STUDIES OF THE VALIDITY OF THE ESTIMATION OF FOOD CONSUMPTION BASED UPON ANALYZED AND COMPUTED WEIGHED INTAKE

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Theodora F. S. M. van Schaik

1951

This is to certify that the

thesis entitled

Studies on the validity of the
estimation of food consumption
based upon analyzed and computed
weighed intakes.

presented by

Theodora F. S. M. Van Schaik

has been accepted towards fulfillment
of the requirements for

Master of Science degree in Foods and Nutrition

Wilma D. Brewer
Major professor

Date August 1, 1951

O-169

STUDIES OF THE VALIDITY OF THE ESTIMATION OF FOOD CONSUMPTION BASED UPON ANALYZED AND COMPUTED WEIGHED INTAKE

By

Theodora F. S. M. van Schaik

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Foods and Nutrition
School of Home Economics

1951

THESIS

STUDIES OF THE VALIDITY OF THE ESTIMATION OF FOOD CONSUMPTION BASED UPON ANALYZED AND COMPUTED WEIGHED INTAKE

By

Theodora F. S. M. van Schaik

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Foods and Nutrition

Year 1951

Approved: Wilma D. Brewer

STUDIES OF THE VALIDITY OF THE ESTIMATION OF FOOD CONSUMPTION BASED UPON ANALYZED AND COMPUTED WEIGHED INTAKE

The present study was undertaken to supply additional information concerning the reliability of different methods of calculating records of food intake and the possible relationship between the length of period of observation and the validity of the estimation of food intakes.

The study was divided into four parts: (a) The ten day dietary intake of protein, calcium and phosphorus of eighteen older women were computed by two methods of calculation from weighed food portions. The results were compared with values obtained by chemical analysis of the diets. (b) The seven day intake of calories, protein and riboflavin of eighteen college women were computed by two methods of calculation from measured and weighed food portions. The values obtained were compared with values obtained by chemical analysis of the diets. (c) A comparison was made between the means of the average protein, calcium and phosphorus intakes of ten older women for successive time intervals. (d) The individual protein, calcium and phosphorus intakes of ten older women for a period of twenty days were studied. The mean values and standard errors of the mean for three, five, seven, ten, twelve, fourteen, sixteen, eighteen and twenty days were computed and compared.

The data obtained indicated that the dietary intakes of calories, protein, calcium, phosphorus and riboflavin of a group of individuals can be estimated closely by calculation of the dietary intake.

The mean calcium intake of eighteen women as determined by chemical analysis was significantly higher than that determined by calculation by the food tables of Donelson and Leichsenring (1945). However the analyzed values did not differ significantly from the intake calculated by the food tables of the Bureau of Home Economics (1945). The size of the group appeared to affect the validity of estimation of the dietary intake. When the intake of calcium for a seven day period was determined for a group of only seven women, the calcium intake determined by chemical analysis was significantly higher than the calculated calcium intakes.

The error of estimate of the dietary intakes of ten older women decreased as the length of time of observation was increased. Since the error of estimate was constant after seven to ten days, a study of a dietary pattern for a seven days period including Saturday and Sunday seems desirable.

The study on the individual intakes of ten older women indicated that a good estimate of protein can be obtained from 10 to 16 consecutive days of dietary records, of phosphorus from 12 consecutive days, and of calcium from 16 days. It would appear therefore that a 14 day period would be desirable to estimate the protein, calcium and phosphorus intakes of an individual.

Donelson, E. G., J. M. Leichsenring 1945 Food composition table for short method of dietary analysis. J. Amer. Dietet. Assoc., 21: 440.

Bureau of Human Nutrition and Home Economics in Cooperation with the National Research Council 1945 Table of food composition in terms of eleven nutrients. U. S. Dept. of Agr., Misc. Pub. 572.

ACKNOWLEDGMENTS

The author wishes to express her sincere gratitude to Dr. Margaret A. Ohlson for making this interesting study possible and having suggested a problem that will be very valuable to the author's work in the Netherlands and for her kind advice throughout the study. The author deeply appreciates the patient guidance and the criticism of Dr. Wilma D. Brewer and her great help to accomplish the study in the available time.

She is indebted to Dr. William Baten for his help with the statistical analysis and very grateful to Blair Williams, Lois Jackson, and Ruth Beegle for their helpfulness, interest and encouragement during this study.

The author thanks the Department of Foods and Nutrition for making available dietary records and results of the chemical analysis.

Grateful acknowledgment is also due to the American Home Economics Association, the Omicron Nu Club, The Home Economics Club of Michigan State College, the Institute of International Education and Michigan State College for the Scholarships provided, without which, the study would not have been possible. Finally the author extends her sincere thanks to the Public Health Department, Ministry of Social Affairs of the Netherlands for having granted study leave.

TABLE OF CONTENTS

Page

INTRODUCTION.. 1

REVIEW OF LITERATURE.. 1

- Methods for estimating food consumption....................... 1

- Evaluation of the food value of diets from dietary records.. 8

- Calculation of diets by values from food groups............... 14

EXPERIMENTAL PROCEDURE.. 19

- Dietary records... 19

- Calculation of dietary intakes................................ 22

- Sampling of diets for chemical analysis....................... 22

- Statistical interpretation of data............................ 23

RESULTS AND DISCUSSION.. 24

- Comparison of calculated and analyzed food intake of eighteen older women.. 24

- Comparison of estimated calorie, protein, riboflavin intakes of eighteen college women, determined by chemical analysis and by dietary calculation from weighed and measured food portions........................ 29

- Average protein, calcium and phosphorus intakes of ten older women during successive time intervals from one to twenty-five days... 36

- Protein, calcium and phosphorus intakes of individual women during successive time intervals for a period of twenty days.. 37

SUMMARY AND CONCLUSION.. 47

LITERATURE CITED.. 50

APPENDIX.. 5[illegible]

TABLES

TABLE	TITLE	PAGE
1.	Description of Subject and Methods of Evaluation of Food Intakes	20
2.	Estimated Protein Intakes of Eighteen Older Women as Determined by Chemical Analysis and Computed by Two Methods of Calculation	25
3.	Estimated Calcium Intakes of Eighteen Older Women as Determined by Chemical Analysis and Computed by Two Methods of Calculation	26
4.	Estimated Phosphorus Intakes of Eighteen Older Women as Determined by Chemical Analysis and Computed by Two Methods of Calculation	27
5.	Estimated Calorie Intakes of Eighteen College Women as Determined by Chemical Analysis and by Dietary Calculation from Weighed and Measured Food Portions	31
6.	Estimated Protein Intakes of Eighteen College Women as Determined by Chemical Analysis and by Dietary Calculation from Weighed and Measured Food Portions	32
7.	Estimated Riboflavin Intakes of Eighteen College Women as Determined by Chemical Analysis and by Dietary Calculation from Weighed and Measured Food Portions	33
8.	Estimated Calcium Intakes of Eighteen College Women as Determined by Chemical Analysis and by Dietary Calculation from Weighed and Measured Food Portions	35

[illegible]. The Average Protein, Calcium and Phosphorus Ingested by 10 Older Women During Successive Time Intervals from One to Twenty-five Days .... [illegible]

10. The Average Amount of Protein in Grams Per Day Ingested by 10 Older Women During Successive Time Intervals from Three to Twenty Days .... [illegible]

11. The Average Amount of Calcium in Grams Per Day Ingested by 10 Older Women During Successive Time Intervals from Three to Twenty Days .... [illegible]

12. The Average Amount of Phosphorus in Grams Per Day Ingested by 10 Older Women During Successive Time Intervals from Three to Twenty Days .... [illegible]

APPENDIX

13. The Average Protein Intakes of 10 Older Women During Successive Time Intervals from One to Twenty-five Days .... [illegible]

14. The Average Calcium Intakes of 10 Older Women During Successive Time Intervals from One to Twenty-five Days .... [illegible]

15. The Average Phosphorus Intakes of 10 Older Women During Successive Time Intervals from One to Twenty-five Days .... [illegible]

16. Daily Amount of Protein Ingested by 10 Older Women During Twenty Consecutive Days Expressed in Grams .... [illegible]

17. Daily Amount of Calcium Ingested by 10 Older Women During Twenty Consecutive Days Expressed in Grams .... [illegible]

18. Daily Amount of Phosphorus Ingested by 10 Older Women During Twenty Consecutive Days Expressed in Grams .... [illegible]

FIGURES

NUMBER	TITLE	PAGE
1.	Average of the Standard Errors of the Mean Protein Intake for Ten Older Women During Successive Time Intervals	41
2.	Average of the Standard Errors of the Mean of the Calcium and Phosphorus Intakes for Ten Older Women During Successive Time Intervals	44

INTRODUCTION

Studies of the validity of the estimation of food consumption based upon analyses and computed weighed intakes.

INTRODUCTION

During the last decade the analysis of dietary intakes of individuals or groups has become an important tool in evaluation of nutritional status. The knowledge of dietary intakes has moreover become an important factor in national and international socio-economics, since the information has been applied to problems of food distribution among various countries.

The methods in use for estimating the food consumption of individuals vary from a qualitative dietary history or food habit inquiry to quantitative laboratory analysis of the composition of food eaten. Each method has its relative advantages and disadvantages. Therefore it is important to consider carefully which method is the most suitable under certain circumstances and for a particular purpose (Food and Nutrition Board of the National Research Council, 1949).

The present study was undertaken to obtain additional information concerning the relative value of different methods of recording food intakes and the possible relationship between the length of period of observation and the validity of the estimation of food intakes.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Methods For Estimating Food Consumption. Various methods have been used to estimate the food consumption of individuals or groups; however these methods may be considered to fall within five types of procedures.

The simplest method which has been used for estimating food consumption is the diet recall method in which a record of the foods ingested by an individual or group over a 24 hour period is obtained by personal interview or through correspondence. In contrast with the dietary survey, the dietary history is used to obtain information about the characteristic food pattern of an individual over a relatively long period of time. For a dietary history, personal interviews are conducted to obtain answers for planned questionnaires. The third method is that of the consumption survey in which an inventory is taken of the food on hand in the home at the beginning and end of a seven day period and a record is made of the food brought into the house during that time. Another method consists of obtaining records of the quantity of food eaten by the individual by measuring in common household units or by weighing. The fifth method commonly employed is that of the dietary analysis in which all foods eaten are weighed and aliquots of foods are taken for laboratory analysis.

There have been relatively few studies which have attempted to evaluate the reliability of the results obtained by the various methods of studying food consumption. The simplest procedure and least expensive to carry out is that of the diet recall. However studies of food consumption in Vienna in 1946 (Collins, 1948) indicated that there was considerable error in the results of a twenty-four hour dietary survey for a large group of people. In this study, 1,822 dietary records of the amounts and kinds of foods consumed over the preceding twenty-four hours were obtained by dietitians through interviews. The dietary survey was compared with the official issue of food which was considered to represent nearly the total that was available to eat. It appeared that the dietary records of the normal consumers agreed fairly closely with the offical issue of food however, the dietary records of the employees, children and workers indicated food consumption that was lower, greater and lower, respectively, than the official issue. On the average a discrepancy of 18,000 calories for each hundred people was found.

Some investigators have considered that the results obtained from dietary studies were more indicative of the nutritional status of groups when the diet recall was combined with dietary histories. For example, Wiehl (1942b) collected dietary histories in order to obtain further information about the dietary deficiencies of industrial workers and their effect on health and absenteeism. The information obtained was of two types. On record was a quantitative estimate by the informant of all food consumed during the two days preceding the interview; the other record was for the remaining five days of a one-week period and required for the most part only the listing of foods in selected categories which had been included in the diet. The two day quantitative diet history furnished a complete description of all food consumed at each meal and between meals. To assist the informant in describing the servings, models of measured quantities of several foods were displayed on the desk of the interviewer and glasses of different sizes were at hand. These were used as standards of reference and the employee was asked to estimate the amounts of different foods consumed in relation to some one of the sample portions. Wiehl (1942a, 1942b, 1944, 1945) considered that the quantitative values for each food obtained by this method were only approximate, but believed that the estimate of total food intake was reasonably accurate for classifying diets into several broad groups according to food consumption.

A series of studies in which dietary histories were used to evaluate the diets of infants, children and adults has been reported by Burke (1938, 1943, 1947, 1948). Burke obtained recall records of food intake during the twenty-four hours preceding the interview with the subject and also obtained answers to a questionnaire which described the health of the subject, his way of living, economical status, eating habits and other facts related to nutrition. In addition a record of food intake for three consecutive days in the interval under consideration was obtained. The information concerning diets which was obtained in this way was correlated with clinical observations.

The use of the dietary history was applied in England by Bransby (1944, 1945) in studies of the diets of school children in two industrial towns. These children were participating in controlled vitamin feeding tests. Bransby asked the mothers of the children who were selected for the study to cooperate by recording the amount of food eaten by the children during one week. During the week that the dietary records were kept, each of the cooperating mothers was visited by a field worker of the Wartime Social Service, who checked the dietary data and collected other relevant information. The total food intake of the children included the meals provided at school as well as the food consumed at home. The average dietary intakes of both groups of children were compared with the nutritional requirements established by the League of Nations (1938), and the influence of supplements of various vitamins on growth, health and physical fitness was studied.

These studies of Wiehl, Burke and Bransby, illustrate the way in which results of dietary histories have been used to give supplemental information in studies attempting to evaluate nutritional status.

The food inventory method is a procedure which has been used to provide a measure of food consumption for individual families as well as averages for groups of families. The food consumption method was applied by Youmans (1942) in a survey of the nutritional status of a rural population in middle Tennessee. Preliminary visits were made to secure cooperation and to describe the procedure. The household was again visited the day before starting the record of food consumption. Each individual received a household number and an individual number. The members or member of the family who were to keep the records were instructed in the procedure, the forms to be used, details of weighing, recording of food purchased, produced at home and received as gifts. An inventory of food on hand was made in the beginning and at the end of a seven day period. In addition the food actually eaten each day by each individual member of the family was recorded either by the individual himself or by some member of the household. The values obtained from the food inventories were used as a check for other methods of assessing nutrition, i.e., medical histories, physical examinations, and various laboratory tests.

Disadvantages of the food inventory method have been summarized by the Food and Nutrition Board of The National Research Council (1949). These include the fact that repeated visits of the field agent may cause the diet to be affected, even though the family is urged to eat as usual. Moreover the agent may unconsciously express disapproval or approval of certain types of menu . However the most important limitations of the food inventory method are considered to be the burden it places on the cooperating household and the fact that this method is high in cost, because of the repeated visits of the field agent, the high percentage of samples failing to cooperate and the need for assembling food quantities from the daily records.

Food records in which the servings of food were weighed have been widely used. Some of the investigators who have reported the use of such records include Fowke (1945), Roberts (1948), and Bransby (1948a).

In comparing the weighing method with other methods of estimating dietary intakes fair agreement has been found. Bransby (1948a) compared the weighing, household measures and questionnaire methods. It was found that the average daily amounts of food groups consumed were of the same ord r for the three methods, but the agreement was on the whole closer between the weighing and questionnaire method than the household measures.

Ohlson (1950) compared the "weighed" method with the "recall" method. The estimated calorie, protein and calcium intakes computed from recall and weighed diets of thirteen older women were reported. The computations were from three 24 hour recall diets and from ten days of weighed diets for each subject. The recall and weighed diets were computed by the short method of Donelson and Leichsenring (1945). The apparent mean intake of all nutrients were greater when measured by recall diets. The following reasons for the differences were suggested: (a) two separate samples of food intake were represented for each woman. (b) Eating between the meals was recorded during the recall period but apparently was not recorded during the weighed period when in thirteen cases 300 to 8.0 calories fewer were eaten probably due to the inconvenience of preweighing each mouthful. (c) The size of portion selected by many aging women appeared to be smaller than that of younger women whose food habits formed the basis of the calculation of Donelson and Leichsenring (1945). (d) Emotional tensions appearing during balance period were sometimes reflected in a lower or higher intake.

The most accurate method of measuring the daily intake of nutrients would appear to be by chemical analysis of the diet. This procedure has furnished much valuable information which has been utilized in estimating the daily nutritional requirements of individuals. However the procedure is expensive, requires a large technical staff, and is time consuming. Therefore dietary analyses appear to be impractical in mass studies of nutritional status since they can be carried out on only a limited number of individuals for relatively short periods of time.

Various investigators have discussed certain problems involved in collecting dietary records. For example, the importance of considering food waste was shown in a survey of a group of families in Georgia made by the Bureau of Human Nutrition and Home Economics (1949). Several diets classified as "satisfactory" before adjustment was made for the food entered in the record but not eaten by the family was classified as "unsatisfactory" after this adjustment had been made. The Food and Nutrition Board of the National Research Council (1949) emphasized that in taking food consumption records from families, it should be recognized that individual members may not eat all kinds of food served to the family. The possibility of members of the family taking meals away from home quite regularly that may differ in a great deal from the home meals should also be taken into consideration.

The time period during which dietary records are collected also is important. Stiebeling (1939) reported that records of food purchased by families in three regions of this country indicated that the consumption of meat, poultry, and fish was higher in winter and that of fruits and vegetables was higher in summer than in other seasons. Kaser (1947) reported that seasonal differences occurred in fall and spring diets in rural Tennessee. There was a difference in the seasonal consumption of foods known to contribute significant amounts of certain vitamins. For instance carotene rich foods were present more often in the spring dietaries than in the fall. The frequency of spring diets containing eggs was more than twice that of the fall diets. Milam (1942) conducted a nutrition survey in a small North Carolina community and observed that seasonal differences in vitamin C blood levels were found which were apparently due to seasonal differences in intake. Moyer (1943) also reported higher levels of vitamin C in summer time than in winter in the blood of orphanage children. Moyer presumed that the difference could be explained by the consumption of greater quantities of vitamin C rich foods during summer months than in winter.

In addition to seasonal differences, daily and weekly variations in dietary intake also should be considered (Food and Nutrition Board of the National Research Council, 1949).

The question arises as to how long a period should a dietary survey cover in order that the average consumption per day or per week gives a reliable estimate of customary behavior within a given season. That a record over one day can deviate widely from the customary average intake is well-known and has been shown recently by Steinkamp (1945), Kaser (1947) and by Thomas (1950). When the diet habits are very monotonous a record covering a day or a few days would be sufficient. The Food and Nutrition Board of the National Research Council (1949) considered that in the United States a weekly pattern of food consumption is quite pronounced. It referred however to the question raised by the workers on methods of evaluating nutritional status of mothers, infants and children (Burke 1938, 1947, 1948), as to whether a period beyond seven days is needed and if so what is the best method in collecting data.

Evaluation of the Food Value of Diets From Dietary Records. Carefully prepared and properly used tables of food values are important in interpreting the nutritional adequacy of food intakes which have been estimated from dietary records. Commonly used food tables in the United States are Taylor (1942), Bradley (1942), Bureau of Human Nutrition (1945-Watt 1950), Sherman (1946), U. S. Public Health Department (French, 1945), Bowes and Church (1951) and for international use of the food table of the Food and Agriculture Organization of the United Nations (Chatfield, 1949). Values in these tables represent averages of dietary analyses which have been made over a period of years since the publication of Atwater's Table on the Proximate Composition of Foodstuffs (1906). Therefore these values represent averages of food values which have been determined under varying conditions of climate, maturity, method of food preparation, season, etc. (Bassett, 1931).

Many investigators have compared the results obtained by calculating the nutritive value of foods or diets with those obtained by chemical analyses of the nutrients in the foods. Comparisons of calculated and determined values for calories have shown good agreement (Patterson, 1941; Hummel, 1942; Widdowson, 1943; Toscani, 1948). Bransby (1948a) in studies of the diets of children by four methods of dietary survey including chemical analyses of the diets found that there was an over-estimate for calories of 11 to 12 percent by dietary calculations. Thomas (1950) compared the calculated and analyzed values of diets eaten by four children during four consecutive days in fall and in the spring. There were relatively small variations in the energy value of the diets between the two methods of estimation. Results obtained in calculating the energy value of diets may depend upon the factors used if the calorie value is calculated from the proximate composition of the food (Committee on Calorie Conversion Factors and Food Composition Table, 1947).

Agreement usually within five percent has been found between calculated and determined values of protein of diets (Bassett, 1931; Hawks, 1937; Patterson, 1941; Hummel, 1942; Bransby, 1948a, 1948b; Toscani, 1948; Thomas, 1950; Ohlson, 1950). Ohlson (1950) found the laboratory values for protein of mixed diets tended to be slightly higher than the calculated values. Donelson (1931) in studies of the nitrogen, calcium and phosphorus content of fifty-four food composites, representing averages of three, four and ten day periods, obtained a mean value for nitrogen by chemical analysis which was 1.9 percent higher than that of the computed values. Differences for the individual diets varied from 0.7 percent to 38 percent.

Protein values are found by multiplying the nitrogen content of foods by 6.25 on the assumption that proteins contain an average of 16 percent nitrogen (Committee on Calorie Conversion Factors and Food Composition Table, 1947). However proteins vary in nitrogen content. Cereals and grain proteins contain less nitrogen and a better estimate of cereal protein is obtained by multiplying the nitrogen content by 5.7 to 5.95. Milk proteins are somewhat higher. Therefore the calculated protein intake would be expected to agree with the chemically analyzed values if the diet is composed of mixed foods but less satisfactory agreement would be expected if the diet was composed chiefly of single foodstuffs, cereals, for example.

There has been less satisfactory agreement between the analyzed and computed values for dietary fat (Patterson, 1941; Bransby, 1948a; Thomas, 1950). Hummel (1948) and Widdowson (1943) found that the calculated values for dietary fat were slightly higher than values obtained by chemical analyses. Calculated and chemically analyzed values for carbohydrate agreed satisfactorily according to the studies of Widdowson (1943) and Bransby (1948a, b).

There are conflicting reports concerning the agreement which exists between calculated and analyzed values for calcium content of diets. Fair agreement between the two values was reported by Toscani (1949), Bransby (1948a) and Ohlson (1937). However other investigators have found wide differences in values obtained by calculation and by laboratory analyses (Hawks, 1937; Patterson, 1941; Bassett, 1951; Hummel, 1948; Widdowson, 1943; Thomas, 1950). Donelson (1937) reported that the differences in some of the periods studied were approximately 22 percent between the calculated the analyzed values and Mackay (1935) found differences of [illegible] percent when comparisons were made on ten diets.

[illegible] (193[illegible]) compared the determined with the calculated calcium content of a number of representative diets, utilizing the revised data of Sherman (1937). Twenty-eight observations were made in the course of metabolic studies on twenty-one cases during the period 1930 to 193[illegible]. Diets were divided into two groups: high and moderate calcium diets which contained more than 40[illegible] milligrams per day and low calcium diets which contained less than 2[illegible] milligrams per day. There were sixteen low and twelve intermediate diets. The calculated estimates exceeded determined values more consistently in low calcium diets than in intermediate or high calcium diets. In these latter diets, the scatter in percentage deviations showed a total range of + 13 to - 24 percent. The low diets showed a range of 1[illegible] to [illegible]49 percent.

Values for [illegible] obtained by calculation and by analysis have checked fairly well, that is, within five percent (Donelson, 1931; [illegible]ett, 1931; Mackay, 1935; Hawks, 1937; [illegible]essett, 1935; [illegible], 194[illegible]; [illegible], 1[illegible]).

[illegible]essett (1931), Mackay (1935), Ohlson (193[illegible]) and Hawks (1937) found values for iron determined by calculation and by chemical analysis to agree within five percent. [illegible]essett (1935), [illegible] (19[illegible]) and [illegible] (19[illegible], [illegible]) found deviations in both positive and negative directions which were greater than 10 percent.

Studies on magnesium and potassium have indicated good agreement between calculated and determined values ([illegible]ett, 1931; Hawks, 1937; [illegible]essett, 1935;

Hummel, 1942). MacKay (1935) obtained errors for magnesium and for potassium which were as high as 26 to 27 percent respectively. Bassett (1935) found good agreement between calculated and analyzed values for the sodium content of diets. However wide variations were reported by Hawks (1937) and Hummel (1942). MacKay (1935) found that the calculated values exceeded the analyzed by as much as 41 percent.

The widest differences between analyzed and calculated food values of dietaries have been found in vitamin values probably because of wide natural variations in the vitamin content of foods and also losses of vitamins which may occur in the handling of foods. Young (1948), Kaser (1947) and McHenry (1945) reported that the calculated intakes for ascorbic acid were likely to exceed the determined values, particularly when food tables were based upon uncooked foods. Thomas (1950) however obtained good agreement when comparing calculated and analyzed values for ascrobic acid contents of diets. McHenry (1945) reported close agreement between the calculated and chemically analyzed values for vitamin A. Thomas (1950) found significant differences only for analyses made during the fall season.

Poor agreement between thiamine values determined by calculation and those determined by chemical analyses have been found (McHenry, 1945; Thomas, 1950). Kaucher (1946) analyzed the diets of twelve mothers during five day periods at various intervals following the birth of their infants. Duplicate portions of food eaten were composited for each five days and aliquots taken for analyses for energy, fat, vitamins and minerals. The diets were the same, qualitatively, for all of the subjects and consisted of different menus that were repeated in each five day period; left-overs were weighed and subtracted. Several food tables were used for calculation. The calculated intake for thiamine of the diets was found to be 27 milligram percent higher than the determined intake. Results obtained by comparing the calculated and analyzed values for riboflavin were not significantly different. McHenry (1945) also found that there was good agreement between calculated and analyzed values for riboflavin although Thomas (1950) reported significant differences both in fall and spring diets. Kaucher (1946) found good agreement between the calculated and analyzed values of the niacin content of diets. However Thomas (1950) found that there were significant differences between the calculated and analyzed values obtained during the fall season although the values obtained in the spring agreed fairly well.

Several factors should be considered when tables of food values are used for calculating the nutritive value of diets. Food values may be given for raw and/or cooked foods. It is well known that raw and cooked foods may differ in vitamin content and the accuracy of the dietary calculations may depend upon whether or not the correct values are used. Berryman and Chatfield (1943) reported that it was necessary to make the following subtractions in evaluating vitamin content of meals prepared for the army: 50 percent of the thiamine of meats, 25 percent of the thiamine of cooked vegetables, with an additional 20 percent if the cooking liquid was discarded or lost, and 50 percent of the vitamin C of cooked vegetables (except tomatoes) and 25 percent of the vitamin C of fresh vegetables of fruit cut up and consumed raw in salads or desserts.

Further errors may be introduced in the calculation of dietaries if the worker neglects to take into account extraneous sources of nutrients. For example, Widdowson (1943) found that as much as 200 milligrams of calcium a day can be obtained from drinking water in districts where the water is very hard and that calcium "contamination" occurred in vegetables which were boiled in hard water and with salt. Bransby (1948a) emphasized the importance of recognizing systematic deviations from average values, such as a high content of some mineral in the water supply, consistent use of low-fat milk, or continuous use of meat from which visible fat has been trimmed.

Another source of error in dietary calculations may develop when tables of food value are used to calculate mixed foods as stews, casseroles, etc. Ohlson (1950) found in calculating the diets of older women by the tables of Donelson and Leichsenring (1945) that the calculated values for nitrogen, calcium and phosphorus did not correspond to the analyzed values for diets which contained high amounts of processed meats or intricate cookery mixtures. Grant (1944) considered that the errors introduced in the calculations of mixed dishes by using average food values was so great, that it was necessary for the technician to obtain the recipes, cooking times and methods, when collecting dietary records, and then to apply a correction factor to give the relation between the uncooked weight and the cooked.

Calculation of Diets by Values For Food Groups. The use of weighted values for groups of foods closely related in nutritive value has been employed for more than thirty years. The aim of this method has been to reduce the number of calculations, to save time and to cut costs.

A quick method for estimating dietary intakes by approximation of the nutritive value instead of by exact calculation was suggested for the first time in 1918 by Hunt. It was proposed by this worker to arrange foods at the time of their purchase into groups and sub-groups and to determine protein and calories by means of average values for each group and sub-group. The main groups were: vegetable and fruits; protein, rich foods (a the less watery; b the more watery), cereals, bread and other bakery goods, sweets, fatty foods. It was stressed that estimation of dietary intake was more accurate when used for a varied diet than for a repetitious diet. When this method was checked with the more detailed method of dietary calculation, discrepancies of 8-10 percent were obtained.

The second method for simplifying calculations was proposed by Rose (1920). This method provided for ascertaining the total energy value as well as the protein and fat in the diet. The plan included seven main food groups that were divided into sub-groups. Correction factors were assigned for the food value of each foodstuff in a sub-group. Rose did not check this method with the long method.

Hawley (1929) in studying the 3,000 records of food consumption of farm families developed a third method for approximation of dietary intakes. The following groups were used: fruit and vegetable, fats and sugar, meat, milk, and cereals. The main groups were divided into sub-groups according to protein, calcium, phosphorus and iron. From a study of 121 food records, it was found that the method yielded results within five percent of those obtained by detailed calculations.

However the validity of the methods above depends upon obtaining average values for the different nutrients of the various food classes which properly represent the food habits of the individual or group studied. With this in mind Perryman (1943, 1944) developed a short method especially for army diets. The procedure was based on the grouping of foods into classes of: (a) similar nutritive content, (b) special function in the diet and (c) unique contribution to the value of the diet. On these bases, all foods were grouped within seventeen classes. The foods were listed under their appropriate classes and the weighted nutritive values for the various classes of food were applied to the computed intake of each class. The authors compared this short method with calculations found on values for individual food and did not find appreciable errors.

The most commonly used short method in the north-central part of the United States is the method of Donelson and Leichsenring (1945). This was developed in 1942, revised in 1945 and again revised in 1951. The method is based on the use of representative mean values for the composition of food groups. These means are derived from the values for the most commonly occurring foods in a series of dietaries used in the north-central states, computed on the basis of the average size servings reported by Bowes and Church (1940). Mean values for any food group were obtained by combining values for certain foods in accordance with the frequency with which these foods occurred in typical dietaries. Foods were divided into various groups on the basis of the similarity in type of food and nutritive value. Vegetables for example were divided into the following groups: (a) cabbage, (b) green leafy vegetables, (c) green and yellow vegetables, (d) potato, (e) other vegetables, (f) tomato. Cabbage and tomatoes were each put in a separate group since these foods are higher in vitamin C content than the other vegetables. However their dissimilarity in vitamin A content prevented their being grouped together.

The accuracy of this method was compared by Donelson and Leichsenring (1942) with results obtained by more detailed calculations. When the two methods were applied to a single individual record first for one week and second for one day a good agreement was obtained. Also good agreement was obtained when both methods were tested on a series of weekly diets from low-income families which included twenty-four individuals.

In the revision of the food table in 1945 values in the food consumption tables were computed chiefly from values compiled by the Food and Nutrition Board of the National Research Council, supplemented by some values from the tables of Bowes and Church (1944). The vitamin values were reduced to allow for losses in cooking. Carbohydrate and fat were included. The accuracy of the values in the food composition table was tested on a series of thirty-three day diet records against the long method. In no instance was the deviation greater than 2.5 percent.

Since this method for dietary analysis was planned for diets typical of the North Central region of the United States, some modification may be required in order to adapt it to the regions in which the typical diet differs appreciably from that in the north-central region. Because of this fact Steinkamp (1945) made an adaption of the method of Donelson and Leichsenring (1945) in accordance with the food habits of a rural population of middle-Tennessee. The selection of food groups and the weighed values for each group were determined by the use of 130 individual food composition records from the rural population of Tennessee. Some deviations from the food table of Donelson and Leichsenring were: (a) an allowance in the calculations for the wide spread custome of boiling all vegetables with generous amounts of fat, meat or lard, (b) separate groupings for biscuits, corn bread, legumes, pork and molasses as these foods were frequently used in large amounts in rural Tennessee (c) since turnip greens were more widely used in the South than spinach, the food values for the green leafy vegetable group were selected to be more consistent with the values for turnip greens than those for spinach.

To test the accuracy of the method three series of diets (40 spring diets for one day - 40 fall diets for one day - 30 seven-day diets records) were calculated by the long and the short method. The forty spring and fall diets were duplicated for laboratory determination. It was shown that the short table values were in as good or better agreement with the determined values than those obtained by the long method. The seven-day records of 30 cases computed by long and short method showed that the mean differences are lower than those with the one day records.

From these results the conclusion can be drawn that the short method of calculation permits considerable conservation of time without loss of accuracy in dietary calculation. Errors introduced by use of a one-day computation are minimized by the use of a seven-day record of food consumption.

EXPERIMENTAL PROCEDURES

EXPERIMENTAL PROCEDURE

The experimental plan which was followed in this study is given in Table 1. The following comparisons were made: (1) a comparison of the protein, calcium and phosphorus intakes of eighteen older women for 10 day periods as determined by chemical analysis, by calculation using the food tables of Donelson and Leichsenring (1945) and by calculation using the food tables of the Bureau of Human Nutrition and Home Economics (1945), (2) a comparison of the caloric, protein and riboflavin intakes of eighteen college women for seven days as determined by chemical analysis and by calculations using the food tables of Donelson and Leichsenring (1945) and by calculation using the food tables of the Bureau of Human Nutrition and Home Economics (1945), (3) a comparison of the average protein, calcium and phosphorus intakes of 10 older women during successive time intervals from one to twenty-five days and (4) a comparison of the individual protein calcium and phosphorus intakes of ten older women during successive time intervals from one to 20 days.

__Dietary Records.__ The dietary records of the older women were obtained as a part of a study of the nutritional status of older women which was conducted by the Foods and Nutrition Department at Michigan State College. The women ranged in age from 48 to 77 years. They were living in their own homes and were active in the care of these homes. All women had borne one or more children and were free from disease which seriously limited activity. The women represented a cross-section of economic and social groups in Lansing and East Lansing. The contact with the subject was made by a series

TABLE 1

DESCRIPTION OF SUBJECTS AND METHODS OF EVALUATION OF FOOD INTAKES

No. Subject	Age	Description	Nature and Treatment of Data
	years		
1. 1[illegible] women	4[illegible]-[illegible]0	Homemakers	1. Ten-day dietary intake of calories, protein, calcium and phosphorus determined by chemical analysis and computed by two methods of calculation from weighed food portions.
2. 1[illegible] women	1[illegible]-24	College Students	2. Seven-day dietary intake of calories, protein, and riboflavin determined by chemical analysis and computed by two methods of calculation from measured and weighed food portions.
3. 1[illegible] women	40-[illegible]	Homemakers	3. Calculated intakes of protein, calcium and phosphorus during successive time intervals from one to twenty-five days.
4. 1[illegible] women	40-[illegible]	Homemakers	4. Calculated daily intakes of protein, calcium and phosphorus for a period of twenty days.

of interviews during which information was obtained concerning economic and social status, history of illness, operation, number of children and dietary habits. Following the interviews, each woman was trained to weigh her diet and to collect samples of food for laboratory analyses. All servings of food were weighed on a Hansen dietetic scale and the weights of servings were recorded.

The records for the 13 college women were obtained as a part of a research study conducted by the Foods and Nutrition department at Michigan State College during the years 1950 and 1951. The girls were 18 to 24 years of age, and were from 10 to 40 percent overweight. The subjects lived in dormitories or in private rooming houses. All of the subjects had their meals in the building of the School of Home Economics uder the supervision of one of the staff members of the Foods and Nutrition department.

For one week, the girls ate unrestrictedly from meals which were planned to be typical of this region and which were served at the diet table. Several kinds of cookies were distributed for eating between meals if the subject wished,. and each subject was encouraged to follow her customary pattern of eating. All servings of food were weighed on a Hansen dietetic scale. The weights of cookies, cokes and nuts which were eaten between meals were also recorded. At the beginning of the present study, a staff member of the Foods and Nutrition department translated the servings of food from weighed portions to common household units as one serving, one pork chop, one-half cup of peas, etc.. The diet records were made available to the author first in terms of servings of food as recorded in household units and, after this section was completed, in terms of weighed portions of the diet. After the dietary calculations were completed, information was supplied to the author concerning the dietary intakes as determined by chemical analysis.

Calculations of Dietary Intakes. Two types of tables of food values were used for dietary calculations. The table of food values by Donelson and Leichsenring (1945) consists of average nutrients for certain groups of closely related foods. Use of this table facilitates combining several foods for dietary calculations and therefore provides a rapid method for calculating dietary intakes. This method was considered as one type of dietary calculations and was used for each of the comparisons described above. The second method of dietary calculation which was used was the calculation of diets from values for individual foods as listed in the food tables of the Bureau of Human Nutrition and Home Economics (1945). The use of this table is more time consuming since values must be recorded for individual foods. This food table was used for comparisons of protein, calcium, and phosphorus intakes of eighteen older women by chemical analysis and by two methods of dietary calculation, and for comparisons of calorie, protein and riboflavin intakes of eighteen college women by chemical analysis and by two methods of dietary calculations.

Sampling of Diets for Chemical Analysis. The diets of the older women were sampled for chemical analysis by members of the staff of the Foods and Nutrition department. Chemical analyses of the various nutrients were carried out in the laboratories of the Foods and Nutrition department. Results of the chemical analysis were made available to the author for comparison with dietary intakes determined by calculations. The methods of sampling and the procedures for chemical analysis have been reported by Ohlson (1948), Roberts, (1948), Brewer (1950).

<u>Statistical Interpretation of Data</u>. The dietary intakes of various nutrients as determined by chemical analysis and by two methods of dietary calculations were compared, by the "t" test (Fisher, 1937). The standard error of the mean intake of each nutrient was calculated by the following formula (Goulden, 1939).

$$\text{Standard error of the mean} = \frac{\sqrt{\frac{\Sigma(\bar{x} - x)^2}{N - 1}}}{\sqrt{N}}$$

RESULTS AND CONCLUSIONS

RESULTS AND DISCUSSION

Comparisons of Calculated and Analyzed Food Intakes of Eighteen Older Women. The average food intakes for ten day periods of protein, calcium and phosphorus of eighteen older women as determined by chemical analysis and computed by two methods of calculation from weighed servings of food are given in Tables 2, 3 and 4 respectively. The mean intakes for protein were 62.5 4.2 (standard error of the mean) grams by chemical analysis, 56.8 3.8 grams by calculation according to the table of Donelson and Leichsenring (1945) and 55.3 3.6 grams according to calculations from the tables of the Bureau of Human Nutrition and Home Economics (1945). Statistical analyses by Fisher's "t" test (1939) indicated that these values were not significantly different. The average daily protein intake as determined by chemical analysis was 12 percent greater than that determined by calculations according to Donelson and Leichsenring (1945) and nine percent higher than the value obtained by the more detailed tables of food values. The similarity of results obtained by the three methods of determination agreed with the observations of Patterson (1941), Hummel (1942), Widdowson (1943), Bransby (1948) and Thomas (1950).

There was a greater variation among the average daily values for calcium intake determined by the three methods of determination than for protein intakes. The mean daily calcium intake for the eighteen women was 0.77 grams when determined by chemical analysis, 0.56 grams when calculated by the Donelson and Leichsenring food tables and 0.61 grams when calculated from values for individual foods. The differences in calcium intakes as

TABLE 2

ESTIMATED PROTEIN INTAKES OF EIGHTEEN OLDER WOMEN AS DETERMINED BY CHEMICAL ANALYSIS AND COMPUTED BY TWO METHODS OF CALCULATION

Subject	Protein content of diets		
		By Calculation	
	By Chemical Analysis	Donelson and Leichsenring (1945)	Bureau of Human Nutr. and Home Ec. (1945)
	gm./24 hr.	gm./24 hr.	gm./24 hr.
I	55.7	63.2	61.1
II	67.1	74.5	67.4
III	79.5	74.5	75.9
IV	71.6	60.8	57.4
V	70.5	45.1	44.3
VI	77.8	66.5	60.4
VII	64.4	63.0	57.7
VIII	50.7	53.4	53.9
IX	71.8	68.9	66.4
X	105.4	91.4	90.3
XI	73.2	64.1	61.8
XII	45.6	49.3	50.1
XIII	70.7	42.6	50.9
XIV	38.2	31.1	32.2
XV	54.0	51.9	48.4
XVI	60.3	56.4	55.2
XVII	34.7	32.2	28.0
XVIII	34.4	34.0	33.4
Mean	62.5	56.8	55.3
Standard error of the mean	4.2	3.8	3.6

TABLE 3

ESTIMATED CALCIUM INTAKES OF EIGHTEEN OLDER WOMEN AS DETERMINED BY CHEMICAL ANALYSIS AND COMPUTED BY TWO METHODS OF CALCULATION

Subject	CALCIUM CONTENT OF DIETS		
	By Chemical Analysis	By Calculation	
		Donelson and Leichsenring (1945)	Bur. Human Nutr. and Home Econ. (1945)
	gm./24 hr.	gm./24 hr.	gm./24 hr.
I	0.94	0.78	0.[illegible]
II	1.20	0.51	0.58
III	0.83	0.50	0.53
IV	1.11	0.89	0.97
V	0.[illegible]	0.29	0.25
VI	0.35	0.44	0.45
VII	0.81	0.61	0.66
VIII	0.51	0.45	0.47
IX	1.01	1.02	0.94
X	1.10	0.99	1.07
XI	0.89	0.70	0.77
XII	0.55	0.56	0.54
XIII	0.70	0.23	0.42
XIV	0.37	0.23	0.38
XV	0.83	0.51	0.56
XVI	0.86	0.75	0.88
XVII	0.31	0.21	0.26
XVIII	0.37	0.20	0.33
Mean	0.77	0.56	0.61
Standard error of the mean	0.06	0.06	[illegible]

TABLE 4

ESTIMATED PHOSPHORUS INTAKES OF EIGHTEEN WOMEN
AS DETERMINED BY CHEMICAL ANALYSIS AND COMPUTED
BY TWO METHODS OF CALCULATION

Subject	PHOSPHORUS CONTENT OF DIETS		
	By Chemical Analysis	By Calculation	
		Donelson and Leichsenring (1945)	Bur. Human Nutr. and Home Econ. (1945)
	gm./24 hr.	gm./24 hr.	gm./24 hr.
I	0.98	1.10	1.08
II	1.34	1.15	1.17
III	1.32	1.12	1.17
IV	1.49	1.15	1.14
V	1.11	0.77	0.62
VI	1.24	1.18	1.07
VII	1.22	1.01	0.93
VIII	0.89	0.86	0.89
IX	1.31	1.28	1.19
X	1.67	1.44	1.37
XI	1.46	1.12	1.02
XII	0.85	0.82	0.79
XIII	1.12	0.63	0.83
XIV	0.49	0.50	0.49
XV	1.12	0.90	0.90
XVI	1.07	0.98	1.07
XVII	0.60	0.46	0.49
XVIII	0.83	0.50	0.58
Mean	1.12	0.94	0.95
Standard error of the mean	0.07	0.07	0.07

determined by chemical analysis and by calculation from values for individual foods was not statistically significant. However the mean calcium intake determined by chemical analysis was significantly higher than the value of 0.56 which was estimated by the use of the Donelson and Leichsenring food tables. (T = 2.42; probability < 2.5 percent). Donelson (1931), Widdowson and McCance (1942) and Bassett (1935) also have reported that the values for calcium obtained by chemical analysis were generally higher than values calculated from tables of food values; however Gutman (1939), Hummel (1942) and Bransby (1948a) found that the reverse was true. MacKay (1935) and Thomas (1950) have reported that there was irregular variation between the calculated and analyzed values for calcium.

The mean value for phosphorus intake for the eighteen women was found to be 1.12 ± 0.07 grams by chemical analysis, 0.94 ± 0.07 grams by calculations according to the Donelson and Leichsenring food tables (1945) and 0.95 ± 0.07 grams by calculations from values for individual foods as given in the tables of the Bureau of Human Nutrition and Home Economics (1945). These differences were not found to be statistically significant by the "t" test.

The variations in average daily intakes of protein, calcium and phosphorus were influenced to a considerable extent by values for certain individuals, particularly those for subjects V and XIII, for whom the values obtained by chemical analysis exceeded the calculated values by 14 to 26 percent. Ohlson (1950) in a study of the protein nutrition of ageing women also reported marked discrepancies between chemical analyses and the calculated values for certain individuals and observed that these differences could be accounted for in part by the use of breads and of luncheon types of prepared meats which contained sufficient dry milk solids to affect the accuracy of the estimated values. In addition these subjects included a variety of mixed foods in their diets. Such food mixtures are difficult to evaluate when food intakes are calculated without knowing the proportion of ingredients which were used. This observation also has been reported by Grant (1944) and Ohlson (1950). It is difficult to explain why the phosphorus intake as determined by chemical analysis for subject XVIII was 30 to 40 percent higher than the phosphorus intake which was estimated by calculation. The diet of this subject appeared to be typical of the geographical area with only a moderate variation in foods and a moderate use of cereals and legumes. The values for protein and calcium intakes for this subject were in much better agreement than for phosphorus intakes.

These data appear to indicate that the dietary intakes of protein, calcium, and phosphorus of a group of eighteen individuals can be estimated closely by calculations of the dietary intake, if the records consist of records of weighed food portions. The estimation of dietary intake apparently is much less precise for one individual than when the dietary intakes of a group are evaluated. The data further indicate that for calculations of the protein, calcium and phosphorus intakes of a group of women, the use of average values for certain groups of foods as presented in the table of Donelson and Leichsenring (1948) gives as satisfactory information as calculations from values for individual foods such as reported in the food tables presented by the Bureau of Human Nutrition and Home Economics (1945).

Comparison of Estimated Calorie, Protein, Riboflavin Intakes of Eighteen College Women Determined by Chemical Analyses and by Dietary Calculations From Weighed and Measured Food Portions. The average daily intakes of calories protein and riboflavin for seven-day periods as determined by chemical analysis and as calculated from measured serving portions by the table of Donelson and Leichsenring (1945) and from weighed portions by the food tables of the Bureau of Human Nutrition and Home Economics (1945) are given in Tables 5, 6 and 7. The average daily intake of calories for this group was found to be 2244 ±85 by chemical analysis, 2215 ±114 by calculation from measured serving portions according to the food tables of Donelson and Leichsenring and 2224 ±105 by calculation from values for individual foods as given in the Food Tables of the Bureau of Human Nutrition and Home Economics (1945). These values, which were not significantly different ("t" test) showed that calculations of dietary intakes can give a good estimate of the daily caloric intake of a group. Similar reports of good agreement between analyzed and calculated values for calorie intakes have been published by Patterson (1941), Hummel (1942), and Kaser (1947).

There also was close agreement in the protein intakes of the eighteen college women as determined by the three methods. These were 78.8 ±2.4 grams as determined by chemical analysis, 76.0 ±2.9 grams as determined from measured food portions by the Donelson and Leichsenring food tables and 77.0 ±2.8 grams as determined by calculation from individual food values.

The average dietary intake of riboflavin by this group of young women was found to be 2.00 ± 0.03 milligrams according to chemical analysis of the diet, 1.93 ± 0.10 milligrams by calculations using the tables of Donelson and Leichsenring and 1.90 ±0.10 milligrams by calculations based on individual food values. There was no significant difference in either the protein or riboflavin intakes of this group according to the "t" test.

The data obtained for this group of young women indicate that calories and riboflavin also may be estimated accurately by dietary calculations, just as the data presented in the preceding section indicated that protein, calcium

TABLE 5

ESTIMATED CALORIC INTAKES OF
EIGHTEEN COLLEGE WOMEN AS DETERMINED
BY CHEMICAL ANALYSIS AND BY DIETARY
CALCULATION FROM WEIGHED AND MEASURED FOOD PORTIONS

Subject	CALORIC VALUE OF DIETS		
	By Chemical Analysis	BY CALCULATION	
		Donelson and Leichsenring (1945)	Bur. Human Nutr. and Home Econ. (1945)
	Calories per 24 Hr.	Calories per 24 Hr.	Calories per 24 Hr.
I	2167	2495	2437
II	2799	2912	2763
III	2755	2957	2969
IV	2612	2886	2386
V	2158	2470	2349
VI	3020	3072	3149
VII	1998	2120	2068
VIII	1893	1940	1942
IX	3139	1807	1824
X	1789	2001	1828
XI	2235	2491	2556
XII	1995	1710	1926
XIII	1829	1741	1748
XIV	2280	2006	2006
XV	2140	1983	2181
XVI	1837	1894	1904
XVII	1897	1675	1878
XVIII	1831	1711	1818
Mean	2244	2215	2224
Standard error of the mean	85	114	103

TABLE [illegible]

[illegible] PROTEIN INTAKES OF [illegible] AS [illegible]
BY CHEMICAL ANALYSIS AND DIETARY CALCULATION [illegible]
[illegible] PROCESSED FOOD [illegible]

Subject	PROTEIN CONTENT OF DIETS		
	By Chemical Analysis	BY CALCULATION	
		Donelson and Leichsenring (1945)	Bur. Human Nutr. and Home Econ. (1945)
	gm./24 hr.	gm./24 hr.	gm./24 hr.
I	71.5	77.1	73.7
II	79.2	[illegible]	85.2
III	[illegible]	96.9	96.3
IV	94.6	8[illegible].7	86.4
V	72.0	71.3	75.9
VI	95.1	97.7	102.5
VII	73.4	79.6	72.4
VIII	63.3	69.5	59.5
IX	69.1	50.0	49.9
X	60.9	64.0	63.3
XI	74.2	82.9	83.5
XII	83.1	70.3	76.8
XIII	77.2	71.8	71.1
XIV	85.5	81.3	75.3
XV	81.6	77.6	80.5
XVI	77.7	59.6	73.5
XVII	77.6	65.0	71.2
XVIII	73.1	64.7	62.4
Mean	78.2	76.0	77.0
Standard error of the mean	2.4	2.9	2.8

TABLE 7

ESTIMATED RIBOFLAVIN INTAKES OF EIGHTEEN
COLLEGE WOMEN AS DETERMINED BY CHEMICAL ANALYSIS
AND BY DIETARY CALCULATION FROM WEIGHED AND MEASURED FOOD PORTIONS

Subject	RIBOFLAVIN CONTENT OF DIETS		
	By Chemical Analysis	BY CALCULATION	
		Donelson and Leichsenring (1945)	Bur. Human Nutr. and Home Econ. (1945)
	mg./24 hr.	mg./24 hr.	mg./24 hr.
I	2.64	1.68	1.53
II	2.27	2.62	2.00
III	2.55	2.78	3.00
IV	2.45	2.30	2.12
V	2.33	1.67	1.61
VI	2.43	2.75	2.64
VII	2.30	2.28	2.05
VIII	1.82	1.72	1.69
IX	2.00	1.63	1.40
X	1.95	1.77	1.63
XI	1.97	2.03	1.93
XII	1.68	1.61	1.73
XIII	1.65	1.63	1.68
XIV	1.79	1.74	1.72
XV	2.06	1.65	1.78
XVI	1.58	1.73	1.93
XVII	1.30	1.66	1.72
XVIII	1.78	1.50	1.60
Mean	2.00	1.93	1.90
Standard error of the mean	0.03	0.10	0.10

and phosphorus intakes may be estimated satisfactorily by dietary calculations. The influence of a variety of different foods was not apparent in the calculations of the dietary intakes of the college women since these young women selected serving portions from meals which were served at the diet table; moreover there were few mixed dishes included in the meals served to the young women.

The average calcium intakes for seven college women as determined by the three methods used in this stidy are given in Table 8. These young women represented a part of the group of eighteen women for whom the protein, calorie and riboflavin intakes were determined. However the calcium intakes for only seven of this group had been determined by chemical analysis. The mean intake for calcium determined by chemical analysis was 1.02 ±0.05 grams daily; the mean intake of calcium was found to be 0.79 ±0.08 grams by calculation using the table of Donelson and Leichsenring, and 0.92 ±0.02 grams daily by calculations from individual food value. In this case the mean intake of calcium as determined by chemical analysis was significantly greater than the mean intake of calcium as determined by either of the two methods of dietary calculations. This is in contrast to the findings with the series of older women. However it is possible that the size of the group limited the validity of the estimation of the calcium intake by calculations since the comparison with the older women was made with a group of eighteen; in this case the group consisted of only seven individuals. Various investigators (Patterson, 1941; Hummel, 1942; and Widdowson, 1943) have observed that dietary intakes could be estimated more accurately for larger than for smaller groups.

Average Protein, Calcium and Phosphorus Intakes of Ten Older Women During Successive Time Intervals From One to Twenty-five Days. The average protein, calcium and phosphorus intakes of ten older women during successive time intervals from one to 25 days as determined by dietary calculations using the tables of Donelson and Leichsenring (1945) was given in Table 9. The values indicate that the largest variations in the mean values were found when intakes for time intervals up to the first seven days were averaged. The average protein intake for the ten women when only one day's dietary was evaluated was 59.3 grams with a standard error of 5.0 grams. The mean intake for three days for the ten women was 63.2 grams with a standard error of 4.2 grams and for seven days, 67.0 ± 4.6 grams. Since the standard error for the average intakes was large as a result of wide differences in intakes among the women, the differences between means for protein intakes for successive time periods from one to twenty-five days were not significant according to the "t" test (Fisher, 1939). The standard errors of the mean protein intake for successive time intervals from one to twenty-five days decreased from 5.0 to 3.4 grams. It would appear from these values that an estimate of the average intake of a group of ten women can be made from one or three days food records but that the error of estimate decreases as the length of time of observation is increased.

The successive decreases in standard error of the mean for the average calcium intakes of ten women for increasing periods of observation was apparent to seven days. The mean calcium intake for one day was 0.65 ± 0.10 grams, for three days, 0.69 ± 0.11 grams, and for seven days, 0.64 ± 0.07 grams. The mean intakes and standard errors for 15, 20 and 25 days were similar to that of 10 days. There were no significant differences between the means of calcium intake for successive periods up to twenty-five days and there was no apparent advantage for extending the period of observation beyond seven days of observation. Similar results were apparent for average phosphorus intakes for the ten women during successive time periods from one to twenty-five days. The mean intake for one day was 0.98 ± 0.10 grams and the mean intake for seven days was 1.05 ± 0.07 grams. The standard error of the mean was constant after seven to ten days.

The weekly pattern of food consumption in the United States is quite pronounced (Leverton, 1939) and food intakes for Saturday and Sundays may differ from intakes during the week. Therefore the practice of studying dietary patterns for a seven day period including Saturday and Sunday seems desirable. The data in Table 9 indicate that a much better estimate of the intake of a group of women can be made for a seven day period than for a one day period.

<u>Protein, Calcium and Phosphorus Intakes of Individual Women During Successive Time Intervals For a Period of Twenty Days.</u> The average protein, calcium and phosphorus intakes of a group of ten women were given in Table 9 and discussed in the preceding section. It also appeared of interest to examine the daily variations in intakes of these nutrients for the individual women, in an attempt to determine how long a period of observation was necessary to evaluate the dietary intake of an individual. The daily protein intakes for individuals of the group of ten older women during time periods up to twenty consecutive days are given in Table 10.

The average variation in mean protein intake for the individual women was 10 grams. The widest variation in protein intake was found for subject IV whose protein intake averaged 55 grams for a three day period and 77 grams

TABLE 9

THE AVERAGE PROTEIN, CALCIUM AND PHOSPHORUS INTAKES OF 10 OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS FROM ONE TO TWENTY-FIVE DAYS

Time Interval	Protein	Calcium	Phosphorus
No. days	gm./24 hr.	gm./24 hr.	gm./24 hr.
1	59.3 ±5.0*	0.65 ±0.10	0.93 ±0.10
3	63.8 ±4.2	0.69 ±0.11	1.05 ±0.11
7	67.0 ±4.6	0.64 ±0.07	1.05 ±0.07
10	67.0 ±4.8	0.67 ±0.08	1.06 ±0.09
15	64.5 ±4.3	0.66 ±0.09	1.03 ±0.08
20	64.4 ±3.9	0.65 ±0.08	1.06 ±0.08
25	64.0 ±3.4	0.66 ±0.08	1.05 ±0.08

* Standard error of the mean.

for a seven day period. Subject VIII had the greatest constancy in protein intake. The lowest value for this subject was an average of 40 grams for a fourteen day period and the highest value was an average of 58 grams for a twelve day period.

The variations in mean intake for successive periods appeared to be greater for the first seven days than from the period from seven to twenty days. However the mean protein intakes for each woman for three days, five days and seven days were compared with the protein intake for ten days and it was found that the difference between the means were not significant by the "t" test.

The effect of an increased period of observation on the validity of the estimation of the protein intake of the subjects is more readily apparent from an examination of the standard errors of the mean for the successive time periods than from the mean intakes only. For each subject, there was a decrease in the standard error of the means as the period of dietary study was increased. The decrease was greater during the first ten days than from ten to twenty days. For example, the standard error of the mean protein for three days for subject I was 21.1 grams; for ten days, the standard error was 8.3 grams, and for twenty days, the standard error was 6.1 grams.

Figure 1 shows the trend of the averages of the standard error of the means of the ten women. The sharp decrease in standard error from three to ten days and the tendency for a less gradual decline in the standard error of estimate from 10 to 20 days may be seen. During the period of 16 to 20 days, there was a plateau in the curve. This would appear to indicate that there was little advantage in continuing food record collections beyond sixteen days, since the information gained from a sixteen day period was similar to that for a twenty day period.

TABLE 10

THE AVERAGE AMOUNT OF PROTEIN AS GRAMS PER DAY INGESTED BY 10 OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS FROM THREE TO TWENTY DAYS

Time Interval No. Days	SUBJECTS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
3	[illegible]0.7 ±21.1	37.8 ±10.1	75.8 ±12.9	54.9 ±19.4	67.4 ±10.1	66.[illegible] ±3.7	59.3 ±10.8	49.9 ±8.8	55.4 ±2.8	77.0 ±11.4
5	98.2 ±16.0	46.7 ±5.6	73.2 ±10.2	75.1 ±16.6	65.3 ±[illegible].6	65.7 ±3.0	56.1 ±6.2	50.1 ±5.5	56.0 ±4.8	71.0 ±8.3
7	90.8 ±11.7	47.1 ±3.9	77.2 ±7.5	76.5 ±13.6	72.3 ±7.5	67.1 ±2.4	55.2 ±4.4	50.1 ±4.1	60.1 ±4.0	85.0 ±10.7
10	8[illegible].1 ±[illegible].3	46.1 ±2.9	77.4 ±5.3	65.7 ±10.9	69.6 ±5.1	67.6 ±1.[illegible]	53.4 ±3.4	51.6 ±3.5	59.0 ±3.0	91.0 ±9.1
12	82.5 ±[illegible].1	47.0 ±2.5	7[illegible].6 ±5.1	61.7 ±9.4	72.1 ±5.5	[illegible]6.1 ±1.8	54.0 ±3.2	52.4 ±3.1	61.2 ±2.3	89.5 ±7.6
14	80.8 ±7.0	47.4 ±2.7	80.9 ±4.7	59.1 ±[illegible].2	69.0 ±5.2	64.7 ±1.0	52.7 ±2.9	49.4 ±3.3	62.1 ±2.4	[illegible].2 ±[illegible]
16	[illegible].0 ±5.9	49.1 ±3.1	[illegible].9 ±4.[illegible]	55.2 ±7.9	67.9 ±4.[illegible]	62.7 ±2.1	54.9 ±2.9	49.5 ±3.0	61.[illegible] ±2.2	90.1 ±8.1
18	[illegible].0 ±6.3	50.3 ±2.9	[illegible]7.9 ±4.0	[illegible]4.7 ±[illegible]	[illegible].4 ±4.1	62.3 ±1.9	55.9 ±3.3	50.4 ±2.7	61.0 ±2.1	8[illegible].9 ±[illegible].0
20	7[illegible].0 ±[illegible].1	[illegible].3 ±2.7	75.6 ±4.0	[illegible].2 ±[illegible].9	67.3 ±[illegible]	62.1 ±1.7	54.[illegible] ±3.2	51.1 ±[illegible]	50.7 ±2.5	[illegible]7.3 ±5.[illegible]

[illegible]

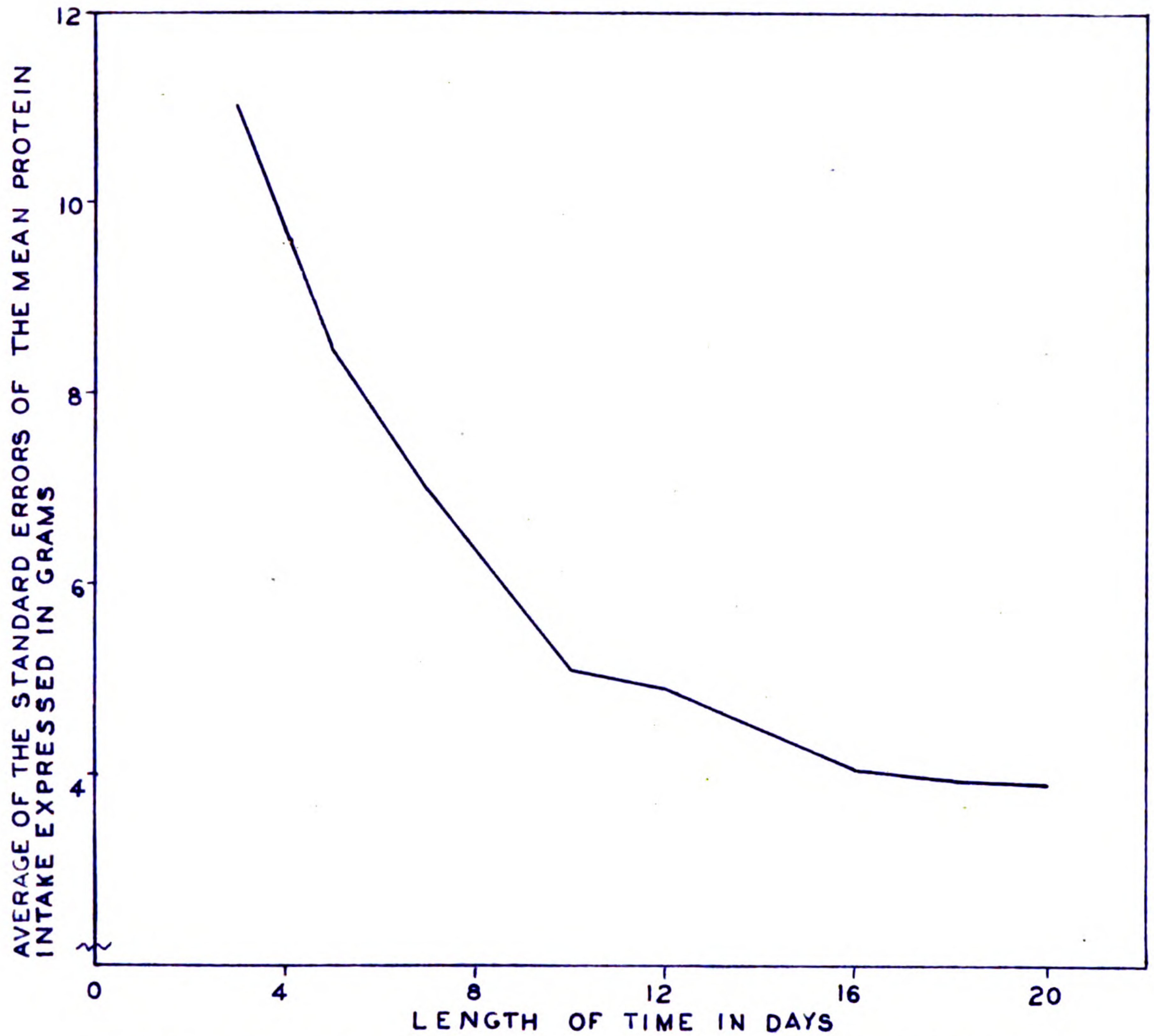

FIG. I AVERAGE OF THE STANDARD ERRORS OF THE MEAN OF THE PROTEIN INTAKE FOR TEN OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS

The mean calcium intakes for the individual women and the standard errors of the mean values are given in Table 11. The widest variation in mean calcium intake for subjects II, VII and IX occurred during the first ten days. These values were from 0.31 to 0.42 grams for subject II, from 0.36 to 0.57 grams for subject VII and from 0.74 to 0.87 grams for subject IX. However the calcium intakes appeared to be relatively constant for each individual subject during the twenty day period. Milk and milk products are the chief source of calcium in the diet, and the amount of milk used daily will affect the calcium intake more than any other food. Certain of the women used milk more than others and the amount of milk used daily appeared to be relatively constant for each subject. For instance, the calcium intake of subject III ranged from 1.02 to 1.33 grams per day and that of subject X ranged from 0.84 to 0.98 grams per day. Both of these subjects used milk generously in their daily diets. Subject IV had a very low calcium intake which ranged from 0.23 to 0.28 grams daily. This subject drank practically no milk.

