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ABSTRACT

NUTRITIONAL STATUS OF OLDER WOMEN

By

Eleanor Dawn Schlenker

In recent years, medical advances in the conquest of infectious diseases have increased the lifespan markedly. Many factors determine the health and longevity of older people. Proper nutrition throughout life has been suggested as one of the best means of minimizing degenerative changes and superimposed diseases. To study the influence of nutritional status in middle age upon health in later years, ultimate longevity, and cause of death, the survivors of a random sample of 103 women from Lansing, Michigan, first studied in 1948 when they ranged in age from 40 to 88 years, were re-examined. In 1948, each subject was interviewed to obtain a 24-hour dietary recall record, and health and nutrition history; about one-half of the subjects submitted to a clinical evaluation which included the collection of fasting blood samples for vitamin analyses.

Sixty of the original subjects are deceased. Twenty-eight survivors, ranging in age from 64 to 90 years,

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participated in the 1972 study. From these individuals was obtained at least one 24-hour dietary record and information relating to current socioeconomic, marital, and health status. Twenty women submitted to a clinical examination with emphasis upon signs of nutrient deficiency. Biochemical measurements to evaluate iron, protein, and vitamin status, were performed on fasting blood and urine samples. A modified test of glucose tolerance was conducted using a high carbohydrate breakfast consisting of 50-60 grams carbohydrate.

According to the death certificates obtained for the deceased subjects, cardiovascular-renal disease was responsible for nearly one-half of all deaths, with cerebrovascular complications and cancer, the next leading causes of death. No single nutrient in the 1948 diets could be related to cause of death. The intake of dietary fat, on an absolute basis, however, was inversely correlated with age at death. The higher the intake of fat, the shorter the life. Similarly, the higher the level of carbohydrate as percent of total calories, and the lower the percent of fat calories, the longer the life. Survivors, when examined in 1948, had significantly higher intakes of dietary protein and ascorbic acid than those now deceased; the survivors were also significantly younger in age at the time of the initial survey.

For the 28 women examined in 1972, mean caloric intake was about two-thirds (1297 kcal) that recommended

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for women of this age, although mean intakes of other nutrients, except calcium, remained adequate. Deficient intakes by individuals most frequently involved calories, calcium, thiamin, and vitamin A. Nearly one-half of those interviewed used some form of dietary supplement, although, in most cases, the supplement taken did not supply those nutrients that were deficient in the diet. Socioeconomic factors as economic limitations or problems with shopping, or dental status, did not significantly affect nutrient intake. Women who lived and ate alone, however, had lowered intakes of calories, fat, protein, iron, and niacin; however, these subjects also tended to be older. Women following modified diets for treatment of chronic diseases, had reduced intakes of fat, linoleic acid, and ascorbic acid.

Comparison of the nutrient intakes of the survivors in 1948 and 1972 revealed that dietary intakes of calories, carbohydrate, and fat, decreased significantly, whereas protein levels remained the same. Since the 1948 survey, survivors have increased their use of eggs and vitamin-A rich fruits and vegetables, continued to consume bread and cereals frequently, and decreased their intakes of high-sucrose baked desserts. Since 1948, vegetable fats have been substituted for animal fats in the diet.

Clinical symptoms frequently associated with nutrient deficiencies, were, in these subjects, not always related to nutrient intake. Oral lesions as angular

stomatitis or filliform papillae atrophy, were associated with dentures rather than a deficiency of the B complex vitamins or iron. Hyperkeratosis of the elbows and knees did relate to lowered intake of linoleic acid. Neurologic changes were associated with advancing age rather than nutritional status. Spinal curvature was significantly related to body weight in 1948. Similarly, the presence of heart disease in 1972 was associated with overweight and hypertension in 1948. About one-half of the subjects had mild edema of the lower extremities and/or varicose veins.

Biochemical values observed in these women were acceptable to high in the majority of subjects. Serum vitamin A and carotene levels were not correlated with dietary intake, although two subjects who had undergone cholecystectomies had serum vitamin A levels indicative of deficiency. Urinary riboflavin was low in 15 percent of the subjects, although biochemical measures of ascorbic acid, thiamin, and iron status, were adequate in all women examined. Decreased levels of serum protein, noted in one-third of the subjects, reflected changes in the globulin rather than the albumin fraction.

Body height was significantly lower among the oldest subjects examined. Body weight, skinfold thicknesses, and body circumferences, were decreased in the subjects aged 80 or above. More than one-half of the women examined were 20 to 40 percent overweight, and had been so in 1948; only 15 percent were severely underweight. Arm and abdominal differences were

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circumferences were the single measurements most highly correlated with body weight. Post-prandial glucose and insulin levels were significantly related to body weight as recorded in 1948.

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NUTRITIONAL STATUS OF OLDER WOMEN

By

Eleanor Dawn Schlenker

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Food Science and Human Nutrition

1976

Life must be lived forward, but understood backward.

Sören Aabye Kierkegaard

To the twenty-eight women who shared with us their food habits and way of life.

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This project would not have been possible without the concerned cooperation of many staff members at Olin Health Center, Michigan State University, including: Ms. B. J. Kreuger, Dietitian, and her staff; Ms. J. E.

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Milan, Director of Nursing and Ms. M. DeWitt, Head Nurse, and their staff; Ms. M. L. Shick, Chief Technologist, and her staff; and Ms. N. L. Tomanica, Chief X-ray Technologist, and her staff.

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Finally, I wish to acknowledge the constant support and encouragement of my father, from whom I have learned to value the opportunity to study.

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INTRODUCTION

In recent years medical advances in the conquest of infectious diseases have increased the lifespan markedly. In 1900 less than one-fifth of the United States population was 45 years or older; by 1970, one-third had attained this age, with more than 20 million persons above the age of 65.

Many factors determine the health and longevity of older people. Over some of these, the individual has little if any control (i.e. heredity, the air he breathes, the water he drinks, the pathogens to which he may be exposed, etc.). Diet is the one factor which for most individuals is subject to a certain amount of choice. One's nutritional status thus looms as an important component of life which may have far-reaching effects on both morbidity and mortality. Proper nutrition throughout life has been suggested as one of the best means of minimizing degenerative changes and superimposed diseases (Irwin, 1970).

Expected life at birth has during this century increased from 48.7 to 74.9 years for women and from 48.2 to 67.4 years for men. Correspondingly, in 1970, the clat

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over-65 population included 8.4 million males and 11.4 million females, respectively. In fifty years, these numbers will have doubled (U.S. Bureau of the Census, 1970).

With these changes in population trends, emphasis upon health care has moved from infant and child mortality to the burgeoning problems of chronic disease. An epidemiological approach to study of a total community (Epstein et al., 1965) revealed that 73 percent of the population aged 60 to 79 years, suffered from at least one chronic problem, either coronary or hypertensive heart disease, diabetes, respiratory disease, or rheumatoid arthritis.

Such chronic disease leads to some degree of physical disability as 42 percent of persons above 65 years of age (U.S. Bureau of the Census, 1973, p. 82) have some limitation of activity, with 37 percent limited in a major way. For one-fifth of these individuals, physical restriction is the result of heart disease, whereas an equal number are partially disabled by degenerative arthritis and rheumatism. Visual impairment, incidence of which may relate to complications of diabetes, limit the activities of 7 percent of the retired population. Three persons/hundred have nervous or mental disorders.

Acute disablement and extreme limitation of self-care, frequently necessitates institutional care of the older citizen. In 1960 (U.S. Bureau of the Census, 1973, p. 44), 512,000 individuals resided in chronic disease hospitals and homes for the aged. By 1970, this figure had nearly

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doubled, although the number of persons of retirement age increased by only 25 percent. With increased mobility and the subsequent decline of the extended family, older family members are more likely to be cared for in an institutional setting. Government health insurance for the elderly has contributed to the payment of such care. In light of these factors, facilities for the extended care of the aged are rapidly increasing in numbers. Of the 995,000 individuals now being cared for by institutional management, 658,000 are women. Inasmuch as the lifespan of women has been consistently increasing, whereas that for men is remaining stationary, the number of older women will continue to outdistance that of men. It therefore behooves us to explore in greater detail, those parameters of diet and daily living which contribute to a healthy old age in women.

Howell and Loeb (1969) suggest that "the most seriously needed type of related study in America is to find, through long periods of time, the degree of correlation that exists between the health records of individuals and their dietary habits." Some longitudinal projects have been undertaken in males, in relation to the etiology of cardiovascular disease; none are available with women.

To correct this, the current study was begun; a re-examination of the survivors of a random sample of 103 women from Lansing, Michigan, first surveyed by this

department in 1948 when they ranged in age from 40 to 88 years. Information obtained from this research may enlarge upon current understanding regarding the influence of dietary intake and nutritional status in middle age upon nutritional status and health in later years, as well as upon ultimate longevity and cause of death.

CHAPTER I

REVIEW OF LITERATURE

Trends in Longevity and Mortality

Life Expectancy

Advances in the control of infectious disease, with concomitant decline in mortality of infancy and early childhood, has increased the lifespan markedly during the past 70 years. Although the life expectancy at birth was for both sexes 48 years in 1900, females in the United States can now be expected to live seven years longer than males, with 67.4 years being the average lifespan for men compared with 74.9 years for women (U.S. Bureau of the Census, 1973, p. 57). Life expectancies for both sexes in Canada and Western Europe are similar to those in the United States, albeit males in Scandanavia and the Netherlands can anticipate living one year longer, whereas women in the United Kingdom, Denmark, Australia, and New Zealand, generally live one year less (Metropolitan Life Insurance Company, 1970b hereinafter referred to as MLIC).

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Causes of Death

The factor contributing most to the differential mortality of the sexes in the United States is the sex-age related incidence of cardiovascular disease, the leading cause of death. According to vital records (U.S. Department of Health, Education and Welfare, 1972c), diseases of the heart were responsible for 38.6 percent of all deaths, regardless of age. In spite of developments in drug therapy and preventative medicine, this figure has not changed appreciably since 1950. When other cardiovascular involvements as hypertension, cerebrovascular incidents, arteriosclerosis, and other artery diseases are included, the death rate equals 490 per hundred thousand, or 52.7 percent of all deaths.

Among life insurance policy holders, deaths from diseases of the heart have declined by 7 percent during the last five years (MLIC, 1973); however, insured persons are not strictly comparable with the general population because of differences by age, sex, and risk selection. Insurance statistics reveal that cardiovascular-renal disorders were the main cause of death for males 35 years and over, accounting for more than half of all deaths occurring beyond age 50. Conversely, this syndrome of disease does not significantly influence the death rate among women until age 60, causing 50 percent of all deaths at ages 65-69, and 70 percent at age 75 and above.

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The impact of advanced drug therapy has been associated with the recent decline in mortality related to hypertension and resultant cardiac damage. Statistics (MLIC, 1972a) confirm that deaths from this disturbance lessened by one-third for males and three-eighths for females, during the past decade. Many deaths attributed to vascular lesions of the central nervous system or chronic nephritis, involve hypertension as a contributory factor. In respect to cerebrovascular incidents (MLIC, 1973c), responsible for 11 percent of total mortality among the general population, deaths are heavily concentrated in the older age groups with 80 percent of these fatalities occurring at age 55 or above.

In 1968 the second highest cause of mortality (MLIC, 1971) was neoplastic malignancy, resulting in 16.5 percent of all deaths. Cancer was the principle cause of death among females between the ages of 30 and 59; at ages 55—74, however, males experienced even higher mortality than females. The steady rise in cancer deaths in males has been largely the result of increased incidence of lung cancer which occurs four times more frequently among men. Malignancy at this site accounted for 30 percent of all cancer deaths in men aged 35 to 74, but for only 8 percent of such deaths of women, similar in age.

Other chronic disease states for which the death rate advances with age are diabetes, nephritis, and liver cirrhosis (MLIC, 1970, 1971c, and 1973a). Diabetes, sponsible for 2 ;

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responsible for 2 percent of all deaths, is, as a contributory factor, also related to arteriosclerotic involvement of the cardiovascular-renal system.

Factors Affecting Mortality

Sex.--That mortality from chronic and acute disease varies according to sex, has been discussed previously in relation to cardiovascular mortality among men before the age of 60 years. In this regard, deaths from nephritis (MLIC, 1971c) are also 50 percent higher among men at all ages. Cirrhosis of the liver strikes only half as many women as men (MLIC, 1973a). Inasmuch as excessive use of alcohol is frequently associated with this disease, higher consumption by males may be a contributory factor. Similarly, mortality from peptic ulcers was in 1967 (MLIC, 1971d), three times higher among men. Young women are most frequently stricken with cancer, whereas young men more likely succumb as a result of accident.

Race.--That race influences morbidity and mortality is suggested by the United States vital statistics (U.S. Burean of the Census, 1973, p. 57), which indicate that life expectancy for nonwhites is nearly seven years less than for whites, death ratios being doubled for nonwhite males, and tripled for nonwhite females. Examination of circumstances leading to death (MLIC, 1971e) reveals that fatal accidents and heart disease were increased two-fold among nonwhite males aged 25-44, as compared with Caucasians of eatm

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similar age; deaths ascribed to liver cirrhosis are threefold. Nonwhite women of middle age are more susceptible to heart disease than malignancy, and both sexes more frequently suffer cerebrovascular incidents than do whites. Above age 65, no racial differences are apparent.

Place of Residence.--One's place of residence and way of life may influence longevity and cause of death. This is suggested by the report (MLIC, 1973b) that at age 65, longevity is above the national average for residents in the northwest, southwest, and Pacific regions of the United States. On the other hand, lifespan is shortest among those in New England and the middle Atlantic regions.

The highly industrialized areas of the East (U.S. Bureau of the Census, 1973, p. 62) would seem to increase one's susceptibility to heart disease, cancer, respiratory infections, and liver cirrhosis, although accidents are relatively low in frequency. Incidence of heart disease and cardiovascular complications are decreased in the South, but accidents and cerebrovascular mortality are high. The mountain states experience less cardiovascular and degenerative conditions, but accidents and respiratory problems are frequent causes of death. In the Pacific area, heart disease is infrequent, only the mountain area experiencing fewer deaths from this infirmity; however, accidents and liver cirrhosis claim a highly significant number of lives.

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On the international scene, life tables from Russia, the Netherlands, and Canada (MLIC, 1971a), show the highest probabilities of individuals living to be 100 years. At age 65, males in Canada, Denmark, Scandinavia, and the Netherlands, enjoy a longer life expectancy than their American counterparts, although lifespans of females are similar. In Australia, England, and Wales, both sexes die earlier, as compared with the United States population.

In respect to cause of death (MLIC, 1971b), the only European nation to approach the incidence of heart disease experienced in this country is Scotland. Although vital records would suggest that cardiovascular-renal complications are less frequent in Western Europe, a measure of explanation lies in the terminology used in reporting deaths. Frequently, in these nations, the older individual is said to have succumbed to "senility." The United Kingdom and Western Europe do experience higher mortality from cerebrovascular complications and malignancy, than does the United States. Conditions of weather and humidity may explain the high frequency of fatal respiratory infections among Britain's elderly.

Socioeconomic Status.--Many investigators have sought to define those factors--social, psychological, and biological, which contribute to individual risk or ultimate longevity. A study of long-lived versus short-lived persons (Pfeiffer, 1970) reveals that social correlates,

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positively related, include high intelligence, sound financial status, well-maintained health with average height and weight, continued physical activity, and intact marriage. Such a constellation of factors Pfeiffer (1970) describes as elite status, for these individuals may be expected to live longer than their less intelligent, poorer breathren, whose health is declining and whose marriages have been dissolved.

Genetic Inheritance.--There have been frequent suggestions to the effect that longevity is largely determined by genetic inheritance, in that some factor or combination of factors, transmitted from one generation to another, can significantly influence lifespan. Hammond and associates (1971), upon evaluation of epidemiological data, concluded that death rates from coronary heart disease were considerably higher among subjects with short-lived parents than in those with long-lived elders. This was true for men with no history of hypertension or diabetes, of normal weight, who did not smoke regularly. Life insurance statistics (MLIC, 1970a) relating major causes of death among individuals with unfavorable family histories, reveal that those with kin exhibiting cardiovascular-renal disease, cancer, or diabetes, experience higher mortality from the same or related causes.

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Physiological Factors.--Inasmuch as cardiovascular-renal disorders appear in epidemic proportions in the highly industrialized nations, special efforts have been directed toward defining factors of vulnerability in respect to this syndrome. Various clinical parameters have been considered as predictors of risk, relative to coronary attack. Body weight and body fat, systolic and diastolic blood pressure, smoking, stress, and serum levels of cholesterol, triglycerides, lipoproteins, and blood sugar, have all been implicated in the etiology of this problem. Keys et al. (1971) and Kannel et al. (1971) reporting long term studies of Minnesota businessmen and the adult population of Framingham, Massachusetts, respectively, conclude that coronary risk is proportional to serum cholesterol levels, with systolic blood pressure and smoking habits important components.

A report (Ward, unpublished data, 1972) examining mortality experience over a seven year period in relation to physical measures, confirms the fact that age and sex are important in predicting lifespan, even in a population whose age averages 74 at the time of survey. It was further suggested that after age and sex, the EKG and blood sugar, along with urine protein, sedimentation rate, and blood urea nitrogen, are particularly significant indicators of risk.

Obesity, a prominent public health problem in the industrialized nations, may be a very significant determinant of lifespan in that it enhances the development of degenerative disease. Jolliffe (1953) hypothesizes that a cure for obesity would increase life expectancy by as much as four years, whereas a cure for cancer would increase it by only two years. Life insurance statistics infer that death ratios are 50 percent higher (Soc. Actuaries, 1959) in respect to all leading causes of death, for those individuals 20 percent or more above desirable weight. A study of mortality (Comstock et al., 1966) among the population of Muscogee County, Georgia, provides evidence that deaths resulting from diabetes, coronary heart disease, accidents, strokes, and hypertension, were strikingly associated with fatness.

Goodman (1955), studying the effect of obesity among 135 chronically ill patients, reported that the overweight subjects were, on the average, five years younger than those of normal weight. Relative to improvement upon weight reduction, obese diabetics, previously dependent upon insulin, usually became aglycosuric following loss of body weight. Conversely, satisfactory regulation even with insulin was unattainable among the obese. In regard to osteoarthritis, a frequent cause of disability among older subjects, physical therapy cannot restore mobility in the overweight without concomitant weight reduction (Traut and Thrift, 1969). The avoidance of

excessive accumulation of body fat would appear to be one of the more effective means of insuring a long and healthy life.

Nutrition and Longevity

Historical Perspective

Since antiquity, men have been concerned with the relationship which exists between nutrient intake, morbidity, and mortality. A Biblical narrative (Holy Bible, RSV, Daniel) discloses that young Jewish men, given vegetables to eat and water to drink, were at the end of ten days "better in appearance and fatter in flesh than all the youths who ate the king's rich food." The writer of Proverbs (Holy Bible, RSV) counsels his followers to "be not a winebibber or gluttonous eater of meat."

In later times advice was directed toward possible means of increasing the lifespan, with suggestions relating to one's choice of food and drink for health and well-being in old age. Cornaro, in the fifteenth century (Beeuwkes, 1952), thought it advantageous for an old man to eat but little, the writer suggesting that it was the over-quantity which injured, even more than eating unsuitable food. Eylot (Beeuwkes, 1952), in one of the earliest medical books published in vernacular English (1534) urged the choice of meats, easily digested, and recommended that wine be served with meals.

In his treatise (Beeuwkes, 1952), Francis Bacon stated that "Diet well ordered bears the greatest part in the prolongation of life," and suggested a spare diet as would be prescribed by the strict rules of a monastic life. One of the early works in the field of geriatrics, published by Hufeland in 1796 (Beeuwkes, 1952), contains many principles emphasized in modern thought. Young people are advised to avoid sugar and confectionary, choose vegetables in large quantity, and limit the amount of meat consumed. One should eat sparingly at night, and never eat so much that one can feel he has a stomach.

In more recent times, Metchnicoff (1910), the Russian physiologist, pursued the theory of auto-intoxication suggesting that death occurred as a result of accumulated toxins within the body. Putrefaction could be avoided by the frequent consumption of yogurt, a food containing lactic acid-producing bacteria which might destroy the intestinal microbes responsible for producing the toxins. He cited examples of the long-lived peoples in Russia who daily consumed fermented milk, as proof of his idea.

Human Nutrition Studies

Long-lived Populations.--Modern scientists have pursued the study of longevity by examining individuals in those cultures where a long life is common, in the hope of

defining those factors of diet or daily pattern which seem to encourage a healthy and robust old age. Several investigators (Toomey and White, 1964; Davis, 1973; and Leaf, 1973) have studied three groups of people among whom a significant proportion of individuals are reported to live to age 100 years or more, yet, remaining in vigorous health.

One such population is the village of Vilcabamba situated in the Andeas Mountains of Ecuador, a totally agricultural community raising vegetables and grains. In 1971 (Leaf, 1973), 7 percent of the people were aged 80 years or more, compared with less than 1 percent in Ecuador as a whole. The dietary pattern in Vilcabamba is almost exclusively vegetarian, with a daily caloric intake of about 1200 kcal. The protein and fat consumed, 35-38 grams and 12-19 grams respectively, are mainly of vegetable origin, with animal sources providing only 12 grams of the daily protein. The preponderance of calories are obtained from carbohydrate foods.

Another investigator (Davis, 1973) estimates the caloric intake of these people to equal about 1700 kcal, but concurs in the opinion that meals are frugal. The meal pattern consists of soup prepared from grains, corn, beans, and potatoes, sometimes augmented with oranges and bananas. Meat is consumed at a level of one ounce per week. What little milk is available is made into cheese. Inhabitants consume large quantities of homemade rum, but only small amounts of unrefined sugar.

A second population possessing many long-lived members is found in the province of Hunza, in Kashmir. As the village in Ecuador, Hunza has an agricultural economy (Leaf, 1973). The farmers raise vegetables, grains (barley, wheat, and millet), fruits, and nuts, but seldom is there enough to last through the severe winter. As a result, there is annually a period of semistarvation. Even throughout the productive seasons, energy intake among males is, by American standards low, averaging 1932 kcal.

The typical diet is composed of 50 grams of protein, 35 grams fat, and 354 grams carbohydrate, with less than one percent of the total daily intake derived from animal sources. Milk and milk products are absent. Meat, primarily mutton, is eaten only once or twice during the year, usually as part of a festival celebration.

The work of Hejda (1968) would confirm those observations of the Hunzas suggesting a positive relation between limited food supply and longevity, as the oldest people in Czechoslovakia frequently experienced what was described as an "inadequate" diet, in that they remembered as children, frequently experiencing hunger.

A different picture is presented of dietary pattern in the Caucasus Mountains of the U.S.S.R., a mixed agriculture-dairy economy where animal products are consumed daily (Leaf, 1973). Aged Georgians consume milk, cheese, and yogurt three times a day, and meat servings are

frequent. The actual daily consumption for those above 50 years of age has been reported as 1800 kcal, with 60 grams fat. An occasional feast may include mutton, goat cheese, beef, green onions, garlic, spicy sauce, and wine. Obesity has been observed among the older people.

Despite the problem of accurate documentation of age among the subjects observed in Ecuador, Pakistan, and the Soviet Union, it would appear that individuals enjoy long and healthy lives, actively participating in the physical work and social life in the community. No evidence of coronary heat disease (Toomey and White, 1964) as noted by EKG tracings was found among aged Hunzas, for whom serum cholesterol averaged 172 mg percent. Of seven centenarians examined in Ecuador (Davis, 1973) four were diagnosed as normal. Relative to dietary factors, observation of these peoples would suggest that a low to moderate caloric intake, limited in animal protein and saturated fat, is conducive to a long and healthy old age.

Examination of 27,000 individuals over 80 years of age in the Soviet Union (Chebotaryov and Sachuk, 1964) revealed that 91 percent consumed a mixed diet, with vegetarians comprising only 8 percent of the population. One of the subjects, however, ate a predominately meat diet; almost all were lean in build.

Longitudinal Nutrition Studies.--Studies in the United States, examining total dietary intake in relation to length of life, have been limited in number. Kelley and coworkers (1957), who examined a random sample of 97 Michigan women between the ages of 40 and 88 years, noted that physical well-being was directly related to nutrient intake. Physical complaints, as pains in the joints or unexplained tiredness, were more frequent among those with diets low in one or more nutrients. Mortality over a seven year period was higher in those subjects reporting less than 40 percent of the Recommended Dietary Allowance (RDA) for at least one nutrient.

A four year follow-up of 577 California residents over 50 years of age (Chope, 1954) revealed higher mortality rates associated with lower intakes of vitamin A, niacin, and ascorbic acid. Subjects with hemoglobin levels below 13 gm/100 ml suffered a higher incidence of respiratory disease, whereas low intakes of vitamin A (below 5000 I.U.) were correlated with disorders of the nervous, circulatory, and respiratory systems. When dietary thiamin was low, diseases of the nervous and circulatory systems increased; however, high intakes of ascorbic acid were related to low incidences of these problems.

Waters and coworkers (1969) studying mortality over a ten year period among 723 British subjects, suggest that those individuals with hematological values near the mean may have lower subsequent death rates. Men

for whom blood packed cell volumes (PVC) measured more than one standard deviation above the mean (45.70 ± 3.08) suffered higher mortality; 20 deaths against the expected 10.6 deaths for this group. Higher death rates occurred among both sexes with low serum iron levels. These reports, although limited in number, would suggest that either inadequate dietary intake or impaired utilization of vitamins or minerals, may predispose the individual to particular physiological disorders.

Macronutrients and Longevity.--Recently, attention has been drawn to the intake of particular macronutrients, namely calories, fat, and carbohydrate, as they might influence mortality, especially in relation to cardiovascular disease. Food disappearance data would suggest that the caloric intake per capita (Swope, 1970) has declined over the past 60 years from 3490 kcal in 1909 to 3240 kcal in 1969. During this period, however, the sources of these calories have changed. Fat comprises a greater portion of the diet, increasing from 32 percent to 42 percent of total calories, while carbohydrates have declined from 56 percent to 46 percent of total calories. Although protein intake on an absolute basis has remained constant, animal sources which contributed only one-half of protein calories in 1909, now account for over two-thirds of dietary protein.

Several investigators, attempting to relate these changes in the food pattern with the significant increase in cardiovascular mortality, have compared the consumption of macronutrients in this and other countries with differing rates of cardiovascular deaths. Weiss and Mattil (1957) assembling data showing the levels of meat, eggs, fats and oils, and total kcal, consumed in 25 countries, found impressive coefficients between the consumption of meat, eggs, and fat, and incidence of arteriosclerotic heart disease. Total caloric intake, however, showed the highest correlation with coronary fatality. These authors point out that dietary levels of food and fat are also positively correlated with measurements of well-being (i.e. percentage of the population reaching the age of 40, and life expectancy at age 40). One could question whether the relationship between food and fats, and atherosclerotic deaths may not result partially from the beneficial effect of these nutrients upon longevity.

Similar conclusions were drawn by Watanabe and associates (1968) upon looking at total calories, animal protein, and fats and oils, consumed in advanced and underdeveloped nations. The higher the nutrient intake, the more favorable the lifespan. Examination of nutrient intake from the advanced nations only yields the opposite interpretation. However, it must be recognized that other factors as poor sanitation and inadequate medical care also contribute to the higher mortality ratios in the less developed nations. By regression analysis, the inflection of the curve, where nutritional influence changes from better to worse, occurs at an intake of 3000 kcal, 90 grams protein, 50-60 grams fat, and 35-40 percent of calories of animal origin, respectively. The quantity of meat consumed provided the strongest association with degenerative heart disease among the advanced nations studied.

Soukupová and Prusová (1970) evaluated nutrient intake and ischemic heart disease incidence in 33 countries. Sex differences were observed, in that heart disease in males was most closely related to dietary fat; in females, total calories were most significant. The coefficient for sugar was low for both sexes. In regard to this epidemiologic evidence, not only is the total quantity of food ingested a significant factor, but also the relative percentages of fat, protein, and carbohydrate calories.

In respect to changes in dietary pattern among the industrialized nations, not only has total carbohydrate declined, but differences in composition have become apparent; the consumption of sugar has increased while that of complex carbohydrate has decreased. Considerable controversy has ensued regarding the role of sucrose as a causal factor in the development of coronary heart disease. Yudkin (1972) reported that young men fed high amounts of sucrose showed increased levels of serum triglycerides after only two weeks on the diet, and one-third of the subjects demonstrated a rise in plasma insulin, platelet adhesiveness, and body weight, all symptoms of atherosclerotic patients. Keys (1971) disputes these findings, charging that all experiments were of short duration, and levels of sucrose fed were several times that found in natural diets.

The incidence of diverticulosis and colonic cancer in the western world has increased markedly in this century, now affecting one-third to one-half of persons over the age of 40. Painter and Burkitt (1971), drawing upon epidemiological evidence suggest this disease to result from a deficiency in fiber, as dietary habits have shifted to use of refined cereals. Diverticulosis is rare in those parts of the world where high residue diets are commonplace. In like manner, deaths from colonic cancer have paralleled the increase of diverticular disease, with this form of cancer being the second most common among both sexes in the United States and Canada (MLIC, 1971). The dietary replacement of complex carbohydrates with sugar and refined cereals would appear to have an unfavorable effect upon health and well-being.

Much debate has surrounded the aspect of dietary fat in the etiology of atherosclerosis and degenerative heart disease. In addition to the increased consumption of lipid, attention has focused on the degree of saturation and chain length of fat moieties, as well as the dietary concentration of essential fatty acids. Changes in serum cholesterol, a known risk factor in the occurrence of cardiovascular problems, have not, however, been the result of changes in dietary fat over the past 60 years. Computations by Kahn (1970) reveal that known changes in the food pattern could not solely have caused observed differences in cholesterol response and cardiovascular mortality.

Inasmuch as heart disease strikes men of middle age, whereas women before the age of 60 are practically immune, Friedman and Rosenman (1957) compared the fat intake of upper class husbands and wives in the San Francisco area in relation to this clinical disease. Results confirm that although males consumed more calories and consequently more total fat, calculated intakes on the basis of body surface area did not differ, equalling 387 and 409 for the men and women, respectively.

One negative aspect of diets specially formulated to reduce serum cholesterol by increased intake of unsaturated fats, has been reported by Pearce and Dayton (1971). Among their male subjects, a decrease in atherosclerotic risk was accompanied by a higher incidence of cancer.

Alternatively, Ederer and coworkers (1971), editing data compiled from four clinical trials in various locations, found no evidence of increased cancer mortality.

Although it would appear that the level and degree of saturation of dietary fat is a factor in the development of cardiovascular disease in males, no such evidence exists in respect to females.

Disturbances of the kidney are a problem which increase in severity with advancing age. Among normal healthy aged, kidney function at age 60, is approximately 50-60 percent that observed at age 30 (Shock, 1968). With a decrease in the number of functioning nephrons, filtration rate declines, with a consequent rise in blood urea nitrogen. One possible means of alleviating the problems of kidney impairment might be a change in the type or quantity of ingested protein, thereby altering the levels of urea produced.

Bolourchi and coworkers (1968), studying physiological responses in young men changed from a typical American diet with protein of primarily animal origin to a regimen consisting entirely of vegetable protein fed in the form of bread, noted a marked reduction in blood urea. Previous investigators (Lyon et al., 1931) indicated that patients with chronic nephritis demonstrated a marked, long-term improvement when given sodium bicarbonate, an alkalinizing agent. Blood urea nitrogen was reduced to non-toxic levels. The authors suggested that any foods producing an alkaline reaction in the body may favor the maintenance of normal kidney function. This could be accomplished by the substitution of protein from vegetable sources (alkaline in nature) for animal foods (enhancing formation of acid). Whether such a reversal of the dietary pattern of the Western nations could effect a reduction of chronic kidney disorders with a concomitant increase in life expectancy, is a postulate deserving of further investigation.

Animal Studies

In the twentieth century, investigators have begun to explore, using animal models, those combinations of diet, varying in both quality and quantity, which increase longevity while reducing morbidity.

Food Restriction.--McCay and coworkers (1943) the first of modern scientists to investigate this relation, showed that the amount of food consumed significantly influenced disease incidence and length of life. Rats fed a diet so limiting in calories as to retard growth and delay sexual maturation, enjoyed a 40 percent increase in lifespan. Upon analyzing the effects of food restriction, type and level of dietary protein, dietary supplements, and exercise, the single most important factor influencing longevity was determined to be the amount of body fat. Histologically, the tissues of the lean, older animals were

similar to those of younger animals. Inasmuch as equal numbers of male and female animals enjoyed longer lives, it would seem that growth retardation equalizes the lifespans of both sexes.

Berg and Simms (1961) determined that rats whose food intake was restricted to 54 percent that given controls displayed only slight retardation in skeletal growth and rate of maturation, despite the absence of depot fat. Restricted animals lived longer, exhibiting delayed onset of myocardial, vascular, and renal lesions. Because a single variable, caloric intake, influenced the sequence of lesions in all tissues examined, these authors postulate that a common factor exists to control the onset of aging and disease, and that adjustment of nutrient supply can affect it.

Indirect support for their hypothesis emerges from the work of Carlson and Hoelzel (1946, 1948) who observed a prolonged lifespan in those rats for whom caloric levels were reduced by intermittent fasting, or the addition of nonmetabolizable bulk-formers to the ration. Everitt (1971) evaluating biological age by determining the breaking strength of collagen fibers, noted that rats restricted in their feed intake were, at 900 days of age, biologically similar to control animals only two-thirds that age. Administration of thyroid hormone (Everitt et al., 1969) resulting in a 39 percent increase in food consumption by the mature rat, accelerated significantly the aging of tail tendon fibers. In relation to susceptibility to disease, Grewal (1971) demonstrated that animals fed 50 percent of the feed consumed by ad libitum fed controls, were upon post-mortem examination, free of chronic respiratory infection, whereas control lungs contained nodular cysts and hemorrhagic areas.

It can be concluded on the basis of animal experiments that caloric restriction to a degree which prevents the accumulation of depot fat while permitting the normal sequence of maturation, significantly increases the lifespan. The leaner animals appear younger, with no increase in susceptibility to disease.

Macronutrients and Longevity.--Ross (Ross, 1972; Ross and Bras, 1973) considering the effect upon life expectancy of a single lifelong dietary regimen, tested semisynthetic formulas varying in protein and carbohydrate ratios, each fed on a restricted or non-restricted basis. Limiting the intake of the protein component only, with isocaloric substitution of corn oil or sucrose, changed the lifespan but little. Restricting carbohydrate enhanced life expectancy only with simultaneous restriction of calories. A low intake of both protein and carbohydrate, limited in calories, produced no effect early in life; however, restricted intake of this protein-calorie ratio

1:5 enhanced life expectancy to the greatest degree, reducing the incidence of chronic disease. Length of life was related to final body weight; for every 10 percent reduction in body weight, a 13.5 percent gain in life expectancy was realized. Lighter animals were more immune to neoplastic growths, whereas the incidence and severity of glomerular nephritis was directly related to intake of protein.

Other studies (Miller and Payne, 1968) investigating the efficacy of varied levels of dietary protein revealed that rats fed a diet high in protein during the period of rapid growth, and low protein thereafter, remained in good physical condition, were lean, and lived 28 percent longer than controls continued on the high protein regimen. In contrast, no significant differences in lifespan were noted by Nakagawa and Masana (1971) among animals given diets containing 10 percent, 18 percent, or 27 percent casein.

Although a low protein diet does not in itself increase the lifespan without concomitant caloric restriction, excessive intake may enhance degenerative disease. In rats, the incidence and severity of glomerular nephritis was directly related to the level of dietary protein.

Another component of the diet examined in relation to morbidity and mortality has been fat. Mice fed a diet composed of 29 percent fat (lard), by the Silberbergs

(Silberberg and Silberberg, 1954) suffered higher mortality regardless of strain, sex, age, or weight gain. The deleterious effect of the high fat regimen was more conspicuous in animals of a long-lived as compared with a short-lived strain; in males than in females; and when fed from the age of one year rather than from weaning. The rate of mortality was associated with the degree of body weight increase.

Similarly, French and coworkers (1953) noted a significant decrease in length of life among rats of both sexes fed a diet containing 22.7 percent corn oil. Histological examination of those animals revealed high liver fat content among males fed the corn oil ration, as compared with controls fed the basal carbohydrate mixture; however, the cause of premature death could not be ascertained. The increased efficiency of utilization seen with the high fat ration, was correlated with the decrease in lifespan.

Schemmel and coworkers (1973) studied rats suckled by dams fed either a high fat (60%) or grain (3% fat) diet, and then weaned to either the high fat or grain ration. After 168 days, the only group in which no deaths had occurred was that suckled by grain-fed dams, and subsequently continued on the grain. Mortality was highest for those nursed by the high-fat fed dams and weaned to the high fat ration. Connective tissue obtained from rats fed a high fat ration (60% animal fat) was found to contain considerable lipid (Svojtkova et al., 1972), which may lead to cumulative cross-linking and accelerated biological aging.

Many investigators have directed their efforts toward elucidation of potentially toxic substances which may be responsible for the lethal effects of dietaries high in fat. Thomasson (1955) who fed to rats diets composed of either 50 percent rapeseed oil or butterfat, observed more rapid growth, higher weight gains, increased incidence and severity of kidney lesions, and shortened lifespan, in those receiving the animal fat. The differences in lifespan could not be explained simply on the basis of the presence of erucic acid, an appetite and growth-inhibiting factor naturally occurring in rapeseed oil.

Unsaturated fats are known to be highly susceptible to oxidation with the subsequent formation of peroxides, implicated in deleterious free radical reactions (Harmon, 1969). Morin (1967) noted no differences in longevity or liver peroxide content in several strains of mice fed stock diets supplemented with sucrose, safflower oil, or hydrogenated coconut oil. A three-fold difference in liver storage of linoleic acid did occur among those ingesting the unsaturated fat.

When Poling and associates (1970) fed heated (oxidized) animal and vegetable fats as 20 percent of a nutritionally adequate diet to rats of both sexes, no differences in longevity were exhibited in respect to those fed the non-heated substances. Animals receiving hydrogenated vegetable fat, whether heated or non-heated, enjoyed the longest lives.

In contrast to these findings, Kaunitz et al. (1970) concluded from his studies that fresh olive, soybean, and corn oils contain, despite processing for human consumption, components which are toxic to rats. Improved rates of survival were seen among those fed oils which had been subjected to mild heating and aeration. Analysis of results testing a variety of animal and vegetable fats, either oxidized or not, fed as 20 percent of the ration, suggests that longevity as well as degenerative diseases which occur in rats (i.e., lung infection, renal lesions, etc.) do not correlate with any of the currently popular fat parameters as linoleate content, melting point or degree of unsaturation. Lower death rates were associated with beef fat and medium chain triglycerides, both low in linoleate, but widely differing in melting point. Animals fed corn oil lived longer, but displayed severe cardiac changes. Components of the non-triglyceride fraction may be involved in these lipid-induced disturbances.

The deleterious effect of dietary fat upon the lifespan of experimental animals has been well established. Although this decrease in longevity is mediated in part by excessive weight gain and fat infiltration of vital organs, it would appear that toxic substances present in the fat may also contribute to degenerative disorders.

Increased intake of refined carbohydrate in the human diet has stimulated research with animal models in light of possible relationships to induced hyperlipidemia and cardiovascular disorders. Early investigators fed large quantities of carbohydrate compounds to rats with differing results. McCay and coworkers (1952) found no apparent differences in lifespan or tissue histology in those rats given a stock diet with a 10 percent sucrose solution for drinking. Feeding cornstarch in a sufficient quantity to produce overweight, equivalent to that of mice receiving a high fat ration, did not alter mortality patterns among those strains studied by the Silbergs (Silberberg et al., 1955). Rats fed a 30 percent lactose ration by Whittier and associates (1935) accumulated less body fat, and lived longer than those given isocaloric levels of sucrose; however, total food consumption by both groups of animals was not reported.

Further deleterious effects resulting from sucrose ingestion have been cited by Dalderup and Visser (1971) and Al-Nagdy et al. (1970). The Dutch investigators, comparing Wistar animals fed sucrose at levels of 14.5 percent or 30 percent, observed higher mortality and premature incidence of severe glomerulonephritis among males fed the sweeter ration; females were not significantly affected. Diets high in sucrose (64-80%) increased serum cholesterol, decreased glucose tolerance, and increased liver fat, in adult rats (Al-Nagdy et al., 1970). In experimental animals it would seem that the detrimental effect of specific carbohydrates upon the lifespan is the result of high caloric intake with excessive weight gain.

Micronutrients and Longevity.--Relative to the micronutrients, investigators, early in this century, concentrated their efforts upon the determination of optimum levels of the newly isolated factors, eventually classified as vitamins. Sherman and others (1945) discovered that although vitamin A fed at levels of 0.8 I.U. per calorie was adequate to maintain 58 generations of rats of the Osborne-Mendal strain, a doubling of dietary vitamin A deferred old age, thereby increasing the length of life.

A recent concern of nutritionists has been the role of free radical reactions and lipid peroxidation in the degenerative changes associated with aging. Inasmuch as vitamin E performs as a biological antioxidant, investigators have tested varying levels of both this nutrient and synthetic antioxidants in relation to fat content of the diet and ultimate longevity.

Kohn (1971) observed that addition to the diet of antioxidants as mercaptoethyamine hydrochloride extended the mean survival time of mice to optimal control values, but maximum values were not increased. Apparently these substances inhibit harmful environmental or nutritional factors which in some experiments cause premature death.

Tappel and coworkers (1973) supplemented the basal diet of their rats with varied amounts of known biological antioxidants including alpha tocopherol acetate, ascorbic acid, methionine, and sodium selenite. Although relative mortality did not change, the animals receiving high levels of antioxidants had significantly less accumulation of fluorescent pigments in the testes and heart. Concentration of such pigments is considered to be a consequence of aging. The lifespan cannot be increased by vitamin supplementation above those levels required for normal growth.

Atmospheric pollutants, resulting from industrial wastes, have led Schroeder and coworkers (1964; 1968) to examine the effects of trace minerals upon the lifespan of mice. Cadmium, titanium, and lead fed at 5 ppm in the drinking water, significantly shortened the life, although tissue concentrations were similar to those observed in human tissues. No metal proved to be carcinogenic, but all exhibited signs of innate toxicity. In contrast, rats fed chromium at the above level experienced an increased rate of growth with higher body weights. Including tin in the drinking water, resulted in liver fat deposition and renal tubular degeneration, although tissue concentrations were minimal.

That not only diet composition but also the manner in which it is consumed can influence longevity, has been suggested by work of Leveille (1972a), as meal-fed animals lived significantly longer than nibblers. One possible explanation is the lower body weight and body fat of the meal-fed animals who consumed 25 percent less food than nibblers.

Nutrient Requirements of Older People

Although much effort has been invested in defining the nutrient requirements at various ages and stage of the life cycle, little is known regarding possible alterations in nutrient needs as a result of the progression from middle to advanced age. Present evidence would suggest that requirements differ for only one nutrient, energy calories. With the change in activity level, as well as body metabolism, previous intake is excessive, and if continued, results in insidious weight gain. No conclusive data has been derived to confirm that the requirements for protein, vitamins, or minerals, differ in healthy aged as compared with young adults.

Factors Affecting Requirements

Digestion.--In attempting to examine the nutrient requirements of older people, one consideration has been possible changes in the efficiency of digestion and absorption of foodstuffs. Although the effects of physiological aging of the gastrointestinal tract could alter both anatomical structure and function, Berman and Kirsner (1972) suggest that digestive problems in later years often reflect other difficulties. Chronic disease may impair general health, thereby limiting physical activity, creating emotional disturbance, and necessitating continued use of drugs. Other physiological factors as changes in protein metabolism and enzyme synthesis, a decrease in regional blood flow, and reduced somatic muscle tone, may result in clinical symptoms, according to Geokas and Haverback (1969).

Enzyme Production.--Meyer and Necheles (1940) comparing basal and stimulated salivary secretion in young and old adults, noted markedly depressed basal levels of salivary amylase among the latter. Following stimulation, pancreatic amylase secretion did not differ between the two groups of subjects. Further studies examining gastric enzyme levels in 26 aged persons (Fikry, 1965) revealed that the volume of gastric juices was only 75 percent of normal, although acid concentration was unaffected. Fikry considers this response to reflect both a decrease in number of parietal cells plus the impaired capacity of available cells. Despite changes in pepsin concentration and acid volume, no subject complained of gastrointestional discomfort.

In regard to stomach motility, no difference in stomach emptying time following a high carbohydrate test meal, administered to young and old men, was noted by Van Liere and Northrup (1941).

Absorption Mechanisms

Carbohydrate Absorption.--In respect to energy requirements, experiments with both animals and humans would imply that intestinal absorption is not a significant factor. Klimas (1968) measuring glucose absorption by means of an intestinal loop in male rats, observed a significant increase in the ability of the gut to absorb this nutrient throughout the first ten months of life; there was no discernible change from that time through the third year.

Early studies of hexose absorption in humans, using galactose as a test substance (Meyer et al., 1943), demonstrated a 30 minute lag in the appearance of this sugar in the blood of older subjects (mean age 76.6 years) as compared with young volunteers (mean age 20.5 years). Total absorption, independent of the time factor, could not be ascertained.

Guth (1968) studying active absorption of pentose, reported delayed xylose excretion following the sixth decade of life; however, this effect might reflect diminished renal function as well as impaired absorption. Plasma xylose two hours following administration did not vary in subjects aged from 30 to 79 years. Although the appearance of absorbed sugars in the blood is delayed in older subjects, possibly as a result of reduced cardiac output and organ perfusion, it has not been shown that total absorption is reduced.

Fat Absorption.--Several investigators examining fat absorption in young and old adults, provide evidence that both rate and degree of total absorption may decline in later years. Lipoprotein lipase concentration is diminished in the intestine.

Becker and coworkers (1950), estimating fat absorption by the chylomicron technique, noted a significant drop in the absorption rate in older subjects, a phenomenon which could be altered by the administration of lipase or Tween 80. Following ingestion of ^{131}I-triolein, a peak in plasma ^{131}I was seen after three hours in the younger subjects, whereas concentration reached a maximum in the older individuals after a period of five hours (Matsumoto, 1968). Evidence suggesting lowered production of pancreatic lipase comes from the work of Pelz and associates (1968) who observed that 17 of 43 older persons, all free of symptoms of organic disease, exhibited stool fat content above 20 percent of dried weight. In ten subjects, split fat was less than 42 percent of total fat.

According to Werner and Hambraeus (1972), when eight subjects aged 67 to 72 years were fed 115 grams of fat daily, equally divided among all meals, the diet was well tolerated. If over one-half of the fat was consumed at one meal, fecal fat increased proportionately. In that free fatty acids did not appear in the fecal mass, the insufficiency likely related to decreased enzyme production.

Although older individuals would appear to have decreased efficiency in digesting and absorbing fat, the problem may be circumvented by equally dividing fat intake among all meals.

Protein Absorption.--A primary concern has been the totality of protein digestion, in that lowered volume and acid content of stomach fluids has been demonstrated in older people (Fikry, 1965), Draper and Lowe (1958) could find no relation between efficiency of protein digestion and age in rats fed a reference sample of nitrogenous foodstuff with a ferric oxide marker.

The rate of digestion and degree of absorption did not differ in the young and old subjects given a test meal of I^{131}-labeled albumin by Chinn and others (1956). In

of I^{131}-labeled albumin by Chinn and others (1956). In only one of the 12 older persons (aged 72-88 years) did less than 10 percent of the ingested isotope appear in the blood within a period of two hours.

Studies on the molecular level have tried to elucidate possible differences in the mucosal transport of amino acids in the aging organism. That uptake of amino acids is related to body need as well as anatomical integrity is suggested by the work of Penźes (1970) who noted that l-arginine was absorbed more rapidly in vivo by young growing rats than in either young or old animals. Measures of specific activity would indicate that reduced passage across the intestinal wall of old animals results from reduced blood flow, with slowed removal of the substance by the cells. In respect to lysine which remains essential throughout the lifespan of the rat (Penźes, 1969) absorption and utilization as measured by the disappearance of l-lysine-^{14}C, was not significantly different in old (27 months) as compared with young (2.5 months) rats.

Of special concern in senescence are the sulfur-containing amino acids, as Barrows and Roeder (1961) suggest that sulfhydryl groups may inactivate free radicals. Animal studies indicate a higher degree of absorption of S^{35}-amino acids in old than young rats, as Penźes and associates (1968) discovered that older animals utilized 23 percent more of an administered dose than did young controls. That increased absorption is a reflection of need is implied by Winter and colleagues (1971) who found that absorption of cystein-S^{35} was significantly less in old animals pretreated with a cysteine complex, than in non-treated animals of the same age. Digestion of proteins and the absorption of amino acids do not seem to be significantly altered as a consequence of advancing age.

Calorie and Energy Needs

The only requirement for which existing evidence suggests a change with the progression from middle to advanced age, is energy calories. That caloric intake is not always decreased proportionately with reduced need can be inferred by the high incidence of obesity among the older populations in the Western countries. Consequently, the RDA for calories as established by the National Research Council, is surrounded by much controversy.

A study of 32 Nebraska women (Fry et al., 1963) ranging in age from 65 to 85 years, revealed that no subject consumed less than two-thirds of that recommended, with the mean intake of 1696 kcal representing 94 percent of the standard. Similarly, a study of 100 Bostonians (Lyons and Trulson, 1956) over 65 years of age revealed that energy intake was, among the women, 1831 kcal or 102 percent of the RDA, whereas the men consumed 2458 kcal or 94 percent of their recommended level.

On the other hand, Swanson and coworkers (1959) noted that the energy value of the diet dropped precipitously after 70 years of age among women of the North Central region. Calories numbered 1630 in the seventh decade as compared with 1353 for decades beyond. Conversely, 60 British women in the eighth decade of life were reported to consume 1890 kcal daily (Exton-Smith and Stanton, 1965).

According to recent observations of rural Pennsylvania elderly (Guthrie et al., 1972), mean energy values as compared to the 1974 RDA were 66 percent for men and 75 percent for women. When Davidson and coworkers (Davidson et al., 1962) expressed the daily caloric intakes of their 130 older subjects on the basis of calories per square meter body surface area, there was little difference between the sexes, 1231 and 1174 for males and females, respectively.

Two factors which contribute to the decline in caloric requirements among the aged are (1) the decline in basal oxygen consumption, and (2) the decrease in physical activity. Regression analysis of the dietary intake and physiological energy parameters of 252 middle and upper class males aged from 20 to 99 years (McGandy et al., 1966), suggests that daily caloric needs decline by 12.4 calories/year, after the age of 20. A lesser portion of this drop is attributed to the decrease in basal metabolic rate (BMR), specifically 5.23 calories/year, whereas 7.8 calories are assigned to the reduced physical expenditure of energy.

According to Keys (1952) basal energy needs decrease by 5 percent each decade beyond the age of 50, with additional reductions for the changes in physical activity. Therefore, older women may maintain their health and vigor with 1500 kcal or less, with older men requiring 2000 kcal or less.

A committee on caloric requirements of the Food and Agriculture Organization (FAO) postulated that the decrement in energy requirement (Joint FAO/WHO Committee, 1973) was quite slow during the middle years, the earliest change occurring about age 40. For this reason, caloric needs decline by only 5 percent/decade between the ages of 40 and 59. From ages 60 to 69, the decrement equals 10 percent each decade, and beyond age 70, a further decrease of 10 percent appeared to be justified.

Energy Expenditure

That physical activity may not decline significantly in healthy elderly women was suggested by Durnin and associates (1961, 1961a) who found their English subjects to expend 1987 or 2100 kcal daily, depending upon their family status (i.e., living alone or caring for a family). Further evidence to suggest that physical activity may not differ significantly between young and old individuals comes from comparisons of men and women either 17-45 years of age, or over 45 years (Durnin, 1966). Among both sexes and age groups, activity was less in the "plump" as compared with "normal weight" subjects. Although men over 45 years engaged in heavy exercise on only isolated occasions, a larger proportion of the young men worked at sedentary occupations. In respect to the female subjects, no differences were noted between the age groups.

Basal Metabolic Rate

Many investigators have chosen to examine the physical change occurring in total body basal metabolism with advancing age. Shock (1955) evaluating all pertinent data, concluded that the average values for basal calories/unit surface area, fall significantly with age in both sexes. Although the decrement is small when examined in terms of individual differences, it remains statistically significant when tested between the ages of 30 and 90.

Matson and Hitchcock (1934) reported that commonly accepted prediction standards as Harris-Benedict or Aub-DuBois, are not suitable for use with subjects over age 75, as these investigators observed their subjects to have a lower heat production than would have been predicted. Confirming evidence comes from the work of Dalderup and coworkers (1972) who concluded that age and height are less important, and weight a more important determinant, in the basal metabolism of older subjects. In this study, physical activity, serum cholesterol level, or cardiac ischemia, did not contribute to the variance in basal metabolic rates.

Benedict (1935), summarizing his findings with several series of subjects, states that "the total twenty-four hour heat production of women seventy-eight years of age and over appears to be close to 1000 calories, irrespective of weight or age." On the other hand, he suggests that low heat production as found in some elderly women does not necessarily indicate abnormality or lack of vigor.

Thyroid Function

One possible explanation for the decline in basal metabolism from youth to senescence is a change in thyroid function. Kountz and others (1949), when measuring serum protein-bound iodine and metabolic rate in 141 subjects between 25 and 100 years of age, observed a gradual decrease in organic iodide in males only; a finding correlated with basal oxygen consumption. This relation between organic iodide and basal metabolism in elderly males was confirmed by Ackermann and Iversen (1953). According to the latter workers, although the rate of thyroid uptake of iodine is lower in the elderly, the total absorption is actually greater, in that kidney removal of iodine from the blood is slowed.

Gregerman and coworkers (1962) evaluating thyroxine turnover in euthyroid men, concluded that the age-related decrease in thyroid function is a homeostatic adjustment necessitated by two factors; (1) a 50 percent decline in the thyroxine degradation rate, and (2) a change in thyroxine distribution space, interpreted to relate to decreased metabolic mass. A decrease in available thyroid hormone would not seem to be a factor in the reduced metabolic rate associated with advanced age.

Body Composition

A decrease in metabolic mass in later years, as alluded to previously, or change in body composition, may be involved with the observed difference in basal metabolism. Studies by Shock and others (1963) confirm that basal oxygen consumption when expressed per unit of total body water or intracellular water, does not show a significant regression with age. If loss of intracellular water is indicative of the loss of functional cells, it would suggest that oxygen consumption in those cells still remaining, has not changed.

Because potassium (K) as an intracellular cation is reported to remain constant in concentration, this measurement is a method of choice for estimation of fat-free metabolic mass. Relative to oxygen consumption, Allen (1960) observed a positive correlation in young male subjects of 314 kcal/day/K equivalent. Several investigators (Forbes and Reina, 1970; Novak, 1972) by the method of whole body counting demonstrated that total body K decreases with age in both sexes. In addition, females have less K/kg body wt at all ages, when compared with males. Data from work of Novak (1972) indicates that in males, loss of body K begins at age 20 and accelerates, reaching a maximum between 65 and 85 years. Loss in females was first noted at age 30, and was seen to accelerate between ages 40 and 50, with relatively little loss thereafter. Longitudinal observations by Forbes and Reina (1970) suggest that between ages 25 and 65, the average male loses 12 kilograms of lean body tissue, with the average female losing five.

With the age-associated decline in lean body mass, there occurs a corresponding rise in the percent of body fat. Among urban Minnesotans (Keys, 1955), submitting to body density determinations by underwater weighing, the percent of weight as body fat increased from age 25 to 55. During that period, body fat as a percent of body weight rose from 14 to 25 percent in males, and from 26 to 38 percent in females.

Population studies in Michigan (Montoye et al., 1965) and Czechoslovakia (Hejda, 1963) suggest that body fat as measured by triceps and subscapular skinfolds, increases until age 65 and then declines, particularly in men. This might denote the earlier death of the fatter individuals, or an actual loss of body fat in advanced age. Montoye and coworkers (1965) conclude, however, that those who do survive are more lean. Women at all ages possess a higher percentage of body fat than do men.

Evidence suggests that aging in women is accompanied by not only an increase in skinfold thickness but also a concomitant change in pattern of distribution. Skerlj and coworkers (1953) upon examination of 84 women from 18 to 67 years, noted that while total body fat as estimated by specific gravity continued to rise from middle to old age, subcutaneous fat and body weight did not. Inasmuch as body weight remained the same, the authors postulate that fat accrued by the female body in late maturity is inner fat; this accumulation would appear to occur in fat depots, or by organ infiltration, at the expense of other tissues.

Findings by Young and others (1963) lend credence to this suggestion, for among their subjects aged 30 to 50 years, skinfold and fat pad thicknesses accurately reflected changes in percent of body weight as fat. From age 50 to 70, however, total body fat increased by 32 percent; skinfold thicknesses did not change. At those ages, body density was most highly correlated with abdominal circumference.

Similarly, Wessel and coworkers (1963) observed marked gains in skinfold measures of the pubis, umbilicus, scapula, and waist, in women 50-54 years of age, suggesting fat deposition on the side, waist, and back. A comparison of white and Negro subjects aged 50 to 70 years (Ohlson et al., 1956) indicated that Negro women were more muscular and less fat, possibly due to more strenuous physical work.

Further evidence to support a relation between physical activity and body weight comes from other work by Wessel et al. (1966) who found a correlation coefficient equalling -0.8 between degree of exercise and body weight, in women aged 20 to 69 years. Relating body fat to functional response, absolute and relative weight and skinfold fat were lower in those women with higher rates of circulatory adjustment (i.e., lower oxygen uptake and pulmonary ventilation, following submaximal exercise). Alternatively, examination of 62 older women (Brown and Shephard, 1967) who as employees of a Toronto department store were physically active, revealed that 24 individuals were obese, being 10-30 kilograms above their ideal weight.

