

THE CALCIUM AND THE PHOSPHORUS  
INTAKES OF TWO COLLEGE WOMEN

by

JEAN CHEN  
(CHEN CHIH YING)

B.A., Hwa Nan College  
Foochow, China, 1933

---

A THESIS

submitted in partial fulfillment of the

requirements for the degree of

MASTER OF SCIENCE

KANSAS STATE COLLEGE  
OF AGRICULTURE AND APPLIED SCIENCE

1938

## TABLE OF CONTENTS

INTRODUCTION. . . . .	1
REVIEW OF LITERATURE. . . . .	2
PROCEDURE. . . . .	9
RESULTS AND DISCUSSION . . . . .	23
CONCLUSIONS . . . . .	42
ACKNOWLEDGMENT. . . . .	44
LITERATURE CITED. . . . .	45

## INTRODUCTION

Calcium is the most abundant mineral in the human body, averaging 1 1/2 per cent of the body weight. Phosphorus is next in amount with an average of 1 per cent. Calcium and phosphorus are essential for building the skeleton and other tissues and maintaining body functions. Generous amounts of calcium and phosphorus are believed to be required by the college woman, who often is still growing, although the exact amounts necessary have not been definitely fixed.

Various attempts have been made to establish standards for calcium and phosphorus for this age group. Numerous dietary studies have been conducted on limited numbers of college women to determine their intakes of these minerals but, for the most part, these have been group investigations so do not give accurate data for the individual. A comparatively small number of individual weighed diets have been studied but they have been too few to be representative.

Other investigations of the amounts of calcium and phosphorus in the diets of college women have been based on output of these elements in the excreta, but such studies do not indicate the exact intake. Calcium and phosphorus balances have been conducted on college women but, for the most part, the subjects have been graduate rather

than undergraduate students so the data fit a somewhat older group. Also, in these cases, most of the diets have been restricted.

Because of the need for exact information on the calcium and the phosphorus requirements of women of college age, it appears desirable to analyze freely chosen diets of individuals in this group. Thus additional data will be supplied which are necessary in order to arrive at adequate calcium and phosphorus standards for the average college woman.

#### REVIEW OF LITERATURE

Sherman (1920 a), from analyses of published balance experiments, has suggested 0.45 gram of calcium as the minimum daily requirement for a man weighing 70 kilograms. Adding 50 per cent as a margin of safety, he has set 0.68 gram as the standard allowance for this mineral. In the same way he has recommended 0.88 gram of phosphorus (1920 b) as the minimum requirement per 70 kilograms of body weight and 1.32 grams as the standard allowance. These amounts of calcium and phosphorus are generally accepted at the present time for the adult male unit which is technically defined by Hawley (1932) as the nutritive requirements of a man of moderate activity weighing 70 kilograms.



A number of dietary studies have been made showing, with varying degrees of accuracy, the calcium and the phosphorus intakes of selected groups of college women. In each case, judged by the ability of the diet to maintain the subjects in health, there has been an attempt to determine the actual needs of the college woman for these minerals.

Borthwick (1917) studied a group of college women living in a residence hall at Montana State College. The food intake for an eight-day period was recorded and the average calcium and phosphorus consumption per day, calculated as calcium oxide and phosphorus pentoxide, was found to be 0.56 gram of calcium and 1.28 grams of phosphorus per capita.

Kramer and Grundmeir of Kansas State College (1926) collected dietary data from 20 groups of students with a total of 465 subjects which included both men and women. Analysis of the data showed an average daily consumption for the 20 groups of 0.58 gram of calcium and 1.24 grams of phosphorus per each 3,000 Calories of food consumed. Ten of these groups were composed of college women who consumed somewhat larger amounts proportionately of calcium and phosphorus than the men students. This was indicated by an average of 0.61 gram of calcium and 1.32 of phosphorus per each 3,000 Calories of food.

The food consumption of women students at Oregon State College was investigated by Grace (1929). She found the supply of calcium was "adequate" in the food served with one exception and "the phosphorus was equal to or above the standard allowance" in all cases.