Differences between means of calcium intake for the individual subjects for three, five and seven days and the mean intake for ten days were not statistically significant.

The averages of the standard errors of the mean intakes of all of the subjects are shown graphically in figure 2. Since the intake of calcium was more constant than that of protein, the decrease in standard errors of the mean calcium intakes was less marked than was the decrease in standard errors of the mean protein intake for successive days of analysis of diet records. There was however a steady decrease in the standard errors of the calcium intakes of these subjects from three to sixteen days. This

TABLE 11

THE AVERAGE AMOUNT OF CALCIUM AS GRAMS PER DAY INGESTED BY 10 CLINIC WOMEN DURING SUCCESSIVE TIME INTERVALS FROM THREE TO TWENTY DAYS

Time Interval No. Days	Subjects I	II	III	IV	V	VI	VII	VIII	IX	X
3	0.69 ±0.2[illegible]*	0.31 ±0.02	1.33 ±0.13	0.23 ±0.03	0.49 ±0.13	0.69 ±0.09	0.57 ±0.09	0.75 ±0.15	0.[illegible]7 ±0.03	0.9[illegible] ±0.09
5	0.64 ±0.15	0.40 ±0.03	1.22 ±0.10	0.23 ±0.06	0.44 ±0.03	0.69 ±0.08	0.53 ±0.15	0.6[illegible] ±0.[illegible]0	0.[illegible]3 ±0.11	0.84 ±0.11
7	0.64 ±0.11	0.41 ±0.06	1.13 ±0.09	0.25 ±0.05	0.5[illegible] ±0.11	0.71 ±0.05	0.36 ±0.08	0.67 ±0.08	0.75 ±0.09	0.91 ±0.11
10	0.76 ±0.10	0.42 ±0.05	1.14 ±0.08	0.23 ±0.06	0.51 ±0.09	0.77 ±0.0[illegible]	0.35 ±0.06	0.[illegible] ±0.06	0.74 ±0.07	0.96 ±0.09
12	0.71 ±0.09	0.41 ±0.04	1.10 ±0.09	0.26 ±0.05	0.54 ±0.08	0.72 ±0.07	0.46 ±0.06	0.[illegible]0 ±0.03	0.74 ±0.08	0.93 ±0.09
14	0.75 ±0.09	0.40 ±0.03	1.13 ±0.09	0.26 ±0.04	0.52 ±0.07	0.69 ±0.07	0.45 ±0.05	0.58 ±0.04	0.7[illegible] ±0.07	0.95 ±0.08
16	0.73 ±0.03	0.41 ±0.03	1.03 ±0.08	0.27 ±0.04	0.53 ±0.06	0.69 ±0.05	0.45 ±0.05	0.55 ±0.04	0.77 ±0.06	0.99 ±0.07
18	0.76 ±0.07	0.42 ±0.03	1.06 ±0.09	0.26 ±0.04	0.53 ±0.03	0.70 ±0.04	0.45 ±0.04	0.57 ±0.04	0.[illegible] ±0.06	0.97 ±0.07
20	0.75 ±0.07	0.42 ±0.03	1.02 ±0.03	0.27 ±0.03	0.59 ±0.07	0.67 ±0.04	0.45 ±0.04	0.5[illegible] ±0.04	0.[illegible]9 ±0.06	[illegible] ±0.08

* Standard error of the mean.

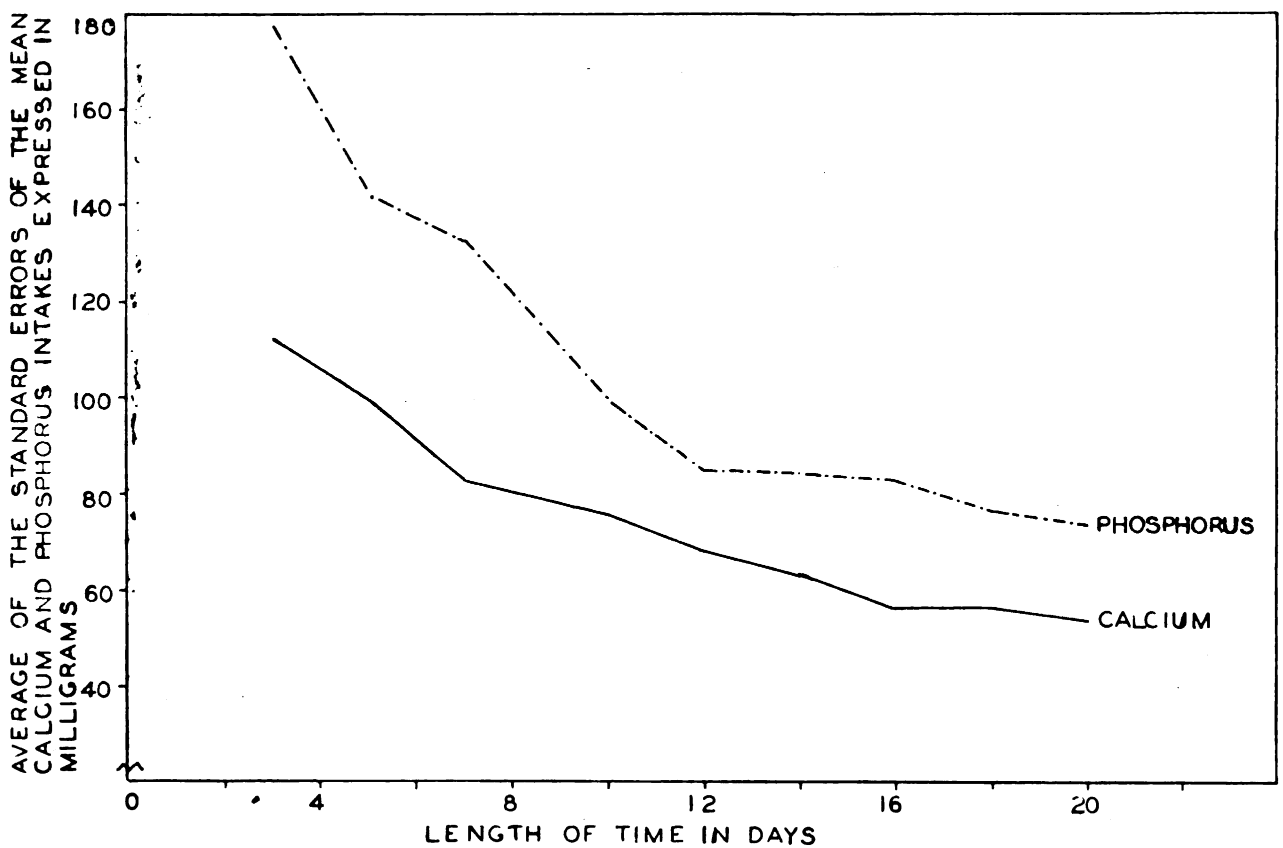

FIG 2 AVERAGE OF THE STANDARD ERRORS OF THE MEAN OF THE CALCIUM AND PHOSPHORUS INTAKES FOR TEN OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS

indicated that the validity of the estimation of the individual diets increased as the length of observation was increased.

The mean phosphorus intakes of the ten women and the standard error of the mean intakes for periods of three to twenty days are given in Table 12, and the averages of the standard errors of the mean are shown graphically in figure 2. The differences in mean intakes for the subjects for the successive time periods were not statistically significant according to the "t" test. However the standard errors of estimate were decreased steadily from three to twelve days. The advantage of continuing the analysis of diet records more than twelve days appeared to be very slight, as judged by the small decrease in the standard error of estimate after twelve days of observation.

The data in Tables 10, 11 and 12 indicate that the error of estimate was wide when the dietary intake of protein, calcium or phosphorus of an individual is evaluated from a short period of observation as three days or less. When the size of error of estimate is used as a criterion, it would appear that a good estimate of protein could be obtained from 10 to 16 consecutive days of dietary records, of phosphorus from 12 consecutive days of dietary records, and of calcium from 16 days.

In the preceding section, it was indicated that a valid estimate of the protein, calcium and phosphorus intake of a group of ten women could be found from the averages of diet records kept for a 7 day period. The data presented in this section would indicate that a 14 day period would be desirable to form an estimate of the protein, calcium and phosphorus intake of an individual.

TABLE 12

THE AVERAGE DAILY AMOUNT OF PHOSPHORUS AS GRAMS PER DAY INGESTED BY 10 OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS FROM THREE TO TWENTY DAYS

Time Interval No. Days	SUBJECTS I	II	III	IV	V	VI	VII	VIII	IX	X
3	1.26 ± 0.40*	0.54 ± 0.09	1.55 ± 0.26	0.71 ± 0.19	0.96 ± 0.18	1.03 ± 0.07	0.93 ± 0.21	0.94 ± 0.16	1.07 ± 0.06	1.59 ± 0.16
5	1.29 ± 0.22	0.70 ± 0.11	1.43 ± 0.20	0.97 ± 0.21	0.[illegible]3 ± 0.14	1.01 ± 0.05	0.[illegible] ± 0.12	0.91 ± 0.10	1.05 ± 0.10	1.32 ± 0.19
7	1.26 ± 0.16	0.[illegible]0 ± 0.12	1.40 ± 0.14	0.97 ± 0.19	1.06 ± 0.1[illegible]	1.07 ± 0.06	0.81 ± 0.10	0.[illegible]2 ± 0.11	0.96 ± 0.10	1.49 ± 0.17
10	1.30 ± 0.12	0.[illegible]2 ± 0.09	1.40 ± 0.10	0.85 ± 0.13	0.93 ± 0.14	1.11 ± 0.06	0.79 ± 0.08	0.[illegible]4 ± 0.07	0.96 ± 0.08	1.54 ± 0.13
12	1.20 ± 0.11	0.[illegible]1 ± 0.08	1.40 ± 0.10	0.79 ± 0.11	1.01 ± 0.11	1.06 ± 0.06	0.[illegible]0 ± 0.07	0.83 ± 0.0[illegible]	0.99 ± 0.06	1.50 ± 0.11
14	1.22 ± 0.10	0.79 ± 0.07	1.44 ± 0.09	0.75 ± 0.10	1.09 ± 0.13	1.03 ± 0.06	0.73 ± 0.0[illegible]	0.79 ± 0.0[illegible]	1.03 ± 0.09	1.49 ± 0.10
16	1.22 ± 0.09	0.[illegible]2 ± 0.06	1.40 ± [illegible]	0.[illegible]2 ± 0.11	1.04 ± 0.12	1.04 ± 0.06	0.[illegible]3 ± [illegible]	0.[illegible]2 ± 0.08	1.0[illegible] ± 0.03	1.52 ± 0.12
18	1.19 ± 0.08	0.[illegible] ± 0.0[illegible]	1.3[illegible] ± 0.0[illegible]	0.[illegible] ± 0.10	1.04 ± 0.11	1.03 ± 0.05	0.[illegible]2 ± 0.0[illegible]	0.[illegible] ± [illegible]	1.07 ± 0.06	1.51 ± 0.11
20	1.16 ± [illegible]	0.[illegible] ± 0.07	1.[illegible] ± [illegible]	0.82 ± 0.09	1.04 ± [illegible]	1.01 ± 0.05	0.[illegible] ± [illegible]	0.83 ± 0.05	1.0[illegible] ± 0.07	1.5[illegible] ± 0.11

*Standard error of the mean.

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

A study was undertaken to supply additional information concerning the relative value of different methods of calculating records of food intake and the possible relationship between the length of period of observation and the validity of the estimation of food intakes.

Ten-day records of the weighed food intakes of eighteen older women were calculated for the protein, calcium and phosphorus content of the diets by the tables of Donelson and Leichsenring (1945) and by the tables of food composition of the Bureau of Human Nutrition and Home Economics (1945). The dietary intakes determined by these methods of calculation were compared with values obtained by chemical analysis of the diets.

The calorie, protein and riboflavin intakes for seven day periods of eighteen college women were calculated from food intakes expressed as number of servings of food by the tables of Donelson and Leichsenring (1945). The calorie, protein and riboflavin intakes of this group also were calculated from food records for the same period which were expressed as weighed portions of food by the food tables of the Bureau of Human Nutrition and Home Economics (1945). The calculated intakes of these nutrients were compared with values determined by chemical analysis of the diets.

The results indicated that the dietary intake of calories, protein, calcium, phosphorus and riboflavin of a group of women could be estimated satisfactorily from diet records by using nutritive values for a group of similar foods as is done in the tables of Donelson and Leichsenring, or by calculation of the nutritive values of individual foods as by the more detailed food tables of the Bureau of Human Nutrition and Home Economics (1945). Furthermore, there was not a significant difference between the dietary intakes calculated from the number of servings of food and the dietary intakes calculated from weighed portions of individual foods.

The intake of calcium for a seven day period was determined by the two methods of calculation and by chemical analysis of the diet for a group of only seven women. In this instance, there was a significant difference between the calcium intake as determined by chemical analysis and that determined by the two methods of calculation. This indicated that the size of the group may affect the validity of the estimation of food intake by dietary calculations.

The possible relationship between the length of period of observation and the validity of the estimation of food intakes was studied. The average protein, calcium and phosphorus intakes of ten older women during successive time intervals from one to twenty-five days were determined by dietary calculations using the food tables of Donelson and Leichsenring (1942). There was not a significant difference in mean intakes of these nutrients for the successive time periods; however the standard error of estimate of the mean intakes for the group of women decreased steadily for the first seven days. This indicated that a seven day period is desirable for a study of the protein, calcium and phosphorus intakes of a group of ten women.

There was not a significant difference between the mean intakes of these nutrients for a three day, five day or seven day period when compared with a ten day period of dietary study. However the error of estimate was wide when the dietary intake of an individual was evaluated from a short period of observation as three days or less. The standard errors of the mean intakes decreased steadily with an increasing period of observation up to 15 consecutive days for protein and calcium and 12 consecutive days for phosphorus. It appeared that a fourteen day period of dietary study would be desirable to form an estimate of the protein, calcium and phosphorus intakes of an individual.

LITERATURE CITED

Adams, G. 1947 Food composition. J. Home Ec. 39: 94.

Atwater, W. O., A. P. Bryant 1906 The Chemical Composition of American Food Materials. U. S. A. Office Exper. Sta. Bull. 28.

Bassett, S., H. Elden, W. S. McCann 1931 Mineral exchanges of man I. Organization of metabolic ward and analytical methods. J. Nutr. 4: 239.

Bassett, S., H. E. Van Alstine 1935 Mineral exchanges of man IV. Variations in the mineral content of diets with a constant and weight formula. J. Nutr. 9: 175.

Berryman, G. H., Ch. Chatfield 1943 A short method of calculating the nutritive value of diets. J. Nutr. 25: 23.

Berryman, G. H., P. E. Howe 1944 A short method of calculating the nutritive value of diets. J. Nutr. 27: 231.

Bowes, A. de Planter., C. F. Church 1940 Food values of portions commonly used. 3'rd Ed. Philadelphia: College Offset Press.

Bowes, A. de Planter., C. F. Church 1944 Food values of portions commonly used. 5th Ed. Philadelphia Child Health Society.

Bowes, A. de Planter., C. F. Church 1951 Food values of portions commonly used. 7th Ed. Philadelphia: College Offset Press.

Bradley, A. V. 1942 Tables of food values. Rev. Ed. Peora Illinois. Manual Arts Press.

Bransby, E. R., J. W. Hunter, H. E. Magee, E. H. M. Milligan, T. S. Rodgers 1944 The influence of supplements of vitamins A, B_1, B_2, C and D on growth, health and physical fitness. Brit. Med. J. I: 77.

Bransby, E. R., G. Wagner 1945 The diets of school-children in two industrial towns. Brit. Med. J. II: 682.

Bransby, E. R., C. G. Daubny, J. King 1948a Comparison of results obtained by different methods of individual dietary survey. Brit. J. Nutr. 2: 89.

Bransby, E. R., C. G. Daubny, J. King 1948b Comparison of nutrient values of individual diets found by calculation from tables and by chemical analysis. Brit. J. Nutr. 2: 232.

Brewer, W. D., H. L. Tobey, Da Hwei Feng Kan, M. A. Ohlson, C. T. Stringer 1950 Riboflavin, nitrogen and thiamine metabolism of women with active tuberculosis. J. Amer. Dietet. Assoc. 26: 861.

Bureau of Human Nutrition and Home Economics in Cooperation with the National Research Council 1945 Tables of food composition in terms of eleven nutrients. U. S. Dept. of Agr., Misc. Pub. 572.

Bureau of Human Nutrition and Home Economics. 1949 Published by: Food and Nutrition Board of the National Research Council, National Academy of Science, Washington 25, D.C. May 1944 Nutrition surveys, their techniques and value. Bull. of the National Research Council 117. 17 pp.

Burke, B. S., H. C. Stuart 1938 A method of diet analysis application in research and pediatric practice. J. Pediatr. 12: 493.

Burke, B. S., V. A. Beal, S. B. Kirkwood, H. C. Stuart 1943 The influence of nutrition during pregnancy upon the condition of the infant at birth. J. Nutr. 26: 569.

Burke, B. S. 1947 The dietary history as a tool in research. J. Amer. Dietet. Assoc. 23: 1041.

Burke, B. S., C. H. Stuart 1948 Nutritional requirements during pregnancy and lactation. J. Amer. Med. Assoc., 137: 119.

Chatfield, Ch. 1949 Food composition tables for international use. Food and agriculture organization of the United Nations, Washington. U. S. A.

Collins, H. 19[illegible] Inadequacy of the twenty-four hour dietary history as a true estimate of food intake in times of acute food shortage as demonstrated by experiences in Vienna in 1946. Brit. J. Nutr. 2: [illegible].

Committee on Calorie Conversion factors and food composition tables. Ma 1947 Energy-yielding components of food and computation of calorie values. Washington: Food and Agriculture Organization of the United Nations.

Donelson, E. G., B. Nims, H. A. Hunscher, C. Shukers, Icie Macy 1931 Simple methods for metabolic balance studies and their interpretation. J. Home Ec., 23: 267.

Donelson, E. G., J. M. Leichsenring 1942 A short method for dietary analysis. J. Amer. Dietet. Assoc., 18: 429.

Donelson, E. G., J. M. Leichsenring 1945 Food composition table for short method of dietary analysis. J. Amer. Dietet. Assoc., 21: 440.

Donelson, E. G., J. M. Leichsenring 1951 Food Composition table for short method of dietary analysis (2nd revision). J. Amer. Dietet. Assoc., 27: [illegible].

Fisher, R. A. 1937 The design of experiments. Oliver and Boyd, London and Edinburgh.

Food and Nutrition Board of the National Research Council, National Academy of Science, Washington 25, D.C. May 1949 Nutrition surveys, their techniques and value. Bull. of the National Research Council 117.

Food and Nutrition Board of the National Research Council, National Academy of Science, Washington 25, D.C. March 1944 Tables of food composition giving proximate mineral and vitamin components of foods.

Fowke, M. M. 1945 Budgetary and dietary surveys. Proc. Nutr. Soc. 3: 20.

French, B. E., M. G. Fends, H. N. Sandstead 1947 Food value tables for calculation of diet records. Nutrition Section Federal Security Agency - U. S. Public Health Service, Washington 25, D. C.

Grant, M. W. 1944 Nutritive value of composite dishes. Nature, 455: 154.

Greaves, J. E., Hirst, C. T. 1929 The mineral content of grain. J. Nutr. 1: 293.

Goulden, C. H. 1939 Methods of statistical analysis. New York. John Wiley and Sons Inc.

Gutman, A. B., Low, M., 1939 On the approximation of the calculated to determined calcium content of human dietaries. J. Nutr. 18: 257.

Hawks, J. E., M. Dye, M. M. Bray 1937 An improved technique for metabolism studies in pre-school children with a statistical determination of its reliability. J. Nutr. 13: 51.

Hawley, E. 1929 A short method of calculating energy, protein, calcium, phosphorus and iron in the diet. U. S. Dept. Agr. Techn. Bull. 105.

Hummel, F. C., M. L. Shepherd, H. Galbraith, H. H. Williams, G. Macy 1942 Chemical composition of twenty-two common foods and comparison of analytical with calculated values of diets. J. Nutr., 24: 41.

Hunt, C. L. 1918 A quick method of calculating food values. J. Home Ec. 10: 212.

Kaser, M. M., R. C. Steinkamp, W. D. Robinson, H. L. Patton, J. B. Youmans 1947 A comparison of the calculated and determined calorie and vitamin contents of mixed diets. Amer. J. Hyg. 46: 297.

[illegible], M., [illegible], [illegible], A. H. [illegible], I. [illegible] 19[illegible] A study of the [illegible] Dietet. Assoc., [illegible]: [illegible].

League of Nations Health Organisation: Technical Commission of [illegible] [illegible] Health Org. L. O. N. 7 [illegible].

Leverton, R. M., Marsh, A. G. 1939 Comparison of food intakes for weekdays and for Saturday and Sunday. J. Home Ec., 31: 111.

Lockhart, E., [illegible] Harris 1944 Study of the nutritional quality of dietaries by chemical analysis. J. Amer. Dietet. Assoc. 20: 742.

McCance, R. A., E. M. Widdowson 1940 The chemical composition of foods. [illegible] Brooklyn: Chemical Publishing Co. Inc.

McCance, R. A., E. M. Widdowson 1946 The chemical composition of foods. [illegible] Spec. Rep. Ser. Med. Res. Coun. Lond. No. 235.

McHenry, E. W., H. P. Ferguson, J. [illegible] 1945 Sources of error in dietary surveys. [illegible] P. Hl. [illegible], [illegible]: [illegible].

McKay, F. A., A. M. [illegible]ler 1934 A comparison of the chemical composition of diets as determined by calculation and analysis. J. Amer. Dietet. Assoc., 10: [illegible].

Maynard, L. A. 1944 The Atwater system of calculating the caloric value of diets. J. Nutr., 28: 443.

Milam, D. F., 1942 A nutrition survey of a small North Carolina community. Amer. J. Publ. Health, 32: 406.

Morey, N. B. 1936 An analysis and comparison of different methods of calculating the energy value of diets. Nutr. Abst. and Review. 6: 1.

Moyer, E., A. P. Harrison, M. Lesher, O. N. Miller 1948 Nutritional Status of children. Blood serum vitC. J. Amer. Dietet. Assoc. 24: 1[illegible].

Ohlson, M. A., K. Daum 1935 Iron metabolism of normal women. J. Nutr. 9: 75.

Ohlson, M. A., Ph. P. Roberts, S. A. Joseph, P. M. Nelson 19[illegible] Dietary practices of 1[illegible] women from [illegible] to 75 years of age. J. Amer. Dietet. Assoc. 2[illegible]: [illegible].

Ohlson, M. A., L. Jackson, J. Boek, D. C. Cederquist, W. D. Brewer, E. G. Brown 1950 Nutrition and dietary habits of aging women. Amer. J. Publ. Health, 40: 1101.

Patterson, J. M., E. W. McHenry 1941 Errors in the calculation of nutritive value of food intake, comparison of calculated and determined amounts of calories, protein and fat. Canad. Publ. Health. J., 3[illegible]: 3[illegible].

Roberts, P. H., C. H. Kerr, M. A. Ohlson 1948 Nutritional status of older women. J. Amer. Dietet. Assoc., 24: [illegible].

Rose, A. R. 1920 Abridged dietary calculations for rations in quantity. Mod. Hosp., 14: 4[illegible]7.

So[illegible]mens, H. L., E. W. McHenry 1944 Errors in the calculations of the nutritive value of food intake. IV Comparison of calculated and determined amounts of calcium. Canad. J. Publ. Health, 35: 2[illegible].

Sherman, H. C. 19[illegible] Chemistry of food and nutrition, 3rd Ed., New York. The Macmillan Company.

Sherman, H. C. 1937 Chemistry of food and nutrition, 5th Ed., Ibid.

Steinkamp, R. C., W. D. Robinson, M. M. Leser 1945 Adaptation of short method of calculating the nutritive content of diets in rural areas of middle Tennessee. J. Amer. Dietet. Assoc., 21: 5[illegible].

Stiebeling, H. K., E. F. Phipard 1939 Diets of families of employed wage earners and clerical workers in cities. U. S. Dept. Agr. Circular 507.

Taylor, C. M. 1942 Food values in shares and weights. New York. The Macmillan Company.

Thomas, [illegible], [illegible], [illegible], E. L. [illegible], [illegible], S. Miller, A. [illegible], C. N. Miller, [illegible] Coryell, I. [illegible] 19[illegible] Nutritional status of children. Accuracy of calculated intakes of food components with respect to analytical values. J. Amer. Dietet. Assoc. 25: [illegible].

Toscani, V. 1948 Comparison of analyzed with calculated diets. Food Research. 13: 186.

War Memor. Med. Res. Counc. 1945 The nutritive values of wartime food. No. 1- London.

Watt, B. K., A. L. Merrill 1950 Composition of foods. Raw, Processed, Prepared. U. S. Dept. Agr. Agriculture Handbook No. 8.

Wiehl, D. G. 1942a Medical evaluation of nutritional status. VII, Diets of high school students of low income families in New York City. Milb. Mem. Fund. Quart. Bull. 20: 61.