Even in subjects of normal weight, the gradual accumulation of body fat at the expense of lean body mass, is a natural consequence of aging. Physically active individuals, however, have less body fat than inactive subjects of similar age.

Protein Requirements

The traditional approach to the delineation of protein requirements for humans of all ages, has been the balance technique. According to a recent evaluation (Food and Nutrition Board, 1974) of the existing literature, the minimum nitrogen loss (via urine, feces, sweat, hair, sloughed skin, secretions, etc.) of a young, 70 kg man consuming no protein is 3.7 grams each day. Such loss would necessitate a daily protein intake of 0.45 grams/kg body weight. Differences of opinion exist among various investigators who consider the protein requirement of older adults to be either greater or less than that of young subjects.

Kountz and coworkers (1951), measuring nitrogen balance in four males aged 69-76 years over a six month period, observed that diets containing less than 0.7 grams protein/kg body wt/day resulted in excessive nitrogen loss in all subjects. These authors concluded on the basis of this study that an adequate protein allowance for older adults equals 1.4 grams/kg body wt/day. In regard to the concept of protein-sparing (Kountz et al., 1955), 400 additional calories in the form of carbohydrate or fat produced in individuals receiving 1.0 grams protein/kg body wt/day, additional nitrogen retention equivalent to that achieved by an increase of 5 to 10 grams protein in an isocaloric regimen, suggesting that the initial caloric intake was inadequate.

Conversely, high intakes of protein, above 1.5 grams/kg body wt/day, were poorly tolerated by elderly subjects (Kountz et al., 1953) causing abdominal distention and nausea, with marked increases in serum non-protein nitrogen levels. Plasma non-protein nitrogen in these four individuals ingesting 1.5 grams/kg body wt daily equalled 36 to 45 mg/100 ml. These values are similar to those observed by Addis and coworkers (1947) in young adults ingesting equivalent levels of protein. Plasma proteins did not change. Daum and associates (1952) noted that daily nitrogen retentions on a series of regimens supplying from 1.2 to 1.6 grams protein/kg body wt/day, were slightly lower in the older than in the younger subjects tested.

Other investigators (Roberts et al., 1948; Ohlson et al., 1952a), studying nitrogen retention in eight women ranging in age from 52 to 74 years, concluded that an average intake of 57 grams of protein daily was required for equilibrium, although for individuals, the requirement varied from 34 to 94 grams. One-half of the women were in balance at intakes of 0.71 to 0.75 grams/kg body wt, although others needed from 0.81 to 1.31 grams. A statistical relationship between intake and retention was apparent only at those levels resulting in negative balance; in the opposite circumstance, the absolute retention was influenced by other factors. A period of loss was followed by a period of retention if intake was sufficient; conversely, if previous intakes had stimulated retention, higher dietary protein would not increase retention, or in several instances, even decreased it. Among these subjects on self-selected diets, energy intakes less than 1800 calories daily were associated with nitrogen loss, reversible if total energy intake increased.

Compiled data from several studies of women in the North Central region (Ohlson et al., 1952) suggests that the protein requirement increases from ages 40-59, indicative of the physical stress during this period. Estimation of intake required for equilibrium rose from 66 grams at ages 30-39 to nearly 70 grams at ages 40-59, with a decline to 59 grams after age 70.

A factor not to be overlooked in the interpretation of balance data is that protein requirements are conditioned by previous intake, which in reference to the elderly, involves the eating habits of a lifetime. Present evidence would not support the conclusion that the protein requirements of older adults differ substantially from those of young adults whose growth is complete.

Amino Acid Requirements

The amino acid requirements for elderly people have not been defined as precisely as those for younger adults. Attempts to determine these requirements have been made by Tuttle and coworkers (1957) who found that when a diet containing the amino acids in the same ratio as in egg protein was fed at a level to provide 7 grams of nitrogen daily to men over 50 years of age, all subjects were in negative nitrogen balance. The same diet, when fed to normal young men, produced a state of nitrogen equilibrium. These authors therefore concluded that the amino acid requirements of older men are above the minimum levels previously determined to be adequate for nitrogen maintenance in young men. The daily amino acid intake of older subjects exceeded these established base levels. One concern in relation to this work is the relatively short experimental periods, as the balance studies were conducted for only six days. Older subjects, especially, may not adapt to a change in dietary pattern within this period of time.

Further study by these workers (Tuttle et al., 1959) indicated that amino acid requirements of older people are related to total calories and nitrogen. When energy intake was adequate to maintain weight, all subjects remained in equilibrium on the amino acid mixture described. If total nitrogen was doubled by the addition of glycine and ammonium citrate, seven of the eight men were in negative balance.

Watts and associates (1964) reported that the need for individual essential amino acids among their male subjects aged 65 years or older was not increased above that required for 25 year old males. Older males remained in positive balance or equilibrium when ingesting 41 to 53 percent of the young adult requirement for methionine. Amino acids were fed in the FAO or milk pattern. This finding is in contrast to that of Tuttle et al. (1957) who found that his older subjects could not remain in equilibrium on intakes of less than 2.4 grams of methionine daily as compared with the value of 1.10 grams, established as adequate for young adults.

As to the quantitative intake of essential amino acids on a self-selected diet, evaluation of the food intakes of 18 women ranging in age from 33 to 77 years (Mertz et al., 1952) revealed that methionine was first limiting, following by phenylalanine. In only 5 of 27 evaluation periods was the daily methionine intake equal to or above Rose's suggested requirements for young adults.

The tryptophane requirement, defined by the plasma response curve, was reported by Tontisirin and coworkers (1973) to approximate two mg/kg body wt/day in elderly subjects receiving protein equivalent to 0.5 grams/kg body wt/day. This level of nitrogen was previously observed to maintain equilibrium in the four males and 10 females tested. The tryptophane value determined for younger subjects using the same procedures equalled three mg/kg body wt/day. Those authors consider the decreased amino acid need to reflect lowered protein metabolism and diminished lean body mass in older individuals.

At the present time there is no conclusive evidence to support the theory that amino acid requirements are higher in aged adults. Hofstatter and associates (1950) measuring plasma levels of amino acids in young and old subjects of both sexes, found that older males had lower concentrations of valine, leucine, and isoleucine, whereas tryptophane, lysine, and isoleucine were lower, and histidine higher, in older females. These aged subjects, however, were hospitalized as a result of chronic disease. The significance of these findings is unknown.

Effect of Anabolic Steroids

Some workers have attempted to induce nitrogen retention in older patients of both sexes by use of anabolic steroids, but results have been inconclusive. Bew (1965) conducting a double blind trial of stanozolal (an anabolic steroid) in 18 elderly females, noted a significant increase in body weight, which in the absence of balance measurements, could reflect fluid retention rather than protein anabolism. Watkin and coworkers (1955) analyzing data from their series of balance studies concluded that anabolic steroids (both estrogen and testosterone derivatives) have no significant effect on nitrogen balance in subjects already in positive balance. If individuals on low protein diets were exhibiting nitrogen loss, steroids induced a positive effect, however, less than that produced by a higher protein intake without steroid therapy. In light of numerous unpleasant side effects resulting from steroid administration, it cannot be routinely employed as a means of effecting positive nitrogen balance in the elderly.

Plasma Proteins

Plasma protein, especially the level of albumin, has been used as an index of over-all protein nutriture in survey subjects. There is some disagreement as to the changes in plasma protein levels that occur as individuals age. One group of workers (Leto et al., 1970) found a negative regression between serum albumin and age, in a sample of 194 healthy males between 20 and 89 years of age. Despite the lower serum protein levels among the elderly, there were no other suggestions of protein deprivation.

There is a possibility that the lowered plasma protein levels reported by Leto et al. (1970) may have been a reflection of an existing or previous disease state in those individuals. This suggestion is based on the work of Woodford-Williams and coworkers (1965) who have shown that only those elderly persons who suffered from chronic diseases as osteo or rheumatoid arthritis or arteriosclerosis, had hypoalbuminemia, with increased globulin concentrations. Older subjects with no obvious pathology have serum protein values closely approximating young normals.

DeCosta and Moorhouse (1969) studying 43 individuals ranging in age from 73 to 87 years, detected no correlation between protein intake and serum albumin despite the fact that several subjects had diets low in protein. Plasma protein indices were within normal ranges. The precise relation between dietary protein levels, plasma proteins, and age, have yet to be defined.

Vitamin Requirements

On the basis of blood levels of a number of vitamins, it appears that older people metabolize these nutrients in the same way as younger people. This suggestion is based on nutritional status studies of older people in San Mateo, California (Gillum et al., 1955a; Morgan et al. et al., 1955); Groton Township, New York (Williams et al., 1951); and Onondago County, New York (Brin et al., 1965). Those surveys revealed no significant differences in serum values of vitamin A, carotene, and ascorbic acid, or in urinary excretion of thiamin and riboflavin, as a function of age. When departures from accepted levels are observed, they can usually be related to inadequate intake of the nutrient concerned. However, as pointed out by Exton-Smith (1968), biochemical variations in blood or urine which might have little significance in the younger person, may, in old age, when homeostatic mechanisms are often impaired or under pathological stress, be the first indication of frank malnutrition. Deficiency states in the elderly, according to that author, are most likely to result from inadequate intakes of the B complex vitamins, ascorbic acid, and vitamin D. The requirements for these nutrients would not appear to be elevated.

Water-soluble Vitamins

Thiamin.--Numerous studies have attempted to relate thiamin needs to health and well-being in older individuals.

Studies with 220 human subjects between 40 and 102 years of age by Kirk and Chieffi (Kirk and Chieffi, 1949; Chieffi and Kirk, 1950) revealed a slight decrease in blood thiamin with advancing age, whereas pyruvic acid levels did not change. These institutionalized patients were receiving diets presumed to be adequate in the vitamin. Clinical evaluation indicated a higher frequency of symptoms (i.e. general fatigue, tongue fissures, impaired vibratory sense, edema, and tenderness of the lower extremities), among those with blood thiamin levels below 2 ug percent. Upon supplementation with thiamin hydrochloride, blood levels rose to normal, with concomitant alleviation of the physical signs. When treatment was discontinued, all symptoms returned.

Rafsky and Newman (1943) noted that although all of their institutionalized subjects between 63 and 89 years of age who supposedly consumed an adequate diet exhibited normal levels of urinary thiamin, 17 individuals required more than one mg/day to produce tissue saturation. Alternatively, no clinical signs were visible in eight elderly subjects (Wertz et al., 1941) whose measured daily thiamin intake ranged from 0.62 to 1.22 mg/day. These workers discerned considerable variation from day to day in thiamin excretion by the same individual, as well as between individuals on the same level of intake. This finding was similar to that of Mickelsen et al. (1946) who, studying thiamin metabolism in young males, concluded that urinary excretion levels were an individual characteristic with a lesser dependence upon dietary intake.

Many investigators have proposed a specific urinary thiamin level as indicating dietary adequacy (Mickelsen et al., 1947). On that basis, individuals excreting reduced amounts of thiamin would be considered to be deficient in intake. That low urinary thiamin levels among older people do not always represent inadequate intake is suggested by the work of Rafsky et al. (1947). They found low thiamin excretions among individuals consuming an adequate amount of this vitamin. The reduced excretion could not be explained on the basis of decreased stomach acidity and consequent faulty absorption. Both low and high measures of urinary thiamin were found in subjects with anacidity, hypochlorhydria, and hyperchlorhydria. Roentgenological examination of patients with low thiamin excretion revealed no significant abnormalities (Maxwell et al., 1952).

Several investigators have examined the relation between thiamin need and advancing age using animal models. An early study by Mills (1948) reported that thiamin requirements in rats doubled with advancing age; no similar change was observed for choline, pyridoxine, riboflavin, or pantothenic acid. The basal ration fed in this experiment, however, consisted of 76 percent sucrose, possibly elevating the need for thiamin.

That any alteration in the thiamin requirement cannot be attributed to differences in mechanisms of absorption and phosphorylation is suggested by Draper (1958) who noted that thiamin was efficiently absorbed (95% of test dose) by rats up to the age of 20 months; beyond this time, absorption declined to a level of 75 percent of the given dose. Liver storage of esterified vitamin was lowered in the older animals.

Riboflavin and Niacin.--Little information is available regarding the riboflavin and niacin requirements of the aged. Vinther-Paulsen (1952) investigating the occurrence of glossitis in 98 patients from 65 to 96 years of age, discovered that 70 percent of the subjects failed to respond to supplementation with the B complex or brewers' yeast. Clinical manifestations of poor thiamin, riboflavin, niacin, and pyridoxine nutriture, in aged patients on a "supposedly good" diet, did respond to supplementation in a double blind study conducted by Taylor (1968). Among those 80 subjects, symptoms of angular stomatitis, cheilosis, swollen red tongue, and "blotchy" red skin, disappeared following several months of supplementation with the B complex vitamins, only to return upon the discontinuation of this therapy.

Horwitt (1953) concluded from several thiamin and riboflavin depletion-repletion studies with six older men (mean age = 70.5 years) and five younger men (mean age =

33.3 years), that under normal conditions, there is no indication of increased requirements for vitamins among older individuals. In the circumstance of low intake, both experimental groups responded with decreased urinary excretion; when the dietary vitamin was increased to RDA levels, tissue stores were replenished.

Pyridoxine.--For two other components of the B complex, pyridoxine and vitamin B_{12}, there is substantial evidence that serum values may decline in healthy, well-nourished aged people. Ranke and coworkers (1960) estimating plasma pyridoxalphosphate levels in terms of SGOT activity, noted a marked difference between young and old (institutionalized) subjects. Values in males dropped from 16.5 units/ml to 13.0, whereas means for females changed even more from 18.8 units/ml to 13.3. When the older men and women were given 250 ug of vitamin B_6 daily for several weeks, stimulated levels of SGOT equalled those normally found in the young. The study was not continued to ascertain if such induced levels are maintained.

Hamfelt's (1964) comparison of three groups; blood donors aged 20-29 and 30-59, and healthy volunteers over 60 years, revealed a significantly lower plasma pyridoxalphosphate value in the last group. Inadequate dietary intake was thought to be unlikely, although not measured.

Vitamin B_{12}.--Evaluation of serum levels of vitamin B_{12} in 324 subjects ranging from 10 to 89 years of age, revealed that the serum vitamin decreased significantly with advancing age (Chow et al., 1956a). Gaffney et al. (1957) found a similar decrement in serum vitamin B_{12} levels among 528 apparently healthy males aged 12 to 94 years. Among subjects aged 20 to 49 years, less than 1 percent had serum levels of vitamin B_{12} below 100 ug percent whereas 23 percent had values below 200 ug percent. In comparison, in the subgroup aged 50 to 94 years, 18 percent exhibited serum levels below the 100 ug level with 74 percent below 200 ug. That diet per se is not solely responsible for this change is suggested by evidence obtained from a sample of institutionalized subjects all of whom were exposed to the same diet for at least five years. When the serum values of these subjects were plotted in relation to age, the regression line obtained was similar in slope to that seen among the 528 males with varying diets.

In contrast, Waters and others (1971), in a ten-year follow-up of 673 Welsh subjects, found that serum vitamin B_{12} concentrations rose in all age categories, possibly as a result of a rise in living standards with an increase in consumption of animal protein over the intervening period; however, the lowest values still existed in the oldest age group.

Watkin et al. (1953) conclude that tissue stores of vitamin B_{12} are lower in older subjects, in that 24-hour excretion following intramuscular administration of a B_{12} preparation is less than that seen in younger males.

These changes in excretion pattern could not be explained merely by known differences in renal efficiency. Tissue unsaturation may be a consequence of a defect in the absorption mechanism of the vitamin (i.e., lack of intrinsic factor), as several laboratories (Chow et al., 1956; Chernish et al., 1957) working independently, have confirmed that absorption of vitamin B_{12} is significantly increased when administered together with a preparation of intrinsic factor.

Differences exist as to the therapeutic value of this vitamin in the treatment of psychological and emotional disorders arising in older patients. Hughes and coworkers (1970) observed that a B_{12} preparation had no greater effect than did a placebo upon the psychiatric state or general well-being of 39 elderly patients who had low serum vitamin levels but no evidence of macrocytic anemia. Similarly, supplementation produced a rapid rise in serum levels in the 44 persons aged 81 to 99 years treated by Davis and associates (1965). There was no evidence of improvement in relation to weight gain, appetite, or sense of well-being.

Conversely, a double blind study of patients above 65 years of age (Rafsky, 1954), all of whom had complained previously of fatigue, revealed that 89 percent showed clinical improvement following injection of crude liver preparations. Upon replacement of the supplement with placebo, the symptoms returned. Mental confusion and disorientation in elderly patients is usually assumed to reflect cerebral atheroma, vitamin deficiency being recognized only infrequently as the cause of the disturbance.

Folic Acid.--Lowered serum folate has, in older people, been associated with macrocytic anemia. Hurdle and Williams (1966) identified folic acid deficiency in 28 of 72 patients over 70 years of age, seeking admission to a geriatric hospital. Degree of disability was significantly related to serum folate levels. Girdwood and coworkers (1967) reported low serum folate in 8 percent of hospitalized elderly patients, whereas vitamin status among subjects of equivalent age living in their own homes, did not differ from young controls. Further evidence is derived from the work of Meindok and Dvorsky (1970) who compared 59 elderly persons residing in institutions and 51 subjects of similar age living independently, with 100 young controls. These workers found low levels of serum folate in 24.0 percent, 7.8 percent, and 5.0 percent of the respective groups. These papers suggest that differences observed between younger and older people in reference to folic acid status, are the result of low dietary folate, rather than increased requirement or alteration in metabolism.

Ascorbic Acid.--Ascorbic acid deficiency has long been associated with clinical manifestations of skin hemorrhages (senile purpura) and sublingual petechiae. Inasmuch as these signs are frequently observed among older individuals, it has frequently been assumed, a priori, that their requirement for ascorbic acid is increased.

Disselduff and Murphy (1968), among 20 hospital patients between 68 and 97 years of age, found no relation between low levels of leucocyte ascorbic acid and either senile purpura or sublingual lesions. Half of their patients were given from 50 to 1000 mg of vitamin C daily. The other subjects received placebos. Two patients in each group of ten, showed a disappearance of clinical signs within two weeks.

Although older people frequently have petechial hemorrhages or comparable lesions, these may not always be the result of a vitamin C deficiency. This is suggested by the report (Andrews et al., 1969) that the sublingual lesions observed at necropsy of 17 older people were presumably due to increased venous pressure. An ascorbic acid deficiency was not the cause, since histological examination revealed the presence of aneurysmal dilations of intact venules, with no sign of hemorrhage. Increased venous pressure rather than ascorbic acid deficiency, would appear to have caused this degenerative change.

Morgan and others (Morgan et al., 1955) investigated the vitamin status of 569 apparently healthy men and women over 50 years of age. Women at all ages had higher serum ascorbic acid than men, 1.07 compared with 0.83 mg percent. Males had higher dietary intakes on an absolute basis; however, when intake was expressed in terms of body weight, the differences were not significant. Inasmuch as serum vitamin was directly correlated with dietary intake, Morgan suggests that the requirement of men over 50 years of age may exceed that of women of similar age. No changes in serum ascorbic acid with age were found among other subjects ranging in age from 21 to 74 years (Williams et al., 1951), although women had substantially higher values, seeming to confirm the observations of Morgan. Other investigators previously reported this sex difference in serum ascorbic acid levels in young subjects.

According to studies by Kirk and Chieffi (1953) serum ascorbic acid does decline in institutionalized men as a function of age, with values for both sexes about one-half those of young controls. Absorption would not appear to be impaired, as supplementation by mouth of 100 mg of vitamin daily demonstrated a marked rise in serum levels. Analysis of hospital food by Eddy (1968) revealed that delay in serving patients cooked potatoes and vegetables can result in a loss of at least 75 percent of the ascorbic acid.

Fat-soluble Vitamins

Vitamin A.--Of the fat soluble vitamins, vitamin A metabolism was studied by Gillum et al. (1955a) in the San Mateo subjects described previously. Although a small age-associated decline occurred in serum vitamin A and carotene, the difference was not significant. Only 5.6 percent of the sample had serum vitamin A below 30 ug percent, and nearly one-half of the group had serum levels ranging between 40 and 60 ug. Inasmuch as thickening of the bulbar conjunctiva was identified in 94 percent of the participants, it would appear that this lesion is a consequence of aging rather than vitamin A deficiency.

A similar conclusion was reached by Chieffi and Kirk (1949) who examined 155 persons over 40 years of age. Classical symptoms of vitamin A lack, as conjunctival thickening, dry skin, and follicular hyperkeratosis, were more frequent among those with low (1-15 ug/100 ml) plasma vitamin levels than among those with higher levels. They suggested that the effect of age on the structure of the eye was considerably greater than that of nutrient level.

Yiengst and Shock (1949) offer evidence that vitamin A absorption is not impaired, as administration of 100,000 I.U. of the vitamin to 126 males between 40 and 80 years of age revealed no differences in maximum serum levels. Subjects over the age of 70, however, required 6-8 hours to reach this value as compared with 3-4 hours required in the younger men. The return to fasting levels was slower in older than younger subjects. Whether these differences would also occur upon administration of normal dietary levels of this vitamin, is not known.

<u>Vitamin D</u>.--In view of the increasing incidence of osteoporosis among the elderly, especially in females,

attention has been directed to the major nutrients involved with bone calcification, including vitamin D. Although laboratory methods exist for the determination of vitamin D in blood, the procedure requires a fairly large sample and has not been adequately evaluated. One study (Neer et al., 1971) suggests that increased production of vitamin D by exposure to ultraviolet light improves calcium absorption in older people. These investigators, by balance technique, found a significant increase in calcium retention among those elderly males exposed to ultraviolet light for one hour daily over a three month period. Controls of similar age who experienced no change in calcium absorption, were not treated with the ultraviolet lamps, and in addition, were not exposed to natural light. Further research to define the requirement for and effect of vitamin D supplementation in elderly adults, especially as it relates to bone disorders, is urgently needed.

Vitamin E.--Recent interest in the requirement for vitamin E has been generated by the increasing substitution of polyunsaturated for more saturated fats in the diet. Horwitt (1960) suggested that the need for alpha tocopherol is directly related to the quantity of polyunsaturates or specifically, linoleic acid, ingested.

Dayton and coworkers (1965) studied vitamin E metabolism in two groups of elderly men consuming diets containing 40 percent fat. For the experimental group, Polyunsaturates comprised two-fifths of the total fat; for controls only one-tenth. Although tocopherol intake for the experimental group did not equal recommended levels of 0.6 mg/gm unsaturated fat, no subject exhibited deficiency signs. A later report by these investigators (Pearce and Dayton, 1971) suggested that cancer mortality was increased among those men receiving the diet high in polyunsaturated fat.

Other workers have been concerned with serum levels of tocopherol in relation to advancing age. In two populations studied in which subjects ranged in age from 17 to 64 years (Herting et al., 1965), and 30 to 81 years (Harris et al., 1961), respectively, serum values of this vitamin did not change. When subjects were supplemented with vitamin E (McMasters et al., 1965), the magnitude of increase in blood levels was similar in all age groups. In contrast, Chieffi and Kirk (1951) reported a tendency for plasma tocopherol levels to rise with increasing age; this was true for men but not women. Others found that among a random sample of patients over 25 years admitted to a municipal hospital (Leevy et al., 1965), low levels of plasma tocopherol were not related to age or sex.

Minerals

Calcium.--Much attention has been directed toward the requirement for calcium in older individuals. This stems from the fact that osteoporosis, resulting from loss of one-third or more of the bone mineral, is one of the most debilitating diseases of later life; furthermore, it carries with it the increased probability of bone fracture. The high incidence of this disease among women is emphasized by Iskrant and Smith (1969) who found significant vertebral atrophy in 80 percent of 2000 women examined in Detroit. During the three years following that examination, occurrence of bone fracture among these subjects, all over 65 years of age, was directly related to the degree of bone demineralization.

Bone Mineral Loss

Extensive evaluation by numerous scientists would imply that the degree of bone lost in later years is a complex phenomenon, displaying interaction among physiological, hormonal, racial, socioeconomic and dietary variables. That this demineralization of bone is not of recent origin is supported by the study of prehistoric skeletons. An anthropologist (Perzigian, 1973) observed that age-associated bone loss characterized peoples in antiquity, suggesting a basic metabolic phenomenon among all human species.

Garn (1972), summarizing aspects of accretion and loss of cortical bone in over 13,000 subjects from seven countries, states that loss of cortical bone begins by the fifth decade in both sexes, and over a period of 50 years approximates in males and females respectively, 15 percent and 39 percent of total bone mineral. Relative to bone dynamics, tubular bone adds to the subperiosteal surface beginning in the fetal period and continuing throughout life. At the endosteal surface, bone is lost until the adolescent growth spurts; from that time on, mineral continues to accrue through middle age. Beginning at age 40, the rate of osteoclastic activity exceeds osteoblastic deposition with the consequent demineralization of the skeleton. Garn concludes that skeletal bone in old age is a function of the degree of skeletal development at maturity; however, the percent of total bone lost is less in males than in females; in Negroes than in whites; and in taller versus shorter individuals.

That dietary factors apart from those most directly linked with bone formation may be associated with bone structure was suggested by Morgan and coworkers (1962). They reported that among 719 women over 50 years of age, bone density was directly correlated with serum levels of vitamin A, carotene, ascorbic acid, and cholesterol.

Steroid hormones have been recognized as exerting distinctive effects upon tubular bone (Garn, 1972). The outer bone surface is specifically responsive to testosterone, the inner bone surface to estrogen. With the decline in gonadotropin in later life, the inner bone surface of the older female undergoes considerable resortion, as similarly it gained in adolescence. Following menopause, bone loss accelerates. The estrogen effect is manifest further as the endosteal apposition is significantly enhanced during the first trimester of pregnancy. Alternately, Smith (1967) suggests that metacarpal thickness decreases more rapidly in women undergoing castration menopause.

In regard to the genetic influence upon bone calcification, Smith and Rizek (1966) reported that Negro women in southeastern Michigan suffered significantly less age-associated loss of compact bone than did whites. Among the latter, women of Anglo-Saxon ancestry appeared to be particularly prone to vertebral atrophy.

One explanation for the negative calcium balance observed among older individuals is inadequate dietary intake, coupled with obligatory urinary loss. A comparison of dietary histories by Hayes and coworkers (1956) revealed no differences in intake between 47 older subjects who suffered fractures, and a similar group who did not; however, twice as many women with fractures had protein takes below the RDA. Further investigation regarding milk drinking habits in childhood, demonstrated that those suffering fractures had consumed greater quantities of this food. Further suggestion that dietary calcium has only a minor effect upon mineralization of compact bone comes from the work of Zeegelaar and associates (1967) who noted that osteoporosis is less common among natives of South America where lifelong calcium intakes are less than 500 mg/day, compared with United States citizens where the intake is much greater.

The role of dietary calcium as a factor influencing the development of osteoporosis is still unsettled. Part of the problem arises from the fact that in many studies, the supplementation of calcium was begun only after the clinical signs of osteoporosis became evident. In one such study, five osteoporotic patients were fed diets and supplements which provided 800 to 1600 mg each day (Whedon, 1959). These patients according to both x-rays of the vertebral bones and clinical evaluation, showed considerable improvement.

In contrast to these results is a study of 39 British women over 70 years of age (Exton-Smith et al., 1966). There were no differences between the women who had lightly or densely calcified bone, as far as intakes of calories, protein, calcium or vitamin D were concerned. Low bone density was associated with low serum calcium-phosphorus products.

A possible impairment in calcium absorption has been proposed in relation to bone fractures in later life. Draper (1964) noted that calcium absorption was unimpaired in senescent rats, as these animals could respond to increased physiological demand for calcium by

increasing intestinal uptake. However, senescent animals are also more susceptible to negative calcium balance as a result of accelerated skeletal catabolism.

The importance of calcium absorption among older people is in an equivocal state. On the basis of Garn's (1972) suggestion, there is little possibility of overcoming the osteoclastic process which inevitably should lead to bone demineralization. There are a few reports suggesting that a decrease in bone density may not necessarily be an accompaniment of the aging process. One of these is the study by Ohlson and coworkers (1952) who noted that women 30 to 85 years of age (n = 136) remained in calcium equilibrium over a wide range of intakes provided they ingested at least 1500 kcal every day. From the fourth through the eighth decade, the predicted calcium requirements were 0.88, 0.87, 0.83, 0.92, and 0.73 grams/day, respectively. Balance periods among these subjects ranged from seven to ten days.

Conversely, Ackerman and Toro (1953; 1954) found that eight men and an equal number of women, all ranging from 48 to 80 years, required at least 0.79 and 0.66 grams of calcium/day, respectively, to remain in positive balance. One male subject remained in negative calcium balance despite an intake of two grams daily. One problem encountered in all balance work is that of adaptation to previous intake. Among the 20 males studied by Malm (1958) 28 to 252 days were required for adaptation to reduced intakes. Absorption studies with radioactive calcium reveal no differences in absorption pattern or cumulative excretion between osteoporotic females and age-matched controls (Canniggia et al., 1965), although plasma ^{45}Ca levels one hour following administration were inversely correlated with age.

The increasing use of food additives containing phosphorus has led to some concern as to a change in the calcium-phosphorus ratio in the American dietary. The effect of varied calcium-phosphorus ratios upon bone mineral deposition and resorption has been explored in animal models. Shah and coworkers (1967) reported that mice fed a Ca:P ratio equalling 2:1 stored more bone than those receiving a 1:1 ratio of minerals. Other authors (Draper et al., 1972) suggest that a relative excess of phosphorus may depress intestinal calcium absorption and inhibit bone salt formation by creating a secondary hyperparathyroidism, with a depression of serum calcium.

Epidemiologic evidence suggest that lifelong intakes of fluoride, in the drinking water of some communities, retards age-associated bone loss. The ingestion of fluoride at low levels enhances bone mineral crystallization rendering it less soluble and therefore less susceptible, to resorption. Comparison of two populations over 45 years of age in North Dakota (Bernstein et al., 1966) indicated that fluoride intake significantly affected bone density in women, although no such statistical association was detected in men. Those women drinking water containing 4.0-5.8 ppm fluoride had greater bone density and less evidence of collapsed vertebrae than those whose water supply contained 0.15-0.30 ppm of this halogen. A similar study by Leone and associates (Leone, et al., 1955) over a period of ten years in Texas revealed that ingestion of water containing up to eight ppm of this element produced no deleterious bone changes. Rather, the authors conclude, the "fluoride effect" may be beneficial upon adult bone. Although fluoridated water, consumed over a fairly long span of the individual's life, may have a beneficial effect on bone mineralization, the ingestion of fluoride after osteoporosis has become apparent, may not be beneficial. This is based on the report by Cohn and coworkers (1971). They observed no significant increase in total body calcium over a period of two to seven months of fluoride supplementation.

Iron.--According to a recent national survey (U.S. Department Health, Education and Welfare, 1972a) approximately 10 percent of the women and 4 percent of the men over 44 years of age had hemoglobin values below 12 gm/100 ml, which frequently is implied to be an iron-deficiency anemia. If it is the latter, a primary cause could relate to diminished absorption of the metal, coupled with occult blood loss. From a theoretical standpoint, there are a number of possible explanations for any reduction in iron absorption among older people. One of these relates to achlorhydria which frequently develops in older individuals. However, uptake of a supplement of labelled iron was not lowered among achlorhydric patients (Jacobs and Owen, 1969). These investigators found that absorption of inorganic iron was, on the other hand, significantly less in subjects below 30 years of age than in persons over 50 years, however, no such difference existed following administration of heme iron.

In contrast, Freiman and associates (1963) report that healthy individuals aged 69 to 85 years absorbed 49—61 percent of ingested ^{59}Fe administered under fasting conditions. Young controls assimilated 71 percent of a similar dose, although this difference was not significant. Inasmuch as the percent of iron absorbed usually reflects need these values suggest existing iron deficiency anemia among both young and old subjects, although hemoglobin levels were within normal limits.

A less than adequate iron intake among older individuals can be accentuated by occult blood loss. Observations in Goteborg (Hallberg and Högdahl, 1971) confirmed that anemia in women over 75 years of age, living independently, was usually related to loss of blood in the stool. A review by Jacobs (1971) emphasizes that iron deficiency anemia in the elderly subject signals an abnormal condition with underlying blood loss and pathology, rather than increased physiological requirements. Balance studies with 70 year old subjects (Finch, 1959) show that physiological iron loss was approximately 0.6 mg daily as compared with the value of one mg daily, established for young males.

Among 340 subjects of both sexes aged 50 years or older, the hematocrit and erythrocyte counts decreased slightly with age, although not significantly so (Fowler et al., 1941; Renbourn and Ellison, 1952; Shapleigh et al., 1952). Gillum and Morgan (1955) reveal that older males had higher values for hemoglobin and packed cell volume than older females. This is also true of younger men versus younger women. A possible explanation for this difference may exist in the quantities of food consumed by men and women. The men in the California study (Gillum and Morgan, 1955) ingested approximately 25 percent more calories, protein and iron/kg body wt. The status of men, as far as iron nutriture is concerned, is influenced by their living conditions. This becomes apparent when it is recognized that elderly males living alone (Hobson and Blackburn, 1953) have significantly lower hemoglobin levels than men living with their spouses. Brewer et al. (1956) noted that institutionalized elderly displayed a greater variability in hemoglobin concentrations than is usually found in younger populations. One possible explanation involves the differences in the acceptance of various foods by older age groups which may in turn reflect the response of the individual to his (her) environment.

Factors Influencing Food Choices of Older People

Daily food choices and consequent nutrient intake are influenced by the interaction of multiple variables, both internal and external in origin. There are probably many factors which interact to influence an older individual's choice of foods. Obviously, such choice is likely to be severely restricted for those older individuals who are institutionalized. For those who are not physically confined, their food habits will be molded by physiological, psychological, social and economic factors, as well as the availability of different foods. To a certain extent, the latter point has been ignored by Troll (1971) who suggests that life in old age is much more a continuation of past ways of living than of marked change. In the United States, there have been so many and such drastic changes in agriculture and food technology, that it is almost impossible for elderly individuals to adhere completely to early eating patterns. Relative to the eating practices of the elderly, the mere fact of their survival attests to some degree of adequacy in this regard.

On the other hand, aging is accompanied by change; the aging body is increasingly sensitive to minor upsets; the accustomed social pattern is disrupted; personal income declines; physical activity is slowed. Consequently, advancing age may bring changes in the customary food pattern, with resultant differences in nutrient intake.

Age

Numerous investigators have observed differences in nutrient intake between younger and older individuals. One change, frequently reported, is a reduction in caloric intake after the age of 55. This trend was noted among London women living alone (Exton-Smith and Stanton, 1965), 780 Canadian subjects (Monagle, 1967), patients in Melbourne, Australia (Saint et al., 1953), healthy elderly in Dublin (Wilson and Nolan, 1970), and 2189 women in the North Central states (Swanson et al., 1959). For the latter, mean intakes for many nutrients were definitely lower among those 70 years and older than among subjects in their thirties. Daily intake declined per decade by 85 kcalories, 4 grams protein, 30 mg calcium, 1.4 mg ascorbic acid, and 194 IU vitamin A. The reduction in specific nutrients with advancing years and the degree to which this occurs, depends, to a certain extent, on the dietary practices of the older people. This was suggested by the higher intakes of calcium and riboflavin among 32 Nebraska women 75 or more years old (Fry et al., 1963). These women continued to consume significant amounts of milk and milk products.

It was noted among the London women (Exton-Smith and Stanton, 1965) that nutrient intake declined as a result of changes in the quantity, rather than the kinds of food consumed; nutrient density per thousand kcalories did not decrease. The reduction in kcalories was brought about primarily by a lowering of dietary protein and fat.

Further evidence for this trend is supplied by Davidson and associates (1962) who noted that among 130 apparently healthy, aged subjects, the use of milk, eggs, meat and fish, declined during adult life. In contrast to these findings, a nutritional survey of families in Groton Township, New York (Wilhelmy et al., 1950), revealed no relationship between the intake of high protein foods and the age of either husband or wife.

Physical Aspects

State of Dentition.--One factor possibly associated with changes in the food choices of older people might be the increased incidence of oral lesions and loss of teeth. In 81 percent of 785 institutionalized elderly people (Bhasker, 1968) with no subjective symptoms, there was soft tissue pathology ranging from innocuous pigmentation to early squamous carcinoma. Problems with mastication were reported among 70 patients over 65 years in Melbourne, Australia (Saint et al., 1953). Dietary intakes as a result thereof, were lowered among three individuals who were edentulous, and 20 who were handicapped by ill-fitting dentures.

Alternatively, protein intake in gm/kg body wt, was inversely correlated with chewing efficiency in the study by Davidson et al. (1962); however, no relation was found between nutrient intake and oral status. Evidence that ability to chew may be involved with ascorbic acid nutriture has been advanced by Exton-Smith and Stanton (1965). These investigators describe two elderly subjects in London who, having only few teeth and no dentures, avoided "hard or tough foods" as fruits and vegetables. As would be anticipated, both women had low intakes of ascorbic acid. Further support for this hypothesis is provided by Morgan and coworkers (1955) who reported that one-half of those subjects with serum ascorbic acid levels below 0.5 mg/100 ml were edentulous, as compared with one-third of those having serum values above 1.1 mg/100 ml, although this difference was not significant.

That dentition is not always the factor limiting nutrient intake is indicated by studies in a number of places in the United States. Healthy people in Groton Township, New York (Wilhelmy et al., 1950), and rural Pennsylvania (Guthrie et al., 1972), demonstrated no influence of dentition upon nutrient intake; only six of 695 aged in Linn County, Iowa (Fuller et al., 1963), reported that dental difficulties interfered with eating. Among 100 older subjects in Westchester County, New York (Jordan et al., 1954), 65 rated their ability to chew as "good," 11 as "fair," and 24 as "poor," with 76 of the group wearing dentures. Only four members of this sample related state of dentition to a change in food habits. Similarly, a USDA survey of older households (Le Bovit and Baker, 1965) revealed that of subjects with poor, fair, and good diets, 5 percent, 6 percent, and 3 percent, respectively, reported difficulty with chewing.

Sense of Taste.--Closely associated with dentition and condition of the oral cavity is the sense of taste, often thought to diminish in sensitivity with advancing years. Nizel (1974) suggests that acuity of taste for salt regresses, as a result of gradual nerve degeneration and/or hyperkeratinization of the epithelium, with subsequent occlusion of taste bud ducts and pores. That sensitivity to all four modalities: sweet, sour, salty, and bitter, begins to decline after the age of 55, has been reported by Cooper and others (1959) from studies of 100 subjects from 15 to 89 years.

Glanville and coworkers (1964) observed that threshold sensitivity to sour sensation decreased less rapidly in females than in males. Henkin (1967) has commented that steroid hormones may play a role in the normal maintenance of the taste bud; however, the extent of this influence relative to taste loss in older people, is not known.

Loss of Appetite.--Loss of taste among older people has been suggested by some investigators as being responsible for the reduced caloric intake among this age group. Vinther-Paulsen (1952a) suggested that primary disturbances of appetite regulation might lie in the lessened secretion of digestive enzymes, along with changes in endocrine function or psychological depression. Not all older people are aware of any change in that 77 percent of the 126 institutionalized elderly in Cherokee, Iowa (Ginzberg and Brinegar, 1954), stated that their appetite was good. Of the 16 percent reporting only fair appetites, most objected to the particular kinds of food they received. The 7 percent with poor appetites were acutely ill and/or suffering from gastrointestinal disorders. Of the people in Boston, who lived in their own homes (Davidson et al., 1962), most considered their appetites to be good to excellent, although many thought of eating as a necessity rather than a pleasure.

State of Health.--Since chronic diseases are common among older people, those who are affected may be limited in their dietary choices by the special diets to which they are restricted. Such evidence is provided by Taylor and coworkers (1971), who, studying 216 elderly in the United Kingdom, found that vascular and epithelial lesions suggestive of vitamin deficiency and low intakes of fruits and vegetables, were significantly more frequent

among those under treatment for chronic illness. State of dentition was not recorded. This finding was supported by other data obtained from Sheffield elderly (Bransby and Osborne, 1953) who tended to reduce their intakes of cereals, biscuits, fruits, vegetables and animal protein, as their health deteriorated. Exton-Smith and Stanton (1965) conclude that although subjects with better than average health consume better than average diets, it cannot be assumed that health influences diet, as the reverse might also be true. That therapeutic diets need not restrict dietary intake is suggested by the USDA survey in Rochester, New York (Le Bovit and Baker, 1965). Those individuals requiring special diets were not consuming "poor" diets. The reverse was true in that the percentage of subjects with organic disturbances who chose poor, fair or good diets, were 22 percent, 34 percent, and 30 percent, respectively.

Social-Psychological Aspects

Social Isolation.--As indicated by Troll (1971), food frequently fulfills social and psychological needs relating to companionship, comfort, and sense of personal and family well-being. By implication, this might mean that social isolation should have an adverse effect on nutrient intake. Whether or not the transition from a family social to a solitary meal situation affects the intake of nutrients, has been the subject of much consideration.

Davidson and coworkers (1962), in the study described previously, reported that "socially isolated" men and women had less variety in their meal pattern, with lower mean daily intakes of all nutrients except iron. Similar findings were reported for the elderly in Dublin (Wilson and Nolan, 1970) where degree of social contact was significantly related to nutrient intake. Those individuals living with relatives had improved overall dietary intake as compared with those who lived alone but obtained some meals at a day center. The subjects who resided alone and never shared meals, consumed less protein, iron and ascorbic acid, with fewer calories.

A survey of 1771 English elderly (Bransby and Osborne, 1953) over 60 years of age, revealed that men and women living alone ate less of those foods requiring some preparation as potatoes, puddings, or sauces. In the previously cited Rochester study (Le Bovit and Baker, 1965) single women consumed as many calories as did those living with their spouses; however, the former had higher intakes of carbohydrate, calcium and ascorbic acid, with less fat. Conversely, Batata and coworkers (1967), studying 100 patients in reference to iron, ascorbic acid, folic acid and vitamin B_{12} nutriture, concluded that the old person living alone was no more likely to be deficient than those with companions.

Sex.--Further consideration of the nutritional status of aged persons living alone does reveal striking differences between males and females. That men are more vulnerable to nutritional inadequacies, being less accustomed to food preparation, has been shown by the Rochester data (Le Bovit and Baker, 1965) in which men residing alone had the highest percentage (39) of poor diets. Exton-Smith and associates (1972) provide additional evidence, in that solitary men over 75 years had a significantly higher incidence of anemia, with low serum folate and ascorbic acid. This might be related to the low consumption of fruits and vegetables by older men living alone (Bransby and Osborne, 1953).

Meal Pattern.--In that retirement places fewer demands upon one's time, several studies have focused upon meal patterns of older individuals. For persons over 60 years of age in Linn County, Iowa (Fuller et al., 1963), the traditional three meal pattern was the favored choice according to 95 percent of those questioned. Fourteen percent of those living alone, consumed only two meals daily.

Relative to cultural differences, surveys of the aged in Westchester County, New York, (Jordan et al., 1954) and New Zealand (Davidson and Butler, 1971), indicated that about one-half of the respondents in each group have their main meal at noon. Investigating sex differences, Lyons and Trulson (1956), studying Boston aged, report that

87 percent of the women as compared with 65 percent of the men enjoyed three meals per day; the remainder chose to have only two. Equal numbers of both sexes had one or more snacks each day. According to Bransby and Osborne (1953) "meals skipped" tend to increase with age, as records of men over 75 years of age revealed that 12 percent did not eat at noon, whereas 14 percent had no evening meal. This finding might relate, in part, to lapse of memory among the older subjects.

Food Faddism.--That food faddism may influence nutrient intake in older people is suggested by the work of Davidson and others (1962), who observed higher intakes of protein (gm/kg body wt), vitamins A and C, thiamin and riboflavin, among those indicating an interest in "health foods." Mayer (1962) reviews this problem, citing that older persons often function at a lower level of information than the young; their isolation, sense of frustration, and incurable chronic complaints, probably make them more susceptible to the cures advertised by the food faddist. Chinn (1956) reports that eight of 500 patients, seeking hospital admission for long term illness, presented definite psychiatric disturbances and had stopped eating. Others with senile psychoses had developed paranoia regarding the ingestion of "unsuitable" food.

Economic Status.--According to current census statistics (U.S. Bureau of Census, 1971) about 4.5 million or one-fourth of all older Americans live in households with total incomes below the poverty threshold. Although the aged comprise only 10 percent of the population, they represent one-fifth of the nation's poor.

Income level and quality of the diet are frequently related. Among Iowa women (Swanson et al., 1959) and Groton Township families (Wilhelmy et al., 1950), protein intake increased with the amount spent for food. For the rural Pennsylvania elderly (Guthrie et al., 1972), dietary protein, iron and riboflavin, were less in low income families. Chope and Dray (1951) confirmed that serum ascorbic acid was directly related to economic status, as 42 percent of the low economic group, 20 percent of the middle income subjects, and none of the high income class, demonstrated serum levels below 0.5 mg/100 ml. The money value of home meals for Everett, Washington, families (Van Syckle, 1957) ranged from 16 to 56 cents/person. When this figure was less than 25 cents/meal, no household attained 100 percent of the RDA for all nutrients. At a cost of 24-44 cents/meal, nine households had "adequate" supplies of nutritious food, although ten families did not. Above this level of spending, all families had available the recommended levels of nutrients. A generous supply of calories does not guarantee that other nutrients will be adequate as 6 of 16 families ingesting 135 percent of the recommended kcalories were still low in calcium, ascorbic acid, riboflavin, or a combination of these.

CHAPTER II

INFLUENCE OF PHYSIOLOGIC, SOCIOLOGIC AND ECONOMIC FACTORS UPON NUTRIENT INTAKE OF OLDER WOMEN

Introduction

Medical advances in the conquest of infectious diseases have increased markedly the lifespan. In 1970, the population of the United States included 20 million persons above the age of 65. This number will have doubled in 50 years (U.S. Bureau of Census, 1970).

Troll (1971) suggests that aging is accompanied by change: the aging body is increasingly sensitive to minor upsets; the accustomed social pattern is disrupted; personal income declines; and physical activity is slowed. All of these factors may result in changes in the customary food pattern, with subsequent alterations in nutrient intake.

Swanson et al. (1959) observed that intakes of energy, protein, calcium, ascorbic acid, and vitamin A, were significantly lower among Iowa women aged 70 years and older as compared with those in their thirties. "Socially isolated" aged Bostonians had less variety in their meal pattern, with lower daily intakes of all nutrients except iron, according to Davidson and coworkers (1962). In contrast, a USDA survey of older households in Rochester, New York (LeBovit and Baker, 1965), revealed that organic diseases requiring special diets were not associated with lowered nutrient intakes. Rather, the individuals who followed modified dietary prescriptions had a higher percentage of good diets than did those not so restricted.

To ascertain the influence of social, psychological, and economic factors upon the nutrient intake of older women, the author re-examined the survivors of a sample of 103 women previously studied by Ohlson and associates in 1948. The women now range in age from 64 to 90 years.

Methods

Original Study

In 1948, Ohlson and associates initiated a study of 96 white women between the ages of 40 and 88 years, residing in Lansing, Michigan. The subjects were chosen at random by the following sampling procedure (Harper, 1956). All blocks within the city limits (1185) were systematically numbered and this figure divided by 100, the number of subjects to be included. For the total of 100 interviews, every twelfth block was visited. With the aid of the Lansing City Directory, all residences in each block were listed in order and assigned a number. The household chosen for the first visit in each block was selected by lot. If a woman above 40 years of age did not reside in that dwelling, or if she could not or would not participate in the study, the procedure was repeated until a subject was secured. By this means 96 subjects began the program. A ninety-seventh subject, a Lansing resident recommended by one of the original sample, joined the study in 1950.

In 1948 and 1950, the women were interviewed by trained personnel from the Department of Foods and Nutrition, Michigan State University. Each subject provided a one-day dietary recall in addition to a health and nutritional history, and facts relating to marital and socioeconomic status. All subjects were rated according to a qualitative index for signs of aging. Forty-five of the participants submitted to a physical examination given by a mobile unit survey team from the U.S. Public Health Service. This nutritional evaluation included the determination of hemoglobin values and fasting serum levels of vitamin A, carotene, and ascorbic acid. A study of basal metabolic rate was performed on 20 subjects, along with rates of oxygen consumption in exercise and recovery. Eighteen of the women cooperated in balance studies of nitrogen, calcium, and phosphorus. These data have been published (Ohlson et al., 1948; 1948a; 1950; 1952; 1952a). A resurvey was completed in 1955 at which time a one-day dietary recall record as well as current information relating to socioeconomic, martial, and health status, was obtained from 55 of the original subjects.

Present Study

Examination of all original records made possible the identification of the 97 subjects who participated in the nutrition survey in 1948, as well as six additional subjects of similar age who had been recruited for metabolic studies at that time. Inasmuch as food records were available which indicated the nutrient intakes of the metabolic subjects when on self-selected diets, these women were included in the follow-up, making a total of 103 subjects.

Intensive search revealed 42 survivors of the original group of 103 women. Three of these died thereafter, making a total of 60 subjects known to be deceased. No information could be found regarding the current whereabouts of four women in the original sample; however, none of these could be located at the time of the resurvey in 1955. All known survivors were sent a letter of introduction indicating plans for the present study (Appendix A-1).

Twenty-eight of the 39 survivors participated in the 1972 study. Six of the 11 women who refused to cooperate lived in Lansing, and five of these appeared to be in good health. Reasons given for not wishing to participate included working full-time, suspicions regarding invasion of privacy, and not wishing to be bothered. Three other women, living at some distance from Lansing or out-of-state, were reached by letter, and for the two in Michigan, by telephone as well, but would not cooperate.

Two of the survivors were being cared for in homes for the aged; the families of these women objected strongly to any visitation by the author.

The 28 subjects, ranging from 64 to 90 years, who did agree to participate were interviewed by the author to secure a 24-hour recall dietary record and nutritional history (Appendix A-2). In addition, information was sought regarding the current marital, socioeconomic, and health status of the subject. Food models were used to ascertain the portion size of the foods consumed. To allow for possible memory lapses, the women were asked to keep a written dietary record for at least two days, given simple instructions, and provided with a suitable record sheet (Appendix A-3). The subject was visited the day following the record-keeping, so that any questions regarding the entries might be clarified. For the two cooperating subjects who lived at some distance from the Lansing area, the above information, as far as possible, was obtained by telephone or through correspondence.

All food records were coded and nutrient values calculated by computer using punched cards giving the nutrient composition of foods according to household measures (cards obtained from the U.S. Department of Agriculture, 1964; 1970). Additional cards were prepared as needed for specific items not included in the USDA inventory.

The calculated dietary nutrient intakes and socio-economic findings were evaluated statistically by analysis of variance and correlation-regression methods.

Results

The living arrangements of the 28 participating survivors are shown in Table II-1. The majority of the women lived with their spouses, whereas about one-fourth resided alone. Two of the three subjects who lived with an offspring were among the oldest subjects, aged 81 and 90 years. The third individual in this category, aged 75, kept house for an unmarried son.

Table II-1.--Living Arrangements of Older Women Examined in 1972.

	Percentage of Subjects	
With spouse	57%	(16)[a]
Alone	28%	(8)
With son or daughter	11%	(3)
With another widow	4%	(1)

[a]Actual number of subjects.

Nutrient Intakes From Food

The mean nutrient intakes (excluding dietary supplements) of the survey subjects are shown in Table II-2 (individual values may be found in Appendix A-4). The mean caloric intake of the women was relatively low, equalling

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1297 kcalories, whereas mean values for all other nutrients, with the exception of calcium, remained adequate in terms

Table II-2.--Mean Nutrient Intakes of Older Women Examined in 1972.

Nutrient	Mean	Range
Calories (kc)	1297	606 - 2153
Protein (g)	59.2	29 - 81
Fat (g)	51.4	22 - 111
Saturated fatty acids (g)	17.6	4 - 52
Oleic acid (g)	17.9	5 - 44
Linoleic acid (g)	3.6	0 - 12
Carbohydrate (g)	151.3	54 - 275
Calcium (mg)	528	171 - 1144
Iron (mg)	10.1	6.2 - 17.4
Vitamin A (IU)	7969	1100 -37310
Thiamin (mg)	0.91	0.41 - 1.90
Riboflavin (mg)	1.45	0.66 - 3.57
Niacin (mg)	12.7	6.7 - 21.0
Ascorbic acid (mg)	93	12 - 200

of the RDA (Recommended Dietary Allowances) for women of this age. The ranges for the nutrient intakes indicate wide individual differences.

Further analysis revealed that dietary levels of the macronutrients--protein, fat, and carbohydrate, in addition to calcium, iron, and thiamin--were related to total energy intake. On the other hand, intakes of vitamin A, riboflavin, niacin, and ascorbic acid, appeared to be dependent upon the selection of specific foods. Riboflavin and niacin levels were correlated with dietary protein which contributed 18.5 percent of total calories among these women. Biochemical indices of blood and urine (repor

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(reported in Chapter V) were, in most cases, consistent with the subjects' reported nutrient intakes.

Nutrient Intakes and the RDA

For the individual nutrients, variable percentages of the subjects consumed at least one-half of that recommended (Table II-3). For energy intake, only 11 percent of the Lansing women met the full allowance of 1800 kcalories, suggested for women aged 55 and above. A more important observation might be that almost half of the subjects consumed less than two-thirds of the RDA for energy; three women ingested less than 1000 kcalories daily. Despite this reduction in caloric intake, the majority of subjects consumed the recommended level of protein; protein intake dropped to 29 grams only when caloric intake was rather low (1009 kcalories). The nutrient consumed in the lowest amounts was calcium, as 32 percent of those interviewed reported dietary levels below one-half the RDA (400 mg). Vitamin A and thiamin might be regarded as nutrients of concern among older women, as 29 and 22 percent, respectively, had only about half or less of the allowance.

When subjects were categorized according to their daily intake of eight nutrients: protein, calcium, iron, vitamin A, thiamin, riboflavin, niacin, and ascorbic acid, ten of those interviewed in 1972 had consumed 80 percent or more of the RDA for each of these nutrients. Six women reached two-thirds of the RDA for all but one nutrient, and

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Table II-3.--Percentage of Subjects Whose Nutrient Intakes in 1972 Were Equal to, or a Fraction of, the RDA.

Nutrients	RDA Fraction							
	1[a]		2/3[b]		1/2[c]		<1/2[d]	
Calories	11%	(3)	43%	(12)	39%	(11)	7%	(2)
Protein	82%	(23)	14%	(4)	4%	(1)	0%	(0)
Calcium	11%	(3)	46%	(13)	11%	(3)	32%	(9)
Iron	57%	(16)	36%	(10)	7%	(2)	0%	(0)
Vitamin A	57%	(16)	14%	(4)	11%	(3)	18%	(5)
Thiamin	43%	(12)	36%	(10)	18%	(5)	4%	(1)[e]
Riboflavin	75%	(21)	21%	(6)	4%	(1)	0%	(0)
Niacin	57%	(16)	36%	(10)	7%	(2)	0%	(0)
Ascorbic Acid	79%	(22)	7%	(2)	7%	(2)	7%	(2)

[a]The dietary intake was greater than or equal to the 1974 RDA (Food and Nutrition Board, Eighth Revised Edition, 1974).

[b]The dietary intake was at least two-thirds but less than 100 percent of the 1974 RDA.

[c]The dietary intake was at least one-half but less than two-thirds of the 1974 RDA.

[d]The dietary intake was less than one-half of the 1974 RDA.

[e]As a result of rounding, the total percentage exceeds 100.

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nine for all but two nutrients. Three women had poorer diets; one consumed less than two-thirds the RDA for three nutrients, one for four nutrients; and the third, the oldest subject, had less than two-thirds the recommended intakes for calcium, thiamin, riboflavin, and vitamins A and C.

Dietary Supplements

Among these women, 12 or 43 percent used some form of dietary supplement with 10 doing so on the advice of their physician. The types of supplements used, listed in Table II-4, included: multi-vitamin preparations with or without iron, the most popular choice; B complex tablets with or without ascorbic acid; calcium; vitamin E; and brewers' yeast. These dietary additions, however, only partially and rather inadequately compensated for the major nutrient deficiencies in the diet, noted on Table II-3. Two women because of diverticulosis were advised to avoid many fruits and vegetables, and consequently, ingested less than half the RDA for vitamin A; on their physicians' advice, they supplemented their diets with the B complex and vitamin E. On the other hand, many individuals with rather good diets used supplements.

Ingestion of supplements as related to nutrient intake from food only, is illustrated in Figure II-1. Two of the ten women who consumed 80 percent of the RDA for all nutrients, excluding calories, used supplements; this

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Table II-4.--Dietary Supplements Used by Older Women Examined in 1972.

Supplement	Number of Subjects Using Supplement	Number of Subjects Following Doctor's Advice
Multi-vitamin capsule	2	2
Multi-vitamin + iron	4	3
B complex preparation	1	1
B complex + vitamin C	1	1
Vitamin E	1	1
Calcium salts	1	1
Calcium salts + vitamin D	1	1
Brewers' yeast	1	0
Total	12	10

was also true for five of the six women whose intakes were low in only one nutrient. Half the subjects whose diets were low in two nutrients, and one of the three having the poorest diets used supplements. These additions improved the nutrient intake as far as the RDA was concerned in only a few subjects. Among those women whose diets were low in one nutrient, the supplement used restored only three of five nutrients to the RDA levels. Although half the subjects low in two nutrients used supplements, in no case did they restore those nutrients present in lowest amount to the recommended level. The individual in the study with the poorest diet who was routinely supplemented, thereby raised her intake to acceptable levels.

Figure II-1. Dietary Supplements and Total Nutrient Intake.

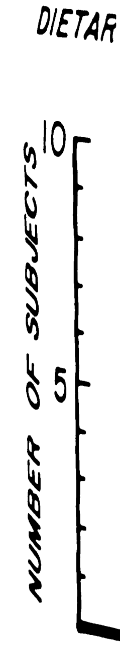
Key:

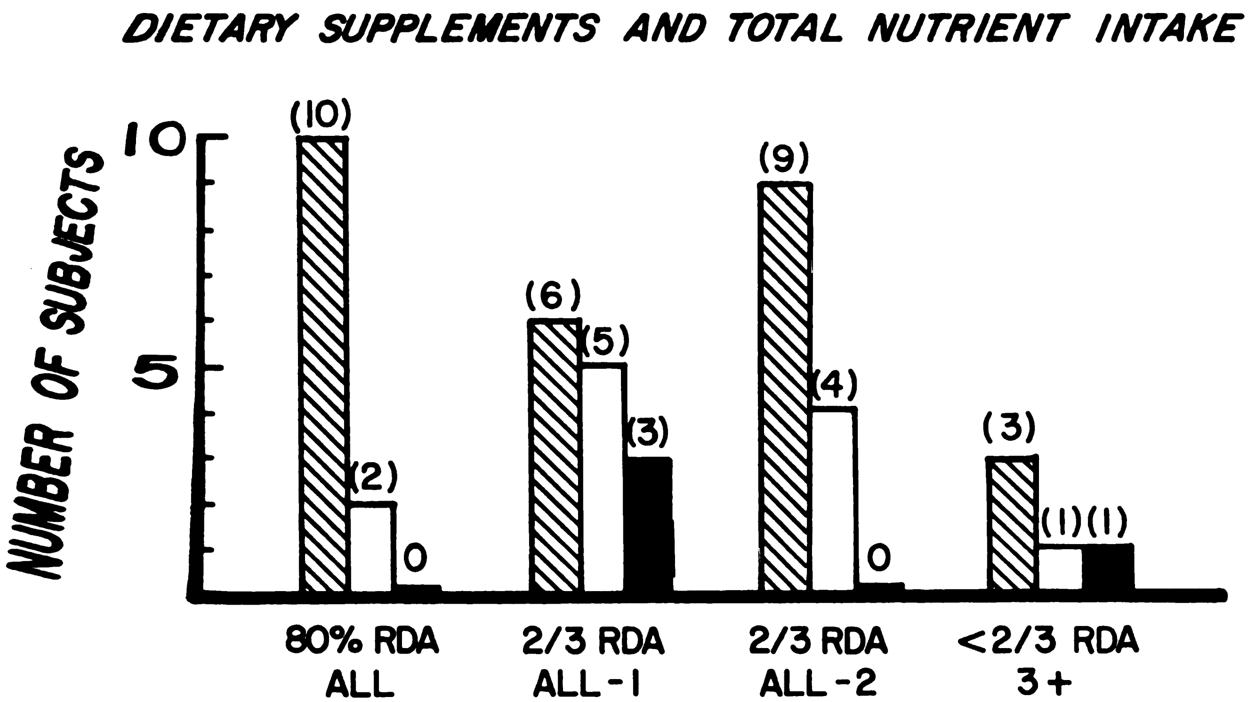
Number of subjects whose nutrient intakes from food met the indicated fractions of the RDA.*

Number of subjects in each group using dietary supplements.

Number of subjects for whom the dietary supplement raises the total intake (food + supplement) to the indicated fraction of the RDA.

*Food and Nutrition Board, 1974.




DIETARY SUPPLEMENTS AND TOTAL NUTRIENT INTAKE
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Age and Nutrient Intake

The 1972 dietary records were analyzed in relation to age by decade interval (Table II-5). Although nutrient values tended to decrease with age, these differences were not statistically significant by analysis of variance. Mean protein intake, however, differed by 14.7 grams, and fat by 13.3 grams, between subjects aged 64 to 69 years and those aged 80 to 90 years. By linear regression, protein intake did decrease by 0.997 grams per year (r=-0.447, n=28, p<.05) among these women aged 64 to 90 years. For other nutrients, no predictive relationships were apparent.

Meal Pattern and Nutrient Intake

The various meal patterns characteristic of the Lansing women are shown in Table II-6. Six or 21 percent of the women ate only two meals per day, brunch in the late morning, and dinner in late afternoon; whereas the others followed the traditional three meals per day schedule. The majority of the subjects claimed they did not eat between meals, the reason given most frequently related to weight control. Eight women ate by themselves; seven of these lived alone, and the other resided with an unmarried son. Twenty or 71 percent of the subjects have companionship at meals. An equal number of the women ate at least one meal per week outside their home. Of the

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Fat (g)
Carbohydr (g)
Calcium
Iron (mg
Vitamin
Thiamin
Riboflav
Niacin (
Ascorbic (mg)
Protein calories
Fat calo
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Table II-5.--Mean Nutrient Intakes of Older Women Examined in 1972 According to Age.

Nutrient	64 - 69	70 - 79	80 - 90
	(9)[a]	(10)	(9)
Calories (kc)	1417 ± 213[b]	1287 ± 425	1189 ± 248
Protein (g)	65.1 ± 13.9	61.7 ± 14.2	50.4 ± 15.3
Fat (g)	57.0 ± 11.9	53.3 ± 25.6	43.7 ± 14.3
Carbohydrate (g)	162.3 ± 36.5	140.0 ± 57.4	152.9 ± 36.4
Calcium (mg)	562 ± 226	600 ± 268	412 ± 159
Iron (mg)	10.5 ± 1.2	10.0 ± 3.4	9.7 ± 3.3
Vitamin A (IU)	7852 ± 7041	6754 ± 4690	9438 ± 12266
Thiamin (mg)	0.89 ± 0.11	0.96 ± 0.42	0.88 ± 0.33
Riboflavin (mg)	1.48 ± 0.58	1.40 ± 0.39	1.48 ± 0.88
Niacin (mg)	12.3 ± 2.3	13.0 ± 4.4	12.8 ± 4.6
Ascorbic acid (mg)	92 ± 52	100 ± 56	85 ± 52
Protein calories %	18.4 ± 4.2	20.0 ± 4.9	16.9 ± 5.0
Fat calories %	36.1 ± 6.4	36.2 ± 7.4	32.2 ± 6.3
CHO calories %	45.6 ± 6.4	44.0 ± 7.9	51.3 ± 7.6

[a]Number of subjects.

[b]Values expressed as mean ± S.D.

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Table II-6.--Meal Patterns of Older Women Examined in 1972.

Category	Percentage of Subjects	
Two meals/day	21%	(6)[a]
Three meals/day	79%	(22)
Snacks between meals	39%	(11)
Eats alone	29%	(8)
Eats with companion	71%	(20)
Eats outside the home (at least once/week	71%	(20)

[a]Actual number of subjects.

eight subjects who usually ate alone in their homes, three had at least one meal per week with family members in their home or with friends at a restaurant. Although the 20 individuals who reported eating outside their home occasionally, had meals in other homes, the majority visited restaurants either with their spouse or older friends, frequently other widows. One woman reported that she and her husband had their noon meal regularly at a nearby fast food restaurant.

The meal pattern of the individual can influence nutrient intake. As shown in Table II-7, the subjects eating alone consumed significantly fewer calories with a concomitant significant decline in dietary protein, fat, oleic acid, carbohydrate, niacin, and iron. Although the individuals living and eating alone tended to be older

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Age (yrs)

Calories
Fat (g)
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Calcium
Riboflav
Age (yrs

Calories
Fat (g)
Oleic ac
Age (yrs

Table II-7.--Relation of Meal Pattern, Nutrient Intake and Age Among Older Women Examined in 1972.

Variable	Eats Alone	Eats With Companion	Statistic
	(8)	(20)	
Calories (kc)	1022 ± 208	1407 ± 287	F = 11.778**
Protein (g)	47.4 ± 15.1	63.9 ± 12.9	F = 8.560**
Fat (g)	36.9 ± 11.6	57.2 ± 18.1	F = 8.596**
Oleic acid (g)	10.9 ± 4.0	20.7 ± 7.2	F = 12.955**
Carbohydrate (g)	122.9 ± 36.4	162.7 ± 42.9	F = 5.327*
Iron (mg)	7.9 ± 1.5	11.2 ± 3.1	F = 7.714**
Niacin (mg)	10.4 ± 2.9	13.6 ± 3.8	F = 4.571*
Age (yrs)	78.2 ± 6.0	73.4 ± 6.8	ns

	Two Meals/Day	Three Meals/Day	Statistic
	(6)	(22)	
Calories (kc)	1271 ± 400	1304 ± 302	ns
Fat (g)	61.5 ± 28.8	48.6 ± 14.8	ns
Protein (g)	51.7 ± 13.6	61.2 ± 15.3	ns
Calcium (mg)	372 ± 188	570 ± 227	ns
Riboflavin (mg)	0.96 ± 0.37	1.59 ± 0.61	F = 5.829*
Age (yrs)	77.5 ± 8.5	74.0 ± 6.4	ns

	Snacks	Does Not Snack	Statistic
	(11)	(17)	
Calories (kc)	1431 ± 434	1211 ± 178	ns
Fat (g)	62.5 ± 23.6	44.2 ± 10.2	F = 8.085**
Oleic acid (g)	21.2 ± 10.3	14.5 ± 4.6	F = 5.466*
Age (yrs)	74.7 ± 7.9	74.8 ± 6.3	ns

All values expressed as mean ± S.D.

*$p \leq .05$.

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with a mean age of 78.2 years as compared with 73.4 years for those having a companion, this difference was not significant. Neither did age relate to meal frequency, as subjects with a mean age of 77.5 years had two meals daily; whereas the individuals consuming three meals were 74.0 years in age. The number of meals daily had no effect upon total energy intake, as the subjects with the lowest (606) and second highest (1840) caloric levels both consumed only two meals each day. In contrast, persons with fewer meals each day ingested higher levels of fat, but less protein, calcium, and riboflavin.

Eating between meals does seem to increase total energy intake. The subjects who snacked had higher dietary levels of kcalories, fat, and oleic acid. No differences in age existed between those who did and did not eat between meals.

Meal Planning

When the subjects were asked, "What do you think about when choosing foods for your meals?" (Table II-8), the most frequent response related to personal taste preference (50 percent of those responding). Forty-three percent of the subjects indicated that weight control was a concern, whereas 39 percent were motivated to produce well balanced meals. Four or 14 percent reported their choice of food to be limited by financial considerations; however, this restriction did not affect the nutrient

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Table II-8.--Factors Considered in Meal Planning by Older Women Examined in 1972.

Category	Percentage of Subjects[a]	
Foods "I like"	50%	(14)[b]
Low calorie menus	43%	(12)
Well balanced meals	39%	(11)
Adherence to doctor's diet	29%	(8)
"Nothing in particular"	29%	(8)
Cost of food	14%	(4)
Ease of preparation	11%	(3)

[a]Subjects could indicate more than one factor.

[b]Actual number of subjects.

content of their meals. The dietary quality of the women whose choice of food was limited by financial considerations is exemplified by their protein intakes which were 80, 78, 57, and 42 grams per day; that should be compared with 58.3 grams, the mean for the others. The woman whose intake of protein equalled 42 grams consumed a total of only 606 kcalories. Despite the cost of fresh produce, dietary vitamin A and ascorbic acid levels among these women were more than adequate. The subjects with financial limitations tended to be slightly younger in age.

Shopping Problems

Six of the 28 Lansing women had problems obtaining groceries; they relied upon neighbors or relatives to drive t

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drive them to a store. Consequently, five shopped only once every two weeks. Twelve of the others visited a food store once per week, whereas seven shop two to three times weekly. One couple bought their groceries daily, seemingly as a diversion; all individuals had facilities for storage of refrigerated and frozen food. The women who were unable to walk or drive to a store ranged in age from 66 to 83 years with a mean of 76.5 years, as compared with a mean age of 74.3 years among those not so dependent. Two of the subjects who required transportation cared for infirm husbands, whereas four lived alone. No differences in nutrient intake were observed between those who did or did not require help with shopping.

Social Activity and Nutrient Intake

The Lansing women were rated as socially active or inactive on the basis of their participation in an activity outside the home (i.e., church, bridge club, senior citizens, dinner with friends, etc.) at least once per week. On that basis, 20 women were socially active whereas eight seldom left their homes. Despite this difference in sociability, there was no significant effect on the nutrient intakes of the women, although the less socially active individuals had an intake of 8.4 mg of iron per day versus 10.9 mg for the others; that difference was not significant ($p=.052$). Social activity would appear to be related to age, as those women who remained at home were older with a mean age of 79.1 years, whereas the others averaged 73.0 years.

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Three subjects who appeared to be unaware of happenings outside their home had substantially lower intakes of protein, iron, the B complex vitamins, and ascorbic acid, than did individuals who read a newspaper, watched television, or were aware of current events. Two of the three women with the poorest diets (less than two-thirds of the RDA for three or more nutrients) were among those with no external involvement. These women were older; however, this difference was not significant.

Food Avoidance and Nutrient Intake

The foods most frequently avoided by the Lansing women are tabulated in Table II-9. Sixty-four percent (18) of the subjects do not eat vegetables of the gas-forming variety as cabbage or onions; the consumption of these vegetables was reportedly responsible for considerable distress. These subjects explained the omission of fats and fried foods from their diets on the basis of the abdominal distress experienced after eating these foods, doctor's orders, or their desire to control their weight. The latter reason was implied when 57 percent of the women acknowledged avoiding "sweets" so as to reduce their "energy" intake. Five subjects on physicians' orders had to avoid pork and ham, because of fat and sodium restrictions. Other individuals (4) expressed a dislike of organ meats. One woman restricted her meat to ground varieties

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Table II-9.--Foods Avoided by Older Women Examined in 1972.

Food	Percentages of Subjects[a]	
Vegetables[b]	64%	(18)[c]
Fried foods	61%	(17)
Fats	57%	(16)
Sweets	57%	(16)
Meat varieties	36%	(10)
Nuts	29%	(8)
Butter	25%	(7)
Whole grains	18%	(5)
Fruits[d]	18%	(5)
Milk	14%	(4)

[a]Subjects could indicate more than one food.
[b]Gas-forming or high in fiber content.
[c]Actual number of subjects.
[d]Acidic or seed-containing.

only, because of ill-fitting dentures. Subjects being treated for diverticulosis had to avoid all raw vegetables and fruits, as well as whole grains. Milk was avoided by four women primarily because of personal taste. No subjects indicated abdominal distress resulting from milk ingestion.

The avoidance of specific foods was categorized as "high" when a woman rejected four or more foods and "low" for those who avoided three or fewer foods (Table II-10). This difference in acceptance of foods influenced primarily the caloric and fat intakes. Total fat as well as the

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Iron (m
Age (yr

Table II-10.--Relation of Physiologic Factors, Nutrient Intake and Age Among Older Women Examined in 1972.

Variable	High Food Avoidance	Low Food Avoidance	Statistic
	(15)[a]	(13)[a]	
Calories (kc)	1177 ± 264[b]	1436 ± 326	F = 5.372*
Fat (g)	42.3 ± 12.2	61.9 ± 19.8	F = 10.274**
Saturated fatty acids (g)	12.3 ± 4.5	23.6 ± 11.5	F = 12.335**
Linoleic acid (g)	2.9 ± 1.4	4.3 ± 3.5	ns
Age (yrs)	75.5 ± 5.8	73.9 ± 8.1	ns
	Prescribed Diet	**Self-Chosen Diet**	**Statistic**
	(8)	(20)	
Fat (g)	42.6 ± 12.5	54.9 ± 19.9	ns
Linoleic acid (g)	1.6 ± 1.2	4.4 ± 2.7	F = 7.534**
Ascorbic acid (mg)	57 ± 34	107 ± 52	F = 6.467*
Age (yrs)	76.5 ± 6.8	74.0 ± 6.9	ns
	Physically Active	**Physically Inactive**	**Statistic**
	(15)	(13)	
Protein (g)	64.9 ± 13.4	52.6 ± 15.1	F = 5.172*
Iron (mg)	11.5 ± 2.9	8.8 ± 2.7	F = 6.543*
Age (yrs)	71.6 ± 4.5	78.4 ± 7.4	F = 8.804**

[a]Actual number of subjects.

[b]All values expressed as mean ± S.D.

*$p \leq .05$.

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dietary level of saturated fatty acids and linoleic acid were reduced when four or more food items were avoided. Despite the relatively high number of subjects who did not consume particular fruits and vegetables, vitamin A and ascorbic acid intakes were unaffected. The women in both groups were similar in age.

Prescribed Diets and Nutrient Intake

Of the eight Lansing women who followed a modified dietary regimen, four had chronic diverticulosis, two individuals were diabetic, one subject had a severe coronary disorder, and another, myasthenia gravis. These women had reduced dietary levels of linoleic acid and ascorbic acid (Table II-10). Several of these subjects had been cautioned in regard to the consumption of fried foods and acid fruits; however, total fat intake nor age differed significantly between those whose diets were restricted for medical reasons and those whose diets were not so limited.

Physicial Activity and Nutrient Intake

The degree of physical activity may influence food intake in older women (Table II-10). Subjects who participated in bicycle riding (winters in Florida), gardening, part-time employment, or hospital volunteer service, etc., consumed more protein and iron than did the sedentary women. The restriction in physical activity of those women, however, may have been associated with age since that difference between the two groups was significant

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(p=.01). Inasmuch as body weight did not differ between the active and inactive women, obesity would not appear to be a factor in determining physical activity.

Loss of Appetite

Relatively few of the Lansing women (8) reported that they "feel hungry" whereas the others indicated that they ate merely because it was the accustomed time. The nutrient intakes of these groups did not differ; similarly the mean age of those who "feel hungry" was 74.2 years compared with 76.0 years among the women who experienced a loss of appetite.

Discussion

Problems in Assessing Nutrient Intake in Older Women

The collection and evaluation of food intake records is fraught with difficulties. Questions arise as to methodology, should 24-hour recall or written records be collected, for how many days, and on which days. Moreover, one may doubt the ability of the individual to accurately estimate the amount of food he has consumed. With the Lansing subjects, a 24-hour dietary recall record was obtained initially; the women were then urged to keep written records of their total food intake for a period of at least two days. Although individuals differed in their degree of cooperation with the study, the majority of participants provided at least one written record. The total r

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total number of food records available per subject ranged from one to eight (Appendix C-2).

Other investigators (Chalmers et al., 1952) have been concerned with the number of daily records required to adequately characterize the true nutrient intake of an individual or a group. Analysis of dietary data obtained from junior high, senior high, and college students; pregnant women; and male industrial workers; revealed that a dietary record consisting of only one day could effectively estimate the nutrient intake of a population group. This was true for all groups and nutrients evaluated. According to those workers (Chalmers et al., 1952), however, characterization of the dietary intake of an individual requires extensive research (dietary records for a period of at least 14 days) on that particular person. This evidence would suggest that the Lansing results estimate the mean dietary intake of women in this age group. Values obtained for individuals would seem to be less reliable.

Many factors may influence the reliability of an individual's dietary record. One of these factors would appear to be one's sex. Indirect evidence obtained from the population groups studied by Chalmers et al. (1952) revealed that precision from day to day tended to be greater for women than for men. To estimate the mean caloric intake of a male within 15 percent of the true value required a dietary record of 14 days; a similar estimate for a women required a record of only 11 days. This could reflect

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reflect a greater ability on the part of women accustomed to preparing foods using household measures, to estimate the quantity of food consumed.

Another factor relating to the reliability of a dietary record is the constancy of the subject's food pattern. Evidence that the constancy of the dietary pattern is an individual characteristic comes from the work of Fry et al. (1963). After studying the normal daily variation of dietary intake among six women who weighed their food for periods ranging from 25 to 150 days, those workers concluded that the particular pattern of the individual is as important as the length of time they are observed. Nutrient intake from day to day was remarkably constant in three of the six women studied. For those Lansing women following modified diets for the treatment of chronic disease or in efforts toward weight control, the dietary patterns tended to be monotonous, with the selection of the same types and quantities of food each day.

Specific nutrients differ in their variability from day to day in the diet records of an individual. Fry and coworkers (1963) reported that vitamin A showed the greatest variability in the dietary records obtained from their midwestern subjects; in that study, thiamin, riboflavin, and ascorbic acid, also differed significantly from one day to another. Further evidence to support this finding of the differential variablility of particular nutrients comes from the work of Chalmers et al. (1952).

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Vitamin A, ascorbic acid, riboflavin, and calcium intakes, could not be accurately estimated for an individual unless dietary records were compiled for several weeks. Similarly among the Lansing subjects, the two nutrients showing the most variability in the food records of particular subjects were vitamin A and riboflavin. This finding usually related to the consumption of liver or a dark green or yellow vegetable or fruit, providing high levels of one or both of these vitamins. Thiamin levels differed markedly from day to day if pork or ham was consumed on one of the survey days.

One might question the validity of recall dietary records secured from older individuals who might be subject to memory lapses. That this was not a problem in the Lansing study is evident from the fact that the written dietary records indicated essentially the same nutrient intakes as the recall records. There was a difference in caloric intake between recall and written records if the written records included a Sunday meal; for many of these women, Sunday dinner represented a special event. For that reason, home interviews were not scheduled on Mondays. That this difference in dietary habits between weekdays and weekends is not a consistent trend among population groups is suggested by Chalmers et al. (1952). Those workers concluded that college groups had lowered nutrient intakes on Saturdays and Sundays, as did male industrial workers.

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A final concern in the evaluation of dietary food records is the ability of the subject to accurately estimate his dietary intake. The Lansing women were experienced in food preparation, and would therefore seem to have a basis for judgment of household measures and portion size. For items such as meat or cake, that cannot be described in terms of liquid or solid measures, volume was described by inch dimensions. Young et al. (1953) found homemakers to be more accurate in their estimation of nutrient intake than either college students or male industrial workers. In that study calculated nutrient intakes were, for two-thirds of the subjects, within 20 percent of measured (weighed) intakes. Ohlson et al. (1950) studying the dietary intakes of aging women concluded that a recall record was as acceptable as a seven-day weighed intake record for estimating the nutrient intake of a group consisting of at least 50 subjects. The Lansing study included only 28 women; however, to the majority of these individuals, the weighing of food would have been unacceptable.

A further problem in the analysis of food records arises in the calculation of the nutrient composition by use of food composition tables. Although such tables attempt to provide representative values of specific varieties of food items, the influence of the soil and climate during the growing season, maturity at harvest, and length and conditions of storage, can markedly influence the nutr

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the nutrient content of fruits, vegetables, cereals, and grains. Similarly, the feed given an animal may affect the chemical composition of meat, eggs, or milk. Furthermore, the chemical methods by which nutrient values were derived may have been superseded by more accurate methods of analysis since the publication of food tables now available. Despite these limitations, the calculated nutrient intakes of the Lansing women were evaluated in terms of the suggested nutrient requirements for women of this age.

Nutrient Intake in Older Women

The most striking aspect of the dietary patterns of the Lansing women was the relatively low energy intake, averaging 1297 kcalories daily, with one as low as 606 kcalories. Exton-Smith and coworkers (1965; 1972), studying two series of English women, found striking differences in that 414 subjects above 65 years of age ingested an average of 1711 kcalories daily, whereas others aged 70 to 80 years had intakes ranging from 1155 to 2930 kcalories with a mean of 1890 kcalories. Among the latter, protein provided only 12.1 percent of total calories, substantially less than that noted among the Lansing women (18.5%).

On the other hand, Swanson and coworkers (1959), summarizing data obtained from 1072 Iowa women, reported a decrease of 85 kcalories per decade from age 30 to 80, with a mean caloric intake of 1425 for those above 70 years. Among the Lansing subjects, energy intake dropped by 130 kcalori

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Alternatively, mean caloric intake equalled 1347 in a study of 69 rural Pennsylvania women over 60 years of age (Guthrie et al., 1972), a value approximately that observed in the Lansing subjects. Similarly, Steinkamp and co-workers (1965a) found a significant decrease in energy intake from 1589 kcalories for females aged 64 to 69, to 1306 kcalories among those over 75 years of age. One of the Lansing women reported an intake of 606 kcalories daily in 1972; the energy value recorded for her in the 1948 survey equalled 745 kcalories. Since elderly women are reportedly maintained in relatively good health on caloric intakes that are about two-thirds the RDA, the true caloric needs of this age group can be questioned.

Adequate protein intake is frequently a matter of concern among older individuals. Protein intakes remained high for the Lansing women despite diets low in calories, which explains why protein contributed 18.5 percent of total calories. Most subjects had at least two servings per day of high quality protein; in many instances, meat was consumed at both lunch and dinner, with an egg at breakfast. The use of low-fat or skim milk contributed to the pattern of increased protein with relatively low calories and fat. The high levels of iron, riboflavin, and niacin, reflect this generous protein intake. Liver was consumed frequently (18% of the subjects) as were highly

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fortified cereal products, supplying iron and the B complex vitamins. One subject, being treated for diverticulosis, used infant cereal which in adult portions provides 10 mg of iron per serving. Inasmuch as food records were collected during the summer and early fall, fresh fruits and vegetables added to the intakes of vitamin A and ascorbic acid. Similarly, Pilcher and coworkers (1950) reported a seasonal effect upon the consumption of green leafy and deep yellow vegetables and fruits among the residents of Groton Township, New York; substantially larger amounts were available in the fall than in the spring. Among the Lansing women, locally grown acorn squash and cantaloupe contributed greatly to vitamin A intakes.

Milk and dairy products were not popular foods among the Lansing women. Calcium was second only to calories in the number of Lansing subjects whose intake was inadequate. The majority of the women drank milk infrequently, consuming this product only with cereal; ice milk and cottage cheese were used more frequently. Riboflavin was provided in some cases by adding liver to the diet; however, dietary calcium was not provided in substantial amounts by any foods other than milk products. A USDA survey of the North Central region (Redstrom, 1973) revealed the average calcium intake among women aged 55 to 64 years to be 58 percent of the RDA; this can be compared with the value of 66 percent observed in the Lansing women.

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Although one-fifth of those interviewed had low thiamin intakes according to the RDA, in only one individual was it less than 0.5 mg per 1000 kcalories. Reduced thiamin levels may relate to the avoidance of pork as well as the relatively low energy intakes. Ohlson and coworkers (1952) in the 1948 study noted that protein, calcium, and thiamin, were directly proportional to kcalories ingested; this was also true in 1972. In the former study, however, vitamin A and riboflavin were also dependent upon the total energy intake. In 1972 these nutrient levels, in addition to that of ascorbic acid, depended upon personal selection rather than total kcalories. In view of decreasing energy intakes in advanced age, sound nutrition is the result of wise choices, with the elimination of those foods high in calories and fat which provide few other nutrients.

The use of dietary supplements by the Lansing women was similar to that observed by other investigators. Among 281 Californians over 50 years of age (Steinkamp et al., 1965a), 35 percent took one or more food supplements with the majority choosing a multi-vitamin preparation. Similarly, 40 percent of the rural Pennsylvania elderly (Guthrie et al., 1972) used vitamin or mineral additives, with nearly one-half doing so on the advice of their physician. In that study only two subjects were supplemented with calcium although this nutrient was present at less than two-thirds the recommended level in 66 percent of the diets. A USDA study of older people in Rochester, New

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York (Le Bovit and Baker, 1965), revealed that one-half of the families using supplements were choosing foods containing more than the standard levels for all nutrients. This was also true among the Lansing women, as only 4 of the 12 using supplements were actually correcting a dietary deficiency. The misuse of vitamin and mineral supplements by older individuals must be recognized as a growing problem. For individuals who cannot, because of dietary restriction, or will not, because of personal taste, eat certain foods, supplementation is a means of nutritional support. On the other hand, for those elderly with financial limitations, available income might better be spent for wholesome food.

The results of the Lansing study confirm other reports that nutrient intake decreases as an individual ages. Among 1,072 Iowa women, Swanson et al. (1959) observed a decrease in daily intake of 4 grams protein, 30 mg calcium, 194 IU vitamin A and 1.4 mg ascorbic acid, per decade, between ages 30 and 80. Further evidence comes from the Rochester survey (Le Bovit and Baker, 1965) where a greater proportion of the households with poorer diets had homemakers over 75 years of age. Exton-Smith and Stanton (1965), studying diets of elderly women living alone, observed a substantial decrease from the mid to the late seventies of 20 percent in kcalories, 30 percent in fat, 24 percent in protein, and 8 percent in carbohydrate. Inasmuch as calories supplied by foods rich in protein and fat are

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fat are more likely to contribute minerals and vitamins to the diet than do carbohydrate foods, the calcium intake among those subjects fell by 18 percent and iron by 29 percent. The Lansing women initially eliminated the less nutritious foods from their diets and thus maintained their vitamin and mineral intakes. A similar trend occurred among the subjects studied by Fry and coworkers (1963). They found that dietary calcium and riboflavin actually increased in their women aged 75 to 85, as did the consumption of milk. In the Lansing study, the older subjects included liver in their diets and thus increased their intakes of riboflavin and vitamin A. Of the nine subjects 80 years of age and above, one had 80 percent of the RDA for all nutrients; three had two-thirds the RDA for all nutrients but calcium; and one for all but vitamin A.

Socioeconomic Patterns and Nutrition in Older Women

A frequent generalization with reference to the nutrition of older people is that individuals living and eating alone become bored with food preparation and consequently resort to a monotonous fare. For the Lansing women, dietary kcalories, macronutrients, iron, and niacin, were significantly lower in those women who ate alone. Of the eight such individuals, five were 80 years of age or above as compared with 3 of 20 subjects who shared their meals with someone. The energy intakes of the subjects eating

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eating alone was low, although the mean value was affected by Subject 225, whose total intake was 606 kcalories.

Similarly, Davidson and coworkers (1962), comparing the diets of "isolated" versus "socialized" Bostonians over 50 years of age, noted that daily intake of all nutrients except iron was lower in the "isolates." Although in that study no person was grossly deficient in protein, the only two individuals consuming less than 1.0 gram/kg body wt/day were in the isolated group. Among the Lansing women, four of five individuals consuming less than 100 percent of the recommended level of protein lived alone; this included the woman who consumed less than two-thirds of the RDA. This lowered protein intake partially explained the reduction in niacin among the individuals who ate alone, whereas iron levels among these women were related to total kcalories. In the Rochester study (Le Bovit and Baker, 1965) the diets of older women living alone contained lesser amounts of meat, eggs, grain products, and potatoes, with subsequent reduced iron intakes. It cannot be assumed, however, that older persons living with others are well nourished. This was evident from the diet records of the two Lansing women who had the poorest nutrient intakes. These individuals lived with relatives, but resisted all efforts of those in the household to improve the quality of their diets. The food pattern of the oldest subject, aged 90, who resided with a married son, consisted of meat, eggs, fish, potatoes and gravy, ice cream, cookies,

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and bread spread generously with butter and sprinkled with sugar.

Meal patterns may change in older subjects who must no longer maintain the time schedule previously imposed by their occupation. Twenty-one percent of the Lansing subjects chose to have only two meals daily, whereas a survey of 14,991 aged individuals in Linn County, Iowa (Fuller et al., 1963), revealed that only 5 percent followed this pattern and none of those lived alone. The latter survey included many farm families who may retain their daily work patterns into advanced age. Inasmuch as milk consumption closely paralleled cereal consumption, intakes of riboflavin were significantly lower in those having only two meals daily. The women who ate only two meals preferred a heavier morning meal for which they usually chose eggs, possibly with a breakfast meat, or a sandwich with a meat filling; this could be a factor in the higher intake of fat among those consuming only two meals. The individual with the highest level of dietary protein and fat was in this group which may also have influenced the mean fat intake of those who followed a two-meal pattern. As part of her evening meal, she consumed a nine-ounce boneless steak with french fried potatoes.

A large percentage of older people supplement their meals with snacks. Among the Lansing women, 40 percent ate between meals as compared with 50 percent of the older subjects from Rochester, New York (Le Bovit and Baker, 1965), a

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1965), and one-third of the aged in Linn County, Iowa (Fuller et al., 1963). Whereas cake, cookies, pie, and other sweets were the most popular snack items among the Iowans, the Rochester elderly and Lansing women more frequently chose dairy products as ice cream or ice milk, cereal with milk, or fruit, although cookies and candy were noted occasionally. These dairy foods may have contributed to the increased intakes of fat and oleic acid among those who snacked.

Population studies (U.S. Bureau of Census, 1971) suggest that at least one-fourth of all older Americans live below the poverty line. It was surprising therefore that only four of the 28 Lansing women interviewed considered their financial situation to be a limitation in food selection. Some explanation may be found in the geographic location of this study. In Lansing, the three largest employers--Oldsmobile and related suppliers, State government offices, and Michigan State University, all provide pension benefits. Among those individuals who were limited by income, protein intake was not lowered. This finding is in contrast to the Iowa women (Swanson et al., 1959), Groton Township families (Wilhelmy et al., 1950), and rural Pennsylvania elderly (Guthrie et al., 1972), whose protein intake was related to financial resources. Perhaps nutrient differences observed in other surveys among participants who expressed financial limitations, may have been a reflection of poor food choices.

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This is suggested by the fact that two of the four women in the Lansing study who stated that their dietary choices were restricted for financial reasons consumed liver on one of the survey days.

Physiologic Aspects of Food Habits in Older Women

Physiological factors have been known to influence nutrient intake among older people. The English women studied by Exton-Smith and Stanton (1965) most frequently avoided acid fruits or foods with small seeds, as a result of diverticulosis or the subsequent development of indigestion; these reasons were given by several of the Lansing women. Others in the English study indicated difficulties with chewing, although this was noted by only one individual in the Lansing survey and that related to meat choices.

Older individuals, according to Werner and Hambraeus (1972), manifest a decrease in digestive enzymes. This change could result in delayed fat digestion, leading to prolonged discomfort. This may explain why 10 of the Lansing women who complained of abdominal distress avoided visable fat in their diets. This limitation on high-fat foods may lower the intake of linoleic acid. Although the suggested requirement for the essential fatty acid is 2 percent of total calories (Food and Nutrition Board, 1974), nine of the 28 Lansing subjects consumed less than that amount.

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The dietary levels of other nutrients may be lowered among older women following prescribed diets. Dietary ascorbic acid levels were reduced among those individuals who had been advised by their physicians to avoid acid fruits; on the other hand, intakes of riboflavin and calcium were high as a result of the selection of milk and/or liver. Two women being treated for diverticulosis had less than 2000 IU of vitamin A daily, and for one, ascorbic acid fell below 30 mg daily. Although orange juice, a generous source of ascorbic acid, does not contain seeds, diverticulosis patients were restricted to non-acid juices and fruits. Inasmuch as 20 percent of all individuals over 70 years of age have diverticular disease (Painter and Burkett, 1971), the nutritional status of those following modified diets prescribed in treatment of this disease, requires further study.

Physical activity may not always decline as a result of advancing age. Such evidence comes from the study of the aged population in Westchester County, New York (Jordan et al., 1954), in which only 30 percent of the subjects were described as sedentary whereas 67 percent were moderately active. Although the Lansing women were about evenly divided on the basis of physical activity, that division appeared to be related to age. In that protein intake decreased in the older subjects, this might explain the lower level of that dietary ingredient among the inactive.

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A reduced level of physical activity is sometimes associated with iron-deficiency anemia. Since seven of the 13 women considered to be inactive had iron intakes less than 80 percent of the RDA, it might be postulated that their inactivity was related to incidence of anemia. Such an explanation is open to question in that the lowest hemoglobin level observed among the subjects with reduced iron intakes was 12.6 g/100 ml. Among the Lansing subjects, the degree of physical activity was not related to body weight. Three of the sedentary women were obese, whereas the others were either underweight or near average weight for their height and age.

Conclusions

Although the intake of energy along with other nutrients, declines with advancing age, this does not necessarily result in poor nutrition. The selection of foods high in nutrient density as skim milk fortified with protein solids and vitamin A, or liver, may contribute to the maintenance of nutritional adequacy. When inadequate dietary intakes are observed among older women, deficiencies are most likely to occur in the levels of calories, calcium, vitamin A, and thiamin. In light of the decrease in physical activity and problems with weight control that occur in later life, the current recommended level of 1800 kcalories daily for women aged 55 and above, may have to be re-examined.

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The misuse of vitamin and mineral supplements by older people is a growing problem, as frequently the supplements do not include the most deficient dietary nutrients. Conversely, many individuals with optimum nutrient intakes, meeting known dietary standards, ingest supplements needlessly.

Socioeconomic factors as social isolation, economic limitations, or problems with shopping, do not always predispose the individual to a nutritionally poor diet. Physiologic factors, however, as modified diets required in the therapy of chronic disease, may impose restrictions on foods that are specific vitamin sources (i.e., vitamin A or ascorbic acid). Supplementation of these diets with the appropriate vitamins may provide a solution to this problem. The avoidance of dietary fat as a result of abdominal discomfort, efforts toward weight control, or a modified diet, limits in this age group, the intake of linoleic acid.

CHAPTER III

NUTRIENT INTAKE IN 1948 AND SUBSEQUENT MORBIDITY AND MORTALITY

Introduction

Life expectancy at birth has, during this century, increased from 48.7 to 74.9 years for women and from 48.2 to 67.4 years for men. This increase in longevity has resulted in a rapid growth in numbers of persons in older age groups. In 1970, there were in the United States, 8.4 million males and 11.4 million females over 65 years of age. Should the rates of mortality for both sexes remain constant, in 50 years, the number of people above this age will have doubled (U.S. Bureau of Census, 1970).

With these changes in population, the emphasis in health care has been directed toward the burgeoning problems of chronic disease, which is so common among older people. Epidemiological evidence (Epstein et al., 1965) suggests that 73 percent of those aged 60 to 79 years suffer from at least one chronic problem (i.e., coronary or hypertensive heart disease, diabetes, respiratory disease or rheumatoid arthritis). Chronic disease may contribute to physic

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physical disability in that 42 percent of aged individuals have some limitation of activity, and for another 37 percent the impairment is major (Metropolitan Life Insurance Company, 1974). Acute disablement frequently necessitates institutionalization of the older citizen; of the 995,000 individuals (U.S. Bureau of Census, 1973, p. 44) now being cared for by this means, nearly two-thirds are women. Inasmuch as the lifespan of women has been increasing consistently, whereas that of men has remained stationary, Howell and Loeb (1969) suggest that "the most seriously needed type of study in America is to find through long periods of time, the degree of correlation that exists between the health records of individuals and their dietary habits."

Studies in the United States examining total dietary intake in relation to morbidity and mortality have been limited. A four year follow-up of 577 Californians (Chope, 1954) over 50 years of age, revealed higher rates of mortality associated with lowered intake of vitamin A, niacin and ascorbic acid. Furthermore, Chope (1954) reported that subjects with hemoglobin levels below 13 gm/100 ml suffered a higher incidence of respiratory disease, whereas daily vitamin A intakes below 5000 IU were correlated with nervous, circulatory and respiratory disorders. When dietary thiamin was low, diseases of the nervous and circulatory systems increased; conversely, high intakes of ascorbic acid were associated with low inciden

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incidences of these problems. Kelley and coworkers (1957), examining a random sample of 97 Michigan women between the ages of 40 and 88 years, noted that physical well-being was directly related to nutrient intake. Physical complaints as pains in the joints or unexplained tiredness were more frequent among those with diets low in one or more nutrients. Mortality over a seven year period was higher in those women reporting less than 40 percent of the Recommended Dietary Allowance (RDA) for at least one nutrient.

To obtain further knowledge regarding the effect of nutrient intake upon morbidity, length of life and ultimate cause of death, the author examined the continued mortality experience of the Michigan women, previously studied by Kelley and associates (1957).

Methods

Between 1948 and 1955, Ohlson and coworkers (1948, 1950, 1952, 1952a) conducted studies with 103 white women between the ages of 40 and 88 years, residing in Lansing, Michigan. The sampling procedure and methods have been described previously (Chapter, II, pp. 92-93). Each subject provided a dietary recall record for at least one day in addition to a health and nutritional history, and facts related to marital and socioeconomic status. All subjects were rated according to a qualitative index of signs of aging. Forty-five of the participants submitted to a physical examination given by a mobile unit survey team f

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team from the U.S. Public Health Service. This nutritional evaluation included the determination of hemoglobin values and fasting serum levels of vitamin A, carotene and ascorbic acid.

Sixty of the original subjects are now deceased and death certificates (Appendix B-1) were secured from the State Department of Vital Records. Causes of death were categorized according to the International Classification of Diseases, Adapted for use in the United States (U.S. Department of Health, Education and Welfare, 1967). To maximize the examination of all available data, factors contributing to death and previously recognized chronic diseases noted on the certificates, were also tabulated. Analysis of variance, student's t, and step-wise deletion multiple regression procedures were employed to seek relationships between nutrient intake, physical and biochemical parameters, chronic disease and mortality experience. (Subjects' ages in 1948 and at time of death may be found in Appendix B-2).

Results

Nutrient Intakes of Deceased and Survivors in 1948

The dietary intakes of the deceased and surviving subjects when both were examined in 1948 are listed in Table III-1. The nutrient levels at that time were similar, with the exception of protein and ascorbic acid. These factors were significantly lower in the diets of those

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Table III-1.--Comparison of Nutrient Intakes of Subjects in 1948.

Nutrient	Deceased[a]	Survivors[b]
Calories (kc)	1580 ± 394	1683 ± 632
Protein (g)	50.8 ± 14.2[c]	58.4 ± 17.9[c]
Fat (g)	72.9 ± 22.1	73.9 ± 32.8
Carbohydrate (g)	180.5 ± 53.0	196.5 ± 78.2
Calcium (mg)	478 ± 247	491 ± 284
Iron (mg)	9.4 ± 2.3	10.2 ± 5.1
Vitamin A (IU)	4214 ± 4408	3866 ± 3728
Thiamin (mg)	0.86 ± 0.24	0.95 ± 0.53
Riboflavin (mg)	1.11 ± 0.45	1.19 ± 0.54
Niacin (mg)	8.4 ± 3.5	9.0 ± 2.3
Ascorbic acid (mg)	51 ± 40[d]	73 ± 40[d]
Protein calorie %	13.1 ± 3.4	14.4 ± 3.4
Fat calorie %	41.3 ± 6.4	38.6 ± 6.5
Carbohydrate calorie %	45.5 ± 7.1	47.0 ± 6.3

[a] n=60. These women died during or prior to 1972.

[b] n=28. These women were interviewed in 1948 and 1972; dietary records used in this calculation were those secured in 1948.

[c] $t=2.140$, $p<.05$.

[d] $t=2.360$, $p<.05$.

Values expressed as mean ± S.D.

Letter pairs are significantly different.

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women who have since died. This difference in protein intake has been examined in relation to the type of protein consumed. As shown in Table III-2, the quantitative differences in total protein intake can be explained solely by the increased consumption of animal protein by the survivors. The mean intake of plant protein (20.4 grams) was the same for both groups. Animal protein, however, equalled 38.0 grams among the survivors, compared with 30.4 grams for the deceased, a significant difference. Therefore, only 57.7 percent of the total protein intake was supplied by animal sources among the deceased, in contrast to 64.4 percent for the survivors.

Age may be an important factor in evaluating the differences between these two groups. In 1948, the average age of the subjects who were re-examined in 1972 was less than those who died in or prior to 1972. The mean age of the deceased was 67.4 years, significantly higher than that of the survivors who averaged 52.1 years ($t=7.309$, $p<.01$, 1-tailed test).

Kelley et al. (1957) observed higher mortality over a seven year period among those individuals who consumed less than 40 percent of the RDA for at least one nutrient. The 1948 dietaries have been evaluated in these terms. Table III-3 indicates that no subject in either group consumed less than 40 percent of the RDA for calories, protein, iron or thiamin. Similarly, it would seem that calcium intake did not influence the mortality rate of

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Table III-2.--Differences in Dietary Levels of Plant and Animal Protein of Older Women in 1948.

Nutrient	Deceased[a]	Survivors[b]
Total protein (g)	50.8 ± 14.2[c]	58.4 ± 17.9[c]
Plant protein (g)	20.4 ± 6.4	20.4 ± 9.6
Animal protein (g)	30.4 ± 14.0[d]	38.0 ± 15.3[d]
% protein--plant	42.2 ± 14.8[e]	35.6 ± 13.4[e]
% protein--animal	57.7 ± 14.7[f]	64.4 ± 13.4[f]

[a]n=60. These women died during or prior to 1972.

[b]n=28. These women were interviewed in both 1948 and 1972; dietary records used in this calculation were those secured in 1948.

[c]$t=2.140$, $p<.05$.

[d]$t=2.316$, $p<.05$.

[e]$t=2.012$, $p=.05$.

[f]$t=2.029$, $p=.05$.

Letter pairs are significantly different.

Values are expressed as mean ± S.D.

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Table III-3.--Percent of Subjects Ingesting Less Than 40 Percent of the RDA* For Various Nutrients in 1948.

Nutrient	Deceased[a]		Survivors[b]	
Calories	0		0	
Protein	0		0	
Calcium	28%	(17)	36%	(10)
Iron	0		0	
Vitamin A	33%	(20)	28%	(8)
Thiamin	0		0	
Riboflavin	5%	(3)	4%	(1)
Niacin	7%	(4)	0	
Ascorbic acid	32%	(19)[c]	7%	(2)[c]

*Food and Nutrition Board, Recommended Dietary Allowances, 1953.

[a]n=60. These subjects died during or prior to 1972.

[b]n=28. These subjects were interviewed in 1948 and 1972; dietary records used in this calculation were those secured in 1948.

[c]Letter pair is significantly different, $\chi^2=5.336$, $p<.05$.

these women, in that 36 percent of the survivors and 28 percent of the deceased had less than 320 mg daily, whereas the recommended level was 800 mg. Although low intakes of riboflavin, niacin and vitamin A, were noted more frequently among the deceased, these differences were not significant. Alternatively, a significant number of the deceased subjects had less than 40 percent of the RDA for ascorbic acid.

Biochemical Indices of Deceased and Survivors in 1948

Dietary intake alone is not indicative of nutritional status, as it ignores factors of absorption and utilization. For this reason, hemoglobin and serum vitamin A, carotene, and ascorbic acid levels, were examined for both groups of subjects in 1948 (Table III-4). No differences were observed. Only two women had hemoglobin levels below 12.0 gm/100 ml; one deceased and one survivor had values of 11.9 and 11.0 gm/100 ml, respectively. Alternatively, two survivors and four deceased had serum ascorbic acid levels below 0.4 mg/100 ml. In contrast, two survivors were observed to have less than 10 ug vitamin A/100 ml serum, whereas the lowest value recorded among the deceased was 25 ug.

Nutrient Intake and Age at Death

When the nutrient intake of the deceased subjects was analyzed in respect to age at time of death, the only nutrient in the diet found, on an absolute basis, to be

Table III-4.--Biochemical Parameters of Subjects in 1948.

Serum Parameter	Deceased[a]	Survivors[b]
Hemoglobin (g/100 ml)	13.5 ± 1.1	13.1 ± 0.8
Vitamin A (ug/100 ml	43.1 ± 11.0	37.1 ± 18.2
Carotene (ug/100 ml)	99.0 ± 47.1	83.9 ± 32.8
Ascorbic acid (mg/100 ml)	0.87 ± 0.42	1.00 ± 0.44

[a]n=33. These women died during or prior to 1972.

[b]n=17. These women were interviewed in 1948 and 1972; records used in this calculation were secured in 1948.

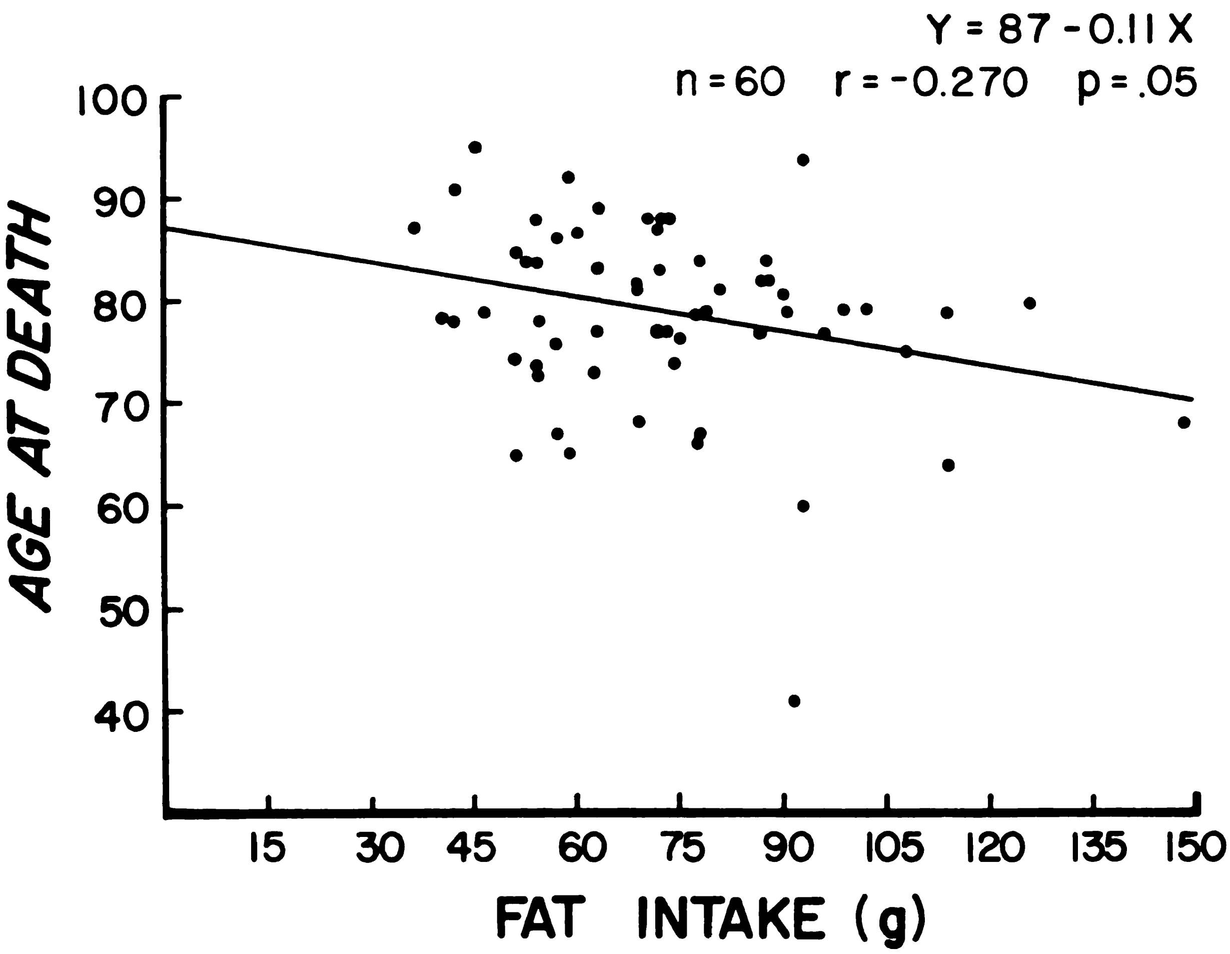
Values expressed as mean ± S.D.

None of these values were significantly different.

significantly related to length of life, was dietary fat. The higher the intake of fat, the shorter the life. As shown in Figure III-1, as the daily intake of fat increased by one gram, lifespan decreased by 0.12 years, or approximately 44 days. However, not only the absolute amount of fat in the diet but also the percent of calories contributed by this nutrient, may alter the lifespan. The coefficient of correlation (r) was even higher when the percent of calories contributed by fat or carbohydrate, was related to the length of life (Figure III-2). The higher the percent of calories obtained from fat, the fewer the calories contributed by carbohydrate, and the shorter the life. One possible explanation for the deleterious effect of dietary fat could relate to high caloric density with

Figure III-1.--Influence of the Amount of Dietary Fat Upon Age at Death.

*The dietary intakes are based on the dietary records secured in 1948.


Y = 87 - 0.11 X
n = 60 r = -0.270 p = .05
AGE AT DEATH
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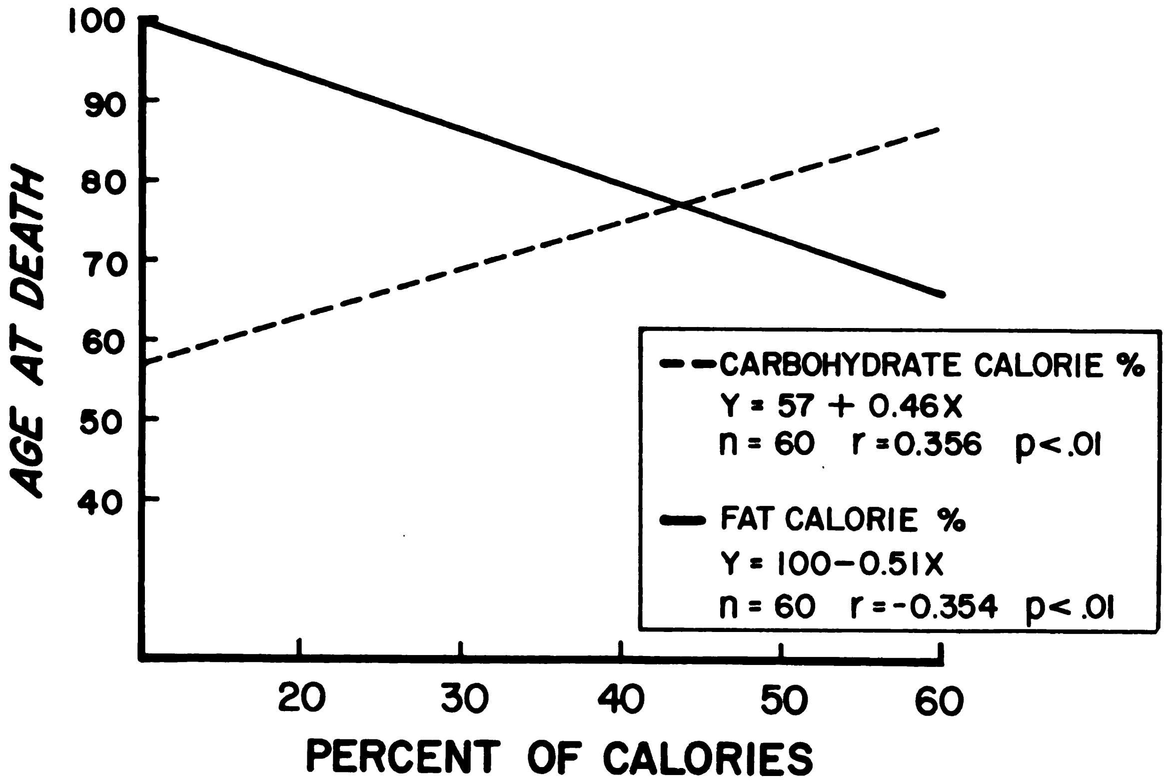
FAT INTAKE (g)

Figure III-2.--Fat and Carbohydrate as Percentages of the Dietary Caloric Intake in 1948 and Age at Death.

*The dietary intakes are based on the dietary records secured in 1948.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PERCENT OF CALORIES
CARBOHYDRATE CALORIE %
Y = 57 + 0.46X
n = 60 r = 0.356 p<.01
FAT CALORIE %
Y = 100−0.51X
n = 60 r = -0.354 p< .01

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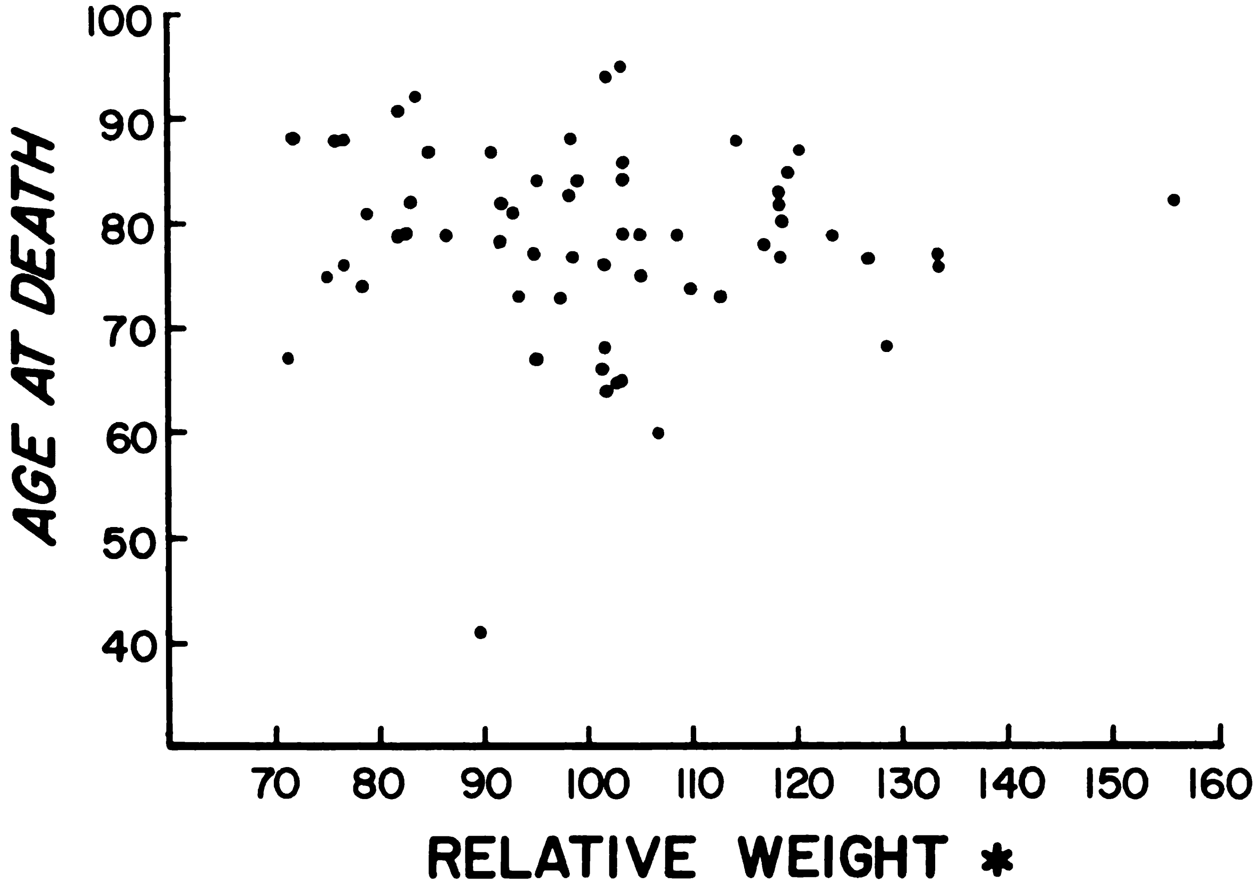
resultant obesity. In Figure III-3 are plotted the relative weights of the Lansing women as a function of dietary fat. Among these women, relative weights were not influenced by the level of fat consumed.

Inasmuch as the women varied in age at the time of the survey, dietary factors were examined in relation to the expected years of life at the time of the survey as suggested by census life tables and insurance statistics, and the actual years lived. A negative relation between the fat content of the diet and expected age, was suggested. Women who died 10 to 15 years earlier than expected were ingesting 46.6 percent of their total calories as fat, whereas individuals living at least ten years longer than anticipated had, in their diets, only 37.4 percent fat ($p<.07$). Preliminary calculations, based upon death certificates from 52 subjects, revealed a significant inverse relationship between dietary fat and expected age. However, included among the eight subjects for whom certification of death was obtained at a later time were several whose experience differed from the previous conclusion. One individual, who survived 12 years beyond her expected age of 81, was consuming 93 grams of fat daily in 1948. Similarly, the woman with the highest daily fat intake, 125 grams, in the initial survey, lived two years beyond her expected age of 78. In contrast, one subject aged 84 in 1948, died two years before reaching her expected age of 89, yet included only 36 grams of fat in her daily diet.

Figure III-3.--Influence of Relative Weight* Upon Age at Death.

*Society of Actuaries, 1959. Build and Blood Pressure Study, Chicago, Illinois.

AGE AT DEATH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Blood Pressure and Age at Death

Systolic and diastolic blood pressure are usually considered to be important determinants of length of life. Among these subjects neither systolic nor diastolic blood pressure as measured in 1948, was related to age at death or expected age.

Nutrient Intake and Cause of Death

The immediate causes of death of the 60 deceased subjects are shown in Table III-5. Cardiovascular-renal disease was responsible for 45 percent of all fatalities and cerebrovascular disorders caused the deaths of an additional 18 percent. About one-fifth of the women were stricken with some form of malignancy, and six died of pneumonia. "Senility" and diabetes mellitus were given as the immediate causes of death for one and two subjects, respectively.

For further examination, the category of cardiovascular-renal disease was divided into sub-headings: (1) symptomatic heart disease which included primarily those individuals dying of congestive heart failure, representing an illness of some duration, and (2) acute arteriosclerotic or ischemic heart disease, including patients suffering an infarct, occlusion or thrombus, with sudden death.

Congestive heart failure (symptomatic heart disease) was the leading cause of death among these women,

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Table III-5.--Immediate Causes of Death of Subjects Who Died in or Prior to 1972.

Cause	Incidence	
Cardiovascular-renal disease	45%	(27)
Symptomatic heart disease (400-404, 427-429)*	30%	(18)
Arteriosclerotic disease (410-414, 441-444)	15%	(9)
Cerebrovascular disease (430-438)	18%	(11)
Cancer (140-209)	22%	(13)
Respiratory disease (480-486, 514)	10%	(6)
Diabetes mellitus (250)	3%	(2)
Senility (794)	2%	(1)

*International Classification of Diseases, Adapted for Use in the United States, Eighth Revision, 1967.

n=60

responsible for 18 fatalities. As to the influence of dietary pattern, the subjects with this syndrome tended to have lower intakes of thiamin than those who did not, values equalled 0.79 and 0.89 mg per day, respectively; however, this difference was not significant. Alternatively, a combination of nutrients was implicated with this disorder. As noted in Table III-6, multiple regression analysis revealed that thiamin and four other nutritional parameters: fat, fat calorie percent, protein calorie percent, and carbohydrate calorie percent, could predict the incidence of death from symptomatic heart disease. Degree of body fat was not a predisposing factor in that individuals

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Table III-6.--Prediction Equation Relating Nutrient Intake in 1948 and Death From Symptomatic Heart Disease Among Subjects Dying in or Prior to 1972.

$$\hat{y} = -31 + 0.31b_1 - 0.0095b_2 + 0.0076b_3 + 0.39b_4 + 0.32b_5$$

	Nutrient	Regression Coefficient	Beta Weight	Partial F	Significance
b_1	Fat calorie %	+0.31	+4.21	6.116	.017
b_2	Thiamin	-0.0095	-0.48	9.692	.003
b_3	Fat	+0.0076	+0.36	4.157	.047
b_4	Protein calorie %	+0.39	+2.85	8.441	.005
b_5	CHO calorie %	+0.32	+4.84	6.499	.014

Analysis of Variance for Regression

	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
Regression	2.8	5	0.565	3.133	.015
Error	9.0	50	0.180		
Total	11.8	55			

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with congestive heart failure had, on the average, a relative weight (Society of Actuaries, 1959) of 102.3 whereas those not affected were within 99.8 percent of their "standard" weight. That long-term arteriosclerotic heart disease may lead to congestive heart failure is suggested by the correlation ($r=0.335$, $n=60$, $p<.05$) existing between reported death from symptomatic heart disease and a previous history of coronary arteriosclerosis.

As to the influence of blood pressure upon subsequent congestive heart failure, diagnosed hypertension was significantly related ($r=0.400$, $n=60$, $p<.01$) to the incidence of death from this disease. As shown below, in 1948, 90 percent of those who later suffered congestive heart failure had systolic blood pressures above 150 mm. This was true for only 62 percent of the subjects who died of other causes. Similarly, diastolic hypertension (above 90 mm) was observed to be twice as frequent among the individuals who eventually died of symptomatic heart disease.

	Cause of Death	
	Symptomatic Heart Disease	Other
Systolic Hypertension	90%	62%
Diastolic Hypertension	50%	24%

Advancing age may increase the probability of death from congestive heart failure, as subjects exhibiting this syndrome were older at the time of death (80.8 years versus 77.6 years for those dying of other causes).

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In contrast to the findings with symptomatic heart disease, acute cardiac attack (infarct or occlusion) was unrelated to either nutrient intake, age at time of death, relative body weight, or blood pressure. The nine individuals suffering a sudden attack actually had lower intakes of total protein, animal protein, and fat. The mean age at death was 80.4 years, approximately equal to that found among women dying of congestive heart failure. Incidence of acute cardiac attack was positively associated with hemoglobin levels although this difference was not significant.

Cerebrovascular attack including cerebral aneurysm or thrombus was the immediate cause of death for 11 subjects. Dietary fat appeared to be related to the development of such disorders. The individuals who died as a result of cerebrovascular attack had significantly higher intakes of fat (86.7 grams/day versus 70.3 grams, p=.05), compared with those dying of other causes. As might be anticipated, the women with the higher intakes of fat also consumed more calories, 1779 versus 1545, but this difference was not significant (p=.07). Age was not a factor in regard to cerebral attack and neither was relative weight; the subjects suffering this complication were slightly but not significantly underweight (relative weights equalled 93.7 and 102.2). Contrary to expectations, systolic and diastolic hypertension were, in 1948, less frequent among the subjects who later evidenced cerebrovascular disease.

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Generalized arteriosclerosis was, however, positively correlated with incidence of this disorder.

In contrast to the findings regarding cerebral complications, cancer deaths were not significantly related to nutrient intake. Those individuals with a malignancy had higher dietary levels in 1948 of thiamin and niacin, but less ascorbic acid. The outstanding characteristic of those whose death was attributed to cancer, was their younger age; it averaged 73.0 years compared with 80.2 years for those dying from other causes ($p<.01$).

Respiratory disease is a frequent complication of immobilization or complete bed rest in elderly patients. The nutritional status of these subjects did not appear to influence their susceptibility to respiratory disorders. The six subjects whose deaths resulted from such complications did have lower intakes of both total protein and animal protein, and were of lower relative weights; frequently, however, respiratory disease was the immediate consequence of physical trauma (i.e., broken bone or surgery).

Nutrient Intake and Chronic Disease Contributing to Death

The incidence of chronic conditions in these women which, according to the attending physician contributed to the immediate cause of death, is listed in Table III-7. Generalized arteriosclerosis was a complicating factor among 53 percent of the subjects. The development of this

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Table III-7.--Incidence of Physical Disturbances Contributing to Cause of Death Among Subjects Who Died in or Prior to 1972.

Physical Condition	Incidence	
Generalized arteriosclerosis	53%	(32)
Arteriosclerotic heart disease	45%	(27)
Hypertension	20%	(12)
Diabetes mellitus	10%	(6)
Nephritis-nephrosclerosis	8%	(5)
Bone fracture	7%	(4)
Surgery (complications--cancer, diabetes)	7%	(4)
Malnutrition	2%	(1)

n=60

For a majority of subjects more than one disturbance was indicated, therefore the total percentage exceeds 100.

condition was not related to nutrient intake, nor to relative weight. Furthermore, the women with generalized arteriosclerosis lived longer, with average age at death being 81.4 years as compared with 75.1 years for the other subjects.

The incidence of arteriosclerotic heart disease was related to the intake of a variety of nutrients. This disease, as shown in Table III-8, was negatively related to intakes of thiamin and calcium, and positively associated with levels of animal protein and the relative degree of calories contributed by the macronutrients. The magnitude of the beta weights (standardized partial correlation

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Table III-8.--Prediction Equation Relating Nutrient Intake in 1948 and Diagnosed Arteriosclerotic Heart Disease in Subjects Dying in or Prior to 1972.

$$y = -31 - 0.0063b_1 + 0.021b_2 + 0.32b_3 + 0.32b_4 - 0.00089b_5 + 0.35b_6$$

Nutrient	Regression Coefficient	Beta Weight	Partial F	Significance
b_1 Thiamin	-0.0063	-0.29	4.841	.033
b_2 Animal protein	+0.021	+0.60	7.348	.009
b_3 Fat calorie %	+0.32	+4.01	5.698	.021
b_4 CHO calorie %	+0.32	+4.48	5.805	.020
b_5 Calcium	-0.00089	-0.45	7.660	.008
b_6 Protein calorie %	+0.35	+2.33	6.522	.014

Analysis of Variance for Regression

	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
Regression	4.3	6	0.725	3.708	.004
Error	9.6	49	0.195		
Total	13.3	55			

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coefficients), listed for each parameter in the equation, suggest that the percent of calories in the diet coming from carbohydrate and fat are the strongest determinants in the relationship.

Upon closer examination, both the level and nature of the protein in the diet appear to be involved with the development of arteriosclerotic heart disease. Those who developed this condition secured 14.2 percent of their calories from protein, whereas the others secured only 12.1 percent ($p=.05$). Although the total protein in the diet did not differ, animal protein was consumed at a level of 34.0 grams per day by the women with arteriosclerotic disease versus 27.5 grams for the other subjects ($p=.08$). The women who exhibited arteriosclerotic heart disease tended to be older at the time of death than were the women relatively free of this disorder (81.1 years versus 76.4, $p=.052$).

Hypertension was a complicating factor in the deaths of 20 percent of the women. This condition was not related to nutrient intake, age at death, or relative body weight. In contrast, women with diastolic pressures above 90 mm when measured in 1948, died slightly earlier than expected ($p=.07$) when compared with the normotensive subjects. Hemoglobin levels, however, were positively correlated ($r=0.377$, $n=32$, $p<.05$) with diagnosed hypertension.

Although nutrient intake was not related to hypertension per se, there was an association between the actual syst

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systolic pressure measured in 1948 and dietary fat. That relationship can be expressed as:

$$\hat{y} = 119 + 2.1\ b_1 - 0.47\ b_2$$

where $\hat{y}$ is the systolic pressure in mm mercury, b_1 the percent of dietary calories from fat, and b_2 the grams of fat in the diet (Analysis of variance for regression, Appendix (B-3). Fat contributed a significantly higher percentage of the total calories to the diets of women with high diastolic pressures also, as compared to individuals with pressures below 90 mm (44.3% and 39.7% respectively, $p<.05$). As the calories from lipids increased, those from carbohydrates decreased in the diastolic hypertensive subjects, although this difference was not significant ($p=.06$).

Diabetes mellitus is frequently a metabolic complication of advancing years. The six diabetics were significantly overweight (relative weight 118.7 versus 98.2 for the other subjects). It was not possible to evaluate blood pressure with diabetes, inasmuch as blood pressure values were available for only two diabetics. One of these had systolic hypertension, whereas neither individual had an abnormally high diastolic pressure.

Kidney involvement, either acute nephritis or nephrosclerosis, contributed to the deaths of five subjects. Although these women were similar in age to those without kidney disease, they consumed fewer calories, less protein, calcium and thiamin. Although the dietary level of vegeta

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vegetable protein was equal in both groups, animal protein intakes were lower among those with kidney involvement. Body weight was a significant factor in the etiology of the nephrotic syndrome (relative weight among the women with kidney disease was 118.6 versus 98.6 among the others).

Eight subjects underwent surgery in the month preceeding death. Four suffered falls with subsequent broken bones; for three, surgery was necessitated by malignant growth; and for one, amputation of the leg resulted from diabetic gangrene. The mean age at death of the eight individuals requiring surgery did not differ from the group at large. Although age was not a factor, these eight women were, in 1948, consuming significantly less energy, fat, carbohydrate and iron. Despite the lower caloric intakes of the subjects undergoing surgery, protein as percent of total calories was higher, equalling 15.4 in these subjects and only 12.7 among the others. The women undergoing surgery had markedly lower relative weights (88.5 versus 102.2, $p=.05$).

Nutrient Intake and Physical Symptoms

At the time of the survey, subjects were questioned about various physical symptoms which might be indicative of organic disease. As shown in Table III-9, 67 percent reported unexplained tiredness, and an equal number, joint pains. Persistent backache, headache, shortness of breath, and fluid retention in the lower extremities, were the next

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Table III-9.--Incidence of Physical Complaints in 1948 Among Subjects Who Died in or Prior to 1972.

Complaint	Incidence	
Unexplained tiredness	67%	(40)
Pains in the joints	67%	(40)
Persistent backache	47%	(28)
Shortness of breath	43%	(26)
Persistent headache	42%	(25)
Swelling of ankles	38%	(23)
Loss of appetite	32%	(19)
Stomach pain	27%	(16)
Chest pains	27%	(16)
Skin rash	20%	(12)
Sore mouth or gums	18%	(11)
Sores that do not heal	17%	(10)
Nosebleeds	8%	(5)

n=60

A majority of subjects listed a number of complaints, therefore the total percentage exceeds 100.

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most frequent discomforts. As to the frequency of physical complaints among individuals, two of the sixty women were free of all symptoms. Seven individuals had only one complaint and twelve subjects reported two or three complaints. Twenty-one or approximately one-third of the women were annoyed by four or five of the physical symptoms tabulated, and 11 women reported six to seven symptoms. Seven subjects had eight or more physical complaints, with 11 complaints being the highest number reported. Of the seven individuals with one symptom, two had joint pain. The other five mentioned tiredness, skin rash, sores that did not heal, swollen ankles and dypsnea. Headache, joint pain, stomach pain, tiredness and loss of appetite, were each noted by two of the six women reporting two symptoms.

When nutrient intake was examined in respect to the incidence of physical symptoms, it was found that chronic tiredness was not in these women the result of reduced levels of dietary iron. This value did not differ between those who were and were not chronically tired--only one individual who complained of tiredness had a hemoglobin value below 12 gm/100 ml. The women in both groups had the same intake of animal protein, suggesting that vitamin B_{12} intake was not a factor; however, no measure of vitamin absorption was available. Neither age nor body weight significantly influenced reports of tiredness. Those who complained of fatigue had higher diastolic blood pressures than those who did not. Nearly one-half of the women who were

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were chronically tired had diastolic pressures exceeding 90 mm, whereas no one in the other group had elevated blood pressure.

In contrast to the symptom of unexplained tiredness, joint pains were associated with higher relative weight. For those with pain, this value was 105.7 as compared with a relative weight of 91.8 among those not experiencing this discomfort. Women with joint pain tended to have higher dietary intakes of ascorbic acid, although serum ascorbic acid levels were similar in both groups. Persistent backache, however, was not related to either body weight or age in 1948.

Shortness of breath appears to be a function of age. Those subjects with limited adaptation to exercise were aged 69.3 years in 1948 versus 64.6 years for those without this difficulty. Neither relative weight nor blood pressure was associated with dsypnea. In contrast, low thiamin intake may be related to cardiac involvement and subsequent fluid retention. Those women whose ankles swelled consumed only 0.76 mg of the vitamin each day versus 0.94 mg reported by those not so affected. Systolic blood pressure also tended to be lower in those persons with fluid retention. The lowest systolic pressure observed among the women with no fluid retention was 140 mm; alternatively, two individuals with swollen ankles had pressures below this level. Low diastolic blood pressures, on the other hand, were associated with complaints of persistent headache.

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Contrary to what might be anticipated, ascorbic acid intake was not significantly related to the incidence of sore mouth and gums, or sores that would not heal; however, dietary intake did tend to be lower among those with these abnormalities. As to the influence of other nutrients, women who reported these symptoms had lowered iron, niacin and thiamin, in their daily diets. Reported loss of appetite by subjects would appear to result from higher intakes of fat. Those experiencing prolonged satiety were ingesting 81.3 grams of fat daily, whereas the others consumed only 69.0 grams.

Although none of these physical symptoms were correlated with age at death, several were associated with reported causes of death. Women who died as a result of cardiac failure had complained previously of dyspnea ($r=0.345$, $n=60$, $p<.05$). Those subjects with arteriosclerotic heart disease had persistent backache ($r=0.288$, $n=60$, $p<.05$) and stomach pain ($r=0.384$, $n=60$, $p<.01$). Sore mouth, swollen ankles, and joint pains, were frequently observed among the diabetic women.

Upon examination in 1948, subjects were rated according to an index of aging as seen in Table III-10. The rating chart was not complete for all subjects, consequently 55 women were included in the calculations for graying of hair and wrinkling of skin and 56 for hearing loss and movement. Graying, skin changes, and impaired locomotion, all appear to be functions of age. Hearing

Table III-10.--Age in 1948 as Related to Index of Aging in Subjects Who Died Prior to 1972.

Table III-10.--Age in 1948 as Related to Index of Aging in Subjects Who Died Prior to 1972.

		None	Some	Marked	Complete
Graying of Hair	Number of Subjects	2	11	21	21
	Age in 1948 (years)	50.0±14.1	64.1±5.6	67.4±8.6	69.6±9.1*
Hearing Loss	Number of Subjects	38	15	2	1
	Age in 1948 (years)	65.2±9.0	68.3±9.0	77.0±9.9	76.0±0
Wrinkling of Skin	Number of Subjects	2	10	28	15
	Age in 1948 (years)	50.0±14.2	61.0±7.4	66.8±6.1	73.3±9.4*
Movement Impaired	Number of Subjects	15	23	14	4
	Age in 1948 (years)	63.0±8.9	65.7±8.2	70.6±7.4	76.8±10.9*

*Groups significantly different by analysis of variance.

Group values expressed as mean ± S.D.

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loss, however, would seem to be non-specific, with only three subjects experiencing marked hearing loss. Relative weight was not a factor in respect to difficulties in locomotion.

Discussion

Nutrient Intake and Longevity

Vitamins.--The results of the present study lend support to the suggestion of other investigators (Chope, 1954; Kelley et al., 1957) that nutrient intake may influence the length of life. Chope (1954) noted higher mortality among those subjects who had low intakes of vitamin A, niacin, and ascorbic acid. A similar situation was observed among the Lansing women, in that the mean dietary intakes of all three vitamins tended to be lower for those now deceased, although ascorbic acid only, was significantly lower. A further report on the 577 Californians initially studied by Chope and Breslow (1956) indicated that both serum vitamin A and ascorbic acid levels were positively related to longevity. Such an association was not evident in the Lansing study; however, serum parameters were available for only 33 of the 60 deceased subjects.

Similarly, Kelley and coworkers (1957) observed that mortality was higher for those individuals who consumed less than 40 percent of the RDA for one or more nutrients. This relation was true for vitamin A, niacin, and ascorbic acid,

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in the 1972 evaluation, although subjects now deceased were less likely to be low in calcium intake than were survivors.

Calcium.--There is considerable controversy about the possible merits of high intakes of calcium. Some of the early work with animals, investigating the effects of high levels of dietary calcium, was done by Campbell and associates (1943). They observed in Osborne-Mendel rats that lifespan was increased when the calcium level in the ration was raised from 0.20 to 0.35 percent. However, levels of calcium above 0.35 percent had no effect, in that the rate of growth or lifespan of rats fed rations containing either 1.0 percent calcium throughout life, 1.0 percent during growth and 0.70 percent thereafter, did not cent during growth and 0.22 percent thereafter, did not differ. Those authors (Campbell et al., 1943) concluded that when the optimum requirement was met, further supplementation had no beneficial effect. In this regard, Garn (1970) proposed that the adult requirement for calcium is approximately 200 mg daily. This is in contrast to the recommendation of 800 mg, put forth by the National Research Council (Food and Nutrition Board, 1953). Using this criteria, 17 of the deceased subjects and 10 of the survivors were, in 1948, consuming less than 40 percent of the recommended level of 320 mg. If Garn's suggested level of calcium intake is accepted (200 mg), then only four of

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the deceased subjects and one of the survivors, had inadequate intakes of this mineral.

Protein.--There was a suggestion in the Lansing study that dietary level of animal protein may have a positive effect on longevity. According to the 1948 diet records, the women who have survived had higher intakes of animal protein than those who did not. Among the deceased, however, there was no relationship between dietary protein and age at death (r=0.022). Although survivors tended to have higher intakes of animal protein, low intakes of this nutrient do not necessarily reduce the lifespan. This idea comes from the fact that one woman, aged 78 in 1948, whose daily intake of protein was 32 grams or 53 percent of the RDA (Food and Nutrition Board, 1953), consumed only nine grams of animal protein each day. Despite this intake, she survived to the age of 88, or two years beyond her expected age.

Furthermore, epidemiological evidence does not support the conclusion that increasing levels of dietary protein are beneficial to health and well-being. Watanabe and coworkers (1968), comparing nutrient intake in a total of 29 advanced and underdeveloped countries, reported that the quantity of meat consumed provided the strongest association with degenerative heart disease.

Similarly, protein intake has been shown to influence kidney regulation. This may have important consequences inasm

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inasmuch as normal aging is accompanied by a 50 to 60 percent reduction in the number of functional nephrons (Shock, 1970). The latter effect is associated with an increase in blood urea nitrogen (BUN). When the intake of acid-producing animal protein is restricted, with the substitution of alkali-producing vegetable protein, BUN levels fall within normal ranges (Lyon et al., 1931). Such a change may enhance normal kidney function throughout a longer fraction of the lifespan.

Studies with animals have not provided any clear-cut evidence regarding the effect of dietary protein upon health and/or longevity. Ross (1961) observed no reduction in the average lifespan of rats fed the minimal level of protein required for good growth. In contrast, the length of life was increased when calories were restricted concomitantly. In these animals, however, excessive levels of dietary protein were associated with increased nephrotic degeneration. Similarly, Nakagawa and Masana (1971) reported no differences in the lifespan of rats fed rations containing 10, 18, or 27 percent casein.

One factor which must be considered in regard to the higher intakes of protein in 1948 by those who have survived, is age. These subjects were younger at the time of the initial survey, whereas the deceased subjects were of retirement age. Differences in the consumption of animal protein may reflect the amount of money available for food expenditures by these two groups. The individuals on a reti

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retirement income may have been forced to limit their servings of meat as a result of cost.

A second factor influencing this difference in animal protein intake between women of two different ages, may be the change in the consumption pattern of most people in the United States which has occurred during this century. In 1900, only one-half of the protein intake was obtained from animal sources, whereas today, two-thirds comes from animal foods (Swope, 1970). The dietary survey conducted in 1972 revealed that survivors have continued to consume generous amounts of animal protein and are still, for their age, in relatively good health. Of greater importance may be the fact that these women have, in the past 24 years, significantly reduced their intakes of calories and fat; this may be a vital determinant in the prolongation of their lives.

Fat.--The finding that age at death was inversely related to dietary fat may be of practical significance. Burrill and associates (1959), studying 349 women from the North Central states who ranged in age from 30 to 97 years, found that dietary fat equalled 72 grams daily, or 38 percent of total calories. Fat intake among the Lansing women in 1948 was about 73 grams, but, as a percent of total calories, equalled in survivors and decreased 38.6 and 41.3, respectively. This difference was not significant; however, fat cal

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fat calorie percent was negatively correlated with both age at death and expected age.

The relation of various levels of dietary fat to health and longevity has been evaluated by Watanabe and associates (1968). These investigators compared the fat intake of the populations of various countries with mortality statistics and incidence of degenerative disease. Regression analysis revealed an inflection on the curve, with a shift from a positive to a negative influence, at an intake of 50 to 60 grams fat, a range 10 to 20 grams less than that consumed by both survivors and deceased in 1948. According to the dietary information collected from the survivors in 1972, fat intake had, over the intervening years, dropped to 51 grams daily. This value compares favorably with the calculations of Watanabe et al. (1968).

The suggestion of a deleterious effect of dietary fat upon the lifespan has been confirmed by several investigators (French et al., 1953; Silberberg and Silberberg, 1954; Schemmel et al., 1973) working with various animal models. The Silberbergs (1954) concluded that a diet high in fat (29% lard), when fed to mice, resulted in higher mortality, regardless of strain, sex, age, or weight gain. The deleterious effect of this regimen was more conspicuous in animals of a long-lived as compared with a short-lived strain, in males than in females, and when fed from the age of one year rather than from weaning. In that study, the rate (

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rate of mortality was positively associated with the increase in body weight.

Similarly, French and coworkers (1953) noted a significant decrease in length of life among rats of both sexes fed a diet in which corn oil provided 22.7 percent of total calories. Histological examination revealed a high fat content in the liver of males fed the corn oil ration, as compared with controls given a low-fat, high-carbohydrate mixture. The cause of premature death in these animals, however, could not be ascertained. As was also noted by the Silberbergs (1954), the deleterious effect of the high fat ration was less pronounced in females. Schemmel and associates (1973) observed that rats suckled by dams fed either a high fat (60%) or grain (3% fat) ration, and then weaned to one of these rations, experienced the highest mortality when nursed by high-fat fed dams and weaned to that ration.

Possible Mechanism of Action of Dietary Fats

The mechanism whereby dietary fat shortens life is not known. A number of possible explanations exist. One of these involves the obesity that may result from the consumption of a high fat diet. This type of obesity has been observed in animals (Mickelsen et al., 1955). Excessive body fat may accelerate the development of a variety of chronic disturbances leading to an early death. In the present study, obesity would not appear to be the means by whic

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which dietary fat shortened the life, as relative body weight was not associated with either age at death or expected age.

Another possible mechanism by which fat may hasten mortality is an effect upon the cardiovascular system. At first glance, this hypothesis would seem to be supported by the present results. For these women, fat intake, both in absolute terms and as a percentage of caloric intake, was related to both symptomatic heart disease and arterio-scelerotic complications. The actual significance of this relationship is questionable, since the true incidence of cardiovascular deaths among the elderly is difficult to determine. Any "sudden death" among these individuals is frequently described as a cardiovascular accident. As emphasized by Mueller-Deham (1946), in senescence, a number of diseases are likely to occur in the same individual, thus making it exceedingly difficult to attribute death to a single cause.

The relationship of fat intake to blood pressure deserves further scrutiny in that Stamler (1962) suggests that arteriosclerosis and hypertension are two distinct diseases, despite the fact that one usually accompanies the other. A prior study of women in the North Central states (Burrill et al., 1959) revealed no relationship between fat intake and blood pressure. In contrast thereto, the results of the present study of the deceased Lansing women suggest that dietary fat, both on an absolute basis and as

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a percentage of total calories, contributed to the prediction of systolic blood pressures.

Results supporting those observed in the Lansing study have been reported from Czechoslovakia. There, Hejda and coworkers (1967) noted among 12,000 aged persons examined that those with low blood pressure (precise value not stated), consumed 84.4 grams of fat each day. This mean value increased to 112.6 grams daily for those individuals with high blood pressure; however, the difference between the two levels was not significant.

Further attempts to determine the mechanism whereby dietary fat shortens life have been directed toward the presence of toxic substances in the fat itself. Considerable work has been carried on by Kaunitz et al. (1966) who concluded that fresh olive, soybean and corn oils, despite processing for human consumption, contain compounds which are toxic to rats. Further work (Kaunitz et al., 1970) suggested that whether the fat was oxidized or not, its inclusion in the ration at a level of 20 percent, decreased longevity in rats. This effect could not be attributed to linoleate content, melting point or degree of unsaturation. It was concluded that non-triglyceride components may be involved in this "toxicity." Another aspect of this problem was demonstrated in humans by Dayton et al. (1968) who reported that older men fed diets containing large amounts of unsaturated fats responded with some change in

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in serum cholesterol levels; however, cancer mortality was increased.

Another factor in the relation of dietary fat and longevity involves a possible change in the distribution of fat within the body as individuals age. The basis for this is the suggestion by Skerjl and coworkers (1953) that the percentage of body fat increases with age, while body weight remains stationary. This may be the result of fat infiltration of organs and muscles, with compensatory loss of lean body mass. Whether this change is enhanced or accelerated by increased levels of dietary fat remains a matter of speculation. The accompanying loss of vital tissue from the fat-infiltrated organs, might shorten the lifespan.

An alternative proposal to that which assumes a deleterious effect of dietary fat, is the consideration of the high fat diet as deficient in cellulose or crude fiber. In most cases, the incorporation of large amounts of fat in the diet is at the expense of plant products adding carbohydrate and fiber. The importance of fiber in the diet has been stressed by Painter and Burkitt (1971). These workers, on the basis of epidemiologic evidence, suggest a significant negative relation between dietary fiber and the incidence of diverticulosis and colonic cancer. Prior to the recent emphasis upon colonic cancer and related disturbances of the lower intestinal tract, the therapeutic role of cellulose and pectins was limited to the control of serum cholesterol levels. Presumably, pectins reduce the reabsorption of bile acids (Leveille and Sauberlich, 1966). Other possible roles of fiber, in addition to the maintenance of normal intestinal function, remain to be elucidated.

Mortality and Cause of Death

The causes of death among the 60 Lansing women are statistically similar to those of the United States white female population. Since only two of the 60 subjects in the present study died before reaching 65 years of age, that was the lower range used in comparing United States vital statistics with the present results. In the United States women above 65 years of age, diseases of the heart are responsible for 46 percent of all deaths (Metropolitan Life Insurance Company, 1971e); this was also true for the Lansing women. Cerebrovascular disease was reported to be the cause of death for 18.0 percent of the Lansing subjects, a value which compares with the national percentage of 16.6. Among United States women over the age of 65, malignant neoplasms are responsible for 14 percent of all deaths, whereas 23 percent of the Lansing women had this disease. For younger United States women aged 45 to 65, however, one-third of all deaths are attributed to cancer of some form. Both Lansing subjects who died before the age of 65, succombed as a result of this disease.

There are some differences between United States vital statistics and the Lansing results as to the incidence

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of various types of cancer. Although cancer of the breast is the most frequent form among United States women, only one subject in the present study presumably died from that cancer. Malignancy of the intestinal tract caused four deaths, and three women had cancer of the reproductive organs. Intestinal cancer is second highest in incidence among United States women, followed by malignancies of the lungs and respiratory system. Since the Lansing women belonged to a generation in which cigarette smoking by women was less frequent, cancer of the lungs and respiratory system might be less likely to occur. Leukemia, myeloma of the bone marrow, Hodgkins disease, a brain tumor and thyroid cancer, each caused one death.

Few specific relationships could be established between nutrient intake and the cause(s) of death as listed on the death certificates. Those women for whom death was attributed primarily to symptomatic heart disease had low dietary thiamin levels. This provides some support for the findings of Chope (1954) that thiamin intakes below 0.8 mg daily were associated with circulatory disease. Although high intakes of calories and fat are generally considered to promote the development of this syndrome, in the current study, a multiplicity of nutrient factors were associated. Such a situation suggests that the relationships between cardiovascular disease and diet which have been suggested from studies of males may not be true in females.

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Among the Lansing women, generalized arteriosclerosis was significantly related to age at death, suggesting this to be a non-specific degenerative process continuing in advanced age. Progressive arteriosclerotic lesions may result in memory lapse or even complete loss of facultative processes. Such unawareness to surroundings, with reduced stress, could facilitate the adaptation of these individuals to their environment, resulting in an extended lifespan. Whether such an adaptation enabled these subjects to live longer than those who were less affected by arteriosclerosis and may have been more aware of their life situation and limitations, remains a possibility.

Arteriosclerotic lesions of the coronary arteries in particular, however, would appear in these subjects to be related to dietary intake. One nutrient which deserves further attention in relation to the development of coronary heart disease in women is protein. The percent of total calories supplied by protein was significantly greater among those exhibiting this disease. The subjects with higher intakes of protein tended to consume more animal protein.

In regard to disease processes, one aspect of the present study which should not be overlooked is the measurement of "total dietary fat." This value was not defined as to the nature of the fat. One possible explanation for the relationship of protein calorie percent and coronary arteriosclerosis might lie with the large amounts

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amounts of saturated fatty acids found in animal foods. The mean age at death of subjects with arteriosclerotic heart disease was 81.1 years, suggesting that this chronic condition, although possibly imposing physical limitations, does not predispose women to an early death.

The results from the multiple regression analyses emphasize the complexity when attempting to relate nutrient intake to physiological syndromes. In reference to cardiovascular diseases, the present data indicate that not only do specific nutrients interact (i.e., thiamin, calcium, fat and animal protein), but the relative proportions in which they are present, is also important. Although thiamin, animal protein and fat, have previously been associated with cardiovascular function or disease, the contribution of calcium to an equation is an interesting observation. The calcification of atherosclerotic plaques seems to be a natural progression of the disease to its more severe form. Future investigators might do well to examine the diet as a whole, in that the level of intake of other nutrient factors, not previously considered, may contribute to degenerative diseases of the coronary arteries and heart muscle itself.

In contrast to the findings regarding cardiovascular disease, cerebrovascular attack was significantly related to dietary fat, and positively associated with the ingestion of calories. Despite seemingly high intakes of calories and fat, the subjects who developed cerebrovascular attacks had lo

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had low relative weights (93.7). Life insurance statistics (Society of Actuaries, 1959) suggest that cerebrovascular disorders are often related to hypertension; however, this was not true of the Lansing women examined in 1948. This finding may reflect the use of more effective drugs for alleviating symptomatic hypertension, although damage may have already occurred. Alternatively, these individuals may have become hypertensive at some time after the examination in 1948.

Body Weight and Blood Pressure

One physiological parameter associated with the development of degenerative disease is body weight. In the present study, relative weight as a measure of the degree of body fatness, was significantly associated with both diabetes and nephrotic syndrome. This finding is comparable to life insurance data (Society of Actuaries, 1959). The latter show that for cardiovasulcar-renal disorders and diabetes mellitus, the mortality ratio (normal weight individuals=100) of overweight women was 177 and 372, respectively. Similarly, mortality ratios are higher for arteriosclerotic heart disease (175) and cerebral hemorrhage (212), among those who are excessively overweight.

The actuarial statistics suggest that in women, elevated blood pressure predisposes the individual to cerebrovascular or heart disease. According to Blackburn and Parlin (1966), the pattern of mortality from cardic

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cardiovascular-renal disease may reflect the extent of association between elevated blood pressure and excessive body weight. In the Lansing study, neither systolic nor diastolic blood pressure correlated with body weight.

A study of chronic disease among the inhabitants in a community of southern Michigan (Epstein et al., 1965) indicated that in women over 60 years of age, heart disease was related to systolic blood pressure but not overweight. Alternatively, hypertensive heart disease was positively associated with body weight. Diabetes mellitus correlated with both systolic blood pressure and relative weight. Comstock and coworkers (1966), studying women over 55 years of age in Muscogee County, Georgia, found the incidence of heart disease to rise from 98/1000 to 142/1000 with increasing fatness, as judged by skinfold thickness. This finding was not substantiated in the present study. Alternatively, in the Georgia study, deaths from cerebrovascular disease were inversely proportional to measures of body fat, a relationship also suggested by the relative weights of the Lansing women.

The interpretation of the results from the present study are subject to certain limitations. The time interval between the collection of dietary and medical data in 1948 and the year of death, ranged from 6 months to 24 years. What changes in nutrient intake, body weight or blood pressure occurred during this period, are not known.

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Furthermore, the information obtained from death certificates cannot be accepted without some degree of reservation, as autopsies are seldom performed on aged individuals dying of natural causes. Mueller-Deham (1946) in his review points out that an essential defect in the reporting of deaths is the neglect of auxiliary diseases and multiple causes. No consistent policy is followed as to whether a severe pre-existent disease or the immediate cause of death should take precedence on the death certificate (U.S. Department of Health, Education and Welfare, 1967). For example, diabetes may be a common cause of death in old age, although most frequently, these patients die from complications of the disease which could be entered under cardiovascular syndrome or infection. Cardiovascular disease would appear to be stressed in dubious cases.

Finally, the size of the Lansing sample is relatively small. However, it is one of the few studies which provides longitudinal information concerning the dietary habits and health, and later mortality experience, of a random group of women.

Conclusions

For these 60 older women, mortality would appear to be higher in those subjects consuming less animal protein and 40 percent or less of the recommended intake of ascorbic acid. Low levels of dietary calcium seemingly have no adverse effect upon lifespan.

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Incorporation into the diet of high levels of fat with concomitant reduction in carbohydrates, was associated with a shortened life. There is a possibility that this deleterious effect of dietary fat is mediated by increases in systolic or diastolic blood pressure. Although dietary fat was associated with the development of cerebrovascular disorders among these women, arteriosclerotic and myocardial lesions appear to be multi-factorial in etiology involving animal protein, thiamin, calcium, and the relative caloric contributions to the diet of protein, fat and carbohydrate, as well as the degenerative processes of normal aging. The two women who died prior to age 65 years were listed as dying of cancer, whereas degenerative diseases of the heart and circulatory system were the common causes of death among the older women.

Body weight and hypertension may have aggravated degenerative disease and so contributed to mortality, but neither factor was directly related to life expectancy. Physical complaints as tiredness, swollen ankles or shortness of breath, although causing personal discomfort, were not associated with mortality or longevity.

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CHAPTER IV

CHANGES IN FOOD INTAKE OF DECEASED AND SURVIVORS BETWEEN 1948 AND 1972

Introduction

During the past decade the number of individuals in this country, over the age of 65, has increased from 16.5 to 20 million. By the year 2000, nearly one-third of our population will be at least 45 years of age (U.S. Bureau of Census, 1970).

Despite the large numbers of persons in this age category, relatively little is known about the individuals' food habits in later life. The dietary pattern of the older adult is a product of his lifelong experiences with food. Although various groups of older people have been studied in relation to their food choices, these surveys, as concluded by Howell and Loeb (1969), do not indicate whether the current food choices of the subjects are those which have persisted from earlier adulthood, or have been altered by physical, social or environmental factors. Similarly, the character and availability of foods in the United States have changed radically during this century.

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For this reason, food consumption patterns of individuals above the age of 60 have, most likely, changed during the course of their lifetime apart from any influence of their own aging process. Whether these changes are reflective of those observed in the general population, or are adaptations to the limitations imposed by advancing age, is not known.

To further examine the influence of age and national food trends upon specific food choices, as well as patterns of consumption, the author examined the dietaries of a group of women in Lansing, Michigan, who were studied in both 1948 and 1972. At the time of the original survey in 1948, the 103 subjects ranged in age from 40 to 88 years. The 28 survivors who were studied in 1972, were aged 64 to 90.

Methods

In 1948-55 Ohlson and coworkers (1948, 1950, 1952, 1952a) conducted nutrition studies with 103 women in Lansing, Michigan, who at that time ranged in age from 40 to 88 years. Each subject provided a 24-hour dietary recall in addition to a health and nutritional history, and facts relating to marital and socioeconomic status. About one-half of the women kept written food records for periods of one to five days. Selection procedures and methods have been described elsewhere (Chapter II, pp. 92-93). In 1972, the survivors of this population were s

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re-examined, and both written and recall dietary records were secured. Twenty-eight subjects, ranging from 64 to 90 years, participated. The methods have been described previously (Chapter II, pp. 93-95.

The nutrient intake of the deceased subjects when measured in 1948, and that of the survivors in both 1948 and 1972, have been compared using the student's t and paired t tests, respectively. To determine the frequency of intake of specific food items, those foods were tabulated which appeared at least once on the food records available for each subject (Appendix C-1, C-2). The quantitative servings listed were those judged to be most representative of the subject's daily diet plan. Servings were defined according to the Exchange Lists used in developing therapeutic diets (Goodhart and Shils, 1973). Statistical differences were confirmed using tests of chi square.

Results

The age distributions of the subject populations studied in both 1948 and 1972, and age at death of the deceased women, are shown in Figure IV-1. In 1948 the greater numbers of subjects were between the ages of 40 and 60 with a mean of 59.5 years. The 28 cooperating survivors in 1972 had a mean age of 74.8 years. Sixty of the subjects are now deceased, having died during or prior to 1972. In Figure IV-2 are tabulated the numbers of deaths

Figure IV-1. Age Distribution of Subjects.

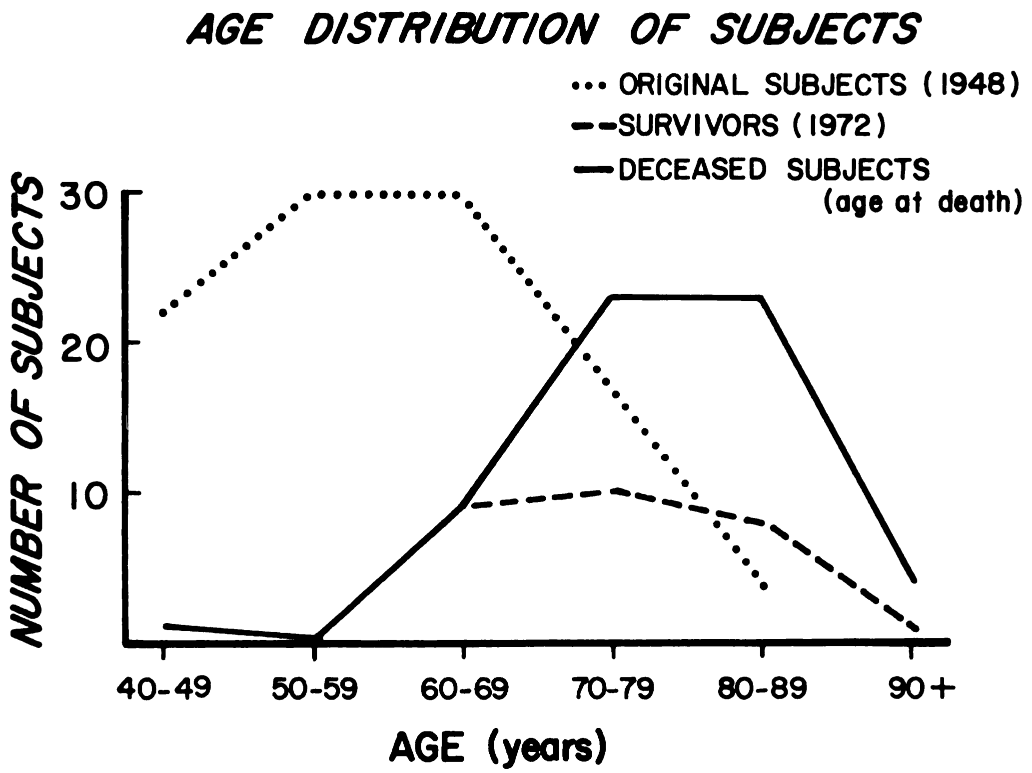
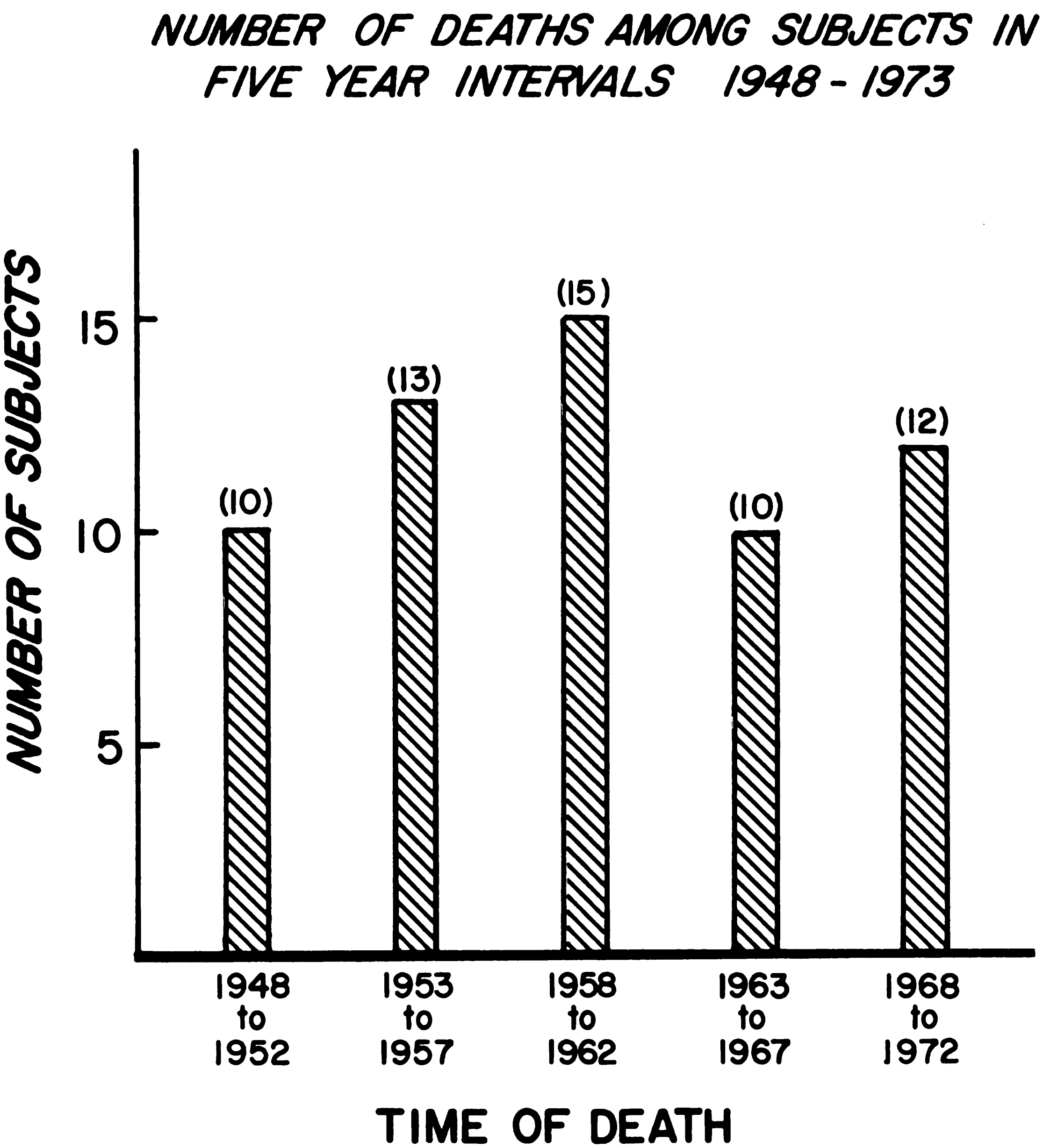

AGE DISTRIBUTION OF SUBJECTS
••• ORIGINAL SUBJECTS (1948)
-- SURVIVORS (1972)
— DECEASED SUBJECTS (age at death)
NUMBER OF SUBJECTS
30
20
10
40-49
50-59
60-69
70-79
80-89
90+
AGE (years)

Figure IV-2. Number of Deaths Among Subjects in Five Year Intervals 1948-1973.


NUMBER OF DEATHS AMONG SUBJECTS IN FIVE YEAR INTERVALS 1948 - 1973
NUMBER OF SUBJECTS
15
10
5
(10)
(13)
(15)
(10)
(12)
1948 to 1952
1953 to 1957
1958 to 1962
1963 to 1967
1968 to 1972
TIME OF DEATH

occurring in each five-year interval since 1948. The death rate would appear to have been relatively constant over the 24-year period.

Differences in Nutrient Intake Between 1948 and 1972

The nutrient intakes in 1948 and 1972 of the deceased and surviving subjects are compared in Table IV-1. The survivors were younger at the time of the first survey, with a mean age of 52.1 years as compared with 67.4 years for those now deceased. The dietary nutrients of the two groups in 1948 were very similar, with significant differences noted only for protein and ascorbic acid. The survivors consumed 58.4 grams of protein daily, in contrast to 50.8 grams for the deceased. Similarly, the mean ascorbic acid intakes were 73 mg and 51 mg for the survivors and deceased, respectively. Although protein intake per se was higher among the survivors, protein as a percent of total calories did not differ significantly between the two groups in 1948.

Despite the fact that nutrient intakes of deceased and surviving subjects were similar in 1948, many changes occurred in the diets of the survivors since that time. Energy intake decreased significantly from 1683 kcalories to 1297. Associated therewith were decreases of about 25 percent in carbohydrate and fat intakes. Alternatively, protein levels remained fairly constant. Dietary vitamin A

Table IV-1.--Comparison of Nutrient Intakes of Subjects in 1948 and 1972.

Nutrient	Deceased[1] 1948	Survivors[2] 1948	Survivors 1972
Calories (kc)	1580 ± 394	1683 ± 632[a]	1297 ± 317[a]
Protein (g)	50.8 ± 14.2[b]	58.4 ± 17.9[b]	59.2 ± 15.3
Fat (g)	72.9 ± 22.1	73.9 ± 32.8[c]	51.4 ± 18.8[c]
Carbohydrate (g)	180.5 ± 53.0	196.5 ± 78.2[d]	151.3 ± 44.4[d]
Calcium (mg)	478 ± 247	491 ± 284	528 ± 231
Iron (mg)	9.4 ± 2.3	10.2 ± 5.1	10.1 ± 2.8
Vitamin A (IU)	4214 ± 4408	3866 ± 3728[e]	7969 ± 8236[e]
Thiamin (mg)	0.86 ± 0.24	0.95 ± 0.53	0.91 ± 0.31
Riboflavin (mg)	1.11 ± 0.45	1.19 ± 0.54	1.45 ± 0.62
Niacin (mg)	8.4 ± 3.5	9.0 ± 2.3[f]	12.7 ± 3.8[f]
Ascorbic acid (mg)	51 ± 40[g]	73 ± 40[g,h]	93 ± 52[h]
Protein calories %	13.1 ± 3.4	14.4 ± 3.4[i]	18.5 ± 4.7[i]
Fat calories %	41.3 ± 6.4	38.6 ± 6.5[j]	34.8 ± 6.8[j]
Carbohydrate calories %	45.5 ± 7.1	47.0 ± 6.3	46.8 ± 7.8

[1] n=60 These women died during or prior to 1972.

[2] n=28 These women were interviewed in 1948 and 1972.

Values expressed as mean ± S.D.
Letter pairs are significantly different, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

and niacin were higher in 1972, whereas thiamin and riboflavin intakes did not differ. Inasmuch as protein remained constant while energy values declined, protein at the later date contributed a higher percentage of total calories, rising from 14.4 to 18.5. Concomitantly, calories from fat declined from 38.6 to 34.8 percent of the total energy. Carbohydrate calories decreased in the same proportion as did the total, with the percentage of calories from this food source remaining the same.

Differences in Food Choices Between 1948 and 1972

Meat, Fish, Poultry and Eggs.--The observed differences in nutrient intake are reflected in the foods chosen by the women in both surveys. Sources of animal protein, selected in 1948 and 1972, are tabulated in Table IV-2. Beef was the most popular meat in both years. Pork was the second most frequent choice of those now deceased, whereas chicken was consumed more frequently by the survivors in 1948. In the initial survey, pork sausage was listed for 3 and 7 percent of the deceased and survivors, respectively. In 1972, two individuals used liver sausage and four women had frankfurters as a main dish. Pork sausage was not consumed by any subject in the later survey. Liver was selected at least once by nearly one-fifth of the survivors in 1972. Eggs were a popular protein source both in 1948

Table IV-2.--Meat Varieties Chosen by Subjects in 1948 and 1972.

Food Item	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
Beef	50%	(30)	57%	(16)	64%	(18)
Ham	3%	(2)	11%	(3)	7%	(2)
Pork	30%	(18)	21%	(6)	18%	(5)
Veal	7%	(4)	11%	(3)	0	(0)
Chicken	7%	(4)[a]	21%	(6)[a]	25%	(7)
Fish	20%	(12)	25%	(7)	36%	(10)
Liver	7%	(4)	4%	(1)	18%	(5)
Luncheon meat	18%	(11)	28%	(8)	25%	(7)
Sausage/weiners	3%	(2)	7%	(2)	21%	(6)
Eggs	48%	(29)	50%	(14)	64%	(18)

[1]n=60 These women died during or prior to 1972.

[2]n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects.
Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

and 1972. The meat varieties chosen by deceased and survivors in both surveys were generally similar.

In contrast to this finding regarding the varieties of meat chosen, significant differences were noted in the number of servings of high protein foods consumed by both groups of subjects (Table IV-3). Although all of the survivors had, in 1948, at least one serving of high quality protein daily (meat or egg), this was not true of the deceased women. For 20 percent of the latter, protein intake (with the possible exception of milk) was of plant origin. The majority of the deceased subjects (55%) had either one serving of meat daily or a serving of meat or egg. The comparable value for the survivors was 39 percent; however, the remainder of the survivors, or 61 percent, had two or more servings of animal protein each day. The number of survivors including both meat and egg in their daily dietary increased from 39 percent in 1948 to 64 percent in 1972. Two individuals had three servings of meat each day in 1948, although none did so in 1972.

Vegetables, Fruits and Legumes.--A number of changes occurred in the consumption patterns of fruits and vegetables among the survivors. As shown in Table IV-4, the use of dark green and deep yellow vegetables did not differ significantly between deceased and survivors in the 1948 dietary survey. By 1972, survivors had increased their intake of those vegetables and fruits high in vitamin A.

Table IV-3.--Amounts of Meat and Eggs Consumed by Subjects in 1948 and 1972.

Food Pattern	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
Meat and/or egg daily	80%	(48)[a]	100%	(28)[a]	100%	(28)
One serving meat/day	32%	(19)	32%	(9)	18%	(5)
Two servings meat/day	10%	(6)	18%	(5)	18%	(5)
Three servings meat/day	2%	(1)	4%	(1)	0	(0)
1-2 servings meat + egg daily	13%	(8)[b]	39%	(11)[b]	64%	(18)
Either meat or egg daily	23%	(14)	7%	(2)	0	(0)
No meat or egg	20%	(12)[c]	0	(0)[c]	0	(0)

*Includes fish and poultry.

[1]n=60 These women died during or prior to 1972.

[2]n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects.
Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

Table IV-4.--Vegetables and Fruits Chosen by Subjects in 1948 and 1972.

Food Item	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
Deep yellow vegetable	25%	(15)	14%	(4)[a]	39%	(11)[a]
Dark green vegetable	5%	(3)	7%	(2)	18%	(5)
Potato	80%	(48)	78%	(22)	75%	(21)
Legumes	32%	(19)	39%	(11)	21%	(6)
No vegetable	0	(0)	0	(0)	0	(0)
Citrus fruit	42%	(25)[b]	78%	(22)[b]	68%	(19)
Deep yellow fruit	23%	(14)	36%	(10)	39%	(11)
No fruit	22%	(13)	7%	(2)	11%	(3)
Vitamin A source	23%	(14)	36%	(10)[c]	64%	(18)[c]
Vitamin C source	43%	(26)[d]	82%	(23)[d]	71%	(20)
Sources - Vitamins A and C	17%	(10)	28%	(8)	54%	(15)

[1]n=60 These women died during or prior to 1972.

[2]n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects.
Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

In 1948, the consumption of citrus foods was significantly less among the deceased subjects. Although nearly twice as many survivors (54%) had, in 1972, a good source of both vitamins A and C, as compared with 1948 (28%), this difference was not significant ($p < 0.1$). Of the deceased subjects, only 17 percent consumed good sources of both vitamins A and C on at least one day.

Use of potatoes in the diet did not differ between groups in 1948, nor was there a change during the intervening years in the percentage of women consuming this food. Legumes appear less frequently in current diet records as compared with the previous study. No individual, in either survey, omitted completely, vegetables from their meals. In 1948, however, 22 percent of the deceased subjects consumed no fruit; this was also true for 7 percent of the survivors.

Further examination of individual diets revealed that 25 percent of the women increased their daily servings of fruit between 1948 and 1972, whereas 28 percent reduced it. Among the latter, citrus fruit was most frequently deleted from the meal pattern as six of the 22 subjects who included citrus in their diet in 1948, did not select such fruit in 1972. Conversely, three subjects who did not choose citrus in 1948, had added this vitamin source to their diets by 1972.

The selection of vegetables in the daily meal pattern was unchanged for 46 percent of the women interviewed in both surveys. In contrast, 12 subjects added a dark green or yellow vegetable to their daily diet over the 24-year interval, whereas three persons deleted this food. During the interval three women excluded potatoes from their diets, and two individuals added this vegetable.

Dairy Foods.--The types of dairy products chosen in 1948 and 1972 (Table IV-5) may explain in part, the decline in fat intake by the survivors over the past 24 years. In 1948 only 7 and 4 percent of the deceased and survivors, respectively, used skim milk, whereas 54 percent of those interviewed in 1972 used a non-fat or low-fat milk. Among the 15 individuals using a milk low in fat in 1972, 12 chose skimmed milk and three, milk with a fat content of 2 percent. A trend toward food choices lower in fat content is further indicated by the increased use of cottage cheese, and the change from ice cream, the dessert of choice in 1948, to ice milk in 1972.

Consumption of those dairy foods which might contribute calcium and riboflavin to the diet increased marginally between 1948 and 1972 (Table IV-6). Although only 14 percent of the survivors consumed no fluid milk in 1972, as contrasted with 28 percent of this group in 1948, relatively few (25%) use at least one cup each day. In

Table IV-5.--Dairy Foods Chosen by Subjects in 1948 and 1972.

Food Item	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
Whole milk	75%	(45)	68%	(19)[a]	32%	(9)[a]
Skim milk/low-fat milk	7%	(4)	4%	(1)[b]	54%	(15)[b]
Cottage cheese	17%	(10)	18%	(5)	32%	(9)
Other cheese	18%	(11)	14%	(4)	18%	(5)
Ice cream/ice milk	8%	(5)[c]	25%	(7)[c]	43%	(12)

[1]n=60 These women died during or prior to 1972.

[2]n-28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects.
Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

Table IV-6.--Amounts of Dairy Foods Consumed by Subjects in 1948 and 1972.*

Food Pattern	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
No fluid milk	17%	(10)	28%	(8)	14%	(4)
≤ 1/4 cup milk/day	22%	(13)	14%	(4)	7%	(2)
1/2 - 1 cup milk/day	47%	(28)	43%	(12)	57%	(16)
> 1 cup milk/day	15%	(9)	14%	(4)	21%	(6)
Milk as only dairy product	63%	(38)[a]	36%	(10)[a]	28%	(8)
≤ 1/2 cup milk + other dairy foods*	15%	(9)	7%	(2)[b]	32%	(9)[b]
1 cup milk + other dairy foods*	5%	(3)[c]	28%	(8)[c]	25%	(7)
Other dairy foods only*	7%	(4)	11%	(3)	11%	(3)
No milk or other dairy foods	10%	(6)	18%	(5)	4%	(1)

*Excluding butter and cream.

[1]n=60 These women died during or prior to 1972.

[2]n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects.
Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

both surveys, the survivors chose dairy foods other than fluid milk, as reflected in the higher consumption levels of cottage cheese and frozen desserts. Only one individual in 1972 consumed no milk or other dairy food, compared to the 11 women in the surviving group so categorized in 1948.

A majority of the subjects interviewed in both years changed their pattern of milk and dairy food consumption. Among the survivors, 10 (36%) increased their intake of fluid milk between 1948 and 1972, whereas one-half this number consumed less fluid milk in the latter survey. Seven women who did not drink milk in 1948 did so in 1972, with three of the seven consuming one cup or more. Conversely, two subjects who drank one cup of milk each day at the time of the initial survey, no longer drank milk; another individual consuming three cups milk each day in 1948, used less than one cup in 1972. Of the 13 women who did not change their intake of this food over the 24-year interval, nine consumed 1/2 to 1 cup milk each day.

In addition to changes noted in the use of fluid milk between 1948 and 1972, differences were evident in the selection of other dairy foods (Table IV-5). Five subjects who used cottage cheese in 1972 did not choose this item in 1948, while one subject deleted this food from her diet. Three women eliminated ice cream as a dessert between 1948 and 1972, whereas seven subjects selected ice milk in 1972.

Bread, Cereal and Baked Products.--The consumption frequencies of bread, cereal and sweet baked products (Table IV-7) suggest a change in the nutrient density of the items selected. Use of white and "whole wheat" bread changed but slightly, whereas more of the survivors now include cereal in their diets. Specialty rolls (for frankfurters and hamburgers) appeared more frequently in the 1972 dietary records. In contrast, the survivors including cake in their diets decreased from 64 percent in 1948, to 25 percent in 1972, a significant difference. Similarly, fewer subjects consumed pastry, although cookies were in 1972 a popular dessert.

The daily servings of bread, cereal and baked products can be seen in Table IV-8. In 1972, as compared with 1948, several subjects decreased their use of bread. Only 11 women, or 40 percent, consumed more than two slices of bread each day in 1972, although 15 (53%) did so in 1948; however, this difference was not significant. Alternatively, 55 percent of the deceased included more than two slices of bread in their daily meal pattern.

In 1972, sweet baked products appeared less frequently in the diets than was the case in 1948 for both survivors and deceased. No subject in 1972 had more than two servings of sweet baked products daily, in contrast

Table IV-7.--Bread and Cereal Products Chosen by Subjects in 1948 and 1972.

Food Item	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
White bread	70%	(42)	64%	(18)	61%	(17)
"Whole wheat" bread	27%	(16)	36%	(10)	39%	(11)
Breakfast cereal	50%	(30)	46%	(13)	68%	(19)
Rice	2%	(1)	7%	(2)	14%	(4)
Pasta	12%	(7)	14%	(4)	21%	(6)
Crackers	25%	(15)	18%	(5)	28%	(8)
Rolls	5%	(3)	11%	(3)[a]	39%	(11)[a]
Cake	48%	(29)	64%	(18)[b]	25%	(7)[b]
Cookies	42%	(25)	39%	(11)	46%	(13)
Pastry	23%	(14)	21%	(6)	11%	(3)

[1]n=60 These women died during or prior to 1972.

[2]n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects.
Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

Table IV-8.--Amounts of Bread and Cereal Products Consumed by Subjects in 1948 and 1972.

Food Pattern	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
1-2 slices bread/day	42%	(25)	46%	(13)	61%	(17)
3-4 slices bread/day	45%	(27)	46%	(13)	36%	(10)
≥ 5 slices bread/day	10%	(6)	7%	(2)	4%	(1)
1-2 sweet baked products/day	58%	(35)	61%	(17)	57%	(16)
≥ 3 sweet baked products/day	18%	(11)	7%	(2)	0%	(0)
No sweet baked products	23%	(14)	32%	(9)	43%	(12)
≥ 1 cereal/day	50%	(30)	46%	(13)	68%	(19)
2 servings bread-cereals/day	7%	(4)	11%	(3)	7%	(2)
3-5 servings bread-cereals/day	45%	(27)	54%	(15)	71%	(20)
≥ 6 servings bread-cereals/day	47%	(28)	36%	(10)	21%	(6)

[1] n=60 These women died during or prior to 1972.

[2] n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects. There were no significant differences.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

to nearly one-fifth of the deceased. Twelve of the survivors had no "high sucrose" baked dessert on any of the recorded days in 1972. The total number of daily servings of bread, cereal and baked products tended to be higher among all subjects in 1948, reflecting the increased intake of carbohydrate calories at that time.

Changes in the pattern of consumption of cereals and baked products noted among various individuals, suggest differences in both the quantity and quality of selections. Eighteen or 64 percent of the survivors included approximately the same number of servings from this food category in their diets in 1972 as in 1948; however, the specific items differed. Baked products, high in sucrose, were less frequent, being replaced by crackers or breakfast cereals. Conversely, three women who consumed only two servings of cereal or baked products in 1948 increased their intake, with two of the three adding a sweet baked product to the daily pattern. The third subject consumed in 1972 more than six servings each day, having added bread or specialty rolls and a sweet dessert. Of the seven women who decreased their use of cereal and baked products, five deleted high-calorie sweets. One subject, who in 1948 consumed three pieces of pie in one day, had no sweet baked product on any day for which records were available in 1972. Four women decreased their intakes of bread.

Sugar and Concentrated Sweets.--Sugar intakes among the Lansing women decreased significantly between 1948 and 1972 (Table IV-9). In the latter year, 15 of the 28 survivors used no sugar as such, and 11 of these avoided other concentrated sweets as jam, candy or syrup. This was true for only six and three of the survivors, respectively, in 1948. Contrary to this finding, 12 women (43%) used slight amounts of jam or jelly (one teaspoon to one tablespoon) on bread or toast in 1972 compared with only five in 1948. Five individuals (18%) reported in 1972, intakes of candy, usually consisting of several hard peppermints or a few gum drops; only one individual had a piece of chocolate. A lesser number of the survivors (14%) included candy in their diets in 1948, although one woman consumed this food in both years. Of the 12 survivors using jam or jelly in 1972, only one listed this confection in the previous survey. As to the use of alcoholic beverages, one deceased subject had a bottle of beer when surveyed in 1948, whereas one survivor in 1972 had one highball each evening.

There was, however, a marked difference in the amount of sugar, as such, consumed by survivors and deceased. At the time of the initial survey, only one-fifth of the deceased consumed no sugar, while one-half had at least two tablespoons daily. Of the deceased, one had six and another nine tablespoons of sugar each day.

Table IV-9.--Sugars and Sweets Chosen by Subjects in 1948 and 1972.

Food Item	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
Jam or jelly	10%	(6)	18%	(5)[a]	43%	(12)[a]
Table syrups*	7%	(4)	14%	(4)	14%	(4)
Candy	5%	(3)	14%	(4)	18%	(5)
No sugar	22%	(13)	21%	(6)[b]	54%	(15)[b]
≤ 1 tablespoon sugar	28%	(17)[c]	68%	(19)[c,d]	39%	(11)[d]
2-3 tablespoons sugar	43%	(26)[e]	11%	(3)[e]	0	(0)
≥ 4 tablespoons sugar	7%	(4)	0	(0)	7%	(2)

*Chocolate syrup, corn syrup or molasses.

[1]n=60 These women died during or prior to 1972.

[2]n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects.
Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

In contrast, only 11 percent of the survivors in 1948 had daily intakes of sugar above two tablespoons. By 1972, the majority of this group had deleted sugar as such from their diets, using artificial sweeteners for flavoring coffee, tea or cereal. The two survivors who in 1972 consumed four and six tablespoons of sugar daily, respectively, have doubled their intake since 1948. These women, aged 73 and 90 years, sprinkle sugar on their bread. Eleven of the 19 survivors have continued intakes of one tablespoon or less of sugar each day, whereas eight of those so categorized in 1948 no longer use sugar.

Animal and Vegetable Fats.--Both the kind and quantity of fats consumed by the Lansing women changed from 1948 to 1972. As shown in Table IV-10, 62 and 78 percent of the deceased and survivors, respectively, used butter in 1948, although only 25 percent of the survivors continued to use this fat in 1972; a significant decline. Conversely, 18 percent of the survivors chose margarine in the initial survey, whereas 61 percent used this table fat in 1972. Four of the survivors used no table fat in 1972, as compared with only one from that group in 1948. Of the five survivors who previously chose margarine, one changed to butter, and one has deleted table fat. Two women who in 1972 consumed no table fat formerly used butter, whereas one survivor used neither butter nor margarine in either study.

Table IV-10.--Animal and Vegetable Fats Chosen by Subjects in 1948 and 1972.

Food Item	Deceased[1] 1948		Survivors[2] 1948		Survivors 1972	
Butter	62%	(37)	78%	(22)[a]	25%	(7)[a]
Margarine	32%	(19)	18%	(5)[b]	61%	(17)[b]
Cream	62%	(37)	43%	(12)[c]	4%	(1)[c]
Bacon	17%	(10)	11%	(3)	18%	(5)
Peanut butter	7%	(4)	11%	(3)	0	(0)
Fried foods	88%	(53)	82%	(23)[d]	46%	(13)[d]
No table fat*	7%	(4)	4%	(1)	14%	(4)
$\leq$ 1 T table fat	13%	(8)	21%	(6)[e]	78%	(22)[e]
2 T table fat	48%	(29)	54%	(15)[f]	4%	(1)[f]
3 T table fat	10%	(6)	11%	(3)	4%	(1)
$\geq$ 4 T table fat	22%	(13)	11%	(3)	0	(0)

*Butter or margarine.

[1]n=60 These women died during or prior to 1972.

[2]n=28 These women were interviewed in 1948 and 1972.

Numbers in parentheses are actual numbers of subjects. Letter pairs are significantly different, $\chi^2 \geq 3.841$, $p \leq .05$.

Total number of food records available for calculations:
Deceased in 1948 = 125
Survivors in 1948 = 56
Survivors in 1972 = 66

Similarly, the quantity of table fats consumed has significantly decreased (Table IV-10). Although 76 percent of the survivors consumed more than one tablespoon of butter or margarine daily in 1948, this was true for only 8 percent in 1972.

Observed changes in the use of condiments high in fat revealed a less consistent trend. Although a majority of the women interviewed in 1948 included cream (or half and half) in their daily meal pattern, only one subject in 1972 reported use of this dairy product. Two others who previously used cream, reported using a "non-dairy" coffee whitener in 1972. Despite the decline in consumption of high-fat dairy items, bacon was included more frequently in the menus of the survivors in 1972, than in 1948.

Inasmuch as salads and fresh vegetables were popular among many survivors in 1972, salad dressings made from vegetable oil appeared on the food records of eight subjects with two others including commercial "low-calorie" salad dressings. Six survivors used mayonnaise when studied in 1948 compared with one in 1972. A striking difference in the consumption of fats is reflected in the significant change in use of this method of food preparation. In 1948, 23 of the survivors (82%) consumed at least one fried food. This was true for only 13 (46%) in 1972.

Discussion

It is difficult to arrive at a valid explanation(s) for the changes in food patterns of the Lansing women over the period 1948 to 1972. A number of factors may be involved therein. The more obvious is that the trends reflect alterations in the tastes of women as they age. That may not be the only factor since there have been prominent alterations in the availability of different foods during the 24-year interval. These changes involve both fresh and "processed" foods of which frozen foods are the best example. Similarly food varieties commonly used in 1972 as ice milk (frozen dessert) and milk with 2 percent fat content, were virtually unknown in 1948. Such differences in food availability have produced changes in the dietary patterns of all age groups over this period. The alterations in the food habits of the Lansing women which occurred between 1948 and 1972 will be examined in respect to the advancing age of these individuals as well as national trends reflected in persons of all ages.

Food Selection and Nutrient Intake.--The significant differences in the nutrient intakes of the survivors between 1948 and 1972, and between survivors and deceased in 1948, can be related to the food selection patterns of each group of women. Protein intakes in 1948 were lower among those now deceased, in that one-fifth of this group did not have a serving of meat or egg each day. This value compares favorably with the findings of Jordan and associates (1954) who reported that 34 percent of their aged subjects in Westchester County, New York, had less than one serving of meat, fish or poultry each day. Inasmuch as the deceased Lansing subjects were, at the time of the initial survey, primarily of retirement age, economic limitations may be responsible in part for their lowered protein intake. Although the survivors were older in 1972 than were the deceased in 1948, they continued to have generous servings of animal protein. The emphasis placed upon protein nutrition by the popular press, may have contributed to the selection patterns observed among the survivors. Alternatively, one might question whether the higher protein intakes of the younger subjects has contributed to their survival.

A second nutrient differing in quantity in the diets of both groups of women in 1948 was ascorbic acid. This is confirmed by the fact that only 42 percent of the deceased consumed a citrus fruit on at least one day for which food records were available, contrasted with 78 percent of the survivors. Intakes of ascorbic acid have remained high among survivors over the 24-year interval.

Food Selection as Related to Age.--Advancing age has been reported to be associated with a reduction in meat consumption. Davidson and coworkers (1962) stated that one-half of their 104 apparently healthy Bostonians over 50 years of age, had lowered their intakes of meat. Those authors suggest this change to be the consequence of living alone, diminished income or "aging." No subject in that study confessed to lowered meat intake as a result of difficulty with chewing. Inasmuch as problems with dentition can influence meat choices, this variable was examined in regard to the deceased Lansing subjects. Although 11 of the 60 deceased Lansing women reported problems with "sore mouth or gums," this symptom was not related to the intake of animal, plant or total protein.

Increasing age, per se, has not caused a diminution in protein intake among the Lansing survivors. As these women have become older, their servings of meat, fish and eggs, have in some cases, actually increased. Fish, chosen by 25 percent of the survivors in 1948, was noted on the food records of 36 percent of this group when examined in 1972. Eggs have also increased in popularity, being consumed by 64 percent of the survivors as an addition to at least one serving of meat. The high percentage of the survivors consuming eggs in 1972 is surprising, in view of the widespread publicity given to the effect eggs are reported to have on serum cholesterol levels, and the relation of the latter to cardiovascular disease. The Lansing women were similar, in this respect, to aged Britishers. Exton-Smith (1972) observed that 879 English subjects above 65 years of age maintained their pattern of egg consumption, despite advancing age. According to that author, older individuals tend to eat more eggs than does the population as a whole. Among the aged Bostonians (Davidson et al., 1962), changes in consumption patterns were not consistent, as 16 percent were eating eggs more frequently than before, and 30 percent avoided eggs for health reasons. For the others, no change was recorded.

Additional evidence suggesting that protein intake does not always decrease with age, comes from a study of older households in Rochester, New York (LeBovit and Baker, 1965). At that time, 96 percent of the household units reported at least one serving of meat daily (poultry and fish were excluded); this value was only slightly less (91%) among females residing alone. One factor to be considered in relation to these data is that each subject completed dietary records for seven days. Despite the extended period for which records were available, liver or a liver product, was consumed at least once by only 14 percent of the Rochester respondents as compared with 18 percent of the Lansing women interviewed in 1972; in the latter cases, the dietary records included a period of one to eight days.

Several investigators (Jordan et al., 1954; Davidson et al., 1962; LeBovit and Baker, 1965) have noted the low consumption of milk or dairy (calcium) equivalents among older subjects. Forty-three percent of the aged individuals interviewed in Westchester County, New York (Jordan et al., 1954) had less than a pint of milk or its equivalent each day. In comparison, 39 percent of the deceased subjects when examined in 1948, and 43 and 21 percent, respectively, of the survivors in 1948 and 1972, consumed less than one cup of milk daily. Older women living alone in Rochester (LeBovit and Baker, 1965) used the equivalent of 3.7 quarts of milk per week, or approximately one pint per day. One-fourth of the Bostonians studied by Davidson and coworkers (1962) reported increased milk consumption in their fifth, sixth and seventh decades; however, an equal number were drinking less milk than formerly. As to changes in milk consumption within the Lansing subjects, ten survivors consumed more fluid milk in 1972 as compared with 1948, and five, less. Among the Lansing women, milk consumption was closely related to the use of breakfast cereals.

The decrement in dietary calories and fat among the Lansing survivors in 1972 may be explained, in part, by their selection of specific dairy products. While only one subject in 1948 used a low-fat milk, 54 percent of those interviewed in 1972 use either skimmed or low-fat milk. This finding may be compared with the 27 older families in Everett, Washington (Van Syckle, 1957), none of whom selected skim milk. Alternatively, 14 percent of the Boston subjects (Davidson et al., 1962) and 11 percent of the Rochester families (LeBovit and Baker, 1965) were using low-fat milk. Similarly, cream, selected by 62 and 43 percent of the deceased and survivors, respectively, in 1948, was noted on 44 percent of the diet records obtained in Everett, Washington (Van Syckle, 1957), but on only 15 percent of those from older households in Rochester, New York (LeBovit and Baker, 1965).

Exton-Smith and Stanton (1965) reported that for 60 aged women living alone in London, cheese was not a popular food, despite the fact that it was a cheaper source of protein than meat or eggs, and could be stored easily. Cheese was consumed by less than one-third of the London women. According to those subjects, cheese was indigestible and caused constipation. In 1972, cottage cheese was consumed regularly by nearly one-third of the Lansing survivors, although only 18 percent of those interviewed consumed other varieties of cheese. Contrary to the findings of Exton-Smith and Stanton (1965), however, no particular reasons were given by the Lansing women for either selecting or avoiding cheese foods.

Vegetables and fruits may be deleted from the diets of older subjects as a result of digestive disturbance or intestinal disease. The foods most consistently omitted from the diets of older subjects studied by Jordan and associates (1954) were dark green and yellow vegetables.

Items from this food group were consumed by only 41 percent of those subjects (Jordan et al., 1954). A similar situation existed among the older people living at home, studied by Lyons and Trulson (1956). Thirty-five percent of the men and 41 percent of the women selected a vegetable providing adequate levels of vitamin A. Similarly, in the Lansing study, only 23 percent of the deceased subjects consumed, on at least one day, a dark green or deep yellow vegetable or fruit. In contrast, 64 percent of the survivors chose one of these foods when queried in 1972; an observation which explains, in part, the high mean intake of vitamin A. Survivors in 1972 frequently mentioned their concern for selecting "balanced diets" and the need for including specific types of vegetables and fruits. This awareness of nutritive needs could contribute to the increased selection of vitamin A-rich vegetables and fruits.

A significant difference existed between the numbers of deceased and survivors who included a citrus fruit in their diets in 1948. Only 42 percent of the deceased had such a fruit in their meal plan as compared with 78 percent of the survivors. As a result, dietary levels of ascorbic acid were significantly higher among the latter. By comparison, 62 percent of 245 Minnesota homemakers (mean age = 43 years) interviewed in 1948 (Clark and Fincher, 1954) had a citrus food on the day studied. The

slight decrease in consumption of vitamin C-rich fruits by survivors between 1948 and 1972 may relate to the avoidance of acid foods by several subjects now under treatment for diverticular disease. Potatoes, a potentially good source of ascorbic acid, were consumed by 75 percent of the survivors in 1972. That number is similar to the 82 percent of older households in Rochester, New York (LeBovit and Baker, 1965), who included potatoes in their diet pattern.

Information from both the 1948 and 1972 food records suggest that older subjects consume adequate levels of fortified bread and cereals. Further evidence to support this finding comes from the aged populations in Westchester County, New York (Jordan et al., 1954), and and Boston (Lyons and Trulson, 1956), as only one of the 200 persons interviewed failed to have at least one serving daily of an enriched or whole grain bread or cereal. Only one Lansing subject interviewed in 1972 failed to include one slice of bread in her dietary; however, she did consume one serving of cereal plus a sweet roll.

There is a popular generalization that older individuals consume higher levels of starches and sweets than does the general population. As suggested by Jordan et al. (1954), aged subjects do not always use these items in excess, for desserts, as cake or pie, were omitted from the dietaries of 37 percent of those studied in Westchester, New York. That finding is supported by the Lansing results indicating that two-fifths of the survivors, when examined in 1972, had no sweet baked dessert on any of the recorded days.

In contrast to the decline in consumption levels of high-sucrose desserts, the use of jam and jelly has increased since 1948. More than twice the number of survivors in 1972 included fruit preserves in their diets compared with 1948. Among these subjects such "sweets" were used as a substitute for butter or margarine, thereby decreasing the total intake of fat. Although fewer women included jam or jelly in their diets in 1948, butter and margarine were used in more liberal amounts. Health reasons (i.e., digestive disturbance, weight control) were cited as motivating factors in decreasing consumption of fat.

Food Selection as Related to Food Availability

The changes in the nutrient intake of the Lansing subjects between 1948 and 1972 may relate, in part, to their increasing age; however, there have also been changes in food availability over this period, modifying the food habits of the population as a whole. The higher intakes of animal foods (meat and egg servings) by the surviving Lansing women in 1948 may partially reflect the general trend in the United States. According to USDA market surveys (Swope, 1970), animal foods provided only one-half of the total protein intake in 1909, compared with two-thirds in 1965. The survivors, being younger in age, might have responded to this trend to a greater degree than the older women who are now deceased. As mentioned previously, the reduced financial resources of the older retired subjects, may have limited their purchases of meat. The level of consumption of meat (including fish or poultry) by the Lansing women in 1948 was similar to that reported in a USDA study of homemakers in a North Central community (Clark and Fincher, 1954). Whereas 80 percent of the deceased Lansing subjects and 100 percent of the survivors had in 1948 at least one serving of meat or egg each day, 90 percent of the Minnesota homemakers, studied in the same year, consumed at least one of these animal foods on the day surveyed.

Current controversy regarding a possible relation between dietary cholesterol and arterial disorders has drawn attention to the inclusion of eggs in the diet. One-half of the Minnesota homemakers (Clark and Fincher, 1954) consumed an egg on the day of the survey in 1948. This value is equal to that noted among the Lansing subjects in that year. In contrast to the general population, the Lansing survivors, during the next quarter century, actually increased their use of this food. USDA household surveys (Swope, 1970) revealed that eggs were used less frequently by the general population in 1965 than had been true ten years prior.

Differences were observed in the varieties of meat chosen by the survivors in 1948 and 1972. Beef was a choice of 57 percent of the survivors in 1948, a value higher than that noted among Minnesota women (Clark and Fincher, 1954) interviewed in 1948, as only 38 percent consumed beef on the day surveyed. One factor that must be considered in the comparison of the Lansing subjects and the Minnesota women (Clark and Fincher, 1954) is the number of days for which records were available. The Minnesota women provided a 24-hour recall on one day only, whereas 181 food records were available for the 88 Lansing subjects. This may explain, in part, the difference in beef consumption observed between the Minnesota and Lansing subjects.

Beef has increased in popularity in the North Central region (U.S. Dept. of Agriculture, 1968) as evidenced by a 22 percent increase in the use of this meat by households surveyed in 1955 and 1965. This change is reflected in the number of survivors choosing beef in 1948 and 1972 (57 versus 64%), although this difference was not significant. Another trend observed among North Central households between 1955 and 1965 (U.S. Dept. of Agriculture, 1968) was a 27 percent increase in the use of chicken, although only a slight change (4%) was noted among the Lansing survivors. This difference could relate to the fact that USDA household consumption surveys are based upon 7-day records, as compared with an average of two days for the Lansing women.

Fish was consumed more frequently by Lansing women in 1948 than by other North Central homemakers. Twenty and 25 percent, respectively, of the deceased and survivors had fish on at least one day, compared with only 11 percent of the Minnesota subjects (Clark and Fincher, 1954). Although the use of fish dropped by 15 percent in the North Central region between 1955 and 1965 (U.S. Dept. of Agriculture, 1968), this food was found in the diets of 36 percent of the survivors in 1972, compared with only 25 percent in 1948. As to the use of specialty meats, 21 percent of the survivors included weiners in their meals in 1972; this value is only one-half that noted in other North Central households, 45 percent of whom used this food in 1965 (U.S. Dept. of Agriculture, 1968).

Milk was not a popular food among the Lansing women in either 1948 or 1972. When examined in 1948, 83 percent of the deceased had some fluid milk as compared with only 71 percent of the survivors and 72 percent of other North Central women (Clark and Fincher, 1954). The consumption of fluid milk has, however, increased among the survivors from 1948 to 1972, despite an 18 percent decline in use of this food among North Central families (U.S. Dept. of Agriculture, 1968).

Other changes in the types of dairy foods chosen by survivors, however, do parallel trends observed among the North Central population. Household surveys (U.S. Dept. of Agriculture, 1968) suggest that use of non-fat dry milk doubled between 1955 and 1965. The Lansing survivors also have substituted low-fat varieties of milk for those higher in calories. Similarly, cream is purchased less frequently, and cheese and frozen milk desserts more frequently, by both the Lansing subjects in 1972 and the general population in 1965 (U.S. Dept. of Agriculture, 1968), as compared with 1955. Ice milk, a popular choice among the survivors in 1972, was not generally available for consumer purchase at the time of the initial survey. These changes in dairy items selected in both Lansing and a cross-section of United States households, could reflect a voluntary restriction on calories and fat. Another factor may be that of economy, with the substitution of milk for cream in coffee.

The pattern of consumption of fruits and vegetables by the Lansing subjects in 1948 differed from that of other North Central women. Sixty-two percent of Minnesota homemakers interviewed that year (Clark and Fincher, 1954) had a citrus food on the day surveyed, compared with 42 and 78 percent of the Lansing deceased and survivors, respectively, who had this food on at least one day for which records were available. Although only 23 and 36 percent of the two subject groups in Lansing reported a vitamin A source in 1948, 69 percent of the women in another North Central study (Clark and Fincher, 1954) did so. Conversely, potatoes were more popular among the Lansing subjects. In comparing these data, the influence of seasonal differences is difficult to measure, as the Minneapolis women were studied in winter when fresh produce was less likely to be available. In contrast, many of the Lansing women, who demonstrated lower intakes of fruits and vegetables, were interviewed during the winter, spring and early summer in 1948.

According to a USDA survey of North Central households in 1965 (U.S. Dept. of Agriculture, 1972), the quantity of fresh fruits and vegetables consumed and the money spent per household for these items changed dramatically from one season of the year to another. These changes were not always consistent. Use of fresh vegetables was twofold in the summer, as compared with other seasons of the year; however, the consumption of dark green and deep yellow vegetables varied less than 10 percent over this time period. Fresh tomatoes appeared to be the vegetable showing the greatest fluctuation over the calendar year. Although fresh fruit was purchased in greatest quantity during the summer season, this was not true of citrus varieties. Contrary to what might have been anticipated, household consumption of citrus fruits was increased threefold in the winter as compared with the summer. As expected, the money spent for fresh produce was highest during the summer months. One factor to be considered with these data is a possible difference between the time when these items were purchased and the date when eaten. Fresh produce may be canned or frozen for use in a later season.

Over the past 24 years, the use of fruits by the Lansing survivors has remained constant, whereas deep green and yellow vegetables are included in the diet more frequently. This has not been true of other households in the North Central region. Between 1955 and 1965 (U.S. Dept. of Agriculture, 1968), the consumption of all fruits declined by 15 percent with a concomitant reduction of 6 percent in the ascorbic acid available to each person in the household (Swope, 1970). Although potatoes were used less frequently by North Central households in 1965 than ten years prior, this food remained popular among the Lansing survivors. The 10 percent decline in the consumption of all vegetables by North Central families between 1955 and 1965 (U.S. Dept. of Agriculture, 1968) resulted in lowered vitamin A intake, whereas the Lansing women actually increased their selection of vitamin A-rich produce. The continued use of potatoes by the Lansing subjects may reflect long-established food habits among older individuals. The selection of fruits and vegetables high in nutrients, however, in contrast to general trends, may indicate a conscious effort toward good nutrition. In the dietary interview in 1972, subjects frequently noted choosing foods that constituted "a well-balanced diet."

The Lansing women have continued to consume rather generous levels of bread each day, although use of this food declined by 8 percent among the population as a whole (Swope, 1970). In contrast, the consumption of other bakery products, including sweet confections, increased by 66 percent in the North Central region from 1955 to 1965 (U.S. Dept. of Agriculture, 1968). Although the older Lansing women significantly increased their use of rolls, which could relate to the recent popularity of weiners and hamburgers among all age groups, they severely curtailed their consumption of sweet products. Restricted intake of baked items high in sugar and fat was frequently cited as a factor in weight control among the Lansing subjects. Breakfast cereals which have increased in popularity, nationwide, were noted more frequently in the 1972 diets than in those of either group in 1948.

The diets of the Lansing survivors reflect both national and regional trends in the use of animal and vegetable fats. Although 79 percent of the survivors used butter in 1948, this value had dropped to 25 percent by 1972. A lesser decline in the use of butter, 34 percent, was noted in the North Central region between 1955 and 1965 (U.S. Dept. of Agriculture, 1968), according to household food consumption data. In reciprocal fashion, margarine has been added to the diet. Sixty-nine percent of North Central households surveyed in 1965 (U.S. Dept. of Agriculture, 1968) reported using margarine, a value comparable to that observed (61%) among the Lansing survivors.

The use of fats and oils has, during the past 24 years, changed both qualitatively and quantitatively. As the Lansing survivors have significantly decreased their consumption of visible fat, so did other households in the North Central region (U.S. Dept. of Agriculture, 1968), although to a lesser degree (10%). Shortening and lard are now used in significantly lower amounts by North Central families, whereas the consumption of salad and cooking oils doubled between 1955 and 1965 (U.S. Dept. of Agriculture, 1968). The shift of the population to oils, however, did not totally compensate for the shift away from fats. The general rise in household use of cooking oils could relate, in part, to preparation of fried foods. Significantly fewer items prepared by this method were noted on the diet records of the survivors in 1972 as compared with 1948 (82 versus 46%). Many subjects avoided fried foods on the advice of their physicians, as a result of occurring distention or gall bladder insufficiency. As an alternative, meats were frequently broiled.

One factor contributing to the per capita consumption of fat has been the growth of the fast-food industry which concentrates heavily upon fried items. Three of the survivors, interviewed in 1972, obtained at least one meal during the period of record at a fast-food restaurant. This would suggest that older individuals do accept new forms of food delivery, if applicable to their circumstances.

Sugar substitutes or artificial sweeteners are becoming increasingly popular among all groups in the general population. This is suggested by recent household consumption data (U.S. Dept. of Agriculture, 1968) indicating that dietary intakes of sucrose in the form of sugar, jelly and jam, decreased by nearly 15 percent in the North Central region between 1955 and 1965. The findings pertaining to the ingestion of sugar among the Lansing survivors in 1972 are, for the most part, consistent with the regional trend. Over one-half of these women consumed no visible sugar. This was true for only 21 percent of the survivors when surveyed in 1948. The two survivors who did in 1972 consume at least four tablespoons of sugar each day, sprinkle this sweetener on their bread. In contrast to the general population, the number of Lansing subjects who have added jam or jelly to their diets has increased dramatically. For several women who severely restrict their intakes of fat, jam or jelly is being used as a substitute for butter and margarine on bread or toast.

Conclusions

Personal food habits can and do change from middle to older age. Despite advancing years, the surviving subjects have increased their consumption of animal protein, low-fat varieties of milk and frozen desserts, with a changeover from animal to vegetable fats. Such trends have also been observed among the general population. In contrast to the national trends, these women have increased their use of eggs and vitamin A-rich fruits and vegetables, have continued to choose bread and cereals, and actually decreased their intakes of sweet baked products as cake or pie, sugars, and fats.

Motivation toward the maintenance of good health or limitations imposed by physical disorders and weight control, may contribute to these observed choices. Spontaneous alterations in food selection as the increased consumption of foods high in protein or ascorbic acid, may reflect increased consciousness of nutrient factors.

CHAPTER V

INFLUENCE OF NUTRIENT INTAKE UPON CLINICAL AND BIOCHEMICAL PARAMETERS IN OLDER WOMEN

Introduction

In recent years the conquest of infectious diseases has markedly increased the lifespan. There are now in this country, 8.4 million males and 11.6 million females over the age of 65 years (U.S. Bureau of Census, 1973, p. 31). Many factors determine the health and longevity of older people. Proper nutrition throughout life has been suggested as one of the best means of minimizing the degenerative changes and superimposed diseases frequently associated with old age (Irwin, 1970). One's nutritional status thus looms as an important component of life which may have far-reaching effects on both morbidity and mortality.

The evaluation of nutritional status in the elderly is difficult, in that little is known regarding possible alternations in nutrient requirements as a result of the progression from middle to advanced age. For the latter group, there is only limited information about the biochemical parameters frequently employed to measure nutriture. As to vitamin status, studies of 577 persons over 50 years of age in San Mateo, California (Gillum et al., 1955a; Morgan et al., 1955), the population of Groton Township, New York (Williams et al., 1951), and the aged in Onondago County, New York (Brin et al., 1965), revealed no significant change in serum levels or urinary excretion as a function of age.

One complication in assessing the nutritional status of older people is the fact that some symptoms associated with nutrient deficiency may be a general accompaniment of old age. For example, Gillum and associates (1955a) concluded that the thickening of the bulbar conjunctiva, identified in 94 percent of 569 aging subjects, was a consequence of aging rather than a deficiency of vitamin A. This observation suggests that the anatomy of aging is not well understood.

To further investigate the relation between nutrient intake, clinical symptoms, biochemical parameters and physical health in older persons, the author re-examined cooperating survivors of a sample of 103 women from Lansing, Michigan, previously studied by Ohlson and coworkers (1950, 1951, 1952, 1952a) in 1948 when the subjects ranged in age from 40 to 88 years.

Methods

Procedures of sample selection and data collection in 1948 (Chapter II, pp. 92-93) and re-examination in 1972 (Chapter II, pp. 93-95) have been described previously.

For clinical and biochemical evaluation, subjects were admitted to Olin Health Center, Michigan State University, in the evening (Protocol, Appendix D-1). A dentist performed an oral examination (Appendix D-2) that evening. Blood was drawn the next morning following a 12 hour fast. In Table V-1 are listed the biochemical analyses applied to the fasting blood sample, as well as the laboratory where each was performed. Aliquots of serum for the determination of vitamin A and β carotene levels, and serum iron and iron-binding capacity, were immediately frozen and stored at -40°C. Blood to be analysed for iron was handled in acid-washed glassware. For ascorbic acid analysis, serum aliquots were precipitated with trichloroacetic acid (TCA) and the TCA filtrate, similarly frozen.

The first urine voided upon arising in the morning was collected in a clean, dry container, evaluated in terms of color and volume (Appendix D-3), protected from light, and refrigerated. As shown in Table V-2, standard urinalyses included tests for pH, specific gravity, glucose, ketones, protein, and occult blood. Following acidification with 0.1N HCl (ICNND, 1963), suitable aliquots were stored at -40°C for vitamin, creatinine, urea nitrogen and total nitrogen determinations.

Those individuals who would not come to the Health Center the evening before testing were directed to fast following their evening meal, and were transported to the

Table V-1.--Biochemical Methods of Blood Analysis.

<u>Whole Blood--Fasting</u>
Hemoglobin[a]
Hematocrit[a]
Red blood cell count[a]
White blood cell count[a]
Mean cell volume[a]
Mean cell hemoglobin[a]
Mean corpuscular hemoglobin concentration[a]
<u>Blood Serum--Fasting</u>
Glucose[b]
Cholesterol[b]
Calcium[b]
Phosphorus[b]
Total protein[b]
Albumin[b]
Blood urea nitrogen[b]
SGOT[b]
Alkaline phosphatase[b]
Bilirubin[b]
Uric acid[b]
Lactic acid dehydrogenase[b]
Vitamin A[c] (Neeld and Pearson, ICNND, 1963)
β carotene[c] (Neeld and Pearson, ICNND, 1963)
Ascorbic acid[c] (Roe, Vitamins, Vol. VII, 1967)
Serum iron and iron-binding capacity[c] (Caraway, 1963)
Insulin[c] (Amersham/Searle, 1969)
<u>Blood Serum--Post prandial</u>
Glucose[a]
Insulin[c] (Amersham/Searle, 1969)

[a]Performed by Olin Health Center Clinical Laboratory, Michigan State University.

[b]Performed on the Autoanalyzer 12/60, Technicon Corp., by the Mid-Michigan Clinical Laboratory, Lansing, Michigan.

[c]Performed by the author.

Table V-2.--Biochemical Methods of Urine Analysis.

Urine--Fasting		
Routine urinalysis		
Specific gravity[a]		
pH[a]		
Presence:	glucose[a]	(Bili-Lab Stix)
	ketones[a]	(Bili-Lab Stix)
	protein[a]	(Bili-Lab Stix)
	occult blood[a]	(Bili-Lab Stix)
Thiamin[b]	(Leveille, 1972)	
Riboflavin[c]	(Pelletier and Madine, 1970)	
Urea[b]	(Phenol-Hypochlorite method, Hyland Laboratory, Costa Mesa, California)	
Total nitrogen[b]	(Kjeldahl method)	
Creatinine[b]	(Alkaline picrate method, modified by Olin Health Center Clinical Laboratory, Michigan State University)	
Urine--Post pandial		
Presence:	glucose[a]	(Bili-Lab Stix)
	ketones[a]	(Bili-Lab Stix)

[a]Performed by Olin Health Center Clinical Laboratory, Michigan State University.

[b]Performed by the author.

[c]Performed on Technicon Auto-Analyzer, Department of Food Science and Human Nutrition, Michigan State University.

campus in the morning, prior to breakfast. These subjects were instructed to collect the first urine voided upon arising, and provided with a sterile swab, collection device and suitable container. Twelve subjects were admitted to the Health Center in the evening, and eight women came on the morning of testing.

Twenty subjects submitted to the physical examination (Appendix D-4) which emphasized clinical parameters indicative of nutrient deficiency. In addition, each woman was rated as appearing physically younger than, older than, or typical of her age. To minimize variation in judgment, all the subjects were examined by the same physician. The clinical and biochemical data obtained were examined in relation to nutrient intake, using correlation-regression methods and analysis of variance. Clinical parameters were examined in relation to nutrient intake from food sources only, and therefore represent the minimum intake of these individuals. Although six subjects reported using a supplement which contained at least one of the nutrients tabulated, it was not known how regularly such supplements were ingested. Furthermore, several of the supplements used were not realistic in respect to known requirements, providing up to ten times the Recommended Dietary Allowance (RDA) of the particular nutrient. One subject received, in addition, vitamin by injection from her physician, and the possibility exists that this was true for others as well, who were given therapy regularly, but were unaware of what was administered. When a clinical abnormality was associated with lower mean nutrient intake, this parameter was examined further in relation to intake from known supplements. Biochemical parameters were studied for all clinical abnormalities observed.

It should be noted that 20 of the 28 women who participated in the dietary survey, came to the Health Center for examination. Two women aged, 68 and 81, resided at some distance from Lansing, one living out of state, and a third individual, aged 80, moved out of the state shortly following the dietary interview. Two other subjects, aged 73 and 85, did not wish to be bothered. The younger of these had diverticulitis, although she appeared to be relatively active. The 85 year old drove from Lansing to Chicago, a distance of 235 miles, once each month to visit relatives, and considered herself to be too busy to participate. The oldest subject, 90 years of age, had problems with sight and hearing, and lived with a married daughter; her main objection was distrust of physicians, rather than physical disability. The desire to be left alone, was the reason given by a woman aged 83, who still lived alone. This subject seldom goes out, other than to accompany neighbors who provide her with transportation to a food market. Only one individual of the eight who did not undergo the clinical examination, was prohibited from doing so by physical disability. This woman, aged 75, had undergone surgery for intestinal cancer and was receiving cobalt therapy. When approached again, the following year, she was still confined to her home.

Results

Incidence of Clinical Abnormalities

When evaluated on the basis of general appearance, a surprisingly large proportion (80%) of these older women were in good condition. No individual was listed as in poor condition, while four (20%) were rated as fair. A rating of good or fair was not dependent upon the age of the individual, as those rated fair were aged 69, 73, 75, and 80 years.

Face and Skin.--The incidence of clinical abnormalities of the face and skin among the 20 subjects examined are shown in Table V-3. Pallor was observed in only one-fifth of those evaluated, however, the frequency doubled with advancing age. Extreme paleness was not noted in any subject below 70 years of age, although one-fourth of those in the eighth decade, and one-half of those in the ninth decade of life, showed this condition. Conversely, the majority of the subjects in the younger age groups had suborbital pigmentation. Mild hyperkeratosis of the elbows and knees occurred in 12 and 13 subjects, respectively, and was not more frequent in any particular age group. One subject who was free of hyperkeratosis of the

Table V-3.--Incidence of Abnormalities of the Face and Skin Among the Twenty Older Women Examined in 1972.[a]

Characteristic	With Abnormality 60-69 Years (8)	70-79 Years (8)	80-85 Years (4)
Face			
Pallor	0	25% (2)[b]	50% (2)
Suborbital pigmentation	62% (5)	75% (6)	0
Nasolabial seborrhea	0	12% (1)	0
Skin			
Xerosis	0	12% (1)	0
Hyperkeratosis (elbows)	62% (5)	62% (5)	50% (2)
Hyperkeratosis (knees)	62% (5)	62% (5)	75% (3)
Crackled skin	50% (4)	88% (7)	75% (3)
Creased skin	62% (5)	88% (7)	75% (3)
Pigmentation	12% (1)	12% (1)	25% (1)

[a]Clinical evaluation performed by J. S. Feurig, M.D., Olin Health Center, Michigan State University.

[b]Actual numbers of subjects.

elbows, did show this lesion on the knees. Crackled and creased skin were commonly observed in these subjects.

Eyes, Lips, Tongue, and Gums.--Lesions of the eyes, lips, tongue, and gums, occurred among lesser percentages of the women (Table V-4). Only two individuals showed blepharitis, suggestive of serious vitamin A lack. One of these had crusted eyelids as well, whereas both showed abnormalities of the palpebral and bulbar conjunctivas. The majority of the subjects had bulbar spots, although the etiology of this discoloration is not known.

Table V-4.--Incidence of Abnormalities of the Eyes, Lips, Gums, and Tongue Among the Twenty Older Women Examined in 1972.[a]

Characteristic	With Abnormality 60-69 Years (8)[b]	70-79 Years (8)	80-85 Years (4)
Eyes			
Crusted eyelids	0	12% (1)[b]	0
Blepharitis	0	25% (2)	0
Bulbar spots	62% (5)	62% (5)	25% (1)
Lips			
Angular stomatitis	38% (3)	25% (2)	0
Cheilosis	0	12% (1)	0
Gums			
Gingivitis	0	12% (1)	0
Recession	62% (5)	50% (4)	75% (3)
Retraction	25% (2)	25% (2)	75% (3)
Tongue			
Red (color)	12% (1)	25% (2)	0
Papillae, Filliform, atrophy	38% (3)	38% (3)	25% (1)
Papillae, Fungiform, atrophy	25% (2)	12% (1)	0
Fissures	25% (2)	25% (2)	0

[a]Clinical evaluations performed by J. S. Feurig, M.D., Olin Health Center, Michigan State University.

[b]Actual number of subjects.

Angular stomatitis, of a mild degree, was noted among one-fourth of the subjects, whereas only one woman had severe cheilosis. Gum recession and retraction were relatively common findings; one or both of these changes had occurred in about half of the group, although the frequency was highest among the oldest subjects. Discolorations of the tongue were seldom seen, although atrophy of the filliform papillae was observed in seven women.

Cardiovascular System.--Chronic cardiovascular disorder, as judged by heart enlargement, was present in one-third of the subjects (Table V-5); for two of them, the hypertrophy was severe with accompanying mild general edema. Fluid retention in the lower extremities was apparent in 9 of the 20 subjects; for three, the problem was serious. Varicose veins were evident among half of these older women, although this clinical problem was most frequent in those 80 years of age or older. Irregularities in heart rhythm, or the presence of a heart murmur, was not detected in any of the women examined.

Skeletal System.--Aging has frequently been associated with changes in the normal curvature of the spine (Table V-6). Two such changes, kyphosis and scoliosis, were not present in any of the women examined. In contrast, six individuals were noted to have lordosis.

Table V-5.--Incidence of Functional Abnormalities Relating to the Cardiovascular System Among the Twenty Older Women Examined in 1972.[a]

Characteristic	With Abnormality 60-69 Years (8)[b]	70-79 Years (8)	80-85 Years (4)
Cardiovascular system			
Heart rhythm	0	0	0
Heart murmur			
Functional	0	0	0
Organic	0	0	0
Abnormal size	25% (2)[b]	50% (4)	25% (1)
General edema	12% (1)	12% (1)	0
Lower extremities			
Edema	25% (2)	75% (6)	25% (1)
Varicose veins	50% (4)	38% (3)	75% (3)

[a]Clinical evaluations performed by J. S. Feurig, M.D., Olin Health Center, Michigan State University.

[b]Actual number of subjects.

Neurological Reflexes.--Neurological abnormalities (Table V-7) except for response to proprioceptive stimuli and Babinski reflex, were present in only one or two of the women. One subject, aged 69, who suffers from myasthenia gravis, a neuro-muscular disorder, had lost the normal response to all reflexes tested. Nearly one-third of those examined had diminished proprioception while only two women exhibited a normal Babinski reflex. Surprisingly, both subjects retaining the normal Babinski response were among the oldest examined, aged 81 and 85 years.

Table V-6.--Incidence of Abnormalities of the Spine Among the Twenty Older Women Examined in 1972.[a]

Characteristic	With Abnormality		
	60-69 Years	70-79 Years	80-85 Years
	(8)[b]	(8)	(4)
Spine			
Kyphosis	0	0	0
Lordosis	50% (4)[b]	25% (2)	0
Scoliosis	0	0	0

[a]Clinical evaluations performed by J. S. Feurig, M.D., Olin Health Center, Michigan State University.

[b]Actual number of subjects.

Table V-7.--Incidence of Neurological Abnormalities Among the Twenty Older Women Examined in 1972.[a]

Characteristic	With Abnormality		
	60-69 Years	70-79 Years	80-85 Years
	(8)[b]	(8)	(4)
Knee jerk	12% (1)[b]	0	0
Biceps jerk	12% (1)	0	0
Triceps jerk	12% (1)	0	0
Ankle jerk	12% (1)	0	0
Vibratory sense	12% (1)	12% (1)	0
Proprioception	12% (1)	62% (5)	
Babinski reflex	100% (8)	100% (8)	50% (2)

[a]Clinical evaluations performed by J. S. Feurig, M.D., Olin Health Center, Michigan State University.

[b]Actual number of subjects.

Pulse Rate and Blood Pressure.--Individual values for heart rate and systolic and diastolic blood pressure in both 1948 and 1972 are shown in Table V-8. All subjects examined in 1972, including those admitted to the Health Center the morning of testing, had, following breakfast, at least 30 minutes to rest in bed, before the clinical evaluation. Pulse rates ranged from 72 to 78 beats per minute for 19 of the older women, with one individual having a rate of 82 beats per minute. Systolic hypertension (above 150 mm) was observed in eight subjects; the highest pressure measured was 182 mm. That woman had expressed concern about her husband who was in poor health, being alone at home. Six individuals had diastolic pressures above 90 mm, and for all of these, systolic pressures were also above desirable levels.

Evaluation According to Age.--The physician, on the basis of visual observation and physical examination of the subjects, attempted to evaluate their condition relative to what he considered normal for women of that age. One-fifth (4) of the subjects appeared to be physically younger than their age and moved about more easily than would be expected. Two women were in poor physical condition relative to their years. Three of the four subjects judged to be in exceptionally good health were aged 80 or above; those in poor health were 69 and 73 years of age.

Table V-8.--Pulse and Blood Pressures of the Twenty Older Women Examined in 1948 and 1972.

Subject	Age 1972	Systolic Blood Pressure 1948	Diastolic Blood Pressure 1948	Systolic Blood Pressure 1972	Diastolic Blood Pressure 1972	Pulse 1972
202	81	160	90	128	82	74
206	80	116	60	168	98	74
207	66	*	*	104	62	76
208	73	130	80	142	86	72
212	75	140	95	182	98	72
213	75	*	*	138	86	72
214	81	128	70	142	86	76
218	69	*	*	142	86	72
221	64	165	90	158	84	78
223	71	120	80	144	84	72
224	68	155	80	168	102	82
225	77	230	132	168	102	72
226	85	160	90	158	94	74
228	64	*	*	132	86	78
232	75	*	*	162	98	74
233	67	158	100	168	88	72
235	69	*	*	144	82	78
239	74	*	*	142	84	72
241	75	140	90	128	82	72
242	69	*	*	128	82	74

*Not measured in 1948.

Dental Characteristics and Food Restrictions

Although the majority of these women are dependent upon partial or complete dentures to aid in the mastication of food, they managed to enjoy a wide variety of items. For only one individual, were food choices severely restricted. As expected, a large proportion of these women had lost many or all of their teeth; only three subjects had lost three or less teeth. One of the latter had been judged physically younger than her years, whereas another was considered to appear older. Five of the women had partial dentures and 12 had complete dentures. Of this group, only one had been fitted with dentures (complete) within one year of the survey. Four subjects having partial dentures and 9 of the 12 edentulous subjects, had their dentures for at least 20 years. Eight individuals had mild to severe periodontal problems, although only two of these reported any dietary restriction. As shown in Table V-9, 15 women have no limitations in food selection resulting from mastication difficulties. One subject with partial dentures avoided "tough" cuts of meat as did another who was edentulous. Two women with complete dentures could not incise firm fruits and vegetables such as raw apples or celery stalks. Both individuals, however, included such chopped raw items in their diets. The woman most recently fitted with complete dentures had to restrict her choice of foods even further--she limited her meat to that which was

Table V-9.--Percent of Twenty Older Women Examined in 1972 Who Restricted Their Food Intake Because of Dental Problems.

Food Restriction	Few Teeth Lost (3)*	Partial Dentures (5)	Complete Dentures (12)
None	100% (3)*	80% (4)	67% (8)
Foods that must be incised	0	0	17% (2)
"Tough" meat	0	20% (1)	8% (1)
Ground meat only	0	0	8% (1)

*Number of subjects.

ground. For her, finances would not hinder any attempt to remedy the problem.

Biochemical Indices of Nutritional Status

The nutritional status of these women, as evaluated by laboratory tests, was assessed on the basis of standards proposed by the International Committee on Nutrition for National Defense (ICNND, 1963). Suggested guides to the interpretation of blood and urine data are found in Appendices D-5 and D-6. According to these standards, the majority of the subjects examined received an adequate nutrient intake. Serum or urine levels below those considered to be "acceptable" were noted for only three nutritional parameters: total serum protein, serum vitamin A, and urinary riboflavin excretion (Table V-10 and V-11).

Table V-10.--Mean Levels of Fasting Blood Constituents for Twenty Older Women Examined in 1972 Categorized According to ICNND Standards.[a]

Parameter	Deficient		Low		Acceptable		High	
	Mean ± S.D.	n	Mean ± S.D.	n	Mean ± S.D.	n	Mean ± S.D.	n
Total serum protein (gm/100 ml)	5.7 ± 0.1	(2)[b]	6.3 ± 0.2	(5)	6.6 ± 0.1	(5)	7.3 ± 0.2	(8)
Serum albumin (gm/100 ml)		(0)		(0)	4.0 ± 0.1	(18)	4.3 ± 0.1	(2)
Hemoglobin (gm/100 ml)		(0)		(0)	13.6 ± 0.4	(12)	14.9 ± 0.4	(8)
Hematocrit (percent)		(0)		(0)	40.8 ± 1.1	(9)	45.0 ± 1.4	(11)
Serum vitamin A[c] (μg/100 mil)	<10	(1)	18	(1)	39 ± 9	(7)	69 ± 16	(9)
Serum β carotene[c] (ug/100 ml)		(0)		(0)	64	(1)	233 ± 62	(17)
Serum ascorbic[c] (mg/100 mil)		(0)		(0)	0.39	(1)	0.88 ± 0.22	(17)

[a] Interdepartmental Committee on Nutrition for National Defense, 1963. Suggested guide for the interpretation of blood values may be found in Appendix D-5.

[b] Actual number of subjects.

[c] Performed for 18 subjects only.

Table V-11.--Mean Urinary Thiamin and Riboflavin Excretions of Twenty Older Women Examined in 1972 Categorized According to ICNND Standards.[a]

	Deficient		Low		Acceptable		High	
	Mean ± S.D.	n	Mean ± S.D.	n	Mean ± S.D.	n	Mean ± S.D.	n
Thiamin (ug/gm creatinine)		(0)[b]		(0)	120 ± 1	(2)	964 ± 1012	(18)
Riboflavin (ug/gm creatinine)		(0)	43 ± 6	(3)	145 ± 36	(8)	612 ± 364	(9)

[a]Interdepartmental Committee on Nutrition for National Defense, 1963. Suggested guide for the interpretation of urine values may be found in Appendix D-6.

[b]Actual number of subjects.

<u>Protein Status</u>.--The serum protein levels (for individual values, see Appendix D-7) for two-thirds of the subjects were "acceptable" or "high" according to the proposed standards (Table V-10). Actually, eight of these women had serum protein levels above 7.0 gm/100 ml. Despite the fact that seven of the subjects had "low" or "deficient" serum protein levels, the latter were not associated with dietary practices. The two women with "deficient" serum protein values (<6.0 gm/100 ml) had daily protein intakes of 46 and 73 grams. Surprisingly, for these women, there was a significant negative relation (r=-0.566, n=20, p=.01) between daily dietary protein expressed as grams/kg body weight and total serum protein levels.

Although several individuals appeared deficient in total serum protein, all subjects had acceptable or high levels of serum albumin. As was true of total serum protein levels, serum albumin level did not relate to daily protein levels in either 1948 or 1972. The albumin value was negatively related to protein calorie percent in 1972 (r=-0.483, n=20, p<.05). The reduced total serum protein levels, noted in seven subjects, were the result of lowered plasma globulin levels. This finding did not relate to any dietary parameter.

Both total serum protein and serum albumin values were examined in relation to the age of the subjects. Total serum protein levels tended to increase with age, although this was not statistically significant. Serum albumin values, on the other hand, were unrelated to age. Serum protein was not determined in the 1948 survey.

Iron Status.--Among these women iron nutriture appeared adequate, as measures of hemoglobin and packed cell volume were within normal ranges (for individual values, see Appendix D-8). There was no relation between the hemoglobin level and iron intake of these women in either 1948 or 1972. Furthermore, the current RDA for iron does not appear to be a reliable estimate of the needs of this group. This is evident from the observation that the subject with the lowest intake of dietary iron (6.2 mg per day) which was less than two-thirds of that recommended (Food and Nutrition Board, 1974) had a hemoglobin value of 14.7 gm/100 ml. Neither hemoglobin level nor packed cell volume was significantly associated with intakes of either dietary iron or protein.

Blood smears for these women appeared normal with no evidence of cells of abnormal size, as would be indicative of either microcytic or macrocytic anemia. Megaloblastic anemia, the incidence of which usually increases with age (Wintrobe et al., 1974, p. 604), was not present in any of these subjects. The volumes of the red cells were, in three women, slightly elevated (98 to 101 cubic microns); for them, mean cell hemoglobin was increased while red cell counts ranged from 4.0 to 4.5 million. Of these three women, the one, aged 68, with the lowest red blood cell count (4.05 million) had a mean daily iron intake of 12.5 mg and consumed liver on one day of the survey; her hemoglobin level was 13.0 g/100 ml. For this subject, however, traces of occult blood were detected in the urine. The other two individuals, aged 64 and 75 years, both had adequate dietary iron, hemoglobin levels, and red cell counts. Serum and percentage of transferrin bound iron, was, for all subjects, in the normal range. In these women, no parameter of iron status was found to be related to age.

Hemoglobin levels as measured in 1972 were compared with values obtained for these individuals in the 1948 survey. Hemoglobin levels in the former year ranged from 12.2 to 14.5 g/100 ml. Of the 12 subjects for whom previous values were available, ten were observed to have higher hemoglobin levels in 1972 than previously; this increase ranged from 0.3 to 1.6 g/100 ml. The higher gains were observed among women who, in 1948, were between the ages of 40 and 52. One subject, aged 80, showed a decrease in hemoglobin level from 14.0 to 13.3 g/100 ml, whereas for another individual, aged 73, the same value (13.6 g/100 ml) was recorded.

Vitamin Status

Vitamin A and Carotene.--Serum vitamin A and β carotene levels (for individual values, see Appendix D-9) were acceptable to good for all but two subjects, one of whom had less than 10 ug retinol/100 ml and the other 18. Both women had their gall bladders removed some years earlier. Despite their low vitamin A blood levels their dietary intakes were markedly different, with the first woman consuming 1940 IU per day and the second supplementing her dietary intake with 10,000 IU each day. Serum carotene ranged from 64 to 372 ug/100 ml among all the subjects examined. For the two individuals with low blood levels of vitamin A (<10 and 18 ug/100 ml), β carotene levels were within the normal range equalling 163 and 121 ug/100 ml, respectively. Neither serum vitamin A nor carotene was significantly related to dietary intake, calculated with or without supplements. Furthermore, the level of vitamin A in the serum was not related to the level of carotene. Age was not associated with either parameter.

In 1948, serum vitamin A levels for these subjects ranged from 0 to 67 ug/100 ml, and carotene levels from 37 to 149 ug/100 ml. There had been a marked drop in serum vitamin A for the subject who in 1972 had only 18 ug vitamin A/100 ml; in 1948 her recorded value was 67 ug. Conversely, over this time, the carotene level in this subject rose from 54 to 121 ug. No 1948 values were available for the other subject exhibiting biochemical evidence of vitamin A deficiency. Among the 10 women for whom information in 1948 and 1972 permitted comparison, seven showed increases in serum vitamin A, ranging from 1 to 58 ug. The woman for whom no serum vitamin A could be detected in 1948, had in 1972, a value of 58 ug/100 ml. Serum vitamin A dropped slightly in two of the subjects examined. Carotene values rose in all individuals studied.

Ascorbic Acid.--The serum vitamin C levels were, for all subjects but one, high, according to the ICNND (1963) standards (for individual values, see Appendix D-9). The lowest serum ascorbic acid level was 0.39 mg/100 ml; the highest was 1.28 mg. In contrast to vitamin A, there was a relation between serum ascorbic acid levels and dietary intake including supplements ($r=0.560$, $n=18$, $p<.05$). Serum ascorbic acid levels were not affected by age.

Serum ascorbic levels tended to be higher when measured in 1948 than in 1972. Six of the ten women exhibited a decrease in serum ascorbate, the most precipitous drop being from 1.40 to 0.44 mg/100 ml. Some determinations in 1948 may have been performed on non-fasting blood samples. Four women were observed to have higher serum levels of ascorbic acid in 1972; the individual with the lowest ascorbic acid value in 1948, 0.30 mg/100 ml, had a serum level of 0.95 mg in 1972. All blood analyzed in 1972 was fasting.

Thiamin and Riboflavin.--The urinary excretion levels of thiamin and riboflavin calculated per gram of creatinine (for individual values, see Appendices D-10 and D-11) are evaluated according to ICNND (1963) standards in

Table V-11. The excretion levels of both vitamins were significantly related to total dietary intake. Although thiamin excretion was directly related to intake (r=0.528, n=20, p<.05), the two lowest, although acceptable excretion levels, were for individuals consuming 0.95 and 1.20 mg thiamin daily. The urinary thiamin excretion data appeared to confirm the suggestion that the requirement for this vitamin is proportional to caloric intake. This was evident from the fact that those women securing less than two-thirds of the RDA for thiamin had relatively high excretion values; however, their caloric intakes were low.

Urinary riboflavin, on the other hand, very closely followed recorded intakes (r=0.767, n=20, p<.001). In contrast to findings for thiamin, two of the three subjects for whom riboflavin excretion was low according to accepted standards (below 79 ug/gm of creatinine) had dietary intakes approximating only two-thirds the RDA for this vitamin. The third subject, with riboflavin excretion of 50 ug/gm creatinine, had a dietary intake of 1.29 mg.

When urinary vitamin levels were examined in regard to age, it was found that thiamin excretion did increase significantly with advancing age. This was not true of urinary riboflavin. The finding regarding thiamin excretion could relate to the fact that three of four subjects aged 80 or above, were receiving supplementary thiamin.

Table V-12.--Dietary, Biochemical and Physical Factors Relating to the Absence or Presence of Abnormalities of the Eyes, Lips, Gums and Tongue Among the Twenty Older Women Examined in 1972.

Characteristic	Factor (units)	Absent Mean ± S.D.	Absent n	Present Mean ± S.D.	Present n	Statistic
Angular stomatitis	Dietary calcium (mg)	476 ± 199	(15)	727 ± 309	(5)	F = 4.558*
	Dietary iron (mg)	10.1 ± 3.1	(15)	12.7 ± 2.8	(5)	n.s.
	Dietary riboflavin (mg)	1.33 ± 0.45	(15)	1.87 ± 0.40	(5)	F = 5.799*
	Urinary riboflavin (ug/g creatinine)	379 ± 380	(15)	258 ± 192	(5)	n.s.
	Age (yrs)	74.1 ± 6.2	(15)	69.4 ± 4.0	(5)	n.s.
Red tongue	Dietary calcium (mg)	458 ± 159	(17)	995 ± 136	(3)	F = 29.998**
	Dietary iron (mg)	10.3 ± 2.9	(17)	13.6 ± 3.3	(3)	n.s.
	Dietary thiamin (mg)	0.88 ± 0.23	(17)	1.38 ± 0.46	(3)	F = 8.928**
	Dietary riboflavin (mg)	1.37 ± 0.47	(17)	1.99 ± 0.19	(3)	F = 5.118*
	Dietary niacin (mg)	12.4 ± 3.7	(17)	13.6 ± 2.4	(3)	n.s.
	Urinary thiamin (ug/g creatinine)	867 ± 1022	(17)	947 ± 983	(3)	n.s.
	Urinary riboflavin (ug/g creatinine)	323 ± 324	(17)	494 ± 483	(3)	n.s.
	Age (yrs)	73.1 ± 6.3	(17)	70.7 ± 4.5	(3)	n.s.
Tongue filliform atrophy	Dietary calcium (mg)	461 ± 146	(13)	683 ± 340	(7)	$p < .06$
	Dietary iron (mg)	10.4 ± 3.1	(13)	11.4 ± 3.3	(7)	n.s.
	Dietary thiamin (mg)	0.94 ± 0.23	(13)	0.99 ± 0.37	(7)	n.s.
	Dietary riboflavin (mg)	1.25 ± 0.36	(13)	1.84 ± 0.49	(7)	F = 9.615**
	Dietary niacin (mg)	12.6 ± 3.8	(13)	12.6 ± 3.0	(7)	n.s.
	Dietary ascorbic acid (mg)	118 ± 49	(13)	56 ± 41	(7)	F = 8.201**

Table V-12.--Continued.

Characteristic	Factor (units)	Absent Mean ± S.D.	n	Present Mean ± S.D.	n	Statistic
Tongue filliform atrophy (cont.)	Urinary thiamin (ug/g creatinine)	882 ± 1088	(13)	874 ± 862	(7)	n.s.
	Urinary riboflavin (ug/g creatinine)	257 ± 214	(13)	521 ± 477	(7)	n.s.
	Serum ascorbic acid (mg/100 ml)	0.82 ± 0.24	(11)	0.89 ± 0.25	(7)	n.s.
	Age (yrs)	73.5 ± 6.6	(13)	71.7 ± 4.8	(7)	n.s.
Tongue fissures	Dietary ascorbic acid (mg)	110 ± 50	(16)	42 ± 35	(4)	F = 6.447*
	Serum ascorbic acid (mg/100 ml)	0.88 ± 0.25	(14)	0.75 ± 0.17	(4)	n.s.
	Age (yrs)	73.3 ± 6.5	(16)	71.2 ± 3.3	(4)	n.s.
Receding gums	Dietary ascorbic acid (mg)	115 ± 48	(8)	84 ± 57	(12)	n.s.
	Serum ascorbic acid (mg/100 ml)	0.78 ± 0.27	(7)	0.90 ± 0.22	(11)	n.s.
	Age (yrs)	73.1 ± 4.6	(8)	72.8 ± 7.0	(12)	n.s.
Retracting gums	Age (yrs)	71.6 ± 4.7	(13)	74.9 ± 7.8	(7)	n.s.

*$p \leq .05$
**$p \leq .01$

Descriptions of abnormalities may be found in Appendix D-13.

Relation Between Clinical Symptoms, Nutrient Intake, Physical Factors, and Age

Eyes, Lips, Tongue, and Gums.--The occurrence of two lesions of the eye, crusted eyelids and blepharitis, observed in one and two subjects, respectively, was significantly related to vitamin A nutriture as indicated by blood levels. These lesions were not associated with dietary intake since one woman supplemented her daily diet with 10,000 IU of the vitamin; the other secured less than 50 percent of the RDA. Both individuals had less than adequate serum vitamin A values which equalled < 10 and 18 ug/100 ml. Age was not a factor associated with the development of these lesions. Bulbar spots, on the other hand, related to neither nutrient intake, biochemical parameters, nor age.

Dietary nutrients that are frequently associated with lesions of the lips, tongue, and gums, are listed in Table V-12. Angular stomatitis was diagnosed in five of the 20 women examined. Contrary to what might be anticipated, dietary riboflavin was significantly higher for those women in whom this lesion was observed. In addition, these subjects had higher intakes of calcium and iron, although the difference in dietary iron level was not significant. For the women displaying angular stomatitis, urinary riboflavin was, according to ICNND (1963) standards, acceptable for three of the five and high for the remaining two. Conversely, no individual with "low" riboflavin excretion, indicative of inadequate dietary intake, had oral lesions. In confirmation of the work of Machella and McDonald (1943), four of the five subjects with fissures at the corners of the mouth had either partial or complete dentures. Age was not a factor in the development of angular stomatitis.

Lesions of the tongue, as abnormal red color or atrophy of the filliform or fungiform papillae, were not associated with low dietary intakes of iron, thiamin, riboflavin, or niacin, nutrients frequently cited in respect to the development of such lesions. Both thiamin and riboflavin intakes were significantly higher in the subjects exhibiting red tongue. Higher levels of the latter vitamin were also associated with the incidence of papillae atrophy, although niacin values did not differ between those with and without papillae atrophy. Excretion of the B vitamins was either acceptable or high for all subjects observed to have red tongue or papillae atrophy, with dietary intakes equalling at least 80 percent of the RDA. One of the three individuals with a tongue of abnormal color consumes, on doctor's prescription, a dietary supplement containing the B complex. A second individual in this group consumes at least one serving daily of infant cereal, providing nearly 10 mg of iron per serving, with high levels of thiamin, riboflavin and niacin. Calcium intakes were higher in those women with both red tongue and papillae atrophy; dietary riboflavin levels in these individuals reflected generous servings of milk.

Dentures, more than nutrient intake, may be involved in some of the tongue abnormalities observed in these women. This hypothesis is based on the fact that three of the seven women with papillae atrophy were ingesting dietary supplements providing the B vitamins and iron, as compared with only 4 of the 13 subjects without filliform atrophy. Although ascorbic acid intake from food was significantly lower among the women with papillae atrophy, calculations which included dietary supplements revealed that only two individuals were consuming less than 150 percent of the RDA for this vitamin. All three women exhibiting red tongue, had papillae atrophy as well. Age was unrelated to the occurrence of either tongue abnormality. All women with red tongue wore dentures, as did five of the seven with papillae atrophy.

In contrast, fissures of the tongue may be related to dietary intake of ascorbic acid. Women with tongue fissures ingested significantly less ascorbic acid than those without fissures, a mean value of 42 mg as compared with 110 mg. Two of the women with fissured tongues had total intakes of ascorbic acid which equalled 27 and 36 mg, or 60 and 80 percent, respectively, of the RDA for this vitamin. Serum ascorbic acid levels for these two subjects were, however, 0.60 and 0.63 mg/100 ml, which was not indicative of deficiency. The other two individuals with fissured tongues ingested, with supplements, at least 100 mg of ascorbic acid daily; serum ascorbic acid levels were for these women 0.83 and 0.95 mg/100 ml. Tongue fissures were not associated with advancing age.

Receding and retracting gums were not related to either dietary intake or age among these subjects. Despite the fact that ascorbic acid nutriture is frequently associated with health of the gums, dietary levels of ascorbic acid and serum ascorbic acid values were not related to either gum recession or gum retraction. The lowest serum ascorbate level observed was 0.39 mg/100 ml; that subject, aged 69, had neither receding nor retracting gums.

<u>General Appearance</u>.--All subjects were rated by the physician as to their general appearance, indicative of their state of health. This rating was not always related to their nutritional status as evidenced by either dietary intake or biochemical tests. Sixteen women were rated as good with four subjects rated as fair. As noted in Table V-13, a rating of fair was associated with low intakes of ascorbic acid and low relative body weights. Mean dietary ascorbic acid equalled 111 mg for those whose appearance was good as compared with an intake of 39 mg for those rated as fair. When general appearance was

Table V-13.--Dietary, Biochemical and Physical Factors Relating to General Appearance Among Twenty Older Women Examined in 1972.

Factor (units)	General Appearance				Statistic
	Good		Fair		
	Mean ± S.D.	n	Mean ± S.D.	n	
Dietary protein (g)	60.9 ± 14.0	(16)	55.2 ± 18.7	(4)	n.s.
Dietary iron (mg)	10.7 ± 2.9	(16)	10.9 ± 4.6	(4)	n.s.
Dietary ascorbic acid (mg)	111 ± 50	(16)	39 ± 29	(4)	F = 7.383**
Serum ascorbic acid (mg/100 ml)	0.88 ± 0.25	(14)	0.76 ± 0.17	(4)	n.s.
Relative body weight	118.1 ± 25.6	(16)	86.0 ± 25.8	(4)	F = 5.040*
Age (yrs)	72.6 ± 6.4	(16)	74.2 ± 4.6	(4)	n.s.

*$p \leq .05$
**$p \leq .01$

good, the subjects tended to be somewhat overweight, mean relative weight equalling 118.1, whereas those rated as fair were underweight with a relative mean of 86.0. This effect was not dependent on age, for the subjects rated only fair in appearance were 69, 73, 75 and 80 years of age. The biochemical data for these women revealed that both subjects with serum vitamin A levels below 20 ug/100 ml were rated as fair. In contrast, the three subjects with low urinary riboflavin excretion were rated as good.

Face and Skin.--Four women showed definite pallor, and three of these had been rated as only fair in appearance. Pallor, in these subjects, was associated with a lower intake of dietary thiamin and advanced age (Table V-14). Two of the subjects with extreme paleness had only 52 and 79 percent of the RDA for thiamin, although excretion levels of this vitamin were within an acceptable range. On the other hand, three women with thiamin intakes ranging from 61 to 78 percent of the RDA had normal skin color. Iron intake did not differ generally between those with and without pallor, although one subject who showed this abnormality was consuming less than two-thirds of the recommended level of iron. Hemoglobin levels were normal for all subjects examined. One individual observed to have pallor had a history of pernicious anemia, now under control. The pale women were older, with two aged 80 or above, while the others were 73 and 75 years of age;

Table V-14.--Dietary, Biochemical and Physical Factors Relating to the Absence or Presence of Abnormalities of the Face and Skin Among the Twenty Older Women Examined in 1972.

Characteristic	Factor (units)	Absent Mean ± S.D.	Absent n	Present Mean ± S.D.	Present n	Statistic
Pallor	Dietary protein (g)	62.8 ± 13.9	(16)	47.8 ± 11.9	(4)	p < .07
	Dietary iron (mg)	10.9 ± 2.5	(16)	9.9 ± 5.5	(4)	n.s.
	Dietary thiamin (mg)	1.00 ± 0.29	(16)	0.65 ± 0.22	(4)	F = 5.212*
	Hemoglobin (g/100 ml)	14.2 ± 0.8	(16)	13.9 ± 0.5	(4)	n.s.
	Urinary thiamin (ug/g creatinine)	836 ± 1044	(16)	1050 ± 848	(4)	n.s.
	Age (yrs)	71.7 ± 5.9	(16)	77.8 ± 3.6	(4)	p < .07
Hyperkeratosis (elbows)	Dietary fat (g)	66.0 ± 20.1	(8)	45.9 ± 17.2	(12)	F = 5.723*
	Dietary saturated fatty acids (g)	21.5 ± 12.9	(8)	14.7 ± 8.5	(12)	n.s.
	Dietary oleic acid (g)	23.2 ± 9.2	(8)	16.1 ± 5.6	(12)	F = 4.596*
	Dietary linoleic acid (g)	5.9 ± 3.2	(8)	2.7 ± 1.7	(12)	F = 8.426**
	Dietary vitamin A (IU)	5251 ± 4018	(8)	8094 ± 7832	(12)	n.s.
	Serum vitamin A (ug/100 ml)	57 ± 26	(6)	48 ± 23	(12)	n.s.
	Age (yrs)	74.0 ± 6.8	(8)	72.2 ± 5.6	(12)	n.s.
Hyperkeratosis (knees)	Dietary fat (g)	66.6 ± 21.6	(7)	47.1 ± 17.1	(13)	F = 4.894*
	Dietary saturated fatty acids (g)	22.1 ± 13.8	(7)	14.9 ± 6.9	(13)	n.s.
	Dietary oleic acid (g)	23.8 ± 9.9	(7)	16.4 ± 5.4	(13)	F = 4.918*
	Dietary linoleic acid (g)	6.3 ± 3.2	(7)	2.7 ± 1.6	(13)	F = 10.993**
	Dietary vitamin A (IU)	5568 ± 4230	(7)	7704 ± 7629	(13)	n.s.
	Serum vitamin A (ug/100 ml)	57 ± 26	(6)	48 ± 23	(12)	n.s.

Table V-14.--Continued.

Characteristic	Factor (units)	Absent		Present		Statistic
		Mean ± S.D.	n	Mean ± S.D.	n	
Hyperkeratosis (knees) (cont.)	Age (yrs)	73.0 ± 6.6	(7)	72.8 ± 5.9	(13)	n.s.
Crackled skin	Dietary fat (g)	49.8 ± 15.1	(6)	55.7 ± 22.8	(14)	n.s.
	Dietary linoleic acid (g)	3.8 ± 2.1	(6)	4.0 ± 3.2	(14)	n.s.
	Dietary ascorbic acid (mg)	102 ± 59	(6)	94 ± 55	(14)	n.s.
	Age (yrs)	70.5 ± 6.3	(6)	73.9 ± 5.7	(14)	n.s.
Creased skin	Dietary fat (g)	55.8 ± 17.5	(5)	53.3 ± 22.0	(15)	n.s.
	Dietary linoleic acid (g)	6.0 ± 3.5	(5)	3.3 ± 2.3	(15)	n.s.
	Dietary ascorbic acid (mg)	117 ± 52	(5)	90 ± 56	(15)	n.s.
	Age (yrs)	71.4 ± 6.7	(5)	73.4 ± 5.9	(15)	n.s.
Pigmentation (skin)	Dietary iron (mg)	10.0 ± 2.2	(17)	13.8 ± 3.6	(3)	F = 6.210*
	Hemoglobin (g/100 ml)	14.2 ± 0.8	(17)	13.7 ± 0.7	(3)	n.s.
	Age (yrs)	72.6 ± 6.0	(17)	74.3 ± 7.0	(3)	n.s.

*$p \leq .05$
**$p \leq .01$

Descriptions of abnormalities may be found in Appendix D-13.

mean age differences were not statistically significant ($p < .07$). Protein intakes were somewhat lower among those with pallor.

In contrast to pallor which was noted in relatively few subjects, other skin lesions as hyperkeratosis of the elbows and knees, and crackled and creased skin, were observed in the majority of individuals examined. Hyperkeratosis of the elbows and/or knees (one subject showed this symptom on the knees only) was significantly related to lower intakes of linoleic acid. This value was 2.7 grams among those with hyperkeratosis of elbows and/or knees as compared with 6.3 grams in the women with no such symptoms. Levels of oleic acid and total fat were also lower among those women whose skin was rough. This difference may lead to questions regarding the recommended dietary level for linoleic acid. That suggestion is based on the fact that eight of the thirteen women with lesions had consumed the amount of linoleic acid recommended by the Food and Nutrition Board (1974), two percent of total calories. Age was not a factor in the appearance of hyperkeratosis, nor was vitamin A status. Almost one-half of the subjects with this problem had serum vitamin A levels above 50 ug/100 ml. The women with creased skin also tended to have lower intakes of linoleic acid, although this difference was not significant ($p < .07$).

Another skin abnormality, appearing less frequently in these women, was extensive skin pigmentation, diagnosed in three of twenty subjects examined. These three women did have significantly higher intakes of dietary iron, although biochemical parameters of iron status did not differ between those with and without pigmented skin. Extensive skin pigmentation would not seem to be related to age, being observed in women aged 67, 75 and 81 years.

Skeletal System.--Deformity of the skeletal system resulting in a loss in stature and/or a stooped appearance in older people may be associated with overweight. Although loss of calcium from the bone is frequently cited (Garn, 1972) as a factor in vertebral changes, calcium intakes for these subjects in neither 1948 nor 1972 were associated with the development of lordosis, the only spinal abnormality observed among these subjects (Table V-15). That overweight is a relevant factor in producing spinal deformity in older people is suggested by the fact that relative body weight in 1972 equalled 135.8 for the six women with lordosis, whereas this value was only 98.4 among those with a normal spine, a significant difference. Excessive weight over long periods of time may substantially contribute to the development of this condition, as the subjects exhibiting lordosis in 1972 were also overweight when surveyed in 1948. Mean relative weight at that time was 122.7 for those who now have lordosis,

Table V-15.--Dietary and Physical Factors Relating to the Absence or Presence of Lordosis Among the Twenty Women Examined in 1972.

Factor (units)	Lordosis				Statistic
	Absent		Present		
	Mean ± S.D.	n	Mean ± S.D.	n	
Dietary protein - 1948 (g)	62.1 ± 18.6	(14)	57.5 ± 18.7	(6)	n.s.
Dietary protein - 1972 (g)	58.9 ± 15.4	(14)	61.8 ± 13.8	(6)	n.s.
Dietary calcium - 1948 (mg)	501 ± 324	(14)	422 ± 224	(6)	n.s.
Dietary calcium - 1972 (mg)	550 ± 248	(14)	513 ± 272	(6)	n.s.
Relative body weight - 1948	102.9 ± 26.9	(14)	122.7 ± 22.5	(6)	n.s.
Relative body weight - 1972	98.4 ± 20.8	(14)	135.8 ± 23.9	(6)	F = 12.439**
Age (yrs)	74.4 ± 5.8	(14)	69.5 ± 5.2	(6)	n.s.

**$p \leq .01$

Description of abnormality may be found in Appendix D-13.

compared with 102.9 for subjects with normal spines. Age would not appear to be a controlling factor in regard to this change, as none of the women in the oldest age group had lordosis.

Neurological Reflexes.--The loss of neurologic function would appear to be associated with advancing age. Eighteen of the twenty subjects examined had lost the normal Babinski response, although both women retaining this function were above the age of 80. These two subjects were in excellent nutritional status in terms of nutrient intake and biochemical measures, and had been evaluated as being in better physical condition than is typical for women of their age. Loss of proprioception was more frequent among the women aged 70 to 79, than among those aged 60-69. Women who had lost their response to proprioceptive stimuli had higher intakes of saturated fat and calcium.

Cardiovascular Function.--Two characteristics frequently associated with cardiovascular dysfunction, enlarged heart and edema of the lower extremities, in these subjects, were not significantly related to nutrient intake (Table V-16). Carbohydrate intake was higher among subjects with normal heart size as compared to those with cardiac hypertrophy, but this difference was not significant ($p = .06$). No other differences in intakes of either

Table V-16.--Dietary, Biochemical and Physical Factors Relating to the Absence or Presence of Cardiovascular Abnormalities Among the Twenty Older Women Examined in 1972.

Characteristic	Factor (units)	Absent		Present		Statistic
		Mean ± S.D.	n	Mean ± S.D.	n	
Enlarged heart	Relative body weight - 1948	99.4 ± 18.3	(13)	126.3 ± 31.0	(7)	F = 6.047*
	Relative body weight - 1972	97.1 ± 21.4	(13)	133.0 ± 22.4	(7)	F = 12.426**
	Systolic blood pressure - 1948[a]	142 ± 16	(7)	162 ± 42	(5)	n.s.
	Diastolic blood pressure - 1948[a]	83 ± 6	(7)	95 ± 26	(5)	n.s.
	Systolic blood pressure - 1972	139 ± 16	(13)	155 ± 25	(7)	n.s.
	Diastolic blood pressure - 1972	84 ± 9	(13)	93 ± 7	(7)	F = 5.281*
	Age (yrs)	73.0 ± 6.3	(13)	73.3 ± 5.7	(7)	n.s.
Edema (lower extremities)	Dietary vitamin A (IU)	4201 ± 2578	(11)	10326 ± 8474	(9)	F = 5.215*
	Serum vitamin A (ug/100 ml)	53 ± 27	(9)	49 ± 21	(9)	n.s.
	Relative body weight - 1972	92.6 ± 18.3	(11)	130.6 ± 22.1	(9)	F = 17.640**
	Systolic blood pressure - 1972	138 ± 15	(11)	152 ± 24	(9)	n.s.
	Diastolic blood pressure - 1972	83 ± 8	(11)	93 ± 8	(9)	F = 8.014*
	Age (yrs)	72.3 ± 7.2	(11)	73.7 ± 4.2	(9)	n.s.

Table V-16.--Continued.

Characteristic	Factor (units)	Absent		Present		Statistic
		Mean ± S.D.	n	Mean ± S.D.	n	
Varicose veins	Dietary iron (mg)	9.3 ± 2.0	(10)	11.9 ± 2.9	(10)	F = 5.574*
	Hemoglobin (g/100 ml)	14.2 ± 0.8	(10)	14.1 ± 0.8	(10)	n.s.
	Relative body weight - 1948	101.2 ± 22.8	(10)	116.4 ± 28.7	(10)	n.s.
	Relative body weight - 1972	101.9 ± 26.5	(10)	117.4 ± 27.6	(10)	n.s.
	Systolic blood pressure - 1972	133 ± 17	(10)	156 ± 17	(10)	F = 9.333**
	Diastolic blood pressure - 1972	84 ± 10	(10)	91 ± 7	(10)	n.s.
	Age (yrs)	71.4 ± 5.7	(10)	74.4 ± 6.2	(10)	n.s.

*p $\leq$ .05
**p $\leq$ .01

[a] Blood pressure measurements in 1948 not available for eight subjects.

calories or macronutrients were observed between the two groups. Dietary vitamin A was higher among the women whose lower extremities were edematous, however, there was no relation between serum vitamin A and fluid retention.

The principal factors associated with chronic cardiac dysfunction in these women appeared to be hypertension and relative body weight. The seven individuals whose hearts were enlarged when evaluated in 1972, were significantly above their ideal weights when examined in both 1948 and 1972. In 1948 mean systolic blood pressure did not differ significantly between those whose hearts are now enlarged, and those with normal-sized hearts. Among those with enlarged hearts, however, three of the five subjects for whom 1948 blood pressure data is available had systolic pressures above 150 mm. This also was true for three of seven women with normal-sized hearts. Similarly, diastolic blood pressure would appear to influence cardiac hypertrophy. Of the seven subjects with normal-sized hearts for whom 1948 blood pressure data is available, none had diastolic pressures above 90 mm; however, three of the five subjects whose hearts are now enlarged in 1948 had diastolic pressures ranging from 95 to 132 mm. Consistent with this finding in 1948, systolic and diastolic blood pressures as measured in 1972, were higher among those with cardiac enlargement and edema, as compared with individuals without these symptoms. Six of seven subjects with enlarged hearts in 1972 had systolic pressures above 150 mm, as compared with two of thirteen in the other group. Similarly, four of the seven with cardiac hypertrophy now exhibit diastolic hypertension; this is true for only two of the others.

Varicose veins, another abnormality of the cardiovascular system, was observed in one-half of the subjects examined. Although dietary intakes of iron were higher among the women exhibiting this vascular problem, biochemical parameters of iron status did not differ between the two groups. Relative body weight as measured in either 1948 or 1972 did not differ significantly between those with and without varicose veins, although women with varicose veins were above their ideal weight. The development of this vascular lesion would appear to be significantly influenced by blood pressure. Although systolic and diastolic blood pressures, as measured in 1948, did not differ between the two groups, systolic pressure in 1972, was significantly higher among those with this lesion. Although the women with varicose veins tended to be older, this difference was not significant.

Blood Pressure.--Regression relationships between dietary intakes in 1948 and 1972, and blood pressure in 1972, were evaluated in these women. No significant relationships were found. Nutrient intake in 1948 was not related to either systolic or diastolic blood pressure in

1972. Protein intake in 1972 was positively associated with diastolic blood pressure, but this value did not reach significance ($p = .06$). Similarly, systolic blood pressure tended to rise with dietary intakes of total fat, saturated fat, and oleic acid. Another parameter closely associated with blood pressure is body weight. Relative body weight in 1948 did seem to positively influence both systolic and diastolic blood pressure as measured in 1972 ($p = .07$). The relative weights of the survey subjects in 1972 were significantly related to both systolic ($r = 0.546$, $n = 20$, $p < .05$) and diastolic ($r = 0.478$, $n = 20$, $p < .05$) blood pressures.

Blood pressures tended to rise between 1948 and 1972 among those subjects for whom measures were available in both years. Comparison with the 1972 values revealed that systolic blood pressure increased in seven subjects, decreased in three, and remained relatively constant (change < 10 mm) in two subjects. Two individuals who in the recent study showed systolic hypertension (> 150 mm), were normotensive in 1948. One individual, aged 81, hypertensive in 1948, had in 1972, a systolic pressure of 128 mm. Four individuals remained normotensive and five subjects were hypertensive in both years. Similarly, three women who, in 1948, had normal diastolic pressures, now had diastolic pressures above 90 mm (one of these women developed systolic hypertension as well).

Six subjects have retained normal diastolic blood pressure between 1948 and 1972, and two subjects remained hypertensive. One individual showed a decrease in diastolic pressure from 100 mm in 1948 to 88 mm in 1972.

Of the three women whose systolic blood pressure dropped over the past 24 years, one is under treatment for hypertension. For this individual systolic pressure has dropped from 230 mm to 168 mm and diastolic pressure from 132 to 102 mm. The other two subjects, aged 81 and 75, are being treated with diuretics; in addition, both women lost about 25 pounds in body weight between 1948 and 1972. Changes in systolic blood pressure, however, do not always reflect changes in body weight. For the two women who developed systolic hypertension over the 24-year interval (systolic pressures increasing from 116 to 168 mm and 140 to 182 mm), this change was not accompanied by an increase in body weight; body weight changes represented less than ten pounds. The latter individual, however, was more than 40 percent above her ideal weight. Only two among the eight women who in 1972 exhibited either systolic and/or diastolic hypertension, are not being treated for this disease. These individuals, aged 80 and 85, have high systolic and diastolic pressures. That hypertension may result in other abnormalities apart from the cardiovascular system is suggested by the observation that the one subject whose urine contained both protein and occult blood was hypertensive (Appendix D-12). This was also true of a second individual whose test was positive for occult blood. These subjects were 68 and 64 years of age, respectively.

Physical Complaints.--When the subjects were questioned regarding the occurrence of repeating pains, 11 complained of such discomforts as arthritic pain in the knees, back, or shoulder, or abdominal and chest pains. However, the incidence of such pains was not related to nutrient intake, body weight in either 1948 or 1972, or age (Table V-17). In contrast, women who tired easily had significantly less riboflavin in their diets. Two of the eight women who tired easily had excretion levels of riboflavin indicative of low intake. Further examination of parameters among those easily tiring revealed no differences in serum hemoglobin, relative body weight, or age, as compared with those with greater work endurance.

Evaluation in Relation to Age.--Following the physical examination, subjects were evaluated by the clinician as physically appearing younger, older, or typical of women of that age. This judgment was based upon appearance (i.e., skin changes, tissue integrity) and function (i.e., cardiovascular system, neurological responses, locomotion). Because of the subjective nature of this judgment, statistical tests were not applied to

Table V-17.--Dietary, Biochemical and Physical Factors Related to the Absence or Presence of Physical Complaints Among the Twenty Older Women Examined in 1972.

Complaint	Factor (units)	Absent		Present		Statistic
		Mean ± S.D.	n	Mean ± S.D.	n	
Repeating pains	Relative body weight - 1948	100.6 ± 23.7	(9)	116.0 ± 27.4	(11)	n.s.
	Relative body weight - 1972	106.7 ± 28.0	(9)	112.1 ± 28.2	(11)	n.s.
	Age (yrs)	71.1 ± 6.1	(9)	74.3 ± 5.7	(11)	n.s.
Tires easily	Dietary iron (mg)	11.7 ± 3.4	(12)	9.3 ± 2.2	(8)	n.s.
	Dietary riboflavin (mg)	1.64 ± 0.50	(12)	1.19 ± 0.36	(8)	F = 4.545*
	Hemoglobin (g/100 ml)	14.0 ± 0.7	(12)	14.4 ± 0.9	(8)	n.s.
	Relative body weight - 1972	108.0 ± 20.4	(12)	112.1 ± 37.3	(8)	n.s.
	Systolic blood pressure - 1972 (mm Hg)	143 ± 19	(12)	146 ± 23	(8)	n.s.
	Diastolic blood pressure - 1972 (mm Hg)	87 ± 10	(12)	88 ± 7	(8)	n.s.
	Age (yrs)	73.6 ± 6.3	(12)	71.9 ± 5.6	(8)	n.s.

*$p \leq .05$

these results. Four subjects were considered to appear younger, two subjects older, and 16 subjects typical of their age.

The evaluation of daily nutrient intake of these groups revealed that in 1948, the subjects appearing older had low intakes of calcium, vitamin A and ascorbic acid. Levels of calcium and vitamin A were approximately one-third of that recommended. The lowered nutrient intakes in 1948 of the subjects appearing older, may be explained in part by the generally low food intake of these women. Mean caloric intake was only 1104 kcal, compared with 1808 and 1838 kcal for the typical and younger-looking women, respectively. The women appearing younger had, in 1948, at least one-half the RDA for all nutrients except calcium.

In 1972, the women who appeared younger had generally good diets; the only nutrient to fall below 60 percent of the suggested recommendation was calcium. This group had lower though adequate levels of protein and less saturated fat and oleic acid, than those who appeared typical or older. One of the subjects appearing "older" had a very poor diet with less than half the RDA for calcium, vitamin A, thiamin, and ascorbic acid. Although this woman reported use of a dietary supplement providing all vitamins and iron, her serum vitamin A level was less than adequate.

Physical condition in later years may relate to the degree of body fat. The two women appearing older than their years were substantially underweight with a mean relative value of 65.8. On the other hand, relative weights among the four younger-appearing women were 100.6, 114.3, 122.8 and 143.8. Blood pressure per se did not seem to influence the category into which these women were classified. Among the four women who appeared younger, one had both systolic and diastolic hypertension in 1972; she was also slightly overweight (relative weight = 114.3). Two others in this group had, in 1948, systolic pressures above 150 mm. In contrast, the two subjects who appeared older than their years had normal blood pressures in 1972.

Discussion

Problems in Assessing Nutritional Status in Older People

An attempt to relate the physical or health condition of these older women to their prior or recent dietary intake is fraught with difficulties. The latter include all the problems associated with distinguishing observed clinical abnormalities from the natural consequences of aging. This difficulty is compounded by the differential rates at which individuals age. Many older people have memory lapses which interfere with attempts to pinpoint the time when certain events related to their health and well-being occurred. Related thereto is the accuracy of any dietary records that are obtained from older people. Superimposed on these problems are the well-recognized limitations of relating dietary intakes to nutritional status. Although the signs and symptoms commonly seen in individuals with classical deficiencies are well known, the recognition of "sub-clinical syndromes" requires, for the most part, differential diagnosis (Sinclair, 1948a; Sandstead et al., 1969). Furthermore, the classical clinical signs associated with nutritional abnormalities among younger people may be pathognomonic of old age, or secondary manifestations of diseases or traumas to which old age is especially susceptible (Jolliffe and Most, 1943).

Despite these limitations, it appears desirable to determine whether any relationships exist between an individual's dietary practices at some previous time and his current health status. The following discussion will attempt to evaluate the results of the Lansing study in the light of other reports and indicate the problems that may be encountered, should this type of research be repeated.

Clinical Aspects of Nutrition and Aging

The skin is probably the most frequently used criterion in estimating the age of an individual. With age, the characteristics of the skin change from the "firm and elastic skin of a young person" to "the pale or yellowed, somewhat flaccid and inelastic skin of the old person" (Andrew, 1971, p. 71).

Skin abnormalities, as suborbital pigmentation, hyperkeratosis of elbows and knees, and crackled and creased epidermis, were each observed in over half of the subjects. Suborbital pigmentation, although frequently seen in malnourished individuals, has not been related specifically to any one particular nutrient (Jolliffe and Most, 1943; Sinclair, 1948). Although such pigmentation has been associated with the eye lesions of vitamin A deficiency, this was not true in the Lansing women; only 2 of the 11 with suborbital pigmentation had serum vitamin A levels that were less than adequate. A more likely cause of this change in skin color is age, as Andrew (1971, p. 87) reported that brown, irregular areas of pigment (lentigo senilis), seldom seen before the fourth decade, tend to increase in size and number with advancing years. This condition appears on the hands, forearms, and face. No connection between the general condition of health and these pigmented markings has been discerned.

A surprising observation was the presence of hyperkeratosis among those women whose intake of linoleic acid was, according to the Food and Nutrition Board (1974), adequate. Additional work is needed to determine whether the recommended level of linoleic acid should be increased or possibly expressed as an absolute amount, rather than as a percentage of total calories. This question is based upon the observation that caloric intakes among these women were approximately two-thirds of that suggested for women above the age of 50 (1297 kcal versus 1800 kcal). Although these subjects may have consumed two percent of their calories as linoleic acid, intake may not have been sufficient to meet body needs. One explanation for the relatively low intakes of linoleic acid is the decrease in total fat consumed by these subjects. A limitation of dietary fat has been emphasized by the popular press as a means of slowing degenerative vascular changes. Furthermore, high intakes of fat may cause abdominal distention among older individuals.

The absolute amounts of dietary fat and linoleic acid, in addition to the percent of fat as total calories, were lower among those with dry skin than in those with normal skin. As was true in this study, Plough and Bridgforth (1960) found no correlation between dietary vitamins and the appearance of follicular hyperkeratosis. Those investigators did not examine linoleic acid intake.

Support for the concept that a deficient intake of linoleic acid may be associated with hyperkeratosis comes from the discussion of Deuel and Reiser (1955). They reported that when subjects were fed a fat-free diet, the primary tissue affected was the epidermis. Surface cells were not shed normally, with subsequent thickening of this layer. The lower transitional cell layers increased markedly, and hyperkeratosis resulted.

On the other hand, other factors may contribute to skin changes in older people. Creased and crackled skin would appear to be non-specific lesions arising in old age since these changes were not related to nutrient intake. These skin changes may reflect the changes in the total number of cells in the dermis as individuals age. Cell concentration is highest during the first four decades of life, and then declines (Andrew et al., 1964). A further consequence of aging is the increase in fibrous material with a concomitant decrease in the gel matrix. Sobel et al. (1958) considered the relative proportion of skin hexosamine to collagen to be an indicator of senescence in both humans and animals.

Gillum and associates (1955a) reported an incidence of mild to moderate skin xerosis in 28 percent of the 514 subjects over 50 years of age examined in San Mateo County, California. As in the Lansing women, mean serum levels of vitamin A were the same for those with and without skin xerosis. The severity of the skin abnormality increased with advancing age. In that study, xerosis was seen more frequently in women. No data was reported relative to the dietary fat intakes of those subjects. Similarly, Chieffi and Kirk (1949) found, among 106 persons over 40 years of age, that changes of the skin were influenced more by age than by plasma vitamin A concentrations.

Lesions of the eyes, lips, tongue, and gums have frequently been related to nutritional deficiencies among subjects fed diets lacking in particular nutrients. However, when a random group of individuals is examined for signs of nutritional disturbances, frequently only non-specific findings are observed. An example of this difficulty is seen in the report of a recent nutrition survey (U.S. Department of Health, Education and Welfare, 1972). From five to 10 percent of the women over 60 years of age examined in that study had atrophy of the filliform or fungiform papillae, whereas eight percent exhibited tongue fissures. Although the general findings of the survey suggested that nutritional problems occurred more frequently among lower-income than higher-income subjects, the tongue lesions were more frequent in the states with the higher incomes.

Further evidence that tongue and oral abnormalities are not always of nutritional origin comes from the work of Plough and Bridgforth (1960). They detected no correlation between angular lesions, cheilosis, papillae atrophy, or tongue discoloration, and dietary riboflavin, niacin, or iron. Cheilosis may result from climatic exposure or local trauma or irritation, and angular lesions frequently reflect ill-fitting dentures. According to

Horwitt and coworkers (1950), oral lesions appeared in riboflavin-deprived subjects when urinary excretion fell below 40 ug per day. That the latter is not an infallible finding is suggested by the observation that the three individuals in the Lansing study for whom urinary riboflavin excretions were 37, 49, and 50 ug per gram of creatinine, showed no oral abnormalities. Alternatively, four of the five women with angular lesions used dentures. This was also true for five of the seven subjects with filliform atrophy of the tongue. Evidence to support the conclusion that denudation of the filliform papillae may result from dentures comes from the work of Sinclair (1948). Among 3184 Dutch subjects, including all ages and both sexes, a smooth tongue was nearly three times as frequent in those having dentures as compared with those who did not.

According to Sinclair (1948a), a scarlet or magenta tongue is non-specific in origin since foods high in temperature or spices may produce bright red fungiform papillae. Confirmation that these tongue lesions may not be related to nutrient intake comes from the observation that one of the three individuals with a red tongue was ingesting, on a doctor's prescription, a high potency B vitamin supplement. Tongue fissures may also be deceptive as they can occur congenitally, appearing in about five percent of the population. The frequency of this condition increases with age (Gorlin and Boyle, 1966).

The results of the Lansing study suggest that dietary intakes of thiamin, niacin, riboflavin, and iron were not related to the appearance of oral lesions. That was based on both nutrient intake data and biochemical indices of nutritional status; however, the possible role of pyridoxine, folic acid, vitamin B_{12}, or zinc in the development of these lesions, cannot be ignored. The occurrence of oral lesions among older people should not be used to propose that older individuals have an increased requirement for various B complex vitamins and iron. This is supported by the fact that equal numbers of the Lansing women, with and without these symptoms, were ingesting between 66 and 100 percent of the RDA for these nutrients, with no additional supplements.

The loss of classical neurological responses as knee jerk and Babinski reflex has been related to deficiencies of thiamin and vitamin B_{12}. In the Lansing study the loss of knee and ankle responses in one individual reflected disease rather than nutritional state. That subject had myasthenia gravis, with resultant loss of muscle tone. Other investigators have reported the existence of clinical neurological abnormalities among older individuals. Carter (1971) surveying 100 individuals over the age of 70, observed abnormal neurological responses in 80 percent of those examined. These neurological changes were attributed to a loss of neurons, associated with advanced age. Although the six women exhibiting abnormal proprioception had high levels of dietary saturated fat and calcium, the significance of such relationships are not understood. Andrew (1971, p. 227) reported that one of the more conspicuous degenerative changes occurring in the nerve cell as a consequence of aging, is the accumulation of fat. Whether the rate at which fat is deposited is more rapid in those individuals whose diets are rich in this nutrient, is not known.

Cardiovascular Function and Blood Pressure in Older Women

A positive association between obesity and blood pressure in young and middle-aged adults has been described in a compilation of life insurance data (Society of Actuaries, 1959). That this relationship is also true in individuals of advanced age is suggested by the results of the Lansing study. Of the eight women exhibiting either systolic and/or diastolic hypertension, all but one were obese. Similar findings were reported by Chope and Dray (1951), who examined 577 older subjects in San Mateo County, California. In that study 32 percent of those examined were hypertensive, and 27 percent of these were obese. Another worker (Goodman, 1955) found that 75 percent of his older, obese subjects had systolic and/or diastolic blood pressures over 150 mm and 90 mm, respectively.

This demonstrated relationship between obesity and high blood pressure among human subjects is frequently used as an argument to encourage weight reduction among older individuals. Evidence from several sources indicates, however, that overweight does not always predispose the individual to hypertension. In a study of 50 extremely obese subjects (Alexander et al., 1962), systolic and diastolic blood pressures of 150 mm and 90 mm or higher, were recorded in one-half of the patients tested, and pressures greater than 200 mm and 120 mm were observed in 10 percent of the group. On the other hand, two-fifths of the remaining individuals were normotensive. Those authors concluded that obesity, even when extreme, will not always result in the development of hypertension. Similarly, among the Lansing subjects, two women who were 20 to 40 percent overweight, had blood pressures of 128/82 and 138/86, respectively.

Elevated blood pressure may be a characteristic of advancing age. Some reports (Lasser and Master, 1959) suggest a steady rise in average systolic and diastolic blood pressures up to the age of 70, with diastolic pressures remaining stable beyond that age. Others (Engel and Malmstrom, 1967) have observed that blood pressures may rise at a relatively moderate rate into advanced age, followed by a later, rapid rise. In contrast to these reports, a sharp rise in blood pressure over the past 24 years was noted in only two Lansing subjects who had normal systolic pressures in 1948 but later exhibited systolic hypertension. Contrary to what might have been anticipated, blood pressure dropped in four of the 12 individuals for whom measurements were available in both years. This could be the result of the increased availability of pharmacologic agents for controlling blood pressure. Another possible explanation for this decline in blood pressure comes from the work of Brown and coworkers (1963). In that study of 100 subjects over 61 years of age, a decline in blood pressure from hypertensive to normotensive levels was frequently associated with the onset or exacerbation of congestive heart failure.

Ventricular hypertrophy may be indicative of serious underlying disease. Hurst and Logue (1970) consider cardiac enlargement to be reliable evidence of heart disease. Furthermore, an enlarged heart is more likely to be associated with heart failure than is a heart of normal size. One clinical syndrome associated with heart failure is edema in the feet, ankles, and lower leg. All but one of the Lansing women with enlarged hearts had edema of the lower extremities. Two other women experiencing fluid retention were overweight or hypertensive. It must be recognized that other factors, completely unrelated to heart disease may contribute to edema; varicose veins, obesity, renal disturbances, phlebitis, steroid administration, or prolonged periods of standing or sitting, may result in this clinical abnormality (Hurst and Logue, 1970).

Seven of the Lansing women were observed to have cardiac hypertrophy. An enlarged heart may be the result of prolonged elevated blood pressure. That body weight may also be a factor in the development of cardiac hypertrophy is suggested by epidemiological evidence. Among the women in Tecumseh, Michigan (Epstein et al., 1965), hypertensive heart disease, as denoted by both elevated blood pressure and ventricular hypertrophy, was significantly associated with relative weight. In the Lansing study, five of the seven women whose hearts were enlarged were both hypertensive and/or overweight. Only one of the subjects who, in 1972, was observed to have cardiac hypertrophy was not either hypertensive or at least 10 percent overweight in 1948. The means by which excessive body weight and elevated blood pressure, in addition to other factors still unknown, may over periods of time be involved in the development of cardiac enlargement, remain to be elucidated.

Dental Status and Nutrient Intake

The dental status of the Lansing women was not related to their nutritional status. Gum lesions associated with gingivitis were seen in only one subject; her serum ascorbic acid level was above 1.0 mg/100 ml. Similarly, Morgan and associates (1955) noted that 12 percent of their aged subjects had gingivitis. Other investigators (Andrews et al., 1969) have reported that sublingual lesions in elderly patients which failed to respond to supplementation with 40-80 mg of ascorbic acid daily, proved, upon histological examination, to be aneurysmal dilations of the venules with no evidence of hemorrhage or localized inflammation.

In like manner, gum recession and retraction were not related to either nutrient intake or age. According to Gorlin and Boyle (1966) that condition is symptomatic of advanced periodontal disease. Marginal periodontal disease is more common in older individuals, among whom it is the primary cause of tooth loss. Patients with a chronic disease, as diabetes mellitus, are especially susceptible to this condition. Nutritional deficiencies can accelerate the loss of dental supporting structures. Other investigators (Ship and Burket, 1965) have reported a generalized mucosal atrophy occurring at the menopause, with pronounced changes in the metabolism and appearance of oral tissues.

Concern is frequently expressed about the influence of dental status of older subjects upon their food choices and consequent nutrient intake. One of the Lansing women claimed she was restricted for dental reasons to ground meat, while two others avoided "tough" meat. All three of these had more than 100 percent of the recommended level of protein. That dentures do not necessarily restrict meat choices is suggested by the observation that both individuals who consumed steak during the dietary survey had complete dentures. Further evidence that loss of teeth does not predispose one to a low nitrogen intake comes from the work of Neill and Phillips (1970). They evaluated masticatory performance and dietary intake in 53 elderly males who had partial or complete dentures, or who were edentulous with no dentures; no differences existed among those with a good, fair, or poor dental state. Although the men with good dentition consumed the most calories, intake of animal protein varied from 63 grams in those with a good dental state to 58 grams in those with a fair or poor dental state. In another study of apparently healthy aged people (Davidson et al., 1962) protein intake, calculated as grams/kg body weight, was inversely correlated with chewing efficiency.

Another dietary problem associated with dentition, is the consumption of fruits and vegetables. Several subjects in the Lansing study admitted avoiding some fruits and vegetables; however, this may be more apparent than real. One woman claimed she restricted her intake of hard foods which required pressure to bite. Despite this, she recorded eating a salad containing raw chopped apple. Evidence that state of dentition may influence ascorbic acid status comes from the study of the San Mateo elderly (Morgan et al., 1955). One-half of the subjects with serum ascorbic acid levels below 0.5 mg/100 ml were edentulous, whereas, complete loss of teeth was noted among only one-third of those with serum levels above 1.1 mg/100 ml. In that the most consistent source of ascorbic acid among the Lansing women was frozen orange juice, the state of dentition should not influence the intake of this nutrient.

Biochemical Measures of Nutritional Status in Older Women

Biochemical parameters have been used frequently to evaluate nutritional status in individuals of all ages. For many nutrients, however, the relationships between nutrient intake and blood or urine parameters are not well understood. In older individuals in whom normal homeostatic mechanisms may be impaired, biochemical measurements are even less reliable indicators of nutriture. Nevertheless, in that other methods of evaluation are not available, biochemical parameters in the Lansing women were evaluated in terms of nutrient intake and clinical findings.

The level of serum protein is frequently used to identify those individuals whose protein intake is inadequate. That this may not be a valid procedure to apply to older people is suggested by the results of this study. Seven of the 20 women examined had serum protein levels which, by ICNND (1963) standards, were less than adequate. However, all seven of these women listed protein intakes which equalled or exceeded the RDA. Although the reported caloric intakes of these women were very low, there was no indication that any of them were losing weight. This observation would suggest that dietary caloric deficiency was not responsible for the implied protein deficiency. Roberts and coworkers (1948) did report, however, that older women consuming less than 1800 kcalories daily were unable to remain in positive nitrogen balance, regardless of the level of protein fed. That further work is required to resolve this question is suggested by the fact that six of the seven subjects with low serum protein levels were consuming 1439 kcalories or less each day. The remaining subject whose total serum protein equalled only 6.1 grams/100 ml, was consuming 1815 kcalories each day and 81 grams protein.

The majority of the Lansing women, however, had serum protein levels which were within the normal ranges established for healthy young individuals. This finding is at variance with those reports which suggest that serum protein concentration, particularly serum albumin concentration, decreases with advancing years. One such study of 194 healthy males between 20 and 89 years of age indicated that serum albumin levels decreased with age, despite adequate dietary protein (Leto et al., 1970). Similarly, Reed and coworkers (1972) reported that the upper limits of albumin concentration determined in 1137 individuals by SMA 12/60 automated screening procedures, declined after the age of 40, with the effect being more pronounced in males.

Serum albumin levels were normal in those individuals with low total serum protein, suggesting that in these women, the globulin fraction decreased. This is in contrast to the findings of Woodford-Williams et al. (1965) who reported that in their older subjects, the albumin concentration declined while the globulin fractions rose. Other workers (Reed et al., 1972) also have noted that the albumin/globulin ratio decreased with age, accompanied by a slight decline in total serum protein.

The aged is one group believed vulnerable to nutritional iron deficiency. This has been stressed by a number of investigators who have reported reductions in hemoglobin, hematocrit, and erythrocyte levels, among healthy older people. Shapleigh and coworkers (1952) came to that conclusion on the basis of a study of 100 healthy individuals over 60 years of age. They observed that the reduction in hematologic characteristics was more pronounced among males, resulting in a narrowing of the normal difference between men and women. Changes in the total number or types of white cells were non-consistent. Similar findings among 140 healthy aged were reported by Renbourn and Ellison (1952), although they concluded that there was no evidence of anemia among their subjects. The infrequency of iron-deficiency anemia among older people was implied by the results of a recent nutritional survey (U.S. Dept. of Health, Education and Welfare, 1972a). Less than five percent of the subjects over 60 years of age had iron-deficiency anemia.

There was no iron-deficiency anemia among the Lansing women, although for several, the mean cell volume (MCV) was slightly above accepted standards. For these three subjects MCV ranged from 98 to 101 cubic microns. Whether this suggests a fundamental change in the erythrocyte in advanced age, or the first indication of a developing megaloblastic anemia, is open to question. In no case did the blood smear indicate the existence of megaloblastic cells. Wintrobe et al. (1974, p. 568), considers an MCV of 95 cubic microns the upper limit of normal, while another hemotalogist (Miale, 1972, p. 644) suggests that an MCV above 100 or 105 cubic microns is indicative of megaloblastosis. In light of the inherent errors of the hematocrit and erythrocyte count, that author concludes that borderline values should be interpreted with caution. Among the women with high MCVs, mean corpuscular hemoglobin concentration remained at normal levels, suggesting that cellular hemoglobin content increased. It should be noted that one subject who has periodically been treated for pernicious anemia, showed no evidence of megaloblastosis. Blood levels of folic acid and vitamin B_{12} were not determined.

That the MCV may increase in old age is suggested by the results of a number of investigators. One such study among 100 elderly males and females indicated a mean corpuscular volume of 97.7 cubic microns (Newman and Gitlow, 1943). Furthermore, other workers (Spriggs and Sladden, 1958) noted that red cell diameters, measured in persons aged one to 90, increased significantly in each decade after the age of 40. Spriggs and Sladden (1958) therefore concluded that the erythrocytes of aged persons with no evidence of megaloblastic anemia, often show moderate degrees of enlargement. In the young, such findings would be considered indicative of a serious disease. It would seem appropriate that aged individuals with borderline values be monitored on a frequent basis to see if their MCV values remain stationary, as might be indicative of normal aging. If blood indices continue to move rapidly away from accepted standards, diagnosis to determine the nature of the megaloblastosis should be instituted.

Vitamin A nutriture is usually assessed on the basis of blood levels, and from the resulting values, conclusions are made about the vitamin intake. That this may not be a valid procedure to use among older people whose nutritional state may be altered by the effects of chronic disease, is suggested by the results of the Lansing study. No significant relationship existed between vitamin A intake, with or without the inclusion of supplements, and serum levels. In like manner, Plough and Bridgforth (1960), analyzing data obtained from eight countries, concluded that dietary vitamin levels did not correlate with either serum vitamin A or carotene.

Two Lansing subjects had serum levels of vitamin A which were below the acceptable range; this, despite reasonable intakes of the vitamin. In these cases the low blood levels may be related to diminished fat absorption, compounded by the regular use of laxatives. Both of these subjects had undergone cholecystectomies in recent years, resulting in a decreased ability to handle dietary fat. The subject with the serum A level of 18 ug/100 ml ingested a supplement providing 10,000 IU of the vitamin daily. Her urinary excretion levels of the B complex factors confirmed her use of a vitamin supplement, but her extremely low body weight (relative weight = 65.4) suggests that she may have had difficulty in assimilating adequate calories; her energy intake was 1173 kcalories.

The other subject with a low serum vitamin A level (< 10 ug/100 ml) had a borderline vitamin A intake to begin with (1940 IU), avoided fat in her diet, and as a consequence of colonic diverticulosis, used a cathartic regularly. In addition, she frequently relied upon an analgesic (Darvon) to relieve abdominal distress following meals. One fact which cannot be overlooked, however, is the relatively high serum carotene level in this subject (163 ug/100 ml). For all subjects, the calculated intakes of vitamin A included both the preformed vitamin plus β carotene. This subject secured about one-half of her vitamin A intake from fortified skim milk, with the other coming from vegetables and canned fruit. She followed a rather circumspect diet, prescribed by her physician for the treatment of diverticulosis; consequently, she is severely limited in her choice of vegetables, but did include carrots when enumerating those which she does consume. Carrots, however, were not included on any of the dietary record days. The relatively high level of β carotene in her serum and the very low vitamin A level suggest that any carotene ingested is not being converted to vitamin A. There is also the possibility that the serum carotene includes non-biologically active pigments. Since insurance statistics (Metropolitan Life Insurance Company, 1972) suggest that over 15 million persons in this country suffer from gall bladder disease, additional work should be done among such older subjects to determine whether there is any abnormality in the metabolism of the fat-soluble vitamins.

Reduced intestinal absorption of the fat-soluble vitamins has been attributed most frequently to a reduction in bile (associated with a cholecystectomy) or the routine use of mineral oil as a cathartic. Increasing evidence suggests there may be other factors, especially among older people, that influence the absorption of these nutrients. This appears to be so, for even when mineral oil is used regularly, the serum levels of the fat-soluble vitamins are not always predictable. This was evident in the report by Gillum and associates (1955a). Two of their subjects who ingested mineral oil every day had the same serum levels of vitamin A (33 and 34 ug/100 ml) but a two-fold difference in carotene levels (122 and 224 ug/100 ml). This finding existed despite high intakes of vitamin A (8290 and 9791 IU as the sum of both preformed retinol and β carotene). Another subject studied by Gillum et al. (1955a), with no apparent gall bladder disease nor known use of mineral oil, had relatively low serum vitamin levels despite very high intakes of both vitamin A and carotene. His serum levels were 54 ug/100 ml of vitamin A and 69 ug/100 ml of carotene while his intakes (including supplements) were 69,350 and 17,288 IU, respectively.

Age is another factor that has been considered to affect serum vitamin levels in that the aging process may result in a decreased absorptive capacity. That this may not be a valid assumption is suggested by the Lansing results, for serum levels of vitamin A were adequate to high in 18 of the 20 women examined. Furthermore, a recent survey of both males and females in the United States (U.S. Dept. of Health, Education and Welfare, 1972a) indicated that mean serum vitamin A levels actually increased with the age of the subjects; less than two percent of the individuals over the age of 59 were classed as deficient. Further evidence to suggest that age, per se, may not reduce the absorption and storage of vitamin A comes from the work of Underwood et al. (1970). They found that liver stores of vitamin A in subjects dying from unnatural causes equalled 126, 96, and 147 ug/g, among those aged 10-19, 20-49, and 50 years of age or above, respectively.

Food choices of the Lansing women had some influence upon their serum vitamin A levels. This was especially apparent among those women whose serum retinol levels were above 60 ug/100 ml. Those women ingested liver, used a high potency supplement, or in one instance consumed spinach several times weekly. The seasonal factor was emphasized in the report of a study of the people in Onondago County, New York (Dibble et al., 1967). Among those subjects the calculated vitamin A intakes were higher in the fall than in the spring, reflecting the increased availability of fresh fruits and green and yellow vegetables. This might also explain the high serum carotene levels among the Lansing subjects since their dietary records were made in the summer and early autumn.

In contrast to serum vitamin A and carotene which were not related to dietary intake, serum ascorbic acid was significantly dependent upon the amount ingested. On the basis of serum vitamin C levels, none of the Lansing subjects were deficient. The differential serum ascorbic acid levels in males and females initially recognized in younger people (Brown et al., 1943) is maintained into old age. That conclusion is based on the report of Morgan and associates (1955) who observed that older women had higher serum vitamin C levels than men, despite lower intakes. In that study, eight percent of the women had serum ascorbic acid levels below 0.3 mg/100 ml, whereas this was not true for any of the Lansing subjects. The latter finding is in agreement with the results of a recent national survey (U.S. Dept. of Health, Education and Welfare, 1972a). According to that report, ascorbic acid status was not a problem among older women.

Some controversy exists regarding the requirements of older people for the B complex vitamins. Results of the Lansing study indicate that both thiamin and riboflavin excretions were related to total dietary intake. The thiamin requirement is frequently expressed in terms of the caloric intake of the individual. Two of the Lansing subjects were consuming only about one-half to two-thirds (0.52 and 0.61 mg) of the RDA for thiamin, but intake was still adequate in that it provided 0.5 mg/1000 calories. Furthermore, urinary thiamin excretion was adequate as based upon the creatinine content of the same sample. Oldham and coworkers (1946), studying thiamin metabolism in healthy women, concluded that an intake of 0.5 mg/1000 calories was probably sufficient to maintain tissue concentrations.

Other investigators have studied thiamin requirements by the measurement of thiamin excretion at various levels of intake. Mickelsen and coworkers (1947) found among their young male subjects that thiamin excretion equalled only 5 ug daily on intakes of 0.61 mg of vitamin daily, but rose to 224 ug on a thiamin intake of 2.00 mg. Excretion levels among the older Lansing women were considerably higher on these levels of intake. Several factors may contribute to this difference. The caloric intake of the Lansing women was relatively low; 9 of the 20 subjects were consuming about 1200 or less kcalories each day. Although the caloric intakes of the young men observed by Mickelsen et al. (1947) were not given, these were most likely higher values. Secondly, the excretions of the young men were determined on 24-hour urine collections, as compared with an overnight fasting sample obtained from the older women. Another factor is the variation among individuals. Mickelsen et al. (1947) pointed out that one "normal" person may excrete twice or even three times as much thiamin as another "normal" person on the same vitamin intake. This characteristic observed in young subjects, also existed among the older individuals aged 63 to 89 years, studied by Rafsky and Newman (1943).

Thiamin excretion levels tended to be high among the Lansing subjects who increased their dietary intakes by the use of supplements or highly fortified cereal products. The individual with the highest urinary thiamin level (3726 ug/gm creatinine) was ingesting daily a multivitamin supplement containing 2.5 mg thiamin, and, in addition, was given a B complex supplement by her physician. Other investigators have confirmed the adequacy of thiamin nutriture among most older people. In a recent Ten-State Nutrition Survey (U.S. Dept. Health, Education and Welfare, 1972a), less than 3 percent of the subjects above the age of 59 had excretion values below 70 ug/gm creatinine, levels indicative of deficient or low intakes. Alternatively, 58 percent of the subjects had excretion levels between 120 and 500 ug/gm creatinine. This proportion compares favorably with the Lansing study in which 11 of the 20 women had urinary thiamin ratios equalling 119 to 495 ug/gm creatinine. In the Ten-State Survey, one-fourth of the older subjects excreted more than 499 ug thiamin/gm creatinine daily.

Although all of the Lansing subjects reflected adequate intakes of thiamin, this was not true for riboflavin. Three subjects had low levels of riboflavin excretion, which in two cases could be attributed to dietary intakes less than or equal to only two-thirds of the RDA. The third subject, excreting 50 ug of riboflavin/gm creatinine, had a mean daily intake of 1.29 mg riboflavin, actually exceeding the RDA. For the most part, urinary riboflavin levels were high, reflecting the consumption of liver and the use of dietary supplements by these women. On a national basis (U.S. Dept. of Health, Education and Welfare, 1972a) the incidence of deficient or low excretory levels of riboflavin among older people, was twice that of thiamin.

The dietary intakes and excretion levels of the B complex vitamins observed in the Lansing women provide no evidence that normal older individuals require higher levels of these nutrients than young adults. Alternatively, these older women excreted higher levels of thiamin on specific intakes than did the young men studied by Mickelsen et al. (1947). These data are not strictly comparable in that only one fasting urine sample was collected from the older women compared to the numerous

24-hour collections followed in the metabolic study. The lowest thiamin excretion noted in the older women, 119 ug/gm creatinine, despite intakes among some subjects which were two-thirds or less of the RDA, was considerably above that of young men ingesting 1.0 mg of thiamin daily--the latter was 65 ug. One argument advanced in justification of higher than normal intakes of vitamins by older individuals is possible aberrations in intermediary metabolism. Whether such problems exist within specific individuals is not known. Shock has, however, described the reduction in kidney function which occurs as a consequence of normal aging. For this reason, the practice of indiscriminate ingestion of high potency supplements which could result in additional stress upon a less efficient kidney, should be seriously questioned.

The judgment about the thiamin and riboflavin nutriture of the Michigan women may be faulty since only one urine sample was collected. There is a possibility that the day-to-day variation in urinary vitamin excretion might be such that the samples secured did not accurately reflect dietary intake. That such variability may exist has been suggested by Hegsted and coworkers (1956) who found considerable variation in riboflavin excretion from day to day in the same subjects. A further concern regarding the urine samples obtained from the Lansing women is the time period of collection. These samples did not represent a 24-hour excretion; they were overnight samples from which the vitamin excretion levels were, on the basis of creatinine content, translated into 24-hour values. The latter concept has been questioned by Vestergaard and Leverett (1958) who observed considerable variation in creatinine excretion among their subjects throughout the 24-hour period. Despite the absence of 24-hour urine collections, it is doubtful whether the conclusions about the thiamin and riboflavin nutriture of these women would be altered by complete urine samples.

Conclusions

Clinical symptoms often associated with nutritional deficiencies, in older women, are not always related to inadequate nutrient intake. Oral lesions as angular stomatitis and atrophy of the filliform and fungiform papillae, appeared to be the result of dentures rather than a deficiency of the B complex vitamins or iron. Hyperkeratosis of the elbows and knees may be caused by a lack of linoleic acid. Pathologic changes in neurologic responses as well as the creasing of the skin seem to be a natural accompaniment of advancing age, unaffected by nutritional status.

Hypertension and overweight acting over a period of the lifespan may influence the development of cardiac hypertrophy. Blood pressure, in women, seems to remain stationary or even decrease from middle to advanced age.

Dental status among older women does not significantly influence nutrient intake; similar foods are consumed by those with natural teeth or dentures.

Biochemical values observed in older women generally parallel those seen in younger individuals. Serum vitamin A and carotene cannot be correlated with dietary intake in older individuals, and may be deficient or low as a result of chronic disease (i.e., diverticulosis or gall bladder insufficiency). Ascorbic acid, thiamin, riboflavin and iron nutriture, would seem to be adequate in most older women. Decreased levels of serum protein reflect changes in the globulin fraction; albumin levels are within normal ranges despite the low globulin levels. Advancing age may result in a gradual increase in red cell volume in subjects with no overt signs of megaloblastic anemia.

CHAPTER VI

PHYSICAL MEASUREMENTS AND GLUCOSE TOLERANCE IN OLDER WOMEN

Introduction

Correlations have been established between the presence of obesity and a variety of diseases. In most cases, such information has come from cross-sectional studies of groups of people of different ages. On such bases, it has been recognized that diabetes mellitus, rheumatoid arthritis, and heart disease, increase in incidence with advancing age. The appearance of some of these conditions has been associated with obesity (Society of Actuaries, 1959). That body weights increase until the seventh decade and then decline has been demonstrated by Montoye et al. (1965). This decline in body weight after age 70 could be the result of the early death of overweight individuals or an actual loss of weight in later life. Even when body weight remains "normal" among older individuals, there is suggestive evidence that these people accumulate body fat at the expense of their lean body mass (Skerjl et al., 1953). A decrease in lean body mass may result in a decline in basal metabolic rate, thus influencing the caloric requirements of the older individual.

Two biochemical parameters which frequently undergo changes in later years are the glucose tolerance curve and serum cholesterol. In that these clinical changes may, in younger individuals, be reversed with a loss of weight, it might be suggested that the accumulation of body fat in aged adults could be responsible for the age changes in glucose tolerance and serum cholesterol.

To further examine the relation between anthropometric measurements, biochemical parameters, and age, the survivors of a sample of 103 women from Lansing, Michigan, previously studied in 1948, were re-examined.

Methods of Procedure

Procedures of sample selection and data collection in 1948 (Chapter II, pp. 92-93) and re-examination in 1972 (Chapter II, pp. 93-95) have been described previously. Anthropometric information recorded in 1948 included body height and weight; however, actual measurements were available for only six of the 20 subjects who participated in the physical evaluation in 1972. The remaining 12 subjects were, in 1948, asked about their current height and weight. Serum cholesterol and glucose tolerance were not measured in 1948.

Anthropometry: In 1972, anthropometric measurements were performed in the Olin Health Center on the morning of testing, immediately prior to lunch (specific measurements recorded may be found in Appendix E-1). Subjects were weighed in their underclothing, without shoes, and weight recorded to the nearest quarter pound. Stature was measured by a cross bar on the scale, and recorded to the nearest eighth inch. Other body measurements (i.e., skeletal widths, skinfold thicknesses, circumferences) were performed according to the procedures outlined by the Committee on Nutritional Anthropometry, National Research Council (Keys et al., 1956). Skeletal widths were determined using a bow caliper and recorded to the nearest mm. A Lange skinfold caliper (pressure at 10 g/mm) was used to measure skinfold thicknesses to the nearest tenth of a mm. Circumference measurements were obtained with a steel tape and recorded to the nearest mm.

Glucose Tolerance: Blood for the determination of fasting glucose and insulin was drawn at the Olin Health Center on the morning of testing, following a 12-hour fast (chemical methods may be found in Table V-1). The glucose load was in the form of a high carbohydrate breakfast (composition of meal may be found in Appendix E-2) which provided 50-60 grams of carbohydrate. It was administered to 19 subjects who submitted to the clinical evaluation. The remaining subject, aged 69, followed a rigid dietary pattern as a result of medication to control myasthenia gravis, and was omitted from this phase of the study.

Postprandial blood samples were taken two hours after the subjects finished eating the meal; glucose and insulin levels were determined.

Serum Cholesterol: Analyses were performed on blood samples obtained following a 12-hour fast (chemical method may be found in Table V-1).

Relative Weight: In that the 20 women examined were, in 1948, aged 40 to 61 years, relative weight for that year was calculated according to height-weight tables compiled by the Society of Actuaries (1959). Since those tables do not include information for individuals above the age of 69, relative weights in 1972 were derived from the height-weight tables of Americans aged 65 to 94 years, published by Master et al. (1960).

Statistical procedures applied to results included analysis of variance and correlation-regression methods.

Results

Anthropometric Measurements

Standing Height.--Loss of body stature has frequently been associated with advancing age. Among the Lansing women standing height when measured in 1972 was significantly related to age ($r = -0.600$, $n = 20$, $p < .01$). Stature decreased by 0.27 inches per year in these individuals who at the last examination ranged in age from 64 to 85 years. When subjects were compared by decade interval (individual values for all anthropometric measurements may be found in Appendix E-3), mean standing height equalled 63.44 inches for those aged 64 to 69 years, 61.99 inches for those aged 70 to 79 years, and 59.16 inches for women aged 80 or above. For the six subjects whose height was actually measured in 1948, changes in body stature over the 24-year interval were calculated. Two subjects aged 81 and 85 years lost 1.35 and 3.88 inches in height. A lesser decline in stature was observed among three subjects aged 71, 75, and 77; for them losses were 0.92, 0.64, and 0.20 inches. One subject, 67 years of age, lost 0.50 inches in height between 1948 and 1972.

Skeletal Widths.--The bone widths of these women are expressed by decade interval in Table VI-1. Mean bi-acromial measurements differed by only one cm between the youngest and oldest subjects. Slight changes in bi-iliac and chest widths were observed among the various age groups. Bi-iliac width equalled 31.34 cm among the women with a mean age of 66.9 years; this value dropped to 28.65 and 28.93 cm, among the women aged 74.4 and 81.8 years. Similarly, the oldest subjects had decreased chest widths as compared with the two younger groups.

Table VI-1.--Mean Anthropometric Measurements According to Age of Twenty Older Women Examined in 1972.

Measurement	60-69 (8)	70-79 (8)	80-85 (4)
Height (in)	63.44 ± 2.04[a]	61.99 ± 2.34	59.16 ± 2.98
Body weight (lbs)	152.50 ± 43.24	160.16 ± 45.22	129.75 ± 19.07
Skeletal widths			
Bi-acromial (cm)	33.95 ± 2.98	33.61 ± 3.02	32.92 ± 2.67
Chest (cm)	27.51 ± 4.07	27.72 ± 3.84	25.80 ± 2.65
Bi-iliac (cm)	31.34 ± 3.57	28.65 ± 3.11	28.93 ± 2.23
Skinfold thicknesses			
Triceps (mm)	27.00 ± 12.00	28.50 ± 11.34	21.92 ± 4.28
Biceps (mm)	15.48 ± 10.87	16.72 ± 8.74	9.92 ± 3.78
Subscapular (mm)	15.25 ± 7.87	14.00 ± 6.57	14.25 ± 1.89
Circumferences			
Upper arm (cm)	29.54 ± 6.80	31.50 ± 6.76	27.38 ± 1.04
Minimum waist (cm)	82.51 ± 15.74	82.88 ± 12.57	78.20 ± 10.49
Maximum hip (cm)	105.95 ± 16.65	108.88 ± 18.36	99.33 ± 7.26
Calf (cm)	33.98 ± 3.94	33.08 ± 11.31	31.20 ± 3.94

[a] Values expressed as mean ± S.D.

Skinfold Thicknesses.--Skinfold thicknesses were determined at various anatomical sites as measures of body fatness. As noted in Table VI-1, subcutaneous fat measurements were lower in the older women. A considerable difference in fatness of the upper arm existed between women below the age of 80 years and those who had reached or surpassed this age. The triceps skinfold was less by about 20 percent in the oldest subjects as compared with the two younger groups, with a greater difference noted in the biceps measurement. This skinfold decreased from 16.72 mm, observed among the women in the eighth decade, to 9.92 mm in those aged 80 to 85 years. None of these differences, however, were statistically significant. In contrast, the degree of subscapular fat as measured in these women remained relatively constant throughout all age groups.

Body Circumferences.--Other measurements sometimes used to obtain an estimate of the degree of body fatness are body circumferences. A similar trend of decreasing fatness among the older women was observed with body circumferences (Table VI-1). The change in the circumference of the upper arm parallels that noted in the triceps and biceps skinfold thicknesses. The minimum waist and maximum hip measurements also tended to be lower in the oldest women; however, none of these differences were significant.

Body Weight.--Body weight is the physical parameter used most commonly in a general assessment of nutritional status. In these older women, body weight was evaluated in terms of the relative degree of fatness of the individual, corrected for height and age (Master et al., 1960). Contrary to what might have been anticipated, only 30 percent (6) of the Lansing subjects were within 10 percent of average weight for their height and age (Table VI-2). In contrast, four of the women were 20-39 percent overweight and five other individuals were more than 40 percent above their average weight. The latter group had body weights of approximately 200 pounds. Alternatively, two of the subjects were markedly underweight, weighing about 35 percent less than would be expected for their

Table VI-2.--Relative Weight Classifications of Twenty Older Women Examined in 1972.

Classification[a]	Percent of Subjects
> 20% Underweight	10% (2)[b]
11-20% Underweight	10% (2)
± 10% Average weight	30% (6)
11-20% Overweight	5% (1)
21-39% Overweight	20% (4)
≥ 40% Overweight	25% (5)

[a]According to Master et al., 1960.

[b]Number of subjects.

height and age. Among the Lansing subjects, body weight was not related to age.

Inasmuch as obesity is a marked public health problem in this and other countries, it is of interest to know what fluctuations in body weight, if any, occur within an individual in later life. In Table VI-3 are tabulated the changes in body weight from those values reported by the subjects in 1948. Seven subjects have lost at least ten pounds of body weight, whereas six individuals have gained at least this amount. One woman, aged 75, lost a total of 75 pounds between 1948 and 1972. Alternatively, the body weights of four subjects weighed in 1972 varied less than five pounds from the value recorded in 1948.

Weight gain or loss was not always related to the age of these older subjects. Those women who had lost at least ten pounds in body weight between 1948 and 1972 included two individuals aged 69, two aged 75, and three others aged 73, 81 and 85, with a mean age of 75.3 years. A weight gain of ten or more pounds was noted in subjects 64, 68, 69, 75, 77 and 81 years of age, with a mean of 72.3 years. Although these values do not differ significantly, it might be pointed out that two of the seven subjects who lost weight were among the oldest women studied. In that average weights (from height-weight tables) are lower for individuals above the age of 70, the relative weight of the subject, aged 81, who

Table VI-3.--Body Weights of Older Women in 1948 and 1972.

Subject Number	Age (yrs)	Body Wt (lbs) 1948	Relative Body Wt[a] 1948	Body Wt (lbs) 1972	Relative Body Wt[b] 1972	Average Wt Change (lbs) 1948-1972
202	81	142.0*	98.6	116.75	100.6	-25.25
206	80	108.0*	73.0	117.00	100.9	+ 9.00
207	66	124.5*	95.8	123.25	90.0	- 1.25
208	73	108.0*	79.4	81.75	65.4	-26.25
212	75	200.0*	138.9	197.00	143.8	- 3.00
213	75	165.0*	111.5	204.25	149.1	+39.25
214	81	143.6	99.7	157.25	122.8	+13.65
218	69	112.0*	78.3	137.50	95.5	+25.50
221	64	158.0*	104.6	178.50	126.6	+20.50
223	71	143.3	107.7	147.75	110.3	+ 4.45
224	68	180.0*	128.6	208.75	145.0	+28.80
225	77	186.1	146.5	201.50	161.2	+15.40
226	85	142.0	108.4	128.00	114.3	-14.00
228	64	136.0*	90.1	128.75	82.0	- 7.25
232	75	250.0*	160.3	174.50	126.4	-75.50
233	67	204.0	150.0	212.75	152.0	+ 8.75
235	69	110.0*	78.6	90.75	66.2	-19.25

Table VI-3.--Continued.

Subject Number	Age (yrs)	Body Wt (lbs) 1948	Relative Body Wt[a] 1948	Body Wt (lbs) 1972	Relative Body Wt[b] 1972	Average Wt Change (lbs) 1948-1972
239	74	105.0*	80.7	109.75	85.1	+ 4.75
241	75	192.3	133.5	170.00	125.0	-22.30
242	69	155.0*	114.0	139.75	99.1	-15.25

[a]According to Society of Actuaries, 1959.

[b]According to Master et al., 1960.

*Not weighed in 1948; estimate of body weight given by subject in 1948.

experienced a weight loss of about 25 pounds between 1948 and 1972, was practically unchanged. Body stature also decreased in the majority of these subjects over the 24-year interval. On the other hand, one-half of the individuals who gained weight over this time interval, were in the youngest age group.

Marked gains or losses in body weight are sometimes associated with a change in health status. Among the Lansing women, no consistent pattern could be discerned. One subject, aged 69, who lost nearly 20 pounds in body weight between 1948 and 1972, has myasthenia gravis, requiring constant medical supervision. Another woman, aged 75, whose body weight also decreased by about 20 pounds, recovered rapidly from major surgery a few years prior to the 1972 study, and works part-time, caring for an invalid. Weight gain, on the other hand, was associated with diagnosed hypertension. Body weight in 1972 was highly correlated ($r = 0.772$, $n = 20$, $p < .01$) with body weight in 1948.

One factor of concern in respect to obesity is the possible relation of nutrient intake to the development of this condition. Neither absolute nor relative body weight in 1972 was related to energy intake in either 1948 or 1972. Furthermore, the amounts of the various macronutrients in the diet were not associated with body mass.

Relationships Between Anthropometric Measurements and Body Weight

One problem in the assessment of nutritional status in older individuals is that a simple physical measurement to identify obesity is still to be defined. For this reason it is of value to examine the relationship between physical measurements and body weight. In Table VI-4 are listed the correlation coefficients indicating the strength of the relationship between the various physical measurements and body weight. Skeletal measures at the bi-acromial and bi-iliac levels would appear to be the least reliable, whereas the chest width showed a higher correlation with body weight. Skinfold thicknesses, especially when measures taken at several sites were added together, were highly related ($r = 0.948$, $n = 20$, $p < .001$) to body weight. For women of this age, however, body circumferences would seem to be of equal or greater value for prediction. Circumferences of the upper arm and maximum hip showed the highest correlations with body weight of any measurements chosen.

Basal Metabolic Rate

Basal metabolic rate, associated with lean body mass, has been known to decrease in older subjects, thereby contributing to the lowering of the energy requirement in later years. Inasmuch as caloric intake was relatively low (mean caloric intake = 1297 kcal) among the Lansing

Table VI-4.--Relation of Anthropometric Measurements to Body Weight of Twenty Older Women Examined in 1972.

	b	r	t
Skeletal widths			
Bi-acromial (cm)	+9.168	+0.638	3.517
Chest (cm)	+9.372	+0.844	6.664
Bi-iliac (cm)	+7.255	+0.657	3.696
Skinfold thicknesses			
Triceps (mm)	+3.431	+0.889	8.240
Biceps (mm)	+4.146	+0.922	10.131
Subscapular (mm)	+4.953	+0.772	5.159
Sum-skinfolds (mm)	+1.617	+0.948	12.676
Circumferences			
Upper arm (cm)	+6.364	+0.964	15.348
Minimum waist (cm)	+2.820	+0.911	9.392
Maximum hip (cm)	+2.429	+0.955	13.322
Calf (cm)	+4.120	+0.766	5.060

b = slope of line

r = correlation coefficient

t = t statistic for regression line
$n = 20$, $p \leq .05$ for all values

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subjects, estimates of the basal metabolic needs of these women were examined. An estimate of the basal metabolic rate of each was calculated according to the surface area equation and Mayo Foundation standards for older individuals reported by Berkson and Boothby (1936). The derived values, based upon height and weight, are tabulated in Table VI-5. For 13 of the women (65%) the calculated basal energy needs were either less than the reported caloric intake or within 100 kcalories of reported intake. The calculated basal requirement was, for seven individuals, 214 to 904 kcalories above the reported energy intake. Body composition is one factor which may influence basal energy needs; a high degree of body fat with reduced lean body mass could lower the energy requirement. Four of the seven subjects who appeared to consume fewer calories than required for basal needs were 40 percent or more above average weight; two others were between 20 and 40 percent above average weight.

Another factor which may influence caloric needs is level of physical activity. Subjects were rated as either relatively active (i.e., those who garden and care for lawns, have part-time employment, provide care for semi-invalid relatives, participate in hospital volunteer work, bicycle in Florida, etc.) or inactive (those who, aside from light housekeeping, spend their time primarily reading or watching television). Although this subjective

Table VI-5.--Basal Metabolic Requirements of Twenty Older Women Examined in 1972.

Subject	Age (yrs)	Relative Weight 1972	BMR[a]	Caloric Intake[b] 1972
202	81	100.6	1187*	1179
206	80	100.9	1183*	969
207	66	90.0	1297	1212
208	73	65.4	1018*	1173
212	75	143.8	1677	1840
213	75	149.1	1606	1190
214	81	122.8	1422	1671
218	69	95.5	1382	1323
221	64	126.6	1584	1728
223	71	110.3	1350	2153
224	68	145.0	1655	1299
225	77	161.2	1510*	606
226	85	114.3	1191*	1367
228	64	82.0	1460	1439
232	75	126.4	1511	1146
233	67	152.0	1654*	1234
235	69	66.2	1115	1815
239	74	85.1	1176	1188
241	75	125.0	1477	1129
242	69	99.1	1372	1327

[a]According to Berkson and Boothby, 1936.
[b]Number of food records available for each subject may be found in Appendix C-2.
*Judged to be relatively inactive.

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judgment was not used in a statistical evaluation, it might be observed that three of the seven subjects with lower caloric intakes than would be anticipated from basal calculations, were inactive. Alternatively, 10 of the 14 women who consumed at least as many kcalories as deemed necessary for basal needs (± 100), were physically active.

Glucose Tolerance

Carbohydrate Challenge.--One characteristic noted frequently among aging populations is a change in glucose tolerance. A modified test of glucose tolerance was performed on the Lansing women, using a breakfast meal containing 50-60 grams of carbohydrate. About one-half of the carbohydrate was supplied by table syrup, which, unfortunately, was not well received by several of the subjects. Four women consumed less than 40 grams of carbohydrate; carbohydrate intakes ranged from 34 to 67 grams. Inasmuch as postprandial glucose and insulin values could be a function of the amount of carbohydrate ingested, this relationship was investigated. Among these women neither postprandial glucose ($r = -0.258$, $n = 19$) nor postprandial insulin levels ($r = 0.192$, $n = 19$) could be predicted from the known amount of carbohydrate ingested. Therefore, all values were included in the following calculations despite existing differences in the carbohydrate challenge.

Fasting and Postprandial Glucose and Insulin.--The fasting and postprandial blood glucose and insulin values are shown in Table VI-6 (mean values by age cohort may be found in Table VI-7). According to accepted standards (Davidsohn and Henry, 1969; Reed et al., 1972) fasting blood glucose levels of 107 to 110 mg/100 ml represent the upper limit of normal. Two of the Lansing women approached these levels with blood values of 103 and 105 mg/100 ml. The individual for whom the fasting level was 159 mg/100 ml was being treated for diabetes mellitus at the time of the study. For the other 16 subjects, fasting blood glucose levels ranged from 65 to 91 mg/100 ml. Fasting glucose values were not related to age.

By known standards (Davidsohn and Henry, 1969), blood glucose levels two hours following a 100 gm glucose challenge should have returned to 110 mg/100 ml, with values between 110 and 120 mg/100 ml indicative of the need for further testing. A postprandial blood glucose value in excess of 120 mg/100 ml is very likely an indication of diabetes (Davidsohn and Henry, 1969). These standards, however, have been derived from clinical evidence obtained with young adults. Whether such standards are also applicable to older individuals is a matter of concern. Postprandial blood glucose levels among the Lansing women ranged from 70 to 163 mg/100 ml. By the usual criteria of judgment, about one-half of the Lansing women showed

Table VI-6.--Serum Measures of Glucose Tolerance of Older Women Examined in 1972.

Subject Number	Age (yrs)	Fasting Glucose uU/ml	Postprandial Glucose* uU/ml	Fasting Insulin uU/ml	Postprandial Insulin* uU/ml
202	81	75	117	11	22
206	80	91	114	14	33
207	66	75	93	13	48
208	73	75	86	13	28
212	75	105	116	18	56
213	75	80	96	13	45
214	81	90	110	13	41
218	69	75	104	13	20
221	64	83	70	15	22
223	71	86	117	15	60
224	68	86	98	16	28
225	77	70	135	17	78
226	85	65	130	14	47
228	64	83	106	12	32
232	75	82	163	18	143
233	67	159	127	20	91

Table VI-6.--Continued.

Table VI-6.--Continued.

Subject Number	Age (yrs)	Fasting Glucose uU/ml	Postprandial Glucose* uU/ml	Fasting Insulin uU/ml	Postprandial Insulin* uU/ml
239	74	103	134	14	26
241	75	76	112	13	23
242	69	85	107	15	46

*Postprandial blood samples taken two hours following ingestion of a high carbohydrate breakfast (50-60 grams carbohydrate). Composition of meal may be found in Appendix E-2.

Table VI-7.--Mean Values of Glucose Tolerance and Cholesterol According to A...
in Older Women Examined in 1972

Table VI-7.--Mean Values of Glucose Tolerance and Cholesterol According to Age in Older Women Examined in 1972.

Serum Measures	60-69 (7)	70-79 (8)	80-85 (4)
Fasting glucose (uU/ml)	92.3 ± 29.8[a]	84.6 ± 12.9	80.2 ± 12.5
Postprandial glucose (uU/ml)	100.7 ± 17.2	119.9 ± 24.2	118.0 ± 8.4
Fasting insulin (uU/ml)	14.8 ± 2.7	15.1 ± 2.2	13.5 ± 0.6
Postprandial insulin (uU/ml)	41.0 ± 24.6	57.4 ± 39.5	35.8 ± 10.8
Cholesterol (mg/100 ml)	247 ± 60[b]	233 ± 26	280 ± 47

[a]Values expressed as mean ± S.D.

[b]n=8

impaired glucose tolerance. Although five of the nine women with above-normal postprandial glucose levels had values only mildly divergent from normal (between 112 and 120 mg/100 ml), five subjects had blood glucose levels above 125 mg/100 ml. One individual (blood glucose = 163 mg/100 ml), on the basis of this test, would appear to be diabetic. For no subject, however, was glucose detected in the urine. In the Lansing women, postprandial blood glucose levels were associated with age ($r = 0.456$, $n = 19$, $p = .05$). Mean postprandial blood glucose values equalled 100.7, 119.9 and 118.0 mg/100 ml among women in the seventh, eighth and ninth decades (Table VI-7).

In contrast to the divergence in fasting glucose levels observed in the Lansing women, fasting insulin values varied only slightly, ranging from 11 to 20 uU/ml. Fasting insulin levels were not related to age. Postprandial insulin measures, on the other hand, ranged from 20 to 143 uU/ml. Postprandial insulin levels were not significantly related to postprandial blood glucose levels; neither did postprandial hormone levels relate to age. Alternatively, a high degree of correlation was observed between fasting and postprandial insulin levels ($r = 0.743$, $n = 19$, $p < .01$).

Glucose Tolerance and Body Weight.--Aberrations in the glucose tolerance curve have been associated with an increase in body fat. For this reason both fasting and

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postprandial blood glucose and insulin levels were examined in respect to relative weight in both 1948 and 1972. The body weight of the Lansing subjects did appear to influence their response to a carbohydrate challenge. Fasting glucose levels were not related to relative body weight in either 1948 or 1972; this was not true, however, for postprandial glucose levels (Table VI-8). That biochemical parameter was significantly related to relative body weight in 1948 ($r = 0.484$, $n = 19$, $p < .05$), although it exhibited no such correlation with relative body weight in 1972. Findings were similar for both fasting and postprandial insulin levels. Relative weight in 1948 was a significant predictor of both fasting and postprandial insulin levels. Alternatively, relative measures of body weight in 1972 were significantly related to fasting insulin levels only, although relative weight in that year did show some association with postprandial insulin response ($p < .07$).

Glucose Tolerance and Nutrient Intake.--Previous intake of carbohydrate has been known to influence the glucose tolerance curve. Dietary intakes of the macronutrients in 1972 were examined in relation to the indices of glucose tolerance. Nutrient intake did not appear to influence the fasting glucose level in the Lansing subjects, as this parameter was not significantly related to dietary intake, although values did tend to be higher in those women with higher intakes of total fat and saturated

Table VI-8.--Factors Relating to Serum Measures of Glucose Tolerance [illegible]
Cholesterol of Older Women [illegible]

Table VI-8.--Factors Relating to Serum Measures of Glucose Tolerance and Cholesterol of Older Women Examined in 1972.

x	y	b	r	t
Relative body weight - 1948	Postprandial glucose	+0.381	+0.484	2.280[a]
Age	Postprandial glucose	+1.525	+0.456	2.113[a]
Relative body weight - 1948	Fasting insulin	+0.066	+0.785	5.226[a]
Relative body weight - 1972	Fasting insulin	+0.055	+0.639	3.424[a]
Relative body weight - 1948	Postprandial insulin	+0.846	+0.728	4.380[a]
Dietary calories - 1948	Serum cholesterol	+0.032	+0.479	2.318[b]
Dietary fat - 1948	Serum cholesterol	+0.650	+0.469	2.251[b]
Dietary carbohydrate - 1948	Serum cholesterol	-1.529	-0.474	2.284[b]
Dietary protein - 1972	Serum cholesterol	+0.265	+0.497	2.430[b]

b = slope of line

r = correlation coefficient

t = t statistic for regression line

[a] $n = 19, p \leq .05$

[b] $n = 20, p \leq .05$

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fat in 1972. Neither postprandial glucose levels, nor fasting or postprandial insulin levels, were related to the 1972 dietary intakes.

Serum Cholesterol Levels

One biochemical parameter frequently associated with aging, obesity, and the development of cardiovascular disease, is serum cholesterol. Among the Lansing women, serum cholesterol values ranged from 184 to 362 mg/100 ml (Table VI-9). Age may not always be a factor influencing serum cholesterol levels in older women, as in these subjects no significant relation was observed; however, serum cholesterol values did tend to be higher among the oldest subjects. Similarly, body weight in either 1948 or 1972 had seemingly no influence on serum cholesterol. Serum cholesterol values have, however, been suggested to be a function of the dietary intake of the individual. This would appear to be true for the Lansing subjects (Table VI-8), as the level of calories ($r = 0.479$, $n = 20$, $p < .05$), fat ($r = 0.469$, $n = 20$, $p < .05$) and carbohydrate ($r = 0.497$, $n = 20$, $p < .05$), consumed in 1948, were positively related to this serum value. The only nutrient in the 1972 diets significantly related to serum cholesterol was protein ($r = -0.474$, $n = 20$, $p < .05$).

Table VI-9.--Serum Cholesterol Levels of Twenty Older Women Examined in 1972.

Subject Number	Age (yrs)	Serum Cholesterol mg/100 ml
202	81	240
206	80	238
207	66	200
208	73	212
212	75	200
213	75	210
214	81	325
218	69	300
221	64	205
223	71	222
224	68	255
225	77	248
226	85	315
228	64	214
232	75	240
233	67	255
235	69	184
239	74	255
241	75	275
242	69	362

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Discussion

Changes in Physical Measurements With Age

Changes in body measurements are known characteristics associated with the aging process. Among the Lansing women only one physical measurement changed significantly with advancing years; standing height decreased as a function of age. A loss of stature by aging individuals has been reported by other investigators. Data from 855 cadavers examined by Trotter and Gleser (1951) revealed significantly lower stature among the older individuals; this finding was not associated with a variance in the length of the long bones (i.e., femur, tibia). Although in that study average stature and lengths of the individual bones measured were relatively constant up to the age of 79, a large decline in both stature (8.2 cm) and femur length (1.5 cm) occurred in females between the eighth and ninth decades. In the Lansing subjects, mean height was lower by 7.1 cm for this age interval.

Other workers studying living populations have reported similar trends. Wessel et al. (1963), in a study of women from 20 to 69 years of age, found differences in stature among the various age groups which could be attributed to changes in trunk measurements, suggesting vertebral and disc changes or osteoporotic degeneration. Other investigators (Ohlson et al., 1956) have pointed out the wide variation among individuals in loss of stature. That study of 12 women between the ages of 48 and 77 years was continued over a period of a decade. Two individuals in the group exhibited no change in height, with losses among the others varying from 0.5 to 2.0 cm. In the Lansing study a greater variation, with losses of 0.51 to 9.86 cm, was observed among the six Lansing women measured in both 1948 and 1972. The greatest loss occurred in the subject who, in 1972, was the shortest in stature and 85 years of age. In this study, however, the time interval equalled 24 years.

Skeletal widths or measures of the body frame also tend to change with the aging process in women, although the magnitude and direction of such changes would appear to depend upon the particular population studied. Wessel et al. (1963) observed a continuing decrease in bi-acromial width between age 20 and 69, whereas the bi-iliac width increased with age in their subjects. The women aged 60 to 69 had narrower shoulders, broader hips, and wider chests, than did the younger subjects. In contrast, other investigators (Skerlj et al., 1953) who examined 84 women ranging from 18 to 67 years of age suggested that the younger women tended to have broad frames, whereas the older groups were narrow in build. According to that author, the more narrow build of the oldest subjects could reflect a diminished availability of nutrients during

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their growth period. In the Lansing study, bi-acromial widths decreased slightly with age, with the narrowest shoulder width (29.4 cm) being observed in the oldest subject, aged 85. Bi-iliac widths also tended to be lower in the older age groups, equalling 31.34 cm among those aged 60-69 compared with a value of 28.93 in those aged 80 or above. Another report combining data obtained from both Michigan and Minnesota women (Ohlson et al., 1956) showed a decrease in bi-iliac width from 31.1 cm in those aged 60 to 69 to 30.6 and 30.9 cm in those aged 70 to 79 and 80 to 89, respectively. Generally, the skeletal widths of the Lansing women fell within the range of values reported by other investigators.

Another factor in addition to age which has been shown to influence skeletal structure is body weight. Ohlson et al. (1956) reported that bi-iliac width increased from 26.7 cm in underweight women to 28.3 and 33.0 cm in average-weight and overweight women. In the Lansing study, mean chest widths tended to be greater (2.0-2.5 cm) than the values reported by Ohlson et al. (1956) for women of similar age; however, five of the Lansing women were more than 40 percent above their average weight.

Other body measurements known to change with advancing age are skinfold thicknesses. All skinfolds measured were lowest among the Lansing subjects aged 80 or above. When the Lansing values were compared with those suggested by other investigators for women of similar age, differences were observed in respect to the particular skinfold site. The triceps measurement in the Lansing subjects aged 64 to 77 years was similar to that found by Young et al. (1963) in subjects between the ages of 60 and 69. These values were 27.00 and 28.50 mm in the Lansing women aged 64 to 69 and 70-79, respectively, compared with 28.0 mm, reported by Young and coworkers (1963).

In contrast to the triceps skinfold found to be similar in the Lansing and New York women (Young et al., 1963), the subscapular skinfold thickness differed markedly in these two subject groups. The subscapular value equalled 22.55 mm in the women studied by Young and coworkers (1963), whereas this measurement was 14.00 to 15.25 mm among the Lansing women of similar age. Alternatively, other investigators (Wessel et al., 1963) reported a scapular skinfold thickness of 14.0 mm in their subjects between the ages of 65 and 69, a finding in close agreement with the Lansing study. Those investigators reported that all skinfold thicknesses decreased beyond the age of 60, with marked changes in the scapula.

The reported decline in skinfold thicknesses in women after the age of 60 suggests that as the degree of fatness in the female body changes, so does its pattern of distribution. As was concluded by Young et al. (1963a), fat in the older woman is deposited on the chest, sides, waist and back, with a lesser amount on the extremities. Among those subjects the measurement showing the highest correlation with body density (determined by underwater weighing) was abdominal circumference at the level of the umbilicus. Similarly, in the Lansing study, maximum hip girth was closely correlated with body weight. The high correlation of the abdominal measure to body weight would seem to confirm the suggestion of Skerjl et al. (1953) that the fat accumulated by the female body during later maturity is inner fat. Inasmuch as the total weight of those subjects did not change, the addition of inner fat seemed to be occurring at the expense of other tissues.

Problems in Assessing Body Fatness in Older People

The prediction of body fatness in older people by the measurement of skinfold thicknesses presents many difficulties. One such problem is the concern that skinfold measurements may, in older age groups, yield less reliable values. Brozek and Kinzey (1960) found upon studying skinfold compressibility in males from 20 to 69 years, that the degree to which skinfolds are compressed by a given pressure, decreases with age. This decrease in compressibility could effectively exaggerate the reported trend toward increased subcutaneous fat measurements in older subjects. The reliability of the skinfold thickness measurement is complicated further by the fact that this change in compressibility is not uniform over the body surface. Those authors (Brozek and Kinzey, 1960) noted significant changes in the measures at the scapula and waist. In the Lansing study, the author noted a tautness in the skin at the scapula level, making it more difficult to lift the skinfold. This could have been the result of tenseness on the part of the subject. For the 20 Lansing women, the scapular skinfold was less highly correlated with body weight than were the arm skinfolds. Another problem relating to the accuracy of skinfold measurements may result from rapid weight loss. Edwards (1950) noted a decrease in tissue elasticity among his patients who had lost in excess of 10 to 15 pounds.

Another consideration in the use of skinfold thicknesses to estimate the degree of body fat is the selection of the particular skinfold measurements to be used. Garn (1955) suggests that relative fat patterning is an individual characteristic. This pattern would appear to possess some degree of permanence over time, as men who lost as much as 28 kg of body weight still maintained their former pattern. According to Seltzer and Mayer (1967) the triceps skinfold would seem to be a more accurate measurement for the estimation of body fat than the scapula measurement. They observed an absence of marked fat depots at the subscapular region, whereas the triceps showed excessive adipose tissue. In their series of obese women, the triceps fold was greater than the subscapular fold in 83 percent of the subjects. This trend was also apparent in the Lansing study, as for 19 of the 20 subjects, the triceps measure exceeded that of the scapula.

The original intention of the author was to calculate the percent body fat of each subject using measured skinfold thicknesses. Durnin and Rahaman (1967) have derived a formula for this purpose which utilizes skinfold thicknesses measured at four sites: the triceps, biceps, scapula and waist. This formula was derived, however, from measurements on young adults. Because of objections from several subjects, the waist skinfold measurement was dropped from the protocol. Unfortunately, a satisfactory procedure for determining the percent of body fat from the available measurements could not be found. Such equations as have been derived are based upon measurements of adolescent females or adult women aged 30 to 50 years. An equation reported by Seltzer and Mayer (1967), developed from the data of Steinkamp et al. (1965), utilizes the triceps skinfold for the calculation of body fat; however, spurious values resulted from this method. One subject in the Lansing study who weighed 197 pounds (relative weight equalled 143.8), had, according to this calculation, approximately 27 percent fat in her body. This value is less than the average of 44.6 percent, reported by Young c

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et al. (1963) as the level of body fat in her normal-weight subjects aged 60-70 years. This would suggest that methodology based upon younger females is not necessarily applicable to aged individuals. As noted by Wessel et al. (1963) all skinfold measures decrease after the age of 60 years. The unreliability of skinfold thicknesses among older subjects would suggest that increased attention be directed toward circumference measurements as indicators of body fat. Among the older women studied by Young et al. (1963) the measurement showing the highest correlation with body density was the abdominal circumference at the level of the umbilicus (r = 0.717). Similarly, in the Lansing women, the maximum hip circumference showed a high correlation (r = 0.954) with body weight. Further work is needed to define the relationships between envelope measurements and degree of body fat in older subjects.

Changes in Body Weight in Older People

One striking observation in the Lansing study was the large number of subjects who were markedly overweight. Other evidence suggests a decrease in body weight among individuals of advanced age. Montoye and associates (1965) observed a decrease in body weight after the age of 60 among the residents of Tecumseh, Michigan. Similarly, Master and coworkers (1960) found, upon examining data obtained from 2,694 women between 65 and 94 years of age, that average weights decreased with advancing years. This was not always true among the Lansing women. Five of the eight women aged 70 to 79 were at least 20 percent above average weight, with three of the five at least 40 percent above that value.

Despite the association between degree of overweight and mortality as established by life insurance statistics, overweight persons can live to an advanced age. Among 200 patients over 65 years of age who had been referred to an outpatient nutrition clinic (Skillman et al., 1960), 68 percent were more than 10 percent above their "desirable" weight (weight standards used were not given). Eight percent of those examined were more than 10 percent underweight, whereas the remainder were of normal weight. It should be noted, however, that the subjects in that study had been referred to a nutrition clinic and were therefore not representative of the general population. Further evidence of overweight among the aged comes from the work of Pomeranze (1957) who pointed out that 19 percent of 120 patients over 75 years of age were, on the basis of skinfold thicknesses, considered obese. As concluded by that author, this does not mean that all obese persons live to old age, but does indicate that obesity does not necessarily preclude longevity. The majority of those obese subjects indicated that they had been obese since early childhood; to them, excess weight had been synonymous with good health. Two women had lost and regained as much as 20 pounds on at least two occasions during their lifetime.

The survival of overweight individuals is confirmed by the Lansing study in which several women were significantly overweight since middle age. These subjects were living independently and, except for one, enjoyed reasonably good health. The woman, aged 69, with the highest body weight, was diabetic. Another individual had severe arthritis which limited her activity. The other obese subjects were, however, relatively active. Two individuals, aged 75 years, and more than 20 percent overweight, worked part-time to supplement their income; one did laundry and ironing for her neighbors and the other cared for an invalid several days each week. Another obese woman, weighing 197 pounds, had a large lawn and flower garden, for which she was responsible. As suggested by Pomeranze (1957), the nutritional inadequacies which frequently result from repeated attempts at weight reduction may be more harmful than a static obesity.

Although the majority of the obese Lansing subjects had been overweight throughout adulthood, this is not always the case among older people. Hollifield et al. (1959) found that almost one-half of their female subjects who were overweight gained this weight after reaching the age of 65. Three of the Lansing women above the age of 65 had gained at least 20 pounds since the 1948 survey. Whether this change in weight was gradual or rapid in onset, is not known. Considerable weight loss has also been associated with advancing age. Hollifield et al. (1959) noted that one-third of their normal-weight subjects had been obese at some earlier age. Five of the Lansing women lost at least 20 pounds or more between 1948 and 1972.

The control of body weight over long periods of time is an area requiring further study. Of considerable interest are the seven Lansing women whose body weight changed by less than 10 pounds between 1948 and 1972. Whether this relative constancy in body weight was the result of internal mechanisms, conscious efforts at weight control, or a combination of both, is not known.

Problems in Estimating Energy Balance in Older People

That the caloric needs of the individual decrease with advancing age has been well established. This decline relates to changes in metabolic rate, as well as differences in physical activity (McGandy et al., 1966). Twelve of the 20 Lansing subjects appeared to be consuming sufficient energy to meet both metabolic and activity requirements, as total caloric intake was greater than or approximately equal to calculated basal needs. Three of the twelve were relatively inactive; for them, the total energy requirement may be very close to basal needs.

In contrast, for seven individuals, a discrepancy existed ranging from 214 to 904 kcalories, between reported caloric intakes and calculated basal needs. This difference could relate to several factors. The most obvious is that these women may have underestimated the quantities of food consumed. One individual reported a mean caloric intake of 606 kcalories; the value reported for her in 1948 was 812 kcalories. Her relative weight was 161.2, although she gained only 15.4 pounds since 1948 when she was last seen. Inasmuch as she was markedly limited in movement because of severe arthritis, her total energy requirement was very likely approximately equal to the basal requirement.

A second factor which might explain the difference between reported and calculated energy needs is error in the calculation of the basal requirement. When using body weight as an estimate of mass, one concern is the actual amount of lean body tissue in relation to body fat. The relative decrease in vital tissue and accumulation of internal fat as a consequence of aging, has been mentioned previously. Standard equations have been developed with subjects of average weight; yet, most of the evidence suggests that basal metabolic rate is related more closely to lean body mass. Actually, when calculated on that basis, the difference in basal metabolic needs for men and women (at least 20 years of age) or young and old adults,

disappears (Shock et al., 1963). Whether the relatively high basal requirements derived for those individuals above average weight are valid, is still to be established.

The question of basal metabolic needs in aged females was studied extensively by Benedict (1935). That investigator concluded that the average value for total heat production in women aged 66 or above, was approximately 1000 kcalories, regardless of age and irrespective of body weight. Furthermore, the predominant component of excess weight is fat, which according to that author (Benedict, 1935), automatically lowers heat production per unit of body weight. This reduction in heat production may be the result of various factors--one of these is the lower heat production of adipose tissue, another is the greater insulating effect of the subcutaneous adipose tissue, thus reducing the need for extra heat production. If it were assumed that the basal energy needs of the Lansing subjects were approximately 1000 kcalories, all but one would appear to be in energy balance; recorded energy intakes would reasonably approximate basal caloric needs.

Occasionally, in other studies, older women have reported extremely low caloric intakes. In a recent national survey (U.S. Dept. of Health, Education and Welfare, 1972b), 9.2 percent of the women above the age of 60 were reported to have less than 750 kcalories daily. Although the basal metabolic rate of the Lansing subject who reported a daily intake of 606 kcalories (relative weight = 161.2) was not determined, her energy needs may not have been any greater than that low value. This is suggested by a report from another investigator (Horton, 1975, personal communication) who observed a basal metabolic rate of less than 600 kcalories in one of his subjects. That woman, like the Lansing subject, was severely obese. This would suggest that basal energy needs of the aged obese may be significantly lower than would be anticipated by standards now in use.

Evaluation of Glucose Tolerance in Older People

The results obtained from the glucose tolerance study of the Lansing subjects have many limitations. Initially, the carbohydrate challenge (50 grams) given to the subjects was considerably less than the 100 gram level for which normal blood values have been standardized. The 100 gram challenge was rejected in that information regarding the current health status of these older women was not available prior to the test, increasing the risk of this examination. Another factor to be considered is the form in which the carbohydrate is administered. The usual method employs a glucose solution which is rapidly absorbed. In that the subjects were to have an active morning including a physical examination, x-rays, etc., it was decided that they should have some type of meal.

Inasmuch as 100 grams of carbohydrate represents a meal of considerable bulk, a point of concern was the ability of the subjects to consume this amount of food. On this basis, a meal was selected which contained 50-60 grams of carbohydrate, with 30 grams to be provided by two tablespoons of a sugar syrup. A fact not anticipated was the subjects' avoidance of the syrup. Four women consumed only the French toast, leaving the syrup on the plate. Consequently, carbohydrate intake among all subjects varied from 34 to 67 grams. Furthermore, the carbohydrate consumed was not pure glucose, but contained fructose as well.

Emotional stress is known to adversely influence the glucose tolerance curve. This could be a factor in the blood glucose levels observed in the Lansing subjects. Many of these women were visibly nervous with one so distraught that she experienced a slight intestinal disturbance. Uneasiness regarding the testing program was especially common among those coming to the health center on the morning of the test. Two women were concerned about their husbands who were in poor health, being alone at home. In addition, the women were allowed coffee with their breakfast. Caffeine may influence blood sugar values. With these limitations in mind, the glucose tolerance patterns were examined in relation to age, nutrient intake, and body weight.

Many investigators have described the effect of age upon the ability of the organism to handle a glucose load. This decrease in glucose tolerance appears to be gradual and progressive throughout adult life (Andres, 1971). According to Gottfried and coworkers (1961), studying 49 supposedly healthy subjects over 70 years of age, carbohydrate metabolism is impaired in the majority of older people. In that study, all individuals displayed a "minimum to moderate" diabetic curve following a glucose challenge. The criteria for diagnosis of this diabetic tendency were not given. Similarly, Metz et al. (1966) reported that 13 of their 18 elderly subjects given 100 grams of glucose by mouth had blood glucose levels above 130 mg/100 ml at the end of the two-hour period. Only five of the 19 Lansing subjects had postprandial glucose levels above 120 mg/100 ml. One explanation for this reduced incidence of abnormality could be the degree of carbohydrate challenge (50-60 versus 100 grams).

Examination of the various biochemical measures in the study of glucose tolerance would suggest that the fasting blood glucose level is the least affected by age. This evidence comes from Burch and O'Meallie (1967) who studied 77 healthy subjects over 65 years of age. Only four of those individuals had fasting blood glucose levels above 120 mg/100 ml. Those findings closely parallel the Lansing results, in that fasting blood glucose was elevated in only one subject. She had a fasting blood glucose level of 159 mg/100 ml and was being treated for diabetes mellitus at the time of the study. Further evidence that fasting glucose levels do not change as rapidly as other measurements comes from the work of Reed and associates (1972). Screening 1,419 clinically normal adults indicated that fasting glucose levels equalled 93 mg/100 ml in women aged 50 years and over, as compared with 86 mg/100 ml, observed in those aged 20 to 49 years.

The most common abnormality of glucose tolerance observed in older subjects is an elevated two-hour post-prandial blood glucose level. This was true for one-third of the older subjects studied by Burch and O'Meallie (1966). In the Lansing study abnormally high postprandial glucose levels (above 120 mg/100 ml) were observed in one-fourth of the women examined. Contrary to what might have been anticipated, the five individuals with the abnormally high postprandial glucose levels were not those who consumed the highest levels of carbohydrate. Three subjects with postprandial glucose levels of 127, 130 and 135 mg/100 ml ingested 40, 41 and 47 grams of carbohydrate, respectively. Another woman whose postprandial glucose level equalled 134 mg/100 ml consumed only 34 grams of the test carbohydrate. The individual with the highest post-prandial glucose level (163 mg/100 ml), however, did ingest 67 grams of carbohydrate. Alternatively, seven other women who had approximately 60 grams of carbohydrate for breakfast had postprandial glucose levels between 70 and 117 mg/100 ml.

A comparison of the two-hour postprandial glucose levels of the Lansing subjects with those obtained by other investigators using a 50 gram test, revealed some similarities. Among 345 English subjects ranging from 20 to 79 years of age (Diabetes Survey Working Party, 1963) mean blood glucose in the oldest subjects, two hours following the ingestion of 50 grams glucose, equalled 119 mg/100 ml, comparable to that found among the Lansing women aged 70 to 85 years (values equalled 119.9 and 118.0 mg/100 ml in subjects aged 70-79 and 80-85 years). The increase in the two-hour blood glucose level among the English subjects was approximately 3.5 mg/100 ml for each succeeding age decade. The effect of age on the glucose level at 120 minutes is less obvious when the glucose load is relatively small. Inasmuch as mean postprandial blood glucose levels of older subjects commonly approach or exceed the upper limits of normality and might therefore be classed as diabetic, another author (Andres, 1971) suggests that standards be adjusted to allow for age-related changes in response. Such a scheme would judge an individual's performance in relation to that of his age cohort rather than to those of younger individuals.

Blood insulin levels, both fasting and postprandial, have also been reported to change as a function of age. This suggestion comes from the work of Chlouversakis et al. (1967) who observed a rise in fasting insulin levels from 7.3 uU/ml among subjects aged 20 to 39, to 10.8 and 16.1 uU/ml in the groups aged 40-59 and 60 years and above, respectively. The fasting insulin value observed among those individuals above the age of 60 (16.1 uU/ml is comparable to the values of 14.8, 15.1, and 13.5 uU/ml found among the Lansing women in various age groups. Alternatively Metz et al. (1966) reported a range of 7 to 40 uU/ml in fasting insulin among his subjects aged 67 to 87 years, whereas in the Lansing subjects this value ranged from 11 to 20 uU/ml.

The postprandial serum insulin levels observed in the Lansing women were compared with the report of Chlouversakis et al. (1967) who administered a 50 gram glucose challenge to 21 subjects above the age of 60. Mean postprandial insulin levels equalled 29.9 uU/ml for those individuals who had previously been screened for normal glucose tolerance. The range of values observed in that study was not given, nor was there any statistical evaluation. Mean postprandial insulin levels tended to be higher among the Lansing subjects, equalling 41.0, 57.4, and 35.8 uU/ml in those aged 60 to 69, 70-79, and 80-85 years of age, respectively. The Lansing sample, however, included individuals displaying abnormal glucose tolerance.

There may be a difference in insulin levels of older men and women. This suggestion also comes from the work of Chlouversakis et al. (1967) who reported that males with normal glucose tolerance had a mean postprandial insulin level of 31.2 uU/ml as compared with a value of 24.5 uU/ml, observed in normal females. This pattern was reversed, however, among borderline diabetics; the post-prandial insulin level for males was 36.4 uU/ml, whereas that for females was 48.4. The two highest post-prandial insulin levels observed in the Lansing subjects were noted in one individual being treated for diabetes mellitus and in another who demonstrated an elevated post-prandial glucose level (163 mg/100 ml). The latter individual would seem to require further testing to ascertain the presence of diabetes.

In the Lansing study, parameters of glucose tolerance were directly related to body weight. That an excessive accumulation of body fat may result in impaired carbohydrate metabolism has been suggested by various investigators. West and Kalbfleisch (1966), studying maturity-onset diabetes in various countries, found the single common denominator to be the degree of body fat. Similarly, Kalkhoff and Ferrou (1971) pointed out the aberrations of glucose tolerance and exaggerated insulin responses observed among obese patients as compared to muscular overweight men.

Frequently, abnormalities in carbohydrate metabolism observed in older people are reversible with weight loss. This suggestion comes from the report of Goodman (1955) who observed significant improvement in elderly diabetics upon successful weight reduction. In contrast to this finding, Brandt (1960) could find no correlation between impaired glucose tolerance and weight gain in his older subjects. At this time, the effect of long-term overweight on carbohydrate metabolism is not completely understood. The Lansing subject who exhibited a postprandial glucose level of 163 mg/100 ml and accompanying insulin level of 143 uU/ml had, in 1948, a relative weight of 160.3. Although she lost 75 pounds between 1948 and 1972, her glucose response pattern was abnormal. Whether obesity-induced aberrations in carbohydrate metabolism are always reversible is a question requiring further study.

Little is known regarding the long-term influences of dietary habits upon blood levels of glucose and insulin. That dietary intake on days immediately preceding testing can influence glucose tolerance has been documented. Conn (1940) stressed the need for adequate dietary carbohydrate (300 grams) prior to the study of glucose tolerance, to insure the presence of adequate liver glycogen stores. Conversely, diets high in protein and fat on the days prior to testing may result in an abnormal response. None of the Lansing women consumed 300 grams of carbohydrate daily, according to the dietary records collected in 1972. This dietary lack of carbohydrate could be a contributing factor in the abnormal glucose tolerance patterns observed.

In older subjects, however, postprandial glucose levels may not always relate to the previous dietary intake. This suggestion comes from the report of Gillum et al. (1955b) who examined 430 subjects over 50 years of age. Postprandial glucose levels in those individuals following a high carbohydrate meal (exact glucose content not given) were unrelated to previous intakes of carbohydrate and protein. Among those women, however, blood glucose values tended to be higher when total fat intake was above 80 grams daily. In the Lansing study, fasting blood glucose showed some positive relation to dietary fat, although this was not true for postprandial values.

Serum Cholesterol Levels in Older People

In males, serum cholesterol values have frequently been related to the incidence of coronary attack (Keys et al., 1971). Alternatively, high levels of serum cholesterol among women do not always predispose one to an early death from cardiovascular disabilities. This is suggested by the fact that two of the Lansing subjects above the age of 80, had serum cholesterol levels above

300 mg/100 ml. The general range of cholesterol values among the Lansing women (184 to 362 mg/100 ml) was similar to those observed by other workers. Women over 50 years of age examined in San Mateo County, California (Gillum et al., 1955) had serum cholesterol values ranging from 140 to 438 mg/100 ml, with a mean of 270 mg/100 ml. Among midwestern subjects (Swanson et al., 1955) mean serum cholesterol levels were 250 and 265 mg/100 ml for two groups of subjects aged 60 to 69 years, and 251 mg/100 ml in both groups aged 70 to 79 years. In that study, serum cholesterol values declined progressively between the ages of 50 and 80 years. A different response was observed in the Lansing women in that mean values equalled 247, 233 and 280 mg/100 ml, in the seventh, eighth and ninth decades, respectively. A recent report (Reed et al., 1972) indicates that the normal range of serum cholesterol values in women above the age of 60 is 182 to 353 mg/100 ml. In that survey, the mean cholesterol value rose from 200 mg/100 ml among women aged 20 to 29, to 250 mg/100 ml among those aged 60 or above.

Serum cholesterol levels in women do not seem to be related to body weight. Gillum et al. (1955) observed no association between serum cholesterol values and body weight among their subjects. This finding was confirmed by the Lansing results in which no relation was found between body weight in either 1948 or 1972 and serum cholesterol. Serum cholesterol values may be influenced by past and present dietary intake, although conclusions have differed in various studies. Dietary protein and fat had little influence upon the cholesterol levels of the midwestern women observed by Swanson et al. (1955). In contrast to this finding, Gillum et al. (1955) noted higher serum cholesterol levels among those women with increased intakes of fat. This observation was confirmed among the Lansing women, for whom fat intake in 1948 was positively associated with 1972 cholesterol levels. In the San Mateo women (Gillum et al., 1955), a slight but positive correlation existed between dietary protein and serum cholesterol.

The relationships between dietary intake in 1948 and serum cholesterol levels in 1972 which were observed in the Lansing subjects deserve examination in future studies. The number of individuals was small; however, these results suggest that in women, serum cholesterol levels may be established in middle age or before, and do not respond to dietary changes thereafter. Whether this might also be true in men has great implications in regard to the treatment of hypercholesteremia.

Conclusions

Normal aging is accompanied by a loss in stature, whereas skeletal widths do not appear to be influenced by advancing age. Fat deposition on the extremities would seem to decrease in advanced age, as evidenced by decreased skinfold thicknesses on the arm. In older women fat may be deposited on the trunk, as circumference measurements were highly correlated with body weight.

Either weight gain or weight loss may occur from middle to advanced age; however, overweight, in these older women, did not necessarily predispose to an early death.

Of all the measures of glucose tolerance, fasting glucose levels are least affected by advancing age. Postprandial glucose and both fasting and postprandial insulin levels are, in older women, positively influenced by body weight. Among older women, serum cholesterol does not appear to be related to age or body weight; this value may relate to previous dietary intake of calories, fat, and carbohydrate.

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APPENDICES

APPENDIX A

INSTRUMENTS AND SUPPLEMENTARY DATA
FOR CHAPTER II

APPENDIX A

INSTRUMENTS AND SUPPLEMENTARY DATA FOR CHAPTER II

Appendix A-1

Letter of Introduction to Survey Subjects

Last fall, Miss Eleanor Schlenker talked with you about a health and nutrition survey. This is a follow-up of a study in which you participated in the 1950's. At that time, we secured records of the food you ate; you were given a physical examination; and a variety of measurements, such as your height and weight were made. These we would like to repeat to determine whether there is any relationship between the kind of diet you followed twenty years ago and your present health. We hope that, as a result of this study, we will have factual information which will indicate the kinds of foods younger people should eat to ensure good health throughout their lives. The importance of your cooperation in such an endeavor needs no elaboration.

Sometime within the next few days, Miss Schlenker will visit you to explain this study in greater detail and will answer any questions you have. At that time, she will arrange for the record of your food intake and a few other items of needed information.

We sincerely appreciate the interest you have shown in this project by your original contribution and now by your willingness to participate in the follow-up study. As a result of your participation in this study the young people in your family may be better able to choose those foods and living habits which should make it possible for them to enjoy a healthy and exuberant future.

Should you wish any further information about the study prior to Miss Schlenker's visit, please call the Department of Food Science and Human Nutrition at 355-7730.

Thank you for your assistance in this study.

Sincerely yours,

Dr. Dena Cederquist
Professor of Nutrition

DC/ps

Appendix A-2

Dietary Interview Schedule
For Survey Subjects

Name: ______________________ Subject Number: __________

Address: ______________________ Date: ______________________

______________________ Time: ______________________

Phone: ______________________

NUTRITIONAL STATUS OF OLDER WOMEN

We are interested in the kinds of foods that you usually eat. If your food choices have changed in the last few years, we would like to know in what way. Would you tell me what foods you have eaten in the past twenty-four hours?

Suppose we begin with your most recent meal.

FOOD	AMOUNT	COMMENT

Name: ______________________ Subject Number: __________

-2-

FOOD	AMOUNT	COMMENT

Name: ______________________ Subject Number: __________

-3-

1. Was this a usual day? ______________________________

2. Are there any foods that you never eat? Why don't you eat them?

____

____

____

3. Are there any foods that you used to eat that you don't eat anymore? Why don't you eat them?

____

____

____

____

4. Are there any foods that you eat now that you didn't eat before? Why did you begin to eat them?

____

____

____

5. Are there any foods that are difficult for you to eat? Why?

____

____

6. Do you prepare your meals? __________________________

Name: ______________________ Subject Number: __________

-4-

7. What do you think about when you choose foods for your meals? Why did you have ____________ for dinner yesterday?

____

____

____

8. Do you usually eat breakfast as soon as you get up in the morning? Do you eat with someone at breakfast? When do you usually eat again following breakfast? Do you eat with someone? Continue through their daily pattern.

____

____

____

____

____

9. How many meals do you eat with someone each week? With whom do you eat?

____

____

____

10. How many meals do you eat alone each week? __________

____

Name: ________________________ Subject Number: ___________

-5-

11. How many meals per week do you usually eat outside your home? With whom do you eat?

____

____

____

12. Which day or days of the week do you usually eat out?

____

____

13. Do you have prepared meals brought to you? ___________

____

14. Do you shop for your food? ____________________________

____

15. Is there someone who helps you with your shopping?

____

16. How frequently do you shop for food? __________________

____

17. At what store do you buy most of your food? __________

____

18. Is there a particular reason why you shop there?

____

____

Name: ______________________ Subject Number: __________

-6-

19. Is this store within walking distance of your home?

____

20. Is any food brought into your home for you? __________

____

____

21. Do you have routemen who stop at your door to sell food to you?

____

____

22. When you went shopping for groceries the last time, what did you buy?

____

____

____

____

23. What facilities do you have for storing groceries?

____

____

24. Do you use any frozen foods? If so, what kinds of foods?

____

____

____

Name: ______________________ Subject Number: __________

25. What facilities do you have for storing frozen food?

____

26. Do you use any frozen prepared dinners like TV dinners?

____

____

____

27. Are there any particular times of the day or night other than your regular mealtimes when you feel especially hungry? What do you usually eat at those times?

____

____

____

28. What kind of salt do you use, plain or iodized? ______

29. Do you do any work to supplement your income? What is the nature of this work?

____

____

30. Do you receive any regular income other than Social Security?

____

Name: ______________________ Subject Number: __________

-8-

31. If you were to receive an extra $100 per month, what would you do with it? If spent for food, what kind of food?

32. Do you feel that your choice of foods is limited by financial considerations?

33. Are you on a diet? What led you to go on a diet? What kind of diet is it?

34. Do you take vitamin supplements? If so, how long have you been taking them? What led you to start taking them? What kind are they? If not, have you taken them at any previous time? What kind were they? Are you taking any other supplements? If so, what kind?

Name: ______________________ Subject Number: ___________

35. Are you bothered with constipation? When you are, do you take or eat anything special to relieve or prevent it?

____

____

____

36. Are there any foods that you use or enjoy that you must obtain at a specialty store like an Italian grocery store, or health food store, or delicatessen?

____

____

____

37. Do you have a garden and raise any of your own food?

____

____

____

38. Do you do any canning or preserving of food or make jam?

____

____

39. Do you think your food habits have changed as you have become older? How?

____

____

____

Name: ______________________ Subject Number: ___________

-10-

40. Does an older person need the same types of food as a younger person?

____

____

____

ACTIVITIES CHECK LIST:

Church: _______

Organizations
   Bridge Club: _____
   Garden Club: _____
   Woman's Club: _____
   Senior Citizens: _____
   Church-related Society: _____
   Other: _____ Specify: _________________

Community Service
   YWCA: _____
   Red Cross Gray Ladies: _____
   Other Volunteer Service: _____ Specify: _______________

Remarks: ____

____

____

How do you spend your day: ______________________________

____

____

Name: ________________________ Subject Number: ___________

Do you have any children or other close relatives living nearby? How frequently do you talk with them or see them?

____

____

____

RATING SCALE FOR SIGNS OF AGING

Hair:				
Baldness	NONE__	MODERATE__	MARKED__	COMPLETE__
Graying	NONE__	MODERATE__	MARKED__	COMPLETE__
Teeth: Yellowing	NONE__	MODERATE__	MARKED__	COMPLETE__
Hearing: Deafness	NONE__	MODERATE__	MARKED__	COMPLETE__
Skin: Wrinkling	SOME__	MODERATE__	MARKED__	CHILDHOOD SKIN__
Movement:	AGILE__	MODERATELY SLOW__	STIFF__	NEEDS HELP__
Posture: Shoulders	ERECT__	ROUNDED__	STOOPED__	MARKEDLY STOOPED__

Remarks: ____

____

____

____

Appendix A-3

Schedule for Written Food Records
by Survey Subjects

NAME: ____________________
ADDRESS: ____________________
____
PHONE: ____________________

Please list on the following page all the foods that you eat or drink during one particular day both at mealtime and between meals as snacks. Try to indicate the amount of each food in household measure, as the number of level or heaping tablespoons, a cup of liquid, or one slice. You might indicate how the food was prepared if baked, broiled, fried, or heated in water or other liquid. You may wish to record the foods immediately following your meal or snack so that no items are overlooked.

I will return in a few days to collect your food record. If you have any questions please feel free to call me, Eleanor Schlenker, at 353-2937 or 355-3839. We greatly appreciate your cooperation in this study.

NAME________________________ DATE:____________________

FOOD	AMOUNT	HOW PREPARED

Appendix A-4

Nutrient Intakes of Older Women Examined in 1972

Subject Number	Age	Calories	Protein	Fat	Saturated Fatty Acids	Oleic Acid	Linoleic Acid	Carbohy-drate	Calcium	Iron	Vitamin A	Thiamin	Riboflavin	Niacin	Vitamin C
	(yrs)	(kc)	(g)	(g)	(g)	(g)	(g)	(g)	(mg)	(mg)	(IU)	(mg)	(mg)	(mg)	(mg)
202	81	1179	48	30	4	9	4	183	602	7.5	2480	1.14	1.20	11.5	175
204	68	1377	68	54	21	22	3	156	705	11.2	11810	0.77	1.43	12.8	142
205	83	872	43	22	7	5	1	130	313	7.0	1690	0.67	0.97	15.0	43
206	80	969	38	34	8	13	3	137	233	8.3	21930	0.52	1.87	10.2	81
207	66	1212	80	38	15	13	0	132	961	11.1	6630	1.03	2.19	13.6	25
208	73	1173	46	36	16	13	0	175	454	7.2	1100	0.41	0.90	8.1	12
209	81	1107	81	36	10	12	2	110	598	13.8	37310	1.43	3.57	21.0	117
212	75	1840	78	111	52	44	6	138	643	12.6	2640	1.00	1.61	18.5	200
213	75	1190	57	51	17	19	3	129	395	10.1	12790	0.61	1.74	11.0	93
214	81	1671	65	62	17	19	3	218	361	13.8	3030	0.88	1.06	14.9	147
215	75	1319	73	48	14	17	4	154	630	10.2	7000	0.90	1.33	17.9	140
216	90	1386	45	62	14	27	6	174	263	6.8	2280	0.58	0.66	8.6	20
218	69	1323	48	70	25	24	12	127	291	9.2	1720	0.95	0.75	10.1	56
220	85	1145	54	50	20	16	0	118	568	8.4	9150	0.59	1.18	7.5	77
221	64	1728	72	74	19	28	6	198	619	10.6	8960	1.00	1.37	12.4	167
223	71	2153	79	84	28	27	5	275	1144	12.4	13580	1.90	1.99	15.9	118
224	68	1299	53	54	15	18	5	159	360	12.5	24520	0.91	2.47	16.6	92
225	77	606	42	24	5	10	2	54	171	6.2	2380	0.79	0.78	9.9	61
226	85	1367	51	54	15	19	3	177	529	14.5	3860	1.26	1.85	17.5	66
228	64	1439	74	44	14	15	1	182	501	10.4	5660	0.73	1.39	8.7	152
230	73	1125	68	45	15	16	3	117	675	6.4	11560	0.58	1.29	11.7	90
232	75	1146	56	41	15	17	3	137	879	17.4	1940	1.20	1.81	11.2	27
233	67	1234	67	61	25	20	3	107	572	10.2	5860	0.78	1.29	13.2	100
235	69	1815	81	66	19	25	2	221	753	11.0	3760	0.98	1.69	12.8	36
239	74	1188	45	54	14	15	9	125	525	7.9	7260	0.97	1.29	6.7	122
241	75	1129	73	39	13	14	4	121	487	10.1	7290	1.19	1.23	18.6	141
242	69	1327	43	52	13	18	5	179	296	8.3	1750	0.90	0.75	10.4	59
244	80	1009	29	43	42	6	2	129	245	7.0	3210	0.85	0.97	8.8	38

APPENDIX B

INSTRUMENTS AND SUPPLEMENTARY DATA

FOR CHAPTER III

Appendix B-1

Certificate of Death
Michigan Department of Public Health

CERTIFICATE OF DEATH

Michigan Department of Public Health

LOCAL FILE NUMBER — STATE FILE NUMBER

DECEASED

1 DECEASED—NAME (FIRST, MIDDLE, LAST) | 2 SEX | 3 DATE OF DEATH (MONTH, DAY, YEAR)

4 RACE (WHITE, NEGRO, AMERICAN INDIAN, ETC. (SPECIFY)) | 5a AGE—LAST BIRTHDAY (YEARS) | 5b UNDER 1 YEAR: MOS, DAYS | 5c UNDER 1 DAY: HOURS, MIN | 6 DATE OF BIRTH (MONTH, DAY, YEAR) | 7a COUNTY OF DEATH

7b CITY, TOWN, OR LOCATION OF DEATH | 7c INSIDE CITY LIMITS (SPECIFY YES OR NO) | 7d HOSPITAL OR OTHER INSTITUTION—NAME (IF NOT IN EITHER, GIVE STREET AND NUMBER)

8 STATE OF BIRTH (IF NOT IN U.S.A., NAME COUNTRY) | 9 CITIZEN OF WHAT COUNTRY | 10 MARRIED, NEVER MARRIED, WIDOWED, DIVORCED (SPECIFY) | 11 SURVIVING SPOUSE (IF WIFE, GIVE MAIDEN NAME)

12 SOCIAL SECURITY NUMBER | 13a USUAL OCCUPATION (GIVE KIND OF WORK DONE DURING MOST OF WORKING LIFE, EVEN IF RETIRED) | 13b KIND OF BUSINESS OR INDUSTRY

USUAL RESIDENCE WHERE DECEASED LIVED. IF DEATH OCCURRED IN INSTITUTION, GIVE RESIDENCE BEFORE ADMISSION →

14a RESIDENCE—STATE | 14b COUNTY | 14c CITY, TOWN, OR LOCATION | 14d INSIDE CITY LIMITS (SPECIFY YES OR NO) | 14e STREET AND NUMBER

PARENTS

15 FATHER—NAME (FIRST, MIDDLE, LAST) | 16 MOTHER—MAIDEN NAME (FIRST, MIDDLE, LAST)

17a INFORMANT—NAME | 17b MAILING ADDRESS (STREET OR R.F.D. NO., CITY OR TOWN, STATE, ZIP)

CAUSE

18 PART I DEATH WAS CAUSED BY (ENTER ONLY ONE CAUSE PER LINE FOR (a), (b), AND (c)) | APPROXIMATE INTERVAL BETWEEN ONSET AND DEATH

IMMEDIATE CAUSE

(a)

DUE TO, OR AS A CONSEQUENCE OF

CONDITIONS, IF ANY, WHICH GAVE RISE TO IMMEDIATE CAUSE (a), STATING THE UNDERLYING CAUSE LAST

(b)

DUE TO, OR AS A CONSEQUENCE OF

(c)

PART II OTHER SIGNIFICANT CONDITIONS (CONDITIONS CONTRIBUTING TO DEATH BUT NOT RELATED TO CAUSE GIVEN IN PART I (a)) | 19a AUTOPSY (YES OR NO) | 19b IF YES WERE FINDINGS CONSIDERED IN DETERMINING CAUSE OF DEATH

20a ACCIDENT, SUICIDE, HOMICIDE, OR UNDETERMINED (SPECIFY) | 20b DATE OF INJURY (MONTH, DAY, YEAR) | 20c HOUR ... M | 20d HOW INJURY OCCURRED (ENTER NATURE OF INJURY IN PART I OR PART II, ITEM 18)

20e INJURY AT WORK (SPECIFY YES OR NO) | 20f PLACE OF INJURY AT HOME, FARM, STREET, FACTORY, OFFICE BLDG., ETC. (SPECIFY) | 20g LOCATION (STREET OR R.F.D. NO., CITY OR TOWN, STATE)

CERTIFIER

21a CERTIFICATION—PHYSICIAN: I ATTENDED THE DECEASED FROM (MONTH, DAY, YEAR) | 21b TO (MONTH, DAY, YEAR) | 21c AND LAST SAW HIM/HER ALIVE ON (MONTH, DAY, YEAR) | 21d I DID/DID NOT VIEW THE BODY AFTER DEATH. | 21e DEATH OCCURRED (HOUR) ... M. AT THE PLACE, ON THE DATE, AND, TO THE BEST OF MY KNOWLEDGE, DUE TO THE CAUSE(S) STATED

22a CERTIFICATION—MEDICAL EXAMINER OR CORONER ON THE BASIS OF THE EXAMINATION OF THE BODY AND/OR THE INVESTIGATION, IN MY OPINION, DEATH OCCURRED ON THE DATE AND DUE TO THE CAUSE(S) STATED; HOUR OF DEATH ... M | 22b THE DECEDENT WAS PRONOUNCED DEAD (MONTH, DAY, YEAR, HOUR) ... M

23a CERTIFIER—NAME (TYPE OR PRINT) | 23b SIGNATURE, DEGREE OR TITLE | 23c DATE SIGNED (MONTH, DAY, YEAR)

23d MAILING ADDRESS—CERTIFIER (STREET OR R.F.D. NO., CITY OR TOWN, STATE, ZIP)

BURIAL

24a BURIAL, CREMATION, REMOVAL (SPECIFY) | 24b CEMETERY OR CREMATORY—NAME | 24c LOCATION (CITY OR TOWN, STATE)

24d DATE (MONTH, DAY, YEAR) | 25a FUNERAL HOME—NAME AND ADDRESS (STREET OR R.F.D. NO., CITY OR TOWN, STATE, ZIP)

25b FUNERAL DIRECTOR—SIGNATURE | 26a REGISTRAR—SIGNATURE | 26b DATE RECEIVED BY LOCAL REGISTRAR

B-36
8-68
300M

DETACH INSTRUCTIONS BEFORE FILING CERTIFICATE WITH REGISTRAR

TYPE OR PRINT (EXCEPT SIGNATURES) IN BLACK INK—THIS IS A PERMANENT RECORD

Michigan Public Act 343 of 1925, as amended, requires that the attending physician, or in the absence of an attending physician, a coroner shall fill out and sign the medical certificate of death within 24 hours after death.

The funeral director is responsible for completing all other portions of the certificate and obtaining a burial or removal permit prior to disposing of the body or removing from the registration district where the death occurred.

Many important legal, personal, public health and social welfare interests require complete and accurate registration of all deaths. Individuals need certification of the facts of death for insurance claims, liquidation of estates, to prove name of spouse and parents and other general legal use. Social and health agencies need information on the causes of death for purposes of planning health programs, they need information on the number of births and deaths in making population estimates; and they need birth and death statistics to measure the fertility and mortality of various racial, economic or social groups.

APPENDIX B

INSTRUMENTS AND SUPPLEMENTARY DATA FOR CHAPTER III

Appendix B-2

Age and Year of Death of Deceased Subjects

Subject Number	Age in 1948 (years)	Age at Death (years)	Year of Death
101	72	83	1959
102	77	79	1951
103	56	64	1956
104	67	79	1960
105	76	79	1951
106	69	77	1957
107	40	41	1949
108	88	88	1949
109	71	74	1951
111	69	89	1969
112	67	86	1967
113	78	88	1959
114	69	88	1967
115	70	93	1972
116	66	73	1956
117	62	67	1954
118	84	87	1952
119	70	92	1970
120	60	65	1954
121	68	75	1955
122	48	68	1968
123	61	81	1968
124	62	79	1966
125	53	65	1960
126	61	73	1960
127	65	73	1957
128	62	68	1955
129	77	84	1956
130	54	77	1971
131	64	77	1961
132	82	91	1958
133	58	79	1970
134	73	84	1959
135	75	77	1951
136	63	82	1967
137	59	60	1950
138	71	82	1959
139	60	76	1965
141	65	79	1962
142	62	81	1967
143	73	87	1962

Subject Number	Age in 1948 (years)	Age at Death (years)	Year of Death
145	81	87	1954
146	56	66	1959
147	66	84	1966
148	62	85	1971
149	73	83	1959
150	75	81	1955
151	71	77	1955
152	60	76	1964
153	75	84	1958
154	74	78	1953
155	63	67	1952
156	77	88	1960
157	67	78	1960
159	58	74	1964
160	63	82	1968
161	56	79	1971
162	72	95	1971
163	55	78	1972
164	56	80	1972

Appendix B-3

Analysis of Variance for Regression

Prediction Equation Relating Nutrient Intake in 1948 and Systolic Blood Pressure of Subjects Who Died in or Prior to 1972

	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
Regression	3958	2	1979	3.471	.045
Error	15964	28	570		
Total	19922				

APPENDIX C

SUPPLEMENTARY DATA FOR CHAPTER IV

APPENDIX C

SUPPLEMENTARY DATA FOR CHAPTER IV

Appendix C-1

Age and Number of Food Records of Deceased
Subjects Secured in 1948

Subject Number	Age (years)	Number of Food Records
101	72	1
102	77	2
103	56	3
104	67	3
105	76	1
106	69	1
107	40	3
108	88	1
109	71	2
111	69	2
112	67	4
113	78	1
114	69	2
115	70	2
116	66	3
117	62	1
118	84	1
119	70	3
120	60	3
121	68	3
122	48	1
123	61	3
124	62	1
125	53	7

Subject Number	Age (years)	Number of Food Records
126	61	1
127	65	1
128	62	1
129	77	5
130	54	1
131	64	3
132	82	3
133	58	1
134	73	2
135	75	1
136	63	1
137	59	5
138	71	1
139	60	1
141	65	1
142	62	1
143	73	2
145	81	3
146	56	3
147	66	3
148	62	1
149	73	3
150	75	1
151	71	1
152	60	1
153	75	3
154	74	1
155	63	3
156	77	3
157	67	1
159	58	3
160	63	2
161	56	1
162	72	4
163	55	1
164	56	2

Appendix C-2

Age and Number of Food Records of Survivors

Subject Number	Age (years) 1948	Number of Food Records 1948	Age (years) 1972	Number of Food Records 1972
202	57	3	81	3
204	45	2	68	2
205	59	1	83	1
206	56	5	80	2
207	43	1	66	3
208	50	2	73	1
209	57	1	81	2
212	52	4	75	1
213	51	1	75	5
214	56	1	81	3
215	52	2	75	3
216	66	3	90	1
218	46	1	69	3
220	60	1	85	1
221	40	2	64	3
223	48	1	71	1
224	45	2	68	3
225	53	2	77	2
226	61	2	85	8
228	40	2	64	1
230	50	1	73	1
232	52	1	75	2
233	43	2	67	3
235	45	1	69	2
239	50	1	74	2
241	52	1	75	3
242	45	1	69	3
244	56	9	80	1

APPENDIX D

INSTRUMENTS AND SUPPLEMENTARY DATA FOR CHAPTER V

APPENDIX D

INSTRUMENTS AND SUPPLEMENTARY DATA

FOR CHAPTER V

Appendix D-1

Protocol for Clinical Testing at Olin Health Center

NUTRITIONAL STATUS OF OLDER WOMEN

PROTOCOL

Subjects to be admitted to Olin Health Center the evening prior to testing.

8:00 P.M. Dental examination - Dr. Larry Stone D.D.S.

7:30 A.M. Subject will be awakened
- A. Blood pressure measurement before arising
- * B. Fasting urine sample obtained
- C. Fasting blood sample obtained

8:30 A.M. High carbohydrate breakfast (approximately 60 gm carbohydrate)

9:15 A.M. Clinical evaluation
- A. Physical examination
    1. Vital functions - heart, lungs, neurological reflexes
    2. Blood pressure in standing position
    3. Deficiency symptoms - eyes, lips, tongue, gums, skin
    4. Medical history
    5. Evaluation in relation to age
- B. X-rays - chest, lower spine, wrist
- C. EKG

10:30 A.M. Post-prandial urine sample obtained
Post-prandial blood sample obtained

11:15 A.M. Anthropometric measurements

A. Body weight
B. Body height - sitting, standing
C. Skeletal widths - bi-acromial, bi-iliac, chest
D. Circumferences - upper arm, waist, maximum hip, calf
E. Skinfold thicknesses - biceps, triceps, subscapular, waist
F. Flexibility - shoulder rotation, ankle flexion
G. Grip strength - right, left
H. Physical activity recall record

12:30 P.M. Lunch

1:30 P.M. Return home

* Collection of all urine voided by subject between 7:30 A.M. and 10:30 A.M. Each voiding will be placed in a separate bottle and labeled according to time of collection.

OI

PE

SO

DII

REMA

Appendix D-2

Schedule Used for Oral Examination

Name: ______________________ Subject Number: __________
Address: ____________________ Phone: __________________
____

ORAL EXAMINATION

Dentist: ____________________ Date: ___________________

MISSING TEETH (encircled)

2	3	4	5	6	7	8	9	10	11	12	13	14	15
31	30	29	28	27	26	25	24	23	22	21	20	19	18

Why Missing: ____

____

ORAL HYGIENE GOOD___ FAIR___ POOR___

PERIODONTICS NONE___ SOME___ SEVERE___

SOFT TISSUE PATHOLOGY: _______________________________

____

____

PROSTHESIS
- Maxilla
  - CD NONE___ HOW LONG_____________
  - PD NONE___ HOW LONG_____________
  - Bridge NONE___ HOW LONG_____________
- Mandible
  - CD NONE___ HOW LONG_____________
  - PD NONE___ HOW LONG_____________
  - Bridge NONE___ HOW LONG_____________

DIETARY VARIETY ANYTHING___ LIMITED___
SEVERELY LIMITED___

REMARKS: ____

____

RE

an
LA

Appendix D-3

Schedule for Recording Urine Data

Name: ____________________ Date: ____________________

NUTRITIONAL STATUS OF OLDER WOMEN

DATA SHEET:

BLOOD PRESSURE (recumbent)_____ TIME: ____________________

FASTING URINE COLLECTION
(7:30 A.M.)

VOLUME: ____________ml TIME: ____________________

COLOR:
- Pale yellow ____
- Dark yellow ____
- Reddish yellow ____
- Reddish brown ____
- Brown ____

APPEARANCE (at time of collection)
- Clear ____
- Cloudy ____
- Sediment ____

REMARKS: ____________________ NURSE: ____________________

COLLECT ALL URINE VOIDED BY SUBJECT BETWEEN 7:30 A.M. and 10:30 A.M. PLACE EACH VOIDING IN A SEPARATE BOTTLE AND LABEL ACCORDING TO TIME OF COLLECTION.

VOLUME: ________ml TIME: ________ NURSE: ____________

VOLUME: ________ml TIME: ________ NURSE: ____________

VOLUME: ________ml TIME: ________ NURSE: ____________

POST-PRANDIAL URINE COLLECTION (10:30 A.M.)

VOLUME: ________ml

TIME: ______________________

COLOR:

Pale yellow ____
Dark yellow ____
Reddish yellow ____
Reddish brown ____
Brown ____

APPEARANCE (at time of collection)

Clear ____
Cloudy ____
Sediment ____

REMARKS: ________________________
____
____

G

EY

KE

Appendix D-4

Schedule Used for Physical Evaluation

Name: ______________________ Age: _____ Subject Number: ___
Address: ___________________ Phone: _____________
____

Family Member: _____________ Phone: _____________
Address: ___________________
____

Physician: _________________ Phone: _____________
Address: ___________________
____

PHYSICAL EVALUATION

Medical Examiner: ____________________ Date: ______________

GENERAL APPEARANCE POOR___ FAIR___ GOOD___

EYES

Crusted Eyelids	A___	P___		
Blepharitis	0___	1___	2___	3___
Palpebral Conjunctiva				
Inflammation	0___	1___	2___	3___
Hypertrophy	0___	1___	2___	3___
Folliculosis	0___	1___	2___	3___
Bulbar Conjunctiva				
Increased Vascularity	0___	1___	2___	3___
Thickening	0___	1___	2___	3___
Spots (number)	____			
Circumcorneal Injection	A___	P___		
Outer Canthi Lesions	0___	1___	2___	3___
Rotation	A___	P___		

Remarks: ____
____
____

KEY - A = Absent
P = Present
S = Scars
0 = Normal
1, 2, 3 = Degree of Severity

NAME: ______________________ Subject Number: ____________

-2-

SKIN - FACE
Complexion - Color
Good ____
Pallor 0___ 1___ 2___ 3___
Suborbital Pigmentation A___ P___
Nasolabial Seborrhea 0___ 1___ 2___ 3___
Follicular Plugs 0___ 1___ 2___ 3___

LIPS
Angular Stomatitis 0___ 1___ 2___ 3___
Cheilosis 0___ 1___ 2___ 3___

GUMS
Gingivitis 0___ 1___ 2___ 3___
Recession 0___ 1___ 2___ 3___
Retraction 0___ 1___ 2___ 3___

Remarks: ____

____

TONGUE
Red (color) 0___ 1___ 2___ 3___
Magenta (color) 0___ 1___ 2___ 3___
Papillae, Filliform
Atrophy 0___ 1___ 2___ 3___
Hypertrophy A___ P___
Papillae, Fungiform
Atrophy 0___ 1___ 2___ 3___
Hypertrophy A___ P___
Swelling A___ P___
Fissuring 0___ 1___ 2___ 3___

NECK
Thyroid - Goiter 0___ 1___ 2___ 3___ S___

Name: ______________________ Subject Number: ___________

-3-

LYMPH NODES

Enlargement				
Anterior Cervical	0___	1___	2___	3___
Posterior Cervical	0___	1___	2___	3___
Supraclavicular	0___	1___	2___	3___
Axillary	0___	1___	2___	3___
Inguinal	0___	1___	2___	3___

EARS

Right	NORMAL__	DISCHARGE__	WAX 0_1_2_3_
Left	NORMAL__	DISCHARGE__	WAX 0_1_2_3_

NOSE

Discharge	NONE___	MUCUS___	PUS___
Obstruction	NONE___	MUCUS___	PUS___
Other Abnormalities	EXPLAIN: ____________________		

SKIN - GENERAL

Xerosis	0___	1___	2___	3___
Folliculosis	0___	1___	2___	3___
Perifollicular Petechiae	A___	P___		
Purpura	A___	P___		
Dermatitis	A___	P___		
Crackled Skin	0___	1___	2___	3___
Creases	0___	1___	2___	3___
Hyperkeratosis (elbows)	0___	1___	2___	3___
Hyperkeratosis (knees)	0___	1___	2___	3___
Pigmentation	0___	1___	2___	3___
Other Lesions	EXPLAIN: ____________________			

LUNGS

Sounds				
Rales	A___	P___		
Wheezing	A___	P___		
Breath Sounds				
Vesicular	A___	P___		
Bronchovesicular	A___	P___		
Expansion	0___	1___	2___	3___

Name: ______________________ Subject Number: __________

-4-

CARDIOVASCULAR SYSTEM

Heart Rhythm	NORMAL___ OTHER______________
Sounds	______________________________
Murmur	
Functional	A___ P___
Organic	A___ P___
Abnormal Size	0___ 1___ 2___ 3___
Pulse (standing position)	______________ TIME: _____ A.M. P.M.
Blood Pressure (standing)	______________ TIME A.M. P.M.

Remarks: ____

____

____

GENERAL EDEMA 0___ 1___ 2___ 3___

ABDOMEN

Hepatomegaly	A___ P___
Splenomegaly	A___ P___
Other Masses on Organs	______________________________
Bowel Sounds	______________________________

LOWER EXTREMITIES

Paralysis	A___ P___ LOCATION____________
Joints	
Enlargement	A___ P___ LOCATION____________
Pain	A___ P___ LOCATION____________
Muscle Cramps	A___ P___ LOCATION____________
Edema	0___ 1___ 2___ 3___ LOCATION___
Varicose Veins	0___ 1___ 2___ 3___
Walking	NORMAL___ OTHER______________

Remarks: ____

____

SPINE

Kyphosis	0___ 1___ 2___ 3___
Lordosis	0___ 1___ 2___ 3___
Scoliosis	0___ 1___ 2___ 3___

Name: ____________________ Subject Number: __________

NEUROLOGICAL REFLEXES

Knee Jerk	ABSENT__	HYPOACTIVE__	HYPERACTIVE__
Biceps Jerk	ABSENT__	HYPOACTIVE__	HYPERACTIVE__
Triceps Jerk	ABSENT__	HYPOACTIVE__	HYPERACTIVE__
Ankle Jerk	ABSENT__	HYPOACTIVE__	HYPERACTIVE__
Vibratory Sense	ABSENT__	HYPOACTIVE__	HYPERACTIVE__
Proprioception	ABSENT__	HYPOACTIVE__	HYPERACTIVE__
Babinski Reflex	ABSENT__	HYPOACTIVE__	HYPERACTIVE__

EVALUATION IN RELATION TO AGE

General Physical Condition	TYPICAL FOR AGE___	
	APPEARS YOUNGER___	APPEARS OLDER___
Mental Competency	TYPICAL FOR AGE	
	APPEARS YOUNGER___	APPEARS OLDER___
Psychological Outlook	TYPICAL FOR AGE___	
	APPEARS YOUNGER___	APPEARS OLDER___
Alertness	TYPICAL FOR AGE___	
	APPEARS YOUNGER___	APPEARS OLDER___
Locomotion	TYPICAL FOR AGE___	
	APPEARS YOUNGER___	APPEARS OLDER___

Remarks: ____

____

____

____

Name: ________________________ Subject Number: ___________

MEDICAL HISTORY

1. Have you had any serious illnesses in recent years? If so, what were they? How long was it before you could resume your normal activities?

____

____

____

2. Have you had any surgery in recent years? If so, what was involved? How long was it before you could resume your normal activities?

____

____

____

3. Have you had any broken bones in recent years? If so, what was broken? Did you regain full use of your limb?

____

____

4. Do you have any repeating pains? If so, where? _______

____

____

5. Do you lose your appetite for more than one day at a time?

____

____

Name: ________________________ Subject Number: ___________

6. Do you tire easily? ____________________________________

____

____

7. Do you take medicines regularly? Were they prescribed by a doctor? What are they for?

____

____

____

____

____

Remarks: ____

____

____

____

Appendix D-5

Suggested Guide to Interpretation of Blood Data[a,b]

	Deficient	Low	Acceptable	High
Total serum protein (gm/100 ml)	$<$ 6.0	6.0 - 6.4	6.5 - 6.9	$\geq$ 7.0
Serum albumin (gm/100 ml)	$<$ 2.80	2.80 - 3.51	3.52 - 4.24	$\geq$ 4.25
Hemoglobin (gm/100 ml)	$<$ 10.0	10.0 - 10.9	11.0 - 14.4	$\geq$ 14.5
Hematocrit (PCV, percent)	$<$ 30	30 - 37	38 - 42	$\geq$ 43
Plasma vitamin A (ug/100 ml)	$<$ 10	10 - 19	20 - 49	$\geq$ 50
Plasma carotene (ug/100 ml)	- -	20 - 39	40 - 99	$\geq$ 100
Plasma ascorbic acid (mg/100 ml)	$<$ 0.10	0.10 - 0.19	0.20 - 0.39	$\geq$ 0.40

[a]Adult women (nonpregnant, nonlactating)

[b]Interdepartmental Committee on Nutrition for National Defense, 1963.

Appendix D-6

Suggested Guide to Interpretation of Urinary Vitamin Excretion Data[a,b]

	Deficient	Low	Acceptable	High
Thiamin (ug/gm creatinine)	< 27	27-65	66-129	≥ 130
Riboflavin (ug/gm creatinine)	< 27	27-79	80-269	≥ 270

[a]Adult women (nonpregnant, nonlactating)

[b]Interdepartmental Committee on Nutrition for National Defense, 1963.

Appendix D-7

Serum Indices of Protein Metabolism in Twenty Older Women Examined in 1972

Subject	Age (yrs)	Albumin g/100 ml	Total Protein g/100 ml	B.U.N. mg/100 ml
202	81	3.95	6.4	16
206	80	3.90	7.0	19
207	66	4.10	6.0	17
208	73	4.23	5.6	12
212	75	4.00	6.5	29
213	75	3.85	7.0	16
214	81	4.25	7.5	19
218	69	4.20	6.7	19
221	64	3.90	6.6	22
223	71	4.00	6.6	14
224	68	4.10	7.3	12
225	77	3.80	6.4	22
226	85	4.20	7.6	17
228	64	4.20	6.4	10
232	75	4.20	7.3	20
233	67	4.12	7.3	9
235	69	4.00	6.1	16
239	74	4.20	6.8	11
241	75	3.83	5.8	15
242	69	4.42	7.1	13

Appendix D-8

Hematologic Values of Fasting Blood of the Twenty Older Women Examined in 1972

Subject	Age (yrs)	Hemoglobin (gm/100 ml)	PCV (vol %)	RBC ($10^6/mm^3$)	WBC (mm^3)	MCV (u^3)	MCH (uug)	MCHC (%)
202	81	13.3	39.6	4.15	4300	94	32.0	35.1
206	80	13.9	41.7	4.41	5400	94	31.5	34.9
207	66	14.6	43.6	4.67	4900	92	30.9	34.8
208	73	13.6	42.3	4.66	5300	89	29.0	33.5
212	75	15.1	43.7	4.66	5700	94	32.2	34.3
213	75	14.8	45.4	4.88	4300	92	30.2	33.9
214	81	13.5	39.3	4.14	4200	95	33.0	34.0
218	69	14.9	44.5	4.85	5100	92	30.4	33.2
221	64	15.6	47.7	5.26	4600	90	29.4	34.1
223	71	13.9	40.5	4.21	5700	96	32.7	34.1
224	68	13.0	40.1	4.05	6900	98	32.0	33.8
225	77	14.7	47.4	5.03	8500	93	29.2	32.4
226	85	13.6	43.5	4.71	7100	92	29.0	31.0
228	64	13.9	42.2	4.19	5400	101	33.1	33.8
232	75	14.5	44.5	4.54	7800	99	32.2	32.9
233	67	13.2	41.1	4.57	4600	90	28.8	33.0
235	69	14.4	45.2	5.07	8800	90	28.3	32.7
239	74	13.1	40.2	4.37	6200	92	29.8	32.5
241	75	14.2	44.1	4.86	6100	89	28.9	33.4
242	69	15.3	45.7	4.92	6300	92	30.9	34.8

Appendix D-9

Serum Vitamin Levels of Older Women Examined in 1972

Subject	Age (yrs)	Vitamin A (ug/100 ml)	β Carotene (ug/100 ml)	Ascorbic Acid (mg/100 ml)
202	81	44	225	1.04
206	80	60	270	0.84
207	66	99	175	1.13
208	73	18	121	0.95
212	75	35	64	0.82
213	75	87	170	0.99
218	69	22	264	0.39
221	64	67	180	0.67
223	71	38	194	1.28
224	68	42	206	0.83
225	77	57	290	0.87
228	64	58	266	1.06
232	75	< 10	163	0.60
233	67	57	279	0.44
235	69	46	246	0.63
239	74	81	248	1.08
241	75	53	291	0.95
242	69	49	372	0.77

Appendix D-10

Creatinine Ratios of Fasting Urine of Twenty Older Women Examined in 1972

Subject	Age (yrs)	ug Thiamin/ gm Creatinine	ug Riboflavin/ gm Creatinine
202	81	3726	739
206	80	571	128
207	66	2035	1047
208	73	2168	1297
212	75	495	206
213	75	257	318
214	81	1220	301
218	69	121	37
221	64	168	179
223	71	688	154
224	68	203	584
225	77	243	43
226	85	2586	638
228	64	414	119
232	75	119	282
233	67	220	50
235	69	335	154
239	74	1059	307
241	75	663	97
242	69	297	121

Urine values expressed per unit volume are shown in Appendix D-11.

Appendix D-11

Biochemical Values of Fasting Urine of Twenty Older Women Examined in 1972

Subject	Age (yrs)	Creatinine (mg/ml)	Urea N (mg/ml)	Total Nitrogen (mg/ml)	Thiamin (ug/ml)	Riboflavin (ug/ml)
202	81	0.384	3.96	4.63	1.431	0.284
206	80	0.375	2.52	5.00	0.214	0.048
207	66	0.691	6.51	7.55	1.406	0.724
208	73	0.595	2.46	2.86	1.290	0.772
212	75	0.194	2.22	2.75	0.096	0.040
213	75	0.491	4.02	4.49	0.126	0.156
214	81	0.372	2.85	3.64	0.454	0.112
218	69	1.293	9.12	10.79	0.156	0.048
221	64	0.380	3.67	4.96	0.064	0.068
223	71	0.260	1.58	4.12	0.179	0.040
224	68	1.171	3.66	5.63	0.238	0.684
225	77	0.654	5.08	7.08	0.159	0.028
226	85	0.495	2.52	3.40	1.280	0.316
228	64	0.370	1.08	3.01	0.153	0.044
232	75	0.823	8.05	9.87	0.098	0.232
233	67	0.726	1.97	4.88	0.160	0.036
235	69	0.492	4.22	6.32	0.165	0.076
239	74	0.404	1.37	4.17	0.428	0.124
241	75	0.413	2.82	5.51	0.274	0.040
242	69	0.364	1.12	3.32	0.108	0.044

Appendix D-12

Indices of Fasting Urine of Older Women in 1972

Subject	Age	Color	pH	S.G.	Protein	Sugar	Ketones	Occult Blood
202	81	Yellow	6.0	1.007	---	---	---	---
206	80	Yellow	6.5	1.010	---	---	---	---
207	66	Yellow	5.0	1.009	---	---	---	---
208	73	Yellow	5.0	1.008	---	---	---	---
212	75	Straw	5.0	1.005	---	---	---	---
213	75	Yellow	5.5	1.008	---	---	---	---
214	81	Yellow	7.0	1.011	---	---	---	---
218	69	Yellow	5.0	1.031	---	---	---	---
221	64	Yellow	5.0	1.010	---	---	---	trace
223	71	Yellow	6.0	1.008	---	---	---	---
224	68	Yellow	5.0	1.010	trace	---	---	trace
225	77	Yellow	5.0	1.012	---	---	---	---
226	85	Yellow	6.0	1.011	---	---	---	---
228	64	Yellow	5.0	1.005	---	---	---	---
232	75	Yellow	6.5	1.019	---	---	---	---
233	67	Yellow	5.0	1.009	---	---	---	---
235	69	Yellow	7.5	1.014	---	---	---	---
239	74	Yellow	6.0	1.007	---	---	---	---
241	75	Yellow	6.5	1.007	---	---	---	---
242	69	Yellow	6.0	1.005	---	---	---	---

Symbols Used: (-) - Negative
trace - Protein (5 mg/100 ml)
trace - Occult blood (> .03 ug hemoglobin/100 ml)

Appendix D-13

Definitions of Clinical Symptoms

Eyes

Bitot's spots: Small circumscribed, grayish or yellowish-gray, dull, dry, foamy superficial lesions of the conjunctivae.

Blepharitis: Inflammation of eyelids.

Circumcorneal injection (bilateral): Increase in vascularity by new ingrowth of capillary loops, with particular concentration around the cornea in the absence of obvious infection.

Conjunctival injection (bilateral): Generalized increase in the vascularity of the bulbar conjunctivae in the absence of obvious infection.

Thickened bulbar conjunctivae: All degrees of thickening may occur. The blueness of the sclera may disappear and the bulbar conjunctivae develop a wrinkled appearance with increase in vascularity. The thickened conjunctivae may result in a glazed, porcelain-like appearance, obscuring the vascularity.

Skin

Crackled skin: Definite scales larger in size than those seen in xerosis. It is not of nutritional origin.

Follicular hyperkeratosis: The skin is rough, with papillae formed by keratotic plugs which project from the hair follicles. The surrounding skin is dry and lacks the usual amount of moisture or oiliness. Lesion has been likened to "gooseflesh" which is seen on chilling, but is not generalized and does not disappear with brisk rubbing of the skin.

Nasolabial seborrhea: A definite greasy yellowish scaling or filliform excrescences in the nasolabial area which become more pronounced on slight scratching.

Pigmentation: Areas of darkened, brown pigmentation over the malar eminences, forehead, hands, or elsewhere.

Purpura: Small localized extravasations of blood, red or purplish in color, depending on time elapsed since formation.

Xerosis: Dry and crinkled skin which is accentuated by pushing the skin parallel to its surface. Nutritional significance is not established.

Lips

Angular lesions: May appear as pink or moist white macerated angular lesions which blur the mucocutaneous junction.

Angular scars: Scars at the angles, which, if recent, may be pink; if old, may appear blanched.

Cheilosis: The lips are swollen or puffy and appear as if the buccal mucosa extends out onto the lip. There may be desquamation.

Tongue

Filliform papillae atrophy: Filliform papillae are exceedingly low or absent, giving the tongue a smooth or "slick" appearance which remains after scraping slightly with an applicator stick.

Fissures: Linear lesions or cracks, with a definite break in continuity of epithelium.

Fungiform papillae atrophy: Positive finding if the fungiform papillae cannot be readily seen.

Magenta colored: The color of alkaline phenolphthalein.

Papillae hypertrophy: Can be seen and is felt when a tongue blade is drawn lightly over the anterior two-thirds of the tongue.

Red (glossitis): Entire tongue is red, angry in appearance, with or without denudation or fissures.

Note: Taken from the Interdepartmental Committee on Nutrition for National Defense, 1963.

Appendix D-14

Letter Requesting Authorization to Release Medical Records to Personal Physician

We would like to take this opportunity to thank you for participating in our health and nutrition survey. As we mentioned last fall, copies of your medical records pertaining to the physical examination by Dr. Feurig, X-rays, EKG, and blood and urine analyses, will be sent to the physician whom you indicated. Inasmuch as all medical records are regarded as privileged information, the Michigan State University Health Center must receive written permission from you authorizing them to release these records to your physician.

I have enclosed an authorization form as well as a stamped, self-addressed envelope. As soon as you return your signed authorization to me, I will mail the set of records to the physician you have chosen. If you have any questions, please do not hesitate to call me at 353-2937 or 355-3839.

We greatly appreciate your cooperation in making this project a success.

Sincerely yours,

Eleanor D. Schlenker
Graduate Assistant

ES/em

Enclosures

Appendix D-15

Authorization Form for Release of Medical
Records to Personal Physician

MICHIGAN STATE UNIVERSITY
HEALTH CENTER

AUTHORIZATION FOR RELEASE OF INFORMATION

DATE________________

This is authorization for you to convey to__________________

____

____

all information from my health records at Michigan State University Health Center.

Signed____________________________

Address____________________________

____

APPENDIX E

INSTRUMENTS AND SUPPLEMENTARY DATA

FOR CHAPTER VI

APPENDIX E

INSTRUMENTS AND SUPPLEMENTARY DATA FOR CHAPTER VI

Appendix E-1

Schedule for Recording Anthropometric Measurements

NAME________________________________ DATE________________

NUTRITIONAL STATUS OF OLDER WOMEN

ANTHROPOMETRIC MEASUREMENTS

DATE OF BIRTH______________(day, month, year)

BODY HEIGHT

Sitting ________cm

Standing________cm

BODY WEIGHT ___________lbs.

CIRCUMFERENCES

Upper arm ________cm

Minimum waist ________cm

Inspiration ________cm

Expiration ________cm

Maximum hip ________cm

Calf ________cm

SKELETAL WIDTHS

Bi-acromial ________cm

Bi-iliac ________cm

Chest ________cm

SKINFOLD THICKNESSES

Biceps	_______cm	_______cm	_______cm
Triceps	_______cm	_______cm	_______cm
Subscapular	_______cm	_______cm	_______cm
Waist	_______cm	_______cm	_______cm

FLEXIBILITY

Shoulder _______degrees

Ankle _______degrees

GRIP STRENGTH

Right _______lbs.

Left _______lbs.

EXAMINER_________________________

Appendix E-2

Composition of High Carbohydrate Breakfast

High Carbohydrate Breakfast
(50-60 grams carbohydrate)

	Carbohydrate (g)	Fat (g)
Orange juice - 4 ounces	13.5	---
French toast -		
1 1/2 slices enriched bread	18.0	1.5
12 grams CHO per slice		
1 gram fat per slice		
Table syrup -		
2 tablespoons	30.0	
15 grams CHO per tablespoon		
Coffee or Tea		
Sugar (optional) -		
4 grams CHO per teaspoon		
Cream substitute (optional) -		
1.8 grams CHO per teaspoon		
0.8 grams fat per teaspoon		

Appendix E-3

Anthropometric Measurements of Twenty Older Women Examined in 1972

Subject Number	Age (yrs)	Ht (in)	Wt (lb)	Skeletal Widths: Bi acromial (cm)	Skeletal Widths: Chest (cm)	Skeletal Widths: Bi-iliac (cm)	Skinfold Thicknesses: Triceps (mm)	Skinfold Thicknesses: Biceps (mm)	Skinfold Thicknesses: Sub-scapular (mm)	Circumferences: Upper Arm (cm)	Circumferences: Minimum Waist (cm)	Circumferences: Maximum Hip (cm)	Circumferences: Calf (cm)
202	81	58.75	116.75	34.0	25.2	29.8	20.5	6.5	15.5	26.2	69.4	91.6	28.4
206	80	58.50	117.00	32.6	24.3	*	22.0	15.0	11.5	26.8	74.2	*	28.0
207	66	61.12	123.25	36.3	27.2	31.9	21.5	10.0	15.0	25.4	73.2	92.5	32.1
208	73	58.50	81.75	27.9	21.3	23.6	10.0	2.0	4.0	20.2	59.6	77.8	6.5
212	75	63.69	197.00	36.4	28.7	33.0	31.0	18.5	21.5	35.8	101.2	120.2	39.2
213	75	64.12	204.25	34.1	31.1	30.6	38.5	25.5	20.0	40.3	89.2	114.6	39.9
214	81	63.25	157.25	35.7	29.7	26.4	17.5	10.5	14.5	28.2	93.4	106.0	36.5
218	69	64.38	137.50	33.6	24.0	27.9	22.0	14.0	10.5	27.6	77.6	98.5	34.4
221	64	63.25	178.50	32.2	29.2	34.4	27.5	20.5	28.5	33.8	92.0	117.8	33.4
223	71	61.88	142.5C	36.1	28.2	29.5	31.0	12.5	11.5	32.0	80.6	108.7	37.6
224	68	64.25	208.75	36.2	31.5	34.7	43.0	28.0	24.5	37.9	98.3	127.1	42.2
225	77	59.50	201.50	31.9	27.6	27.4	38.5	21.5	22.5	36.4	92.2	137.6	41.0
226	85	56.12	128.00	29.4	24.0	30.6	27.7	7.7	15.5	28.3	75.8	100.4	31.9
228	64	67.50	128.75	31.3	24.6	29.5	16.5	4.5	8.5	24.8	67.0	99.1	34.1
232	75	64.56	174.50	36.8	33.9	27.6	33.0	19.5	11.5	30.9	77.4	114.5	36.2
233	67	62.50	212.75	38.9	34.1	36.5	43.5	33.0	17.5	40.1	107.8	127.8	35.7
235	69	61.25	90.75	29.9	21.8	26.7	10.0	2.5	6.0	20.1	62.4	81.8	29.0
239	74	60.12	109.75	31.7	24.6	25.9	11.5	7.0	10.0	23.2	75.8	89.5	29.8
241	75	63.56	170.00	34.0	26.4	31.6	34.5	24.3	11.0	33.2	87.0	108.1	34.4
242	69	63.24	139.75	33.2	27.7	29.1	32.0	11.3	11.5	26.6	81.8	103.0	30.9

* Not measured, subject had colostomy.