes per day, and the number of days per week.

TYPE OF ACTIVITY (walking, swimming, etc.)	MINUTES PER DAY	DAYS PER WEEK

12. During which of the following time periods do you eat the most food? (Circle one number)
    1 BEFORE 11 A.M.
    2 BETWEEN 11-2 P.M.
    3 BETWEEN 2-5 P.M.
    4 BETWEEN 5-7 P.M.
    5 AFTER 7 P.M.

13. How many people including yourself live in your home?
    _____NUMBER OF PEOPLE

14. How often do you prepare the meals for yourself or yourself and others you live with? (Circle one number)
    1 ALL OF THE TIME
    2 MOST OF THE TIME
    3 SOME OF THE TIME
    4 SELDOM OR NEVER

15. Please fill out the following table which describes your daily meal pattern. Indicate which meals you usually eat, what time you usually eat them, and where you usually eat them.

	DON'T EAT	YES DO EAT	WHAT TIME EATEN	WHERE EATEN (USUALLY)
Breakfast.....	1	2 →	_____ →	_____
Lunch.....	1	2 →	_____ →	_____
Dinner.....	1	2 →	_____ →	_____
Snacks.....	1	2 →	_____ →	_____

16. How many hours of television do you watch weekly? (Circle one number)
    1 1 HOUR OR LESS
    2 UP TO 2 HOURS
    3 UP TO 4 HOURS
    4 UP TO 6 HOURS
    5 MORE THAN 6 HOURS

17. How often do you eat meals and/or snacks while watching television? (Circle one number)
    1 NEVER
    2 ONCE IN AWHILE
    3 ALMOST ALWAYS

18. Are you presently working for pay or as a volunteer? (Circle one number)
    1 NO
    2 YES → 18a. How many hours per week do you work?
    _____HOURS PER WEEK

19. What was your approximate weight at the following ages?
    a. weight at age 25: _____POUNDS
    b. weight at age 35: _____POUNDS
    c. weight at age 45: _____POUNDS
    d. weight at age 55: _____POUNDS
20. What is your present weight?
    _____POUNDS
21. What is your approximate height (without shoes)?
    _____INCHES
22. Has your height changed since you were age 25? (Circle one number)
    1 NO
    2 YES
    → 22a. What was your approximate height at age 25?
    _____INCHES
23. What is your present age?
    _____YEARS

24. Please put a number indicating approximately how many servings of each of the following you eat per week:

A. FRUITS (one small fruit or ½ cup is one serving)

_____Citrus	_____Dried fruit	_____Banana
_____Apples	_____Raisins (1/3 cup)	_____Avocado (⅛ med.)
_____Berries		
_____Melon		
_____Plums		
_____Pears		

Other (please specify_____)

B. VEGETABLES (1 small veg. or ½ cup is one serving)

_____Green beans	_____Greens	_____Dried beans
_____Tomatoes	_____Broccoli/cauliflower	_____Lentils
_____Potatoes	_____Sweet potatoes	_____Soybeans
_____Celery	_____Corn	
_____Mushrooms	_____Cabbage	
_____Carrots	_____Onions,mature	
_____Other (please specify_____)		

C. BREADS AND CEREALS (1 slice or ½ cup is one serving)

_____White bread	_____Whole wheat bread	_____Brewer's yeast (3 Tb)
_____White rice	_____Whole wheat pasta	
_____Saltines/soda crackers (4-6)	_____Brown rice	_____Wheat germ (¼ cup)
	_____Rye bread	_____Wheat bran (½ cup)
_____Cookies	_____Cornbread	_____Soy flour (¼ cup)
_____Other (please specify_____)		_____Breakfast cereal

D. MEATS (3 ounces is one serving)

_____Shellfish	_____Canned tuna/salmon	_____Organ meats
_____Shrimp	_____Fish	_____Fresh tuna/salmon
_____Eggs (2 = 1 serv.)	_____Red meats	_____Poultry

E. MILK AND MILK PRODUCTS

_____Milk, all kinds (1 fluid cup is one serving)
_____Yogurt (1 cup is one serving)
_____Cheeses, all kinds (1 ounce is one serving)
_____Cottage cheese (½ cup is one serving)
_____Other (please specify_____)

F. MISCELANEOUS

_____Jam/jelly (2 Tb)
_____Honey (2 Tb)
_____Candy bar (1)
_____Soft drinks (12 oz.)
_____Cake or pie (1 slice)
_____Other (please specify_____)

_____Peanut butter (1½ Tb)
_____Almonds (10)

_____Sunflower seeds (¼ cup)
_____Walnuts (14 halves)
_____Filberts (¼ cup)
_____Peanuts (10)

25. Please use this space for any additional comments you may have.

THANK YOU ! ! !