Wiehl, D. G. 1942b Diets of a group of aircraft workers in souther California. Milb. Mem. Fund. Quart. Bull. 20: 329.

Wiehl, D. G. 1944 Medical evaluation of nutritional status. Calorie intake of high school students in New York City. Mil. Mem. Fund Quart. Bull. 22: 5.

Wiehl, D. G., K. Berry 1945 Medical evaluation of nutritional status XVI. Essential nutrients in diets of high school students according to sex and age and for different cultural groups in New York City. Milb. Mem. Fund. Quart. Bull. 23: 353.

Widdowson, E. M., R. A. McCance 1943 Food tables. Their scope and limitations. The Lancet 244: 230.

Youmans, J. B., E. Patton, R. Kern 1942 Surveys of the nutrition of populations. Description of the population, general methods and procedures and the findings to the energy principle in a rural population in middle Tennessee. Amer. J. Publ. Health, 32: 1371.

Young, C. M., E. W. McHenry 1942 Errors in the calculation of the nutritive value of food intakes. Comparison of calculated and determined amounts of ascorbic acid. Canad. Publ. Health. J. 33:224.

Young, C. M., E. W. McHenry 1944 Errors in the calculation of the nutritive value of food intake III. Comparison of calculated and determined amounts of iron. Canad. J. Publ. Health, 34: 367.

APPENDIX

TABLE 13

THE AVERAGE PROTEIN INTAKES OF 10 OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS FROM ONE TO TWENTY-FIVE DAYS

Subject	GRAMS OF PROTEIN						
	1 day	3 days	7 days	10 days	15 days	20 days	25 days
I	59.0	80.7	90.8	68.8	84.2	71.0	75.3
II	33.5	41.1	47.1	45.1	47.1	51.3	51.
III	67.1	79.1	65.5	77.4	70.3	75.6	74.0
IV	31.2	54.9	76.5	65.7	57.4	56.2	59.2
V	58.8	67.4	72.3	69.6	68.[illegible]	67.2	67.5
VI	60.5	56.4	75.1	67.6	60.7	60.1	60.1
VII	59.0	59.3	55.2	53.4	53.8	54.8	54.3
VIII	61.1	55.4	50.1	51.6	40.9	51.1	51.1
IX	60.8	77.0	60.1	59.4	62.3	59.7	53.3
X	62.4	49.9	84.9	60.7	82.3	67.3	[illegible].5
Total	593.29	631.54	669.58	670.17	644.6	643.8	6[illegible].7
Mean	59.3	63.2	67.0	67.0	64.5	64.-	64.0
Standard error of the mean	5.0	4.2	4.6	4.8	4.3	3.9	3.4

Days	1 vs. 3	3 vs. 7	7 vs. 10	10 vs. 15	15 vs. 20	20 vs. 25
"t" Distribution	0.58	0.61	0.01	0.39	0.00	0.00

TABLE 14

THE AVERAGE CALCIUM INTAKES OF 10 OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS FROM ONE TO TWENTY-FIVE DAYS

Subject	GRAMS OF CALCIUM						
	1 day	3 days	7 days	10 days	15 days	20 days	25 days
I	0.43	0.69	0.64	0.76	0.99	0.75	0.95
II	0.31	0.31	0.41	0.42	0.41	0.42	0.44
III	1.25	1.33	1.00	1.14	1.11	1.02	[illegible]
IV	0.30	0.23	0.25	0.28	0.25	0.27	[illegible]
V	0.49	0.49	0.58	0.50	0.51	0.59	0.5[illegible]
VI	0.56	0.69	0.71	0.77	0.66	0.67	0.65
VII	0.48	0.53	0.47	0.46	0.46	0.45	0.44
VIII	0.98	0.87	0.67	0.62	0.56	0.56	0.5[illegible]
IX	0.87	0.98	0.75	0.74	0.73	0.79	0.7[illegible]
X	0.83	0.78	0.91	0.96	0.89	0.99	0.94
Total	6.50	6.90	6.39	6.65	6.59	6.50	6.57
Mean	0.65	0.69	0.64	0.67	0.66	0.65	0.[illegible]
Standard error of the mean	0.10	0.11	0.07	0.08	0.09	0.08	[illegible]

Days	1 vs. 3	3 vs. 7	7 vs. 10	10 vs. 15	15 vs. 20	20 vs. 25
"t" Distribution	0.28	0.41	0.25	0.05	0.08	0.35

TABLE 15

THE AVERAGE PHOSPHORUS INTAKES OF 10 OLDER WOMEN DURING SUCCESSIVE TIME INTERVALS FROM ONE TO TWENTY-FIVE DAYS

Subject	GRAMS OF PHOSPHORUS						
	1 day	3 days	7 days	10 days	15 days	20 days	25 days
I	0.82	1.22	1.26	1.29	1.23	1.16	1.15
II	0.51	0.54	0.80	0.82	0.80	[illegible]	0.75
III	1.33	1.55	1.21	1.41	1.42	1.3[illegible]	1.30
IV	0.50	0.71	0.97	0.85	0.76	0.72	[illegible]
V	0.99	0.96	1.06	0.98	1.05	1.07	1.23
VI	1.05	1.03	1.07	1.11	0.96	1.01	1.02
VII	0.88	0.93	0.81	0.79	0.71	0.81	0.84
VIII	1.17	1.07	0.82	0.84	0.83	0.83	0.79
IX	1.19	1.59	0.96	0.96	1.07	1.08	1.04
X	1.33	0.94	1.49	1.54	1.39	1.58	1.43
Total	9.75	10.53	10.45	10.58	10.31	10.60	10.45
Mean	0.98	1.05	1.05	1.06	1.03	1.06	1.05
Standard error of the mean	0.10	0.11	0.07	0.09	0.08	0.08	0.08

Days	1 vs. 3	3 vs. 7	7 vs. 10	10 vs. 15	15 vs. 20	20 vs. 25
"t" Distribution	0.55	0.06	0.12	0.24	0.25	0.27

TABLE 16

DAILY AMOUNT OF PROTEIN INGESTED BY 10 OLDER WOMEN DURING THIRTY CONSECUTIVE DAYS EXPRESSED IN GRAMS

Day	SUBJECTS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
1	59.0	33.5	68.1	31.2	68.8	69.6	59.0	61.1	60.9	82.6
2	60.3	43.3	64.4	93.4	49.2	59.5	40.8	55.7	53.8	93.5
3	122.8	43.0	104.9	40.1	84.3	71.4	78.0	33.0	51.7	55.2
4	101.8	46.6	84.6	92.4	82.6	57.3	48.9	42.3	46.4	75.6
5	137.4	67.3	43.7	118.4	41.8	70.8	53.6	58.4	67.3	49.6
6	65.0	47.7	87.7	48.3	93.9	73.5	51.7	41.9	63.8	110.9
7	89.7	44.8	87.0	111.9	85.5	67.9	54.5	58.1	77.9	127.3
8	85.9	35.4	69.7	28.7	72.4	63.4	58.3	40.9	53.9	[illegible]
9	93.4	47.7	85.9	38.0	77.5	72.0	41.3	68.6	66.6	128.7
10	72.9	48.1	78.2	53.4	40.7	70.6	47.6	56.0	58.1	69.1
11	49.4	49.3	104.7	47.2	71.9	57.3	69.0	58.1	67.3	[illegible]
12	58.7	57.1	64.0	37.2	96.9	59.9	45.6	54.2	73.1	86.6
13	61.6	35.5	99.9	47.6	47.5	56.1	41.7	38.5	65.2	99.5
14	78.8	64.9	90.5	31.4	53.6	57.3	47.3	24.7	70.2	61.4
15	131.5	42.4	56.7	34.1	66.0	44.7	70.4	42.2	65.0	110.7
16	61.8	78.9	72.6	22.6	53.4	52.4	70.9	57.6	54.9	95.6
17	58.0	56.1	61.9	45.8	74.8	62.9	[illegible]	61.4	45.5	43.9
18	71.4	64.6	58.0	54.3	70.3	54.6	39.0	53.9	63.7	78.7
19	46.2	61.1	50.0	75.6	50.2	54.6	55.9	63.9	65.4	109.6
20	51.5	57.7	59.5	65.0	62.2	66.4	35.2	50.5	29.7	72.3

TABLE 17

DAILY AMOUNT OF CALCIUM INGESTED BY 10
OLDER WOMEN DURING TWENTY CONSECUTIVE DAYS EXPRESSED
IN GRAMS

Day	SUBJECTS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
1	0.43	0.31	1.25	0.30	0.49	0.56	0.48	0.98	0.77	0.63
2	0.43	0.35	1.15	0.18	0.26	0.[illegible]7	0.22	0.[illegible]	0.[illegible]2	1.14
3	1.21	0.28	1.59	0.22	0.71	0.84	[illegible]	0.49	0.91	0.97
4	0.63	0.72	1.13	0.19	0.45	0.78	0.44	0.52	0.45	0.73
5	0.50	0.36	0.96	0.49	0.29	0.60	0.52	0.53	1.09	0.50
6	0.84	0.46	1.32	0.13	0.78	0.65	0.45	0.52	0.59	0.79
7	0.45	0.42	[illegible]4	0.26	1.07	0.85	0.30	0.77	0.60	1.[illegible]
8	1.28	0.49	0.74	0.15	0.55	0.59	0.69	0.33	0.66	[illegible]
9	0.86	0.29	1.0[illegible]	0.65	0.31	1.36	0.19	0.58	0.53	1.06
10	0.94	0.56	1.37	0.16	0.12	0.[illegible]0	0.39	0.64	0.92	1.31
11	0.38	0.27	1.35	0.29	0.65	0.67	0.62	0.57	0.33	1.09
12	0.60	0.37	0.41	0.09	0.59	0.33	0.36	0.44	1.17	[illegible]
13	1.34	0.33	1.54	0.27	0.39	0.47	0.50	0.37	1.11	1.24
14	0.60	0.33	1.10	0.20	0.48	0.53	0.19	0.21	0.97	[illegible]
15	1.14	0.55	0.79	0.12	0.31	0.45	0.43	0.51	0.71	1.[illegible]
16	0.81	0.48	0.62	0.55	0.73	0.62	0.55	0.43	[illegible]	1.24
17	0.47	0.55	1.56	0.22	1.44	0.81	0.46	0.52	0.51	0.48
18	0.72	0.51	0.31	0.26	0.60	0.76	0.36	0.81	1.21	1.15
19	0.45	0.35	0.39	0.34	0.77	0.43	0.47	0.55	0.76	1.[illegible]5
20	0.90	0.40	0.92	0.20	0.60	0.46	0.41	0.50	1.05	0.46

TABLE 15

DAILY AMOUNT OF PHOSPHORUS INGESTED BY
10 OLDER WOMEN DURING TWENTY CONSECUTIVE DAYS EXPRESSED IN GRAMS

Day	SUBJECTS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
1	0.82	0.51	1.38	0.50	0.99	1.05	0.[illegible]	1.17	1.19	1.33
2	0.82	0.70	1.25	1.09	0.63	1.15	0.60	1.02	1.01	1.57
3	2.02	0.40	2.07	0.54	1.26	0.91	1.30	0.63	1.01	1.67
4	1.30	0.98	1.60	1.11	1.02	1.06	0.75	0.73	0.74	1.10
5	1.51	0.90	0.90	1.64	0.50	0187	0.88	0.90	1.71	0.75
6	1.12	0.76	1.37	0.62	1.06	1.10	0.87	0.73	0.83	1.77
7	1.37	1.37	1.24	1.28	1.09	1.35	0.43	0.47	0.60	2.05
8	1.49	1.12	1.14	0.41	0.99	0.96	1.05	0.72	0.92	1.83
9	1.56	0.72	1.50	0.64	0.92	1.47	0.54	1.11	0.97	1.24
10	0.97	0.73	1.62	0.64	0.50	1.13	0.58	0.87	1.05	1.23
11	0.79	0.65	1.84	0.62	0.96	0.97	0.99	0.92	0.92	1.46
12	0.76	0.74	0.94	0.36	1.26	0.72	0.73	0.67	1.31	1.14
13	1.15	0.54	1.77	0.63	2.27	0.77	0.73	0.59	1.20	1.66
14	1.41	0.86	1.51	0.45	0.91	0.86	0.67	0.54	1.08	1.1[illegible]
15	0.36	0.97	1.12	0.93	0.50	0.77	1.10	1.3[illegible]	1.08	2.[illegible]4
16	1.07	1.18	1.12	1.67	0.93	1.55	1.16	0.72	0.[illegible]	1.72
17	0.72	0.94	1.61	1.13	1.11	1.02	1.14	0.80	1.01	[illegible]
18	1.10	1.75	0.76	0.74	0.9	0.83	0.44	0.[illegible]	1.29	1.28
19	0.76	0.91	1.74	0.67	0.94	0.[illegible]0	0.77	0.[illegible]	1.43	2.04
20	1.10	0.[illegible]	1.10	0.74	0.99	0.[illegible]7	0.62	0.76	0.[illegible]	[illegible]

[redacted]