Trump (1930) made a study at Kansas State College of two groups of sorority women composed of 35 and 22 individuals respectively. The results showed the calcium and the phosphorus consumption for the first group averaged 0.68 gram of calcium and 1.19 grams of phosphorus per capita per day. The second group consumed daily an average of 0.86 gram of calcium and 1.46 grams of phosphorus. For each 3,000 Calories, these groups averaged 0.87 and 0.94 gram of calcium and 1.54 and 1.60 grams of phosphorus respectively, indicating the diets were more than adequate according to adult male standards for these minerals whether computed on the per capita basis or per 3,000 Calories.

The food served in the women's residence hall at Kansas State College was studied by Ryder (1932) over a two-week period during which 5,258 meals were served to 137 persons. She found the average intakes were 0.792 gram of calcium and 1.197 grams of phosphorus per person per day or 1.305 grams of calcium and 1.971 grams of phosphorus per each 3,000 Calories.

In the same year, Coons and Schiefelbusch (1932) made an individual weighed study of the diets of 18 normal college women at the Oklahoma Agricultural and Mechanical College. Two or more observation periods were obtained for each subject while eating her usual self-chosen diet. In 10 cases the periods were non-consecutive and only four days in length. In eight cases the periods were consecutive and seven days each in duration. The average intake of calcium was 0.93 gram per day and of phosphorus, 1.19 grams per day for an average weight of 51.9 kilograms which, when calculated to 3,000 Calories, amounted to 1.40 grams of calcium and 1.79 grams of phosphorus.

A dietary study of the inventory type was conducted by Shirley (1932) on ten student organizations at Kansas State College. Her data for four groups of sorority women indicated that none of the diets was deficient in either calcium or phosphorus when judged by adult standards. The average for the four groups was 0.84 of calcium and 1.47 grams of phosphorus per day per 3,000 Calories or 0.78 gram and 1.38 grams of phosphorus per capita. However, edible waste was included in these data so that actual intake must have been somewhat lower.

Jackson (1934) studied the nutritive value and cost of food consumed by a sorority group, 22 of which were college

women. Records were obtained for a two-week period in which 1002 meals were served. She found the average per capita consumption of calcium, after edible waste had been deducted to be 0.53 gram whereas the phosphorus amounted to 0.977 gram daily. Per 3,000 Calories, the consumption rose to 0.68 gram of calcium and 1.25 grams of phosphorus.

Another group at Kansas State College, composed of 37 individuals including 31 women students living in a sorority house, was studied over a two-week period by Conard (1934). She found the intake per capita per day to be 0.50 gram of calcium and 0.92 gram of phosphorus after edible waste was deducted. These values, when computed on the basis of 3,000 Calories per day, amounted to 0.54 gram of calcium and 1.05 grams of phosphorus.

Goddard et al (1934) investigated the nutritive value of the food served over two eight-day periods in a dormitory occupied by 105 women of the University of California at Los Angeles. In the first period in which a 3699-Calorie diet was eaten, these workers found the intake to be 0.51 gram of calcium and 1.34 grams of phosphorus per capita per day. Per 3,000 Calories, the consumption was lowered to 0.41 gram of calcium and 1.08 grams of phosphorus. For the second period in which each subject ate an average of 2501 Calories daily, the minerals were increased to 0.75 gram of calcium and 1.15

grams of phosphorus per capita per day and to 0.90 gram of calcium and 1.38 grams of phosphorus per 3,000 Calories.

An analysis of the food intake of a cooperative group at Vassar College by Wheeler and Mallay (1935) showed an average daily consumption of 0.92 gram of calcium and 1.32 grams of phosphorus per capita or 1.15 grams of calcium and 1.65 grams of phosphorus per 3,000 Calories.

Schermerhorn (1936) made a 14-day dietary study of the nutritive value of the food consumed by a cooperative group consisting of 129 persons living in a residence hall at Kansas State College, 122 of whom were women students. This group had an average weight of 60.5 kilograms. After deