Selected Vitamin Status of Elderly People in Southern Utah Measured Biochemically and Dietarily, and Correlated to Their Perceived Status

Karen Faddis

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SELECTED VITAMIN STATUS OF ELDERLY PEOPLE IN SOUTHERN UTAH
MEASURED BIOCHEMICALLY AND DIETARILY, AND CORRELATED
TO THEIR PERCEIVED STATUS

by

Karen Sims Faddis

A thesis submitted in partial fulfillment
of the requirements for the degree
of
MASTER OF SCIENCE
in
Nutrition and Food Sciences

Approved:

UTAH STATE UNIVERSITY
Logan, Utah
1976
I would like to acknowledge the quality of Rural Life Program at Utah State University, which is funded by Kellogg for financial support for the evaluation program.

The author wishes to express sincere thanks and appreciation to Dr. Deloy G. Hendricks, Professor of Food and Nutrition, for the many hours he spent in guiding this study. His continual dedication was an inspiration to the students.

I would also like to thank my committee members for their helpful suggestions and constructive criticism, Flora Bardwell, Frances Taylor, and Dr. Eldon Drake.

I would like to give a special thanks to the staff at California State University, Hayward for their help and suggestions with the statistical problems I encountered. Special appreciation goes to Dr. Dean Fearn and Dr. Peter Chamberlain.

Finally, I would like to thank my family and my husband, Chris, for their patience and support through the trial of this project.

Karen Sims Faddis
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ABSTRACT

Selected Vitamin Status of Elderly People in Southern Utah
Measured Biochemically and Dietarily, and Correlated
To Their Perceived Status

by
Karen Faddis, Master of Science
Utah State University, 1976

Major Professor: Dr. Deloy Hendricks
Department: Nutrition and Food Sciences

The purpose of this study was to analyze the diets of elderly people in southern Utah. Three types of information were used in the analysis: biochemical, dietary, and the subject's analysis of his diet. Four vitamins were studied: vitamin A, ascorbic acid, thiamin, and riboflavin.

Dietary data was obtained on the four vitamins and compared by sex and by age. Thiamin and riboflavin dietary levels were evaluated using the Index of Nutritional Quality (INQ), to determine the quality of the diet according to total calories consumed. Seasonal differences between fall and spring data were evaluated.

Plasma vitamin A, plasma carotene and plasma ascorbic acid levels were determined. Plasma vitamin A and plasma ascorbic acid levels were also compared by age, sex, and season. Urinary thiamin and urinary riboflavin levels were evaluated.
The last part of the paper shows the correlation between dietary versus perceived; and dietary versus biochemical status for the four vitamins.
INTRODUCTION

The elderly are a minority that are too easily overlooked in a youth oriented society (as life span increases). The percentage of people over 65 is becoming a more and more significant portion of our society. The problem of nutrition for this elderly group becomes increasingly important when considering the influence of economics, social activity on food consumption patterns. The difficulties in assessing the nutritional status of the aged population are manifold, not only with respect to the collection of data, but also in the interpretation of the collected information.

Flora Bardwell, foods and nutrition specialist at Utah State University (USU), received government funding through Action to conduct a Senior's Nutrition Aide Program (SNAP). The program involved the elderly in the five-county area of southern Utah. The purpose of this program was to improve the nutritional status of senior citizens in the area by involvement in a nutritional and social activity program.

The five-county area of southern Utah includes the counties of Beaver, Garfield, Kane, Washington, and Iron. This area of the state was chosen because of factors which would cause the elderly to have nutritional problems. One factor was this is a low income area with more than one-third of the population having annual incomes below $3,000. This area of the state has the highest percentage of people over 55. It has 10 percent elderly while the mean of the state is 7 percent (Bardwell, 1974). Geographic isolation was also a consideration. The small size of the communities and the distance between,
combine to make transportation necessary in securing food. Also the few, small grocery stores have limited choice and high prices. This becomes a special problem for the elderly with no means of transportation and no public transportation available. All the above items combine to provide a setting for poor nutrition.

This study was conducted to evaluate the nutritional status of the elderly in the five-country area. Nutritional information was divided into two sections, minerals and vitamins, because of the great amount of information collected. This study dealt with the vitamin status of the elderly population in this area.

The objectives of this study were threefold. The first objective was to evaluate the dietary vitamin status of the elderly population using a three day dietary survey. The second objective was to evaluate the biochemical vitamin status of the population in regards to vitamin A, vicamin C, thiamin, and riboflavin. These vitamins were selected because of the relative simplicity and accuracy of the biochemical tests and the prevalence of nutritional inadequacies of these vitamins. The last objective was to compare the dietary and biochemical data to the survey participant's evaluation of his vitamin status.
In 1900 only 4 percent of our population was over 65 years of age (Le Bovit, 1965). They now number 20 million and represent 10 percent of our population. By the end of the decade, if this percentage increases at its present rate, this number is expected to almost double, (Current Comment, 1971). The older American is becoming a more and more significant portion of our population. From 1940 to 1960 the United States population increased about 36 percent. In the same period the population 65 years and older increased 84 percent from nine to almost 16 million. The length of life after age 55 was increased also. In the same 20 year span as stated above, the number of people 75 years and over increased 115 percent from 2.6 to 5.6 million (Theuer, 1971).

People are living longer and expecting more out of their retirement years; however, the so called "Golden Years" are not so "Golden" for many older Americans. Poverty is the way of life for 3 out of 10 people 65 and over in contrast to 1 out of 9 younger people (Current Comment, 1971).

One group of the elderly that needs to be given special attention are the widows. Women make up 57 percent of persons over 65 of whom 31 percent are widows. There are 29 percent living alone in the homes of others. Close to 60 percent of the older women living alone or with non-relatives live in poverty, (2.1 million out of 3.6 million in 1966) and another 10 percent are on the borderline (Current Comment, 1971).
The economic pressures to which many older people are subjected play an important role in determining their dietary sufficiency. Le Bovit (1965) found that while many older Americans have old age social security benefits and nutritionally adequate diets, a considerable number consume food short in one or more of the important nutrients. It was found that 80 percent of those who spent more than the cost of the United States Department of Agriculture's liberal-cost food plan ($19 per week) met the recommended allowances in full, whereas those who spent less than the estimate for the low-cost food plan ($13 per week) failed to meet two-thirds of the recommended allowance for one or more nutrients. It was also found that persons with low income had diets considered "poor" two and one half times as often as did those with high income. Nevertheless, a few households with low expenditures had diets meeting recommendations. A nutritionally adequate diet is difficult but not impossible to provide at minimal costs.

An examination of dietary intake of older people reveals that vitamin A and ascorbic acid are the nutrients most likely to be lacking. As the older person's income decreases, in order to remain financially independent, the older person chooses foods that are least expensive. These foods often turn out to be carbohydrate foods which are easy to obtain and store. The important fruits and vegetables from which the vitamins are obtained are often left out of the diet.
Adequacy of Diets

Congressional hearings in 1967 dramatized the probability that serious hunger and malnutrition existed in the United States. The Ten-State Nutrition Survey (1971) confirmed this with the finding that elderly persons were an age group with evidence of increased nutritional deficiencies. Persons over 60 years of age showed evidence of general undernutrition which was not restricted to the very poor or to any single ethnic group.

Swanson (1964) found that with increasing age, ascorbic acid and vitamin A levels in the diet of women drops. She compared the nutrient intake of Iowa women at 30 to 39 years of age with those of women of 70. She found that low intakes were not associated so much with failure to eat sufficient quantities of fruits and vegetables as with failure to select quantities of fruits and vegetables rich in these vitamins.

In a study conducted by Le Bovit (1965) on 283 households in New York where the homemaker was over 60, the recommended allowance for ascorbic acid was not met in 30 percent of the households, 15 percent failed to meet even two-thirds of the RDA for this vitamin. Consumption of other vitamins was also low with 40, 20, and 11 percent of the households failing to meet the RDA for thiamin, vitamin A, and riboflavin respectively. There were 25 percent with diets containing less than two-thirds of recommended allowances for one or more nutrients. An even higher percentage of the households in which the homemakers who were 75 years of age or older, had diets classified as poor.
Fry (1963) in a study of older women found that vitamin A was the most limiting nutrient with only 41 percent obtaining the RDA for this vitamin. Riboflavin and ascorbic acid were low in 6 and 3 percent of the diets respectively. The mean intake of all nutrients except calcium and riboflavin was higher for women 65 to 74 than for women 75 to 85 years of age.

Morgan (1959) found low vitamin intakes in older women. In the North Central region 20 percent of the older women had low intakes of thiamin. More than 30 percent had low intakes of riboflavin and ascorbic acid, and more than 40 percent had a low intake of vitamin A.

An extensive study was done on the nutritional status of the aged in Onondago County, New York (Brin et al., 1965). The total number of subjects at three major sites was 233 with a mean age of 71 years; 6 percent had low plasma ascorbic acid levels. Vitamin A and carotene plasma levels were low in 4 percent of the participants. Thiamin was the most limiting nutrient with 21 percent having urinary excretion values in the deficient range. An additional 33 percent had low thiamin excretion values. At one site, a community home, 4 of the 10 subjects had biochemical symptoms of thiamin deficiency. It was interesting to note a wide range of values with over 50 percent of the population having vitamin A, carotene, and ascorbic acid levels which were above the cutoff point for high values. Twenty-six percent of the thiamin values were also high.

Fry, Fox and Linkswiler (1963), in a study of 32 women over 65, found that 9 percent had diets low in vitamin A. A study of the elderly in rural Pennsylvania gave more striking results with vitamin
A intakes low in 66 percent of the subjects and thiamin, riboflavin, and ascorbic acid intakes below two thirds for over 40 percent (Guthrie, 1971).

Ascorbic acid has often been cited as the most vulnerable of all food nutrients because of its easy destruction by cooking, storage, canning, and even freezing processes. Diets which are found to be adequate in all other aspects may often fall short in providing this vitamin. The ascorbic acid content of the blood cells also seems to be affected by other factors. Elderly men seem to have lower tissue levels than elderly women (Bramkamp and Wirths, 1973). Smokers have lower ascorbic acid absorption than non-smokers. Another finding is that ascorbic acid content of white blood cells falls significantly during the winter months (Andrews, Brook, and Allen, 1966).

Wilcox, Gillum, and Hard (1952) in a survey conducted in nine western states found that 50 percent of the females over 65 had dietaries that were low in ascorbic acid. Hendel (1969) also found as ascorbic acid intakes below the RDA in 27 percent of the 144 elderly people they studied.

Given the problems of collection and analysis of food composition data, nutrient loss during handling and cooking of food and the vagaries of the human memory, the suggestions gleaned from dietary data must be confirmed by more objective data such as biochemical evaluation. Bramkamp and Wirths (1973) found that blood ascorbic acid levels were higher in elderly women than in elderly men. The respective mean ages of the men and women studied were 68 and 80. There was a linear relationship between ascorbic acid intake and blood ascorbic acid
level women, but in men the correlation was not as high, perhaps this was because 70 percent of the men examined were heavy smokers.

Burr et al. (1974) found that plasma ascorbic acid levels decreased with an increase in the age of the participant. Men 65-69 had a mean plasma ascorbic acid level of 0.30 mg per 100 ml while men over 85 had average values of 0.25 mg per 100 ml. Women were also found to have higher ascorbic acid levels than men. In the same age groups, women were found to have ascorbic acid levels of 0.49 mg per 100 ml and 0.31 mg per 100 ml respectively. He also found smokers had lower plasma ascorbic acid levels than non-smokers.

Andrews et al. (1974) found that attention needs to be given to the diets of patients in hospitals. They found a decreased ascorbic acid concentration in in-patients as compared to out-patients. They also found that the small hospital had significantly higher values than the larger hospital. They attribute this as a direct consequence of reduced ascorbic acid intakes associated with current large-scale catering processes.

Season of the year has an effect on nutrient intake in the elderly. Roine et al. (1974) in a study in Finland with 135 persons between the ages of 50 and 94 found that 24 percent had low levels of ascorbic acid in the fall. This increased to 49 percent during the winter months. Dibble et al. (1967) found that autumn plasma carotene and riboflavin values were higher than spring values in 214 elderly volunteers in Syracuse, New York. One possible explanation for this decrease in the winter could be the fact that 60 to 70 years ago, when elderly people
were establishing their food habits, fresh fruits and vegetables were available only seasonally, thus they may still be consumed only "in season."

**Quality of Diets**

There is evidence that nutritional factors influence not only growth and development before maturity, but also aging of the mature adult, because certain attributes in old age depend upon the body status at the end of the growth period (Exton-Smith, 1972).

Many nutritionists have found a striking decrease in vitamin intakes with age, and the percentage falls for subjects in their late 70's as compared to those in their early 70's. Exton-Smith (1972) found that although there was a considerable difference in total nutrient intake at the different ages, there appeared to be little alteration in the quality of the diet as the person grew older.

A longitudinal investigation of the nutritional status of the aged was carried out in San Mateo, California. The initial survey was conducted in 1948 on 577 healthy subjects age 50 and over. Data from three age groups 55-64, 65-74, and over 75 was collected. There was found to be a progressive fall in vitamin intake with age especially in the subjects over 75. However, when expressed in terms of body weight the differences in intakes was small (Gillium and Morgan, 1955).

Further surveys were conducted 4, 6, and 14 years after the original study. One hundred and forty-one people participated in all four studies. It was noted that there was a reduction in food intake after the age of 75, but there was no significant difference in the
four studies in the proportion of calories contributed by carbohydrates, protein, and fat for any of the groups (Steinkamp, Cohen, and Walsh, 1965).

**Dietary Supplements**

Every year Americans spend $500 million on "Health Foods," manufactured vitamins, capsules, tonics and other supplements to the diet. The people most victimized by this increasing food fadism are older age groups and lower-social economic groups. These groups are least able to afford these myths. Older people are especially vulnerable because of their great concern about their declining health.

Le Bovit (1965) found at the time of the survey over one-third of the households were using vitamin preparations. Of these, 46 percent were consuming diets adequate in all nutrients and needed no supplements. Only 20 percent of those who could have benefitted from supplementation were using supplements that provided nutrients that were lacking in their diets. About 20 percent were supplementing their diets with nutrients they were already getting, but not with the nutrients they needed.

A similar situation was noted in a study of men and women over 50 years of age in California where Steinkamp, Cohen, and Walsh (1965) found that 35 percent were using supplements. Of those taking vitamin supplements 37 percent had diets already adequate in the vitamins taken.

The amount spent on supplements may represent an appreciable portion of the money available for food, with some people spending
more money on vitamin-mineral preparations than they spend on food. It is important that people are educated to supplement their diet where it is lacking and not where it is already adequate.

Educational Needs

It has been remarked that we are a nation of "nutritional illiterates." It is not that we do not have the nutritional knowledge, it is that we do not know how to or do not want to apply it. In a recent National Health Test which had 16 nutrition questions more than half of the population answered 15 correct (Wagner, 1970). People of all ages are becoming educated to make better food choices, yet it seems they memorize the catch words, but fail to apply them to nutrition principles. The problem of discovering approaches that change food selection and behavior acquired through a lifetime of eating experience forever plagues us.

The need for improved nutrition is shown to be important for the elderly. Swanson (1964) found that among 695 persons 65 years of age and older, only one person in 20 was choosing a nutritionally desirable diet. 59 percent were low in vitamin A and ascorbic acid. Yet when the respondents were asked to evaluate their own diets, 34 percent considered their diets very good, 65 percent considered their diets good and only two percent thought their diets were poor. Palmore (1971) found similar results in a study done on 6,289 elderly. Only 6 percent reported their diets were lacking in 3 or more of the basic 7 foods.
Nutrition education is not the sole solution to nutrition problems in the elderly. Pelcovits (1971) feels that the problem of undernutrition can not be solved independently of related problems of limited income, feelings of loneliness, rejection, and apathy, declining health and vigor and loss of mobility, physical handicaps that make food shopping and preparation difficult, and metabolic changes that accompany aging. Pelcovits (1972) feels there is a link between isolation and nutrition. As the elderly fall into poor eating habits, they feel increasingly listless and apathetic. Their isolation intensifies to such a degree they do not reach out for social contacts. Weinberg (1971) feels food is a medium for socialization and not merely a biological necessity. It becomes a psychological need for social interchange, a substitute for love, and even an enhancer of the latter. The social life of the adult is built to a great extent around the pleasure of food and drink.

A failure to understand this results in a failure to meet the nutritional needs of the older person. In our efforts to provide the aged with the proper diet, we often fail to perceive that it is not what the older person eats but with whom that is important. Hendel (1969) brought this out when he asked 144 elderly people what their food selection was most likely to be influenced by. The majority said enjoyment was first with nutritional value placing second. Pelcovits (1972) found that group meal participants gave equal importance to the food and the social aspect.

One program that has been successful in dealing with the problem of nutrition and the elderly is group meals. Pelcovits (1972) found that in a study done on 3,500 people before they joined a group meal
that nearly one-fourth of this group ate less than three meals a day. Half of the group ate only breakfast and supper. Although no hard facts are available, the project instigators found the project meals improved the dietary intake of the participants.

Joering (1971) found in a group of elderly being served meals at community centers or home served meals that daily intake of all nutrients was greater when a meal was provided. Vitamin A, thiamin, and riboflavin intake increased by 42 percent, 43 percent, and 31 percent respectively.

Although acute dietary deficiency disease is now rare in the United States, nutritionists can recognize in middle aged and older members of the population subclinical signs of malnutrition which have been taken as just reflecting the aging process.

The problem of nutrition and the elderly is not a simple one. Many variables need to be considered. Besides limited nutritional knowledge many factors that are characteristic of aging affect a person's ability to prepare nutritious meals. Income seems to be one of the most limiting factors with three out of ten older Americans living in poverty. Other factors that affect nutrition are loneliness, declining health, loss of mobility, physical handicaps, and metabolic changes. As the problem of overweight increases in the elderly additional attention needs to be given to the quality as well as to the quantity of the diet. Because of the many varying factors affecting nutrition no single approach can be fully responsive to the nutritional needs of the aging.
EXPERIMENTAL PROCEDURE

Experimental Design

The purpose of this study was to determine the vitamin status of elderly people in southern Utah. Three types of information were used to accomplish this objective. Biochemical data were obtained by collecting blood and urine samples from study participants and analyzing these. Dietary information was obtained by using a three day recall dietary form. The last type of information that was collected was a survey in which the participants evaluated their own nutritional standing. These three sets of data were then correlated to determine the relationship between perceived nutritional status and actual nutritional status.

Methods and Materials

The SNAP program chose 20 volunteers to work in fourteen towns in the five-county area of southern Utah. From these fourteen towns, five were chosen for the study. The towns were chosen according to varying size and location. The towns of Cedar City, Parowan, Milford, Beaver, and Orderville were the target points of the study. A summary of the population studied and the percent elderly sampled is shown in Table 1. A map of the five-county area is located in Appendix A.

The action volunteers in the five towns worked with USU personnel to obtain volunteers in each of the communities to participate in the
Table 1. Total and elderly population in selected towns in a five-county area of southern Utah.

<table>
<thead>
<tr>
<th>Town</th>
<th>Total Pop.</th>
<th>Elderly Pop.</th>
<th>Percent Elderly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cedar City</td>
<td>9720</td>
<td>612</td>
<td>6.3</td>
</tr>
<tr>
<td>Parowan</td>
<td>1900</td>
<td>277</td>
<td>14.6</td>
</tr>
<tr>
<td>Milford</td>
<td>2000</td>
<td>228</td>
<td>11.4</td>
</tr>
<tr>
<td>Beaver</td>
<td>1800</td>
<td>212</td>
<td>11.8</td>
</tr>
<tr>
<td>Orderville</td>
<td>800</td>
<td>76</td>
<td>9.5</td>
</tr>
</tbody>
</table>


study. The participants were sent dietary records on which they were to record their total food consumption for three days. They were also given urine containers in which to collect all urine voided during a 24-hour period.

One hundred and ninety-two elderly from five communities volunteered to participate in this study. One hundred and forty of the participants were 65 years of age and older, 39 were between the ages of 55 and 64, and 13 were between the ages of 42 and 54. Figure 1 represents a percentage breakdown of the age distribution, by sex, of the survey's participants. These individuals ranged in age from 42 to 93 years of age with the mean age of 69. The sample size over 65 years of age was almost 4 percent of the elderly population in the five-county area. Figure 2 shows the sample size of the elderly population as a percentage of the total elderly in each community.

A team of five people from the Nutrition and Food Science Department of Utah State University and a medical technologist collected blood and urine samples in the five towns selected for sampling during
Figure 1. Age and sex composition of survey participants.
Figure 2. Elderly participants in survey as percentage of total population 65 years of age and older.

October of 1974 and five months later in March 1975. Each person was asked to abstain from food eight hours prior to collection. Blood samples were collected in 15 ml vacuum tubes. In the fall samples were packed in ice to keep them as cold as possible until they could be stored properly. All the samples were collected and serum was separated at the campus laboratory. The samples were separated by centrifuging at 2000 rpm for 20 minutes. The serum was decanted off and stored at -10 C until analysis. In the spring serum was separated at the time of collection, and the same procedure for separation was
followed. The samples were stored at -10°C at the campus laboratory until analysis. This procedure eliminated the problem of hemolysis which was incurred in the fall.

**Biochemical**

Vitamin A, carotene and ascorbic acid levels in the serum samples were determined. Vitamin A and carotene were determined using the "Carr-Price method for plasma or serum vitamin A and carotene" as outlined in the *Manual for Nutrition Survey* (Sandstead, 1963). The proteins of the serum were precipitated with alcohol, and the carotene and vitamin A were extracted with petroleum ether. The carotene concentration was determined by measuring the absorption of the extract at 450 μm. The petroleum ether was evaporated under nitrogen and vitamin A was determined by reading the intensity of the blue color produced by the addition of a trichloroacetic acid-chloroform chromogen and read at 620 μm. A correction was made for the amount of carotene present, since carotene contributes to the total color.

Due to the many tests to be performed on a limited amount of serum, the initial serum used was changed from 2 to 1 ml and other reagents reduced accordingly. The reagents used and amounts included per sample were: 1 ml-95 percent alcohol, 1.5 ml petroleum ether, .5 ml chloroform and 1 drop acetic anhydride. Trichloroacetic acid (TCA) was used in the chromogen solution in place of antimony trichloride. The chromogen solution was modified using a mixture of one part TCA and two parts chloroform according to the direction of Sandstead (1963). This chromogen is not sensitive to moisture as is the antimony trichloride chromogen and therefore was recommended.
Ascorbic acid was determined according to the directions of the Manual for Nutrition Surveys (Sandstead, 1963) using the "Dinitrophenylhydrazine method for serum vitamin C, micro procedure." In the fall the serum was stored for approximately one week before the protein was precipitated using TCA and the acid extract separated. In the spring, to obtain more accurate results, the serum was deproteinated with TCA as soon as the samples were collected. All samples were stored at -10°C until analysis.

After separation of the acid extract the sample was mixed with dinitrophenylhydrazine reagent to produce a color reaction. The reaction time was controlled with sulfuric acid. The samples were then read on a Beckman DU at 515 m\(\mu\) using a micro cuvette. The directions in the manual were followed exactly. Due to machine difficulties the fall samples were not analyzed until May, seven months after their collection. Even though the samples were kept frozen, some deterioration in serum ascorbic acid levels was suspected.

Thiamin and riboflavin excretion levels were determined by analysis of urinary excretion. Each study participant was asked to collect a 24 hour specimen of urine. The volume of the urine was measured and the specific gravity determined. Then a 100 ml aliquot of urine was placed in a plastic bottle containing one ml of 12 N hydrochloric acid. This adjusted the acidity of the added urine to a pH of 2-3. The urine was then packed in ice until it could be frozen and stored at -10°C until time of analysis.

Thiamin was determined by the method outlined by Leveille (1972), the "Modified thiochrome procedure for the determination of urinary thiamin." The most extensively employed method for thiamin
determination is the procedure found in the Manual for Nutrition Surveys. This procedure is generally conceded to be sufficiently accurate for survey purposes although it is laborious, and long; as thiamin must be separated from the other fluorescent compounds in urine by means of column chromatography.

In the method outlined by Leveille a modified procedure is presented for the determination of thiamin in urine avoiding the isolation of thiamin from urine. Blank and standard tubes are used for each sample that correct for native fluorescence in urine as well as for factors appearing to quench thiochrome fluorescence. The modified procedure yields results comparable to those obtained by the method of Slater and Morell.

In the procedure three centrifuge tubes (A, B, C) are prepared, each containing equivalent amounts of urine. To tube A is added the standard thiamin solution, to tube B water is added, and to tube C is added sodium hydroxide and benzenesulfonyl chloride. The fluorescence is proportional to the concentration of thiochrome. Because the thiamin in tube C has been destroyed, the reading for this tube represents a "blank" tube and corrects for any non-thiochrome fluorescence contained in the urine. The difference between the reading for tube B and tube C represents the fluorescence due to the thiochrome produced from the added thiamin standard. Using the three tubes corrects for native fluorescence in urine as well as for factors appearing to quench thiochrome fluorescence.
Urinary riboflavin was determined by the modification of the method of Slater and Morell as outlined in the *Manual for Nutrition Surveys* (Sandstead, 1963). Riboflavin was measured fluorometrically after some interfering substances were destroyed by oxidation using potassium permanganate and others were eliminated by extraction of the riboflavin into a butanol-pyridine solution. An internal standard was used and the blank was determined by destruction of the riboflavin by irradiation. Due to the cost factor and the volume of reagents needed for the tests the urine sample was reduced to one-half the stated quantity and reagents were reduced accordingly. Even with the reduced quantity, it took more than 10 minutes for the aqueous layer to separate out. All other procedures were followed exactly.

Riboflavin and thiamin are expressed per unit creatinine, which is a measure of Lean Body Mass. Creatinine was determined by the Picrate Method as described in the *Manual for Nutrition Surveys* (Sandstead, 1963). Creatinine reacts with picrate in alkaline solutions at room temperature, and in a few minutes a stable intense orange color was produced which was measured spectrophotometrically at 520 μm. Because of the cost factor involved with the volume of reagents needed for the test, the urine was reduced to 2-ml and all reagents decreased by 90 percent. Special attention was given to time of standing because this had a definite affect upon the reading.

**Dietary**

The dietary records were three day dietary sheets completed as the person ate his meals. These records were used to
assess dietary nutritional status. This assessment was made using the Index of Nutritional Quality (INQ), a computer program developed by Dr. Gaurth Hansen and Dr. Ann Sorenson, Utah State University. Each food item and quantity consumed by the participant was coded into the computer and a computer print out of an average of the food intake for the three days was completed. The print out contained the following items: (a) grams of food eaten, (b) Kcal of energy, (c) grams or equivalents of each of the common nutrients, (d) percentage of each nutrient obtained from breakfast, lunch, dinner, and snacks, (e) percentage of recommended daily allowance filled and (f) INQ. The INQ is a measure of the quality of the diet using the total calories consumed as the base for completion of the requirement. If the nutrient percentage of the total calories consumed is the same as the nutrient percentage found in the RDA, the nutrient is given a value of one. This is then used to determine if the diet is balanced within the limits of the total Kcal consumed.

**Educational**

A questionnaire was filled out by the participants to determine how they viewed their nutritional status (Appendix B). The individuals were asked to assess their eating habits, nutrition knowledge, and their nutritional status in relationship to certain nutrients. Part II of the survey deals with their assessment of their intake of vitamin A, ascorbic acid, thiamin, and riboflavin. This self-evaluation was used to correlate with biochemical and dietary information.
RESULTS AND DISCUSSION

Dietary Surveys

The distribution of dietary vitamin A, according to the percent of the RDA met by survey participants, is shown in Figure 3. The dietary intake of vitamin A was high with 83 percent of the females and 68 percent of the males having intakes which provided more than 100 percent of the RDA. A wide range of intake values was noted with only 23 percent of the total population having intakes below 80 percent of the RDA. Values ranged from 1991 to 29,090 IU for the females and from 1988 to 45,101 IU for the males. Diets chosen by 7 percent of the male population provided nine times the RDA.

The distribution of dietary ascorbic acid, according to the percent of the RDA met by survey participants, is shown in Figure 4. This figure, also, shows distribution by sex. Males had the lowest intakes with 9 percent having intakes below 40 percent of the RDA as compared to 2 percent of the females. Again there can be noted a wide spread of values with 85 percent of the females and 78 percent of the males having intakes which provided more than 120 percent of the RDA. Male values ranged from 22 to 436 mg ascorbic acid and female values from 7 to 320 mg. Ascorbic acid values were shown to be very high with 15 of the total population choosing diets which furnished more than 370 percent of the RDA. These results are similar to the values found by Fry, Fox, and Linkswiler (1963) who noted that 18 percent of the diets studied provided 100 percent or more of the RDA.
Figure 3. Distribution of dietary vitamin A according to percent RDA met by survey participants.
Figure 4. Distribution of dietary ascorbic acid according to percent RDA met by survey participants.
The RDA values used in the study were those recommended by the National Research Council (1973). The RDA values were sufficiently high to provide a margin of safety to take into account practically all individual variations in need, efficiency of absorption, and normal losses in food preparation. These figures represent optimal intakes, for the most part about 100 percent above minimal requirements.

The distribution of dietary thiamin according to the percent RDA set by the survey participants is shown in Figure 5. Values were generally low with 76 percent of the females and 75 percent of the males having intakes which did not meet the RDA. Male values ranged from .45 to 2.54 mg and female values ranged from .35 to 2.04 mg.

The distribution of dietary intake of riboflavin according to percent RDA met by the survey participants is shown in Figure 6. Only three percent of the males and none of the females had intakes below 40 percent of the RDA. Diets were more sufficient in riboflavin than thiamin with 63 percent of the females and 53 percent of the males having intakes which met or exceeded the RDA. Riboflavin values ranged from .57 to 2.54 mg for the males and .62 to 3.22 mg for the females.

Thiamin and riboflavin requirements are most accurately based upon caloric intake. Thiamin is part of the coenzyme Thiamin pyrophosphate needed in at least three places in the metabolism of carbohydrates. An increase in carbohydrate intake creates an increased need for thiamin. The current recommendations on the National Research Council are based on a level of .5 mg of thiamin per 1,000 calories, and .55 mg of riboflavin per 1.00 calories. A better representation of the survey participants dietary thiamin and riboflavin would be to
Figure 5. Distribution of dietary thiamin according to percent RDA met by survey participants.
Figure 6. Distribution of dietary riboflavin according to percent RDA met by survey participants.
compare intake to total calories consumed. This was done using the INQ which is an Index of Nutritional Quality. The individual's vitamin intake in relation to calorie intake was compared to the RDA for that vitamin in relation to calorie requirement. A value of 1.00 would mean the individual had consumed a sufficient amount of the vitamin to meet the calorie consumed requirement.

Figure 7 shows the distribution of dietary thiamin according to the Index of Nutritional Quality. When calories consumed were taken into consideration 54 percent of the females met the requirement and 64 percent of the males met the requirement. When intake alone was considered, 25 percent of the total population met the requirement, this was raised to 59 percent meeting or exceeding the requirement when calories consumed was used as an index.

The data in Figure 8 show the distribution of dietary riboflavin according to the Index of Nutritional Quality. Using calories consumed as an index did not make as much difference in the dietary values for riboflavin as it did for thiamin. The basic requirement was met or exceeded in the diets of 74 percent of the females and 65 percent of the males according to calories consumed. When the INQ was used as a measure 70 percent of the total population had values above the requirement as compared to 58 percent when intake alone was considered.

The dietary vitamin A distribution by age and by sex is shown in Figure 9. Vitamin A values did not have any pattern except to rise at age 80 for the females. The male values peaked at age 55 and showed a sharp and steady decline at age 70. The majority of the male values fell between 4,257 and 8,795 IU with 50 percent in this range,
Figure 7. Distribution of dietary thiamin according to the Index of Nutritional Quality (mg/1,000 calories).
Figure 8. Distribution of dietary riboflavin according to the Index of Nutritional Quality (mg/1,000 calories).
and the female values fell between 4,701 and 8,766 IU with 48 percent of all the values falling in this range. Tables showing the mean ages and mean vitamin A intake with standard deviations are located in Appendixes C and D.

The comparison in Figure 9 shows that most of the vitamin A values were higher at each age class for the males than for the females. The mean concentration of dietary vitamin A was slightly higher for the males having a value of $8,745 \pm 4,076$ IU as compared to $7,411 \pm 5,419$ IU for the females.
The dietary ascorbic acid distribution by age and by sex is summarized in Figure 10. The female ascorbic acid values did not show any definite pattern with age. They reached their lowest point at age 75, but started to rise again after this point. The male values decreased with age showing a sharp decline after age 75.

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Figure 10. Dietary ascorbic acid distribution by age and by sex.
The ascorbic acid dietary values were only slightly different for the males and females having values of $104 \text{ mg} \pm 83 \text{ sd}$ and $102 \text{ mg} \pm 54 \text{ sd}$ respectively. The values again showed a great deal of variance with the majority of the values falling between 61-129 mg for 54 percent of the females and 42-146 mg for 75 percent of the males. Tables showing mean ages and mean ascorbic acid intake with standard deviation are found in Appendixes C and D.

The dietary intake of both thiamin and riboflavin were higher for males than for the females. Dietary intake of thiamin was $1.02 \pm .38$ and $0.86 \pm .29$ mg for males and females respectively. The riboflavin dietary values were $1.55 \pm .65$ mg and $1.32 \pm .47$ mg for males and females respectively.

Seasonal differences

The mean dietary vitamin values for the population by sex for fall and spring are given in Table 2. Mean values of three vitamins, ascorbic acid, thiamin and riboflavin, were higher in the spring for both male and female. Vitamin A dietary values were higher in the fall for both male and female.

Table 2. Mean dietary vitamin values for the population by sex and by season.

<table>
<thead>
<tr>
<th>Season</th>
<th>Vitamin A</th>
<th>Ascorbic acid</th>
<th>Thiamin</th>
<th>Riboflavin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IU</td>
<td>mg</td>
<td>mg</td>
<td>mg</td>
</tr>
<tr>
<td></td>
<td>Males Females</td>
<td>Males Females</td>
<td>Males Females</td>
<td>Males Females</td>
</tr>
<tr>
<td>Fall</td>
<td>8795</td>
<td>7411</td>
<td>104</td>
<td>102</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>4076</td>
<td>5419</td>
<td>83</td>
<td>54</td>
</tr>
<tr>
<td>Spring</td>
<td>7783</td>
<td>6136</td>
<td>111</td>
<td>105</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>5866</td>
<td>4879</td>
<td>78</td>
<td>56</td>
</tr>
</tbody>
</table>
This disagrees with the results of Roine et al. (1974) and Dibble et al. (1967) who found lower values in the winter months for ascorbic acid and riboflavin. One reason for the discrepancy could be that these data were taken in early spring instead of winter. Also the elderly in the study were given nutrition education on their fall dietary surveys, which may have caused a change in normal eating habits. One other explanation could be a higher caloric intake in the winter months.

Biochemical Survey

A summary of the biochemical status of the survey participants for plasma ascorbic acid, carotene, and vitamin A, is shown in Table 3. The classifications were those outlined in The Manual for Nutrition Surveys (Sandstead, 1963) and those outlined by Sauberlick, Dowdy, and Skala (1974).

Table 3. Biochemical status of the survey participants for plasma vitamin A, ascorbic acid, and carotene.

<table>
<thead>
<tr>
<th>Group</th>
<th>Percent of group with vitamin A levels considered</th>
<th>Percent of group with carotene levels considered</th>
<th>Percent of group with ascorbic acid levels considered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D*</td>
<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Males</td>
<td>4</td>
<td>45</td>
<td>52</td>
</tr>
<tr>
<td>Females</td>
<td>6</td>
<td>52</td>
<td>41</td>
</tr>
<tr>
<td>M and F</td>
<td>6</td>
<td>50</td>
<td>44</td>
</tr>
</tbody>
</table>

*(D-deficient, L-low, A-acceptable, H-high)
Ascorbic acid values were low with 40 percent of the total population having values between .10-.19 mg/100 ml. This does not agree with the dietary intake data which has 81 percent of the population having values which exceeded 120 percent of the RDA. The long period of storage and subsequent suspected deterioration of samples is one explanation for this contradiction.

The vitamin A data shows that 6 percent of the population had low values with 50 percent having acceptable values and 44 percent having high values. Female values ranged from 15 to 88 μg/100 ml with 58 percent of the values falling in this range.

Carotene values were very high with 100 percent of the females and 94 percent of the males with high values. The mean value for the males was 788 ± 485 μg/100 ml and 819 ± 560 μg/100 ml for the females. Values ranged from 60-3,060 mg/100 ml.

Plasma carotene values reflect fruit and vegetable intake more than plasma vitamin A values. The values in the fall were very high which could be a reflection of the final fruits of a home garden.

Table 4 gives a breakdown of biochemical status of the survey participants for urinary thiamin and riboflavin excretion. The source of the interpretation guide was the same as the one used for vitamin A and ascorbic acid. The values were expressed in μg/gm creatinine.

Two percent of the total population had low values for thiamin as compared with one percent low riboflavin values. The greatest percentage of the values were in the high category with 96 percent of thiamin and 90 percent of riboflavin values falling in this category. Thiamin values ranged from 260 to 99,893 μg/gm creatinine.
The female mean values were higher having a value of $1,781 \pm 2,028 \, \text{g/gm creatinine}$ as compared to $951 \pm 896$ for the males. Riboflavin values ranged from 51 to $13,103 \, \mu\text{g/gm creatinine}$. The female mean value was almost twice as high as the male having values of $2,661 \pm 2,610$ and $1,396 \pm 1,594 \, \mu\text{g/gm creatinine}$ respectively. This agrees with the Ten-State Nutrition Survey (1974) which also found a wide range of values and high values for thiamin and riboflavin.

The mean plasma levels of vitamin A for the different age categories and by sex are shown in Figure 11. The male values showed a wide variation with age, but start to drop at age 70 and reach the lowest value at age 83. Females values were the lowest at both ends of the scale, under 50 and over 85 years of age. The plasma vitamin A levels in females decreased sharply starting at age 83. The mean vitamin A level for the males was slightly higher than in females ($52 \pm 21 \, \mu\text{g/100 ml}$ as compared to $50 \pm 19 \, \mu\text{g/100 ml}$). Tables showing the mean age and concentration of plasma vitamin A

<table>
<thead>
<tr>
<th>Group</th>
<th>Percent of group with thiamin levels considered</th>
<th>Percent of group with riboflavin levels considered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D*</td>
<td>L</td>
</tr>
<tr>
<td>Males</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Females</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>M a n F</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

*(D-deficient, L-low, A-acceptable, H-high)*
Figure 11. Plasma vitamin A distribution by age and by sex.

There was a positive correlation between plasma vitamin A and dietary vitamin A for the males. Both graphs show low values at both ends of the scale with peaks at 57-75 years of age. There was a poor
correlation between dietary vitamin A and plasma vitamin A in the females.

The distribution of plasma ascorbic acid by age and by sex is summarized in Figure 12. The values represent the mean age and concentration for each category. There was no age pattern in the male ascorbic acid values. The values peaked at age 62 and went to the lowest value at age 67. The female values showed a general decrease after age 57, dropping to the lowest value at age 87. Tables found in Appendixes E and F give the mean age and concentration for ascorbic acid.

Figure 12. Plasma ascorbic acid distribution by age and by sex.
There was a low correlation between dietary ascorbic acid and plasma ascorbic acid for either the males or females. Many factors which could effect plasma ascorbic acid levels were not considered in the graph. They include smoking, dietary supplements, and variations within each age category. These factors could account for the discrepancy in the data.

The mean plasma ascorbic acid level for the female was .12 mg/100 ml as compared to .10 mg/100 ml for the male. This agrees with the findings of Bramkamp and Wirth (1973) who found higher plasma ascorbic acid levels for elderly women as compared to elderly men.

Seasonal differences

Vitamin A levels were higher in the fall as compared to the spring levels. Male biochemical values were $52 \pm 21 \mu g/100$ ml and female values $49 \pm 19 \mu g/100$ ml for the fall data as compared to $50 \pm 12 \mu g/100$ ml and $48 \pm 11 \mu g/100$ ml for the spring data.

Carotene biochemical levels were also higher in the fall as compared to the spring. The fall values were $788 \pm 485 \mu g/100$ ml and $819 \pm 560 \mu g/100$ ml for the males and females respectively. The spring values were $330 \pm 159 \mu g/100$ ml and $358 \pm 164 \mu g/100$ ml for the males and females respectively. A breakdown of the biochemical status of the survey participants for the spring data for plasma ascorbic acid, plasma vitamin A, and plasma carotene is given in Table 5.

Ascorbic acid levels were low with 62 percent of the total population having values between .10 and .19 mg/100 ml. This does not agree with the dietary intake data which had high values. One
Table 5. Spring biochemical status of the survey participants for plasma vitamin A, plasma carotene and plasma ascorbic acid.

<table>
<thead>
<tr>
<th>Group</th>
<th>Percent of group with vitamin A levels considered</th>
<th>Percent of group with carotene levels considered</th>
<th>Percent of group with ascorbic acid levels considered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Males</td>
<td>59</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>.9</td>
<td>61</td>
<td>38</td>
</tr>
<tr>
<td>N and F</td>
<td>.6</td>
<td>61</td>
<td>39</td>
</tr>
</tbody>
</table>

*(D-deficient, L-low, A-acceptable, H-high).*

Explanation for the difference could be a deterioration of the samples prior to analysis. If this was the case then the values would be low. With a one division shift upward of the values the distribution takes on a more normal picture and agrees more with the results of Brin et al. (1965), who found 6, 24, and 68 percent of the population with low, acceptable, and high plasma ascorbic acid levels respectively.

The spring plasma vitamin A and carotene values are much the same as the fall values. The values are high with 99 percent of the total population having values in the acceptable as high categories. There is a slight decrease in the number of low levels of plasma vitamin A in the spring 0.6 percent of the population had low levels as compared to 6 percent with low levels in the fall.

Spring plasma carotene values were high with 99 percent falling in the high range. Fall plasma carotene values were almost twice as large as the spring values while the plasma vitamin A levels were relatively the same for both seasons. One explanation for this
could be a decrease in dietary intake of fresh fruits and vegetables because their gardens were not producing.

Table 6 gives a breakdown of the biochemical status of the survey participants for the spring data on urinary thiamin and riboflavin excretion.

Table 6. Spring biochemical status of the survey participants for urinary thiamin and urinary riboflavin excretion.

<table>
<thead>
<tr>
<th>Group</th>
<th>Percent of group with thiamin levels considered</th>
<th>Percent of group with riboflavin levels considered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D*</td>
<td>L</td>
</tr>
<tr>
<td>Males</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>Females</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>M and F</td>
<td>16</td>
<td>21</td>
</tr>
</tbody>
</table>

*(D-deficient, L-low, A-acceptable, H-high)*

Both the thiamin and riboflavin urinary excretion levels were lower in the spring. Eleven percent of the thiamin values and 4 percent of the riboflavin values were in the deficient range. These values agree more with dietary records than the fall data. The values also agree with the data of Brin et al. (1965) who found 21 percent of the population with deficient thiamin levels. A wide range of values can be noted with 45 percent of the riboflavin urinary excretion levels and 32 percent of the thiamin urinary excretion levels falling in the high category.
Individual's Perceived Status Survey

A frequency distribution of the individual's perceived nutritional status for each of the four vitamins surveyed, vitamin A, ascorbic acid, thiamin, and riboflavin is given in Table 7.

Table 7. Perceived nutritional status of the survey participants for vitamin A, ascorbic acid, thiamin, and riboflavin.

<table>
<thead>
<tr>
<th>Perceived Status</th>
<th>Vitamin A</th>
<th>Ascorbic Acid</th>
<th>Thiamin</th>
<th>Riboflavin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Inadequate</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Inadequate</td>
<td>6%</td>
<td>12%</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Adequate</td>
<td>91%</td>
<td>85%</td>
<td>91%</td>
<td>92%</td>
</tr>
<tr>
<td>Excessive</td>
<td>1%</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

On the average 90 percent of the population felt they had adequate diets in relationship to the four nutrients. Only 8 percent of the population felt they had low intakes for one of the four vitamins and two percent felt they had very low intakes for one of the vitamins.

In order to relate the three sets of information, all three sets were given equal rank. Biochemical data was ranked from one to four with one representing deficient level and four representing a high level. Dietary intake was also ranked from one to four. The following gives a breakdown of how the vitamin intake was evaluated: 0-.666 RDA was ranked 1, from .666 RDA to .999 RDA was ranked 2, from 1.00 RDA to
1.50 RDA was given a value of 3, and above 1.50 of the RDA was given a value of 4. The information from the individual's perceived status survey was also ranked. Very inadequate was given a value of 1, inadequate-2, adequate-3, and excessive-4.

The statistical test used to find the correlation among the three sets of data was the Spearman $r$ (Mendenhall, 1971). This test was used to determine the rank correlation coefficient. Because of the small difference of three between the highest and lowest value some modification in interpretation of data was needed. In a true test a value of 1 denotes a perfect correlation and a value of -1 denotes a perfect non-correlation. To evaluate the correlation, the correlation coefficient for a perfect non-correlation was determined. This was then used as a basis for interpretation of the data. Table 8 gives the correlation coefficient for dietary vs. perceived status and dietary vs. biochemical status for each of the four vitamins.

Table 8. Correlation coefficient for dietary vs. perceived and dietary vs. biochemical status for vitamin A, ascorbic acid, thiamin and riboflavin.

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Dietary vs. Perceived</th>
<th>Dietary vs. Biochemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>.966</td>
<td>.956</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>.970</td>
<td>.850</td>
</tr>
<tr>
<td>Thiamin</td>
<td>.999</td>
<td>.996</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>.976</td>
<td>.984</td>
</tr>
</tbody>
</table>
The correlation coefficient for a perfect non-correlation is 0.7149. If a correlation coefficient is greater than 1/2 of the distance between 0.7149 and 1.0 (0.8574) it is more correlated than it is not correlated. The closer the value is to one the greater correlation there is between the two populations. The greatest correlation was found in the thiamin data. Both the dietary vs. perceived and the dietary vs. biochemical coefficients were very close to one. The correlation can be seen in the other values as they approximate one. No correlation was found between ascorbic acid dietary and biochemical data. This was probably due to the deterioration of the ascorbic acid with prolonged storage.

The values for Cedar City were not used in the correlations, because the individual surveys were not completed until after the participants had received the information from the dietary surveys. This slanted the answers, since the appraisal was not based on their feelings but on fact. The population in the five areas studied were not significantly different so it was felt this would not change the final results.
SUMMARY AND CONCLUSION

The diets of 192 elderly people in southern Utah were evaluated to determine their status relative to vitamin nutrition. The mean age of the subjects was 69. Three types of information were used in the evaluation: a three day dietary recall, biochemical analysis of blood and urine, and a survey in which the participants evaluated their nutritional status. Four vitamins were evaluated, vitamin A, ascorbic acid, thiamin, and riboflavin.

Dietary surveys were evaluated using a computer program which gave the INQ, an index of the quality of the diet for each nutrient consumed related to total caloric consumption.

The average dietary vitamin A level was 8,078 IU; the levels were higher in the males (8,745 IU) than in the females (7,411 IU). Out of the total population surveyed 75 percent had levels which met or exceeded the RDA. No relationship was found between female dietary vitamin A levels and age. Male levels decreased sharply at age 70.

Ascorbic acid dietary levels were high with 15 percent of the population having diets which provided more than 360 percent of the RDA. Diets were chosen by 13 percent of the population which provided less than 80 percent of the RDA. The average level was 103 mg. Female levels did not show any age pattern, but male dietary ascorbic acid levels decreased with an increase in age. There was no significant difference between male and female dietary ascorbic acid levels.
The average dietary thiamin level was .94 mg. Male levels were higher (1.02 mg) than the female (.86 mg). Values were generally low with 76 percent of the females and 75 percent of the males having intakes which did not provide the RDA. When thiamin intake was related to calories consumed this was reduced to 41 percent of the population having low levels.

Riboflavin levels were generally inadequate with 42 percent of the population choosing diets which did not provide the RDA. When riboflavin intake was related to calories consumed, 30 percent of the population chose diets which did not provide the RDA. The mean dietary riboflavin intake level was 1.44 gm. Male levels were higher (1.55 mg) than females (1.32 mg).

Dietary ascorbic acid, riboflavin, and thiamin levels were higher in the spring than in the fall for both male and female. Dietary vitamin A levels were higher in the fall for both sexes.

The average plasma vitamin A level was 50 μg/100 ml. There was no significant difference between male and female levels. Out of the total population 6 percent had low plasma vitamin A levels and 44 percent had high levels. Male levels showed some age relationship starting to decrease at age 70. Female plasma vitamin A levels were the lowest at both ends of the scale under 50 and over 85 years of age. Fall plasma carotene levels were high with 97 percent of the population having high values.

The average plasma ascorbic acid level was .11 mg/100 ml. Forty-one percent of the total population had low levels. This was suspected to be related to the long period of storage before analysis. There was no relationship between male plasma ascorbic acid levels and
age. Female levels decreased after age 57 reaching the lowest level at age 87.

Two percent of the population had low urinary thiamin levels, as compared to one percent of the population with low urinary riboflavin levels. The largest percentage of the values were in the high category with 96 percent of the thiamin values and 90 percent of the riboflavin values falling in this range. Both urinary thiamin and urinary riboflavin excretion levels were higher for the females than the males.

Plasma vitamin A and plasma carotene levels were higher in the fall as compared to the spring.

When asked to evaluate their diets the majority of the population (90 percent) felt their diets were adequate in relationship to the four vitamins.

When the three sets of data were related a positive correlation was found between dietary and perceived status, and dietary and biochemical status for thiamin, riboflavin, and vitamin A. Dietary and biochemical status for ascorbic acid showed no correlation. There was a correlation between perceived and dietary status for ascorbic acid. The disagreement in the data could be because of deterioration of plasma ascorbic acid with storage.

In general the survey participants were choosing diets which provided the four vitamins studied in sufficient amounts. The most limiting nutrients were found to be thiamin and riboflavin. It was interesting to note that in previous studies Wilcox, Gillium
and Hard (1962); Hendel (1969), and the Ten-State Nutrition Survey (1974) ascorbic acid was found to be the most limiting vitamin.

One characteristic of this group was the high percentage of home canning. This could account for the high dietary intake of vitamin A, carotene, and ascorbic acid. This was also a cattle raising area with little pork production which is a good source of thiamin.

The emphasis in this area needs to be shifted from the more commonly known nutrients ascorbic acid and vitamin A, to the less emphasized nutrients, thiamin and riboflavin.

Many segments of this study would be further pursued. Some areas for possible further study would include: vitamin supplementation correlated to biochemical levels, mean vitamin status of the different communities, degree of smoking correlated to plasma ascorbic acid levels, and rural Utah vitamin status of elderly compared to urban Utah vitamin status of elderly.

One possible problem with this study could be in using volunteer subjects, the more vigorous and alert of the population may have been surveyed and no access given to the indisposed, in which there might have been intermittent, if not more serious nutritional problems.
LITERATURE CITED


Morgan, Agnes Fay. 1959. Nutritional status USA. California Agriculture Experiment Station Bulletin 769.


APPENDIXES
Map of the Five-County Area of Utah
<table>
<thead>
<tr>
<th>Part II</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Very Inadequate</th>
<th>Inadequate</th>
<th>Adequate</th>
<th>Very Excessive</th>
<th>Very Excessive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Your vitamin A intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Your vitamin C intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Your iron intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Your protein intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Your thiamin intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Your calcium intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Your riboflavin intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Your calorie intake is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

Table 9. Female dietary vitamin A and ascorbic acid mean intake by age.

<table>
<thead>
<tr>
<th>Age</th>
<th>No.</th>
<th>Mean age</th>
<th>Mean vitamin A (IU) intake</th>
<th>Mean ascorbic acid (mg) intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>4</td>
<td>45</td>
<td>4524 ± 949</td>
<td>104 ± 36</td>
</tr>
<tr>
<td>51-55</td>
<td>7</td>
<td>54</td>
<td>5487 ± 2576</td>
<td>103 ± 34</td>
</tr>
<tr>
<td>56-60</td>
<td>7</td>
<td>58</td>
<td>6651 ± 6545</td>
<td>109 ± 59</td>
</tr>
<tr>
<td>61-65</td>
<td>19</td>
<td>63</td>
<td>8376 ± 5601</td>
<td>100 ± 34</td>
</tr>
<tr>
<td>66-70</td>
<td>28</td>
<td>69</td>
<td>7711 ± 5414</td>
<td>103 ± 52</td>
</tr>
<tr>
<td>71-75</td>
<td>27</td>
<td>73</td>
<td>8474 ± 6455</td>
<td>116 ± 67</td>
</tr>
<tr>
<td>76-80</td>
<td>17</td>
<td>78</td>
<td>5152 ± 2641</td>
<td>79 ± 50</td>
</tr>
<tr>
<td>81-85</td>
<td>9</td>
<td>83</td>
<td>6395 ± 3274</td>
<td>96 ± 44</td>
</tr>
<tr>
<td>85&lt;</td>
<td>5</td>
<td>88</td>
<td>11903 ± 5757</td>
<td>107 ± 76</td>
</tr>
</tbody>
</table>
Table 10. Male dietary vitamin A and ascorbic acid mean intake by age.

<table>
<thead>
<tr>
<th>Age</th>
<th>No.</th>
<th>Mean age</th>
<th>Mean vitamin A (IU) intake</th>
<th>Mean ascorbic acid (mg) intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>1</td>
<td>46</td>
<td>7543</td>
<td>55</td>
</tr>
<tr>
<td>51-55</td>
<td>4</td>
<td>53</td>
<td>5780 ± 2420</td>
<td>133 ± 56</td>
</tr>
<tr>
<td>56-60</td>
<td>6</td>
<td>59</td>
<td>12884 ± 12956</td>
<td>127 ± 99</td>
</tr>
<tr>
<td>61-65</td>
<td>8</td>
<td>64</td>
<td>12344 ± 12549</td>
<td>121 ± 116</td>
</tr>
<tr>
<td>66-70</td>
<td>8</td>
<td>68</td>
<td>7678 ± 3691</td>
<td>123 ± 53</td>
</tr>
<tr>
<td>71-75</td>
<td>14</td>
<td>73</td>
<td>11163 ± 10688</td>
<td>102 ± 86</td>
</tr>
<tr>
<td>76-80</td>
<td>11</td>
<td>76</td>
<td>7055 ± 3477</td>
<td>100 ± 64</td>
</tr>
<tr>
<td>85&lt;</td>
<td>7</td>
<td>84</td>
<td>2413 ± 275</td>
<td>48 ± 44</td>
</tr>
</tbody>
</table>
### Table 11. Female biochemical vitamin A and ascorbic acid mean concentrations by age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Mean vitamin A concentration (µg/100 ml)</th>
<th>Mean ascorbic acid concentration (mg/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>34 ± 18</td>
<td>.12 ± .01</td>
</tr>
<tr>
<td>51-55</td>
<td>51 ± 18</td>
<td>.12 ± .05</td>
</tr>
<tr>
<td>56-60</td>
<td>46 ± 22</td>
<td>.14 ± .06</td>
</tr>
<tr>
<td>61-65</td>
<td>48 ± 24</td>
<td>.10 ± .06</td>
</tr>
<tr>
<td>66-70</td>
<td>50 ± 15</td>
<td>.12 ± .07</td>
</tr>
<tr>
<td>71-75</td>
<td>54 ± 21</td>
<td>.12 ± .06</td>
</tr>
<tr>
<td>76-80</td>
<td>51 ± 17</td>
<td>.11 ± .04</td>
</tr>
<tr>
<td>80-85</td>
<td>54 ± 17</td>
<td>.12 ± .04</td>
</tr>
<tr>
<td>85+</td>
<td>35 ± 7</td>
<td>.09 ± .02</td>
</tr>
</tbody>
</table>
## Appendix F

### Table 12. Male biochemical vitamin A and ascorbic acid mean concentration by age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Mean vitamin A Concentration (mg/100 ml)</th>
<th>Mean ascorbic acid Concentration (mg/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;55</td>
<td>52 ± 10</td>
<td>.12 ± .05</td>
</tr>
<tr>
<td>56-60</td>
<td>63 ± 29</td>
<td>.09 ± .04</td>
</tr>
<tr>
<td>61-65</td>
<td>49 ± 18</td>
<td>.14 ± .06</td>
</tr>
<tr>
<td>66-70</td>
<td>46 ± 15</td>
<td>.08 ± .05</td>
</tr>
<tr>
<td>71-75</td>
<td>60 ± 21</td>
<td>.09 ± .05</td>
</tr>
<tr>
<td>76-80</td>
<td>47 ± 26</td>
<td>.11 ± .05</td>
</tr>
<tr>
<td>80&lt;</td>
<td>42 ± 14</td>
<td>.11 ± .03</td>
</tr>
</tbody>
</table>
VITA
Karen Sims Faddis
Candidate for the Degree of
Master of Science

Thesis: Selected Vitamin Status of Elderly People in Southern Utah Measured Biochemically and Dietarily, and Correlated to Their Perceived Status.

Major Field: Nutrition and Food Sciences

Biographical Information:


Education: Attended Clark elementary school; graduated from Evanston High School 1971; received the Bachelor of Science degree from Utah State University, with a major in Home Economics Education, in 1974; completed requirements for the Master of Science degree, specializing in nutrition at Utah State University in 1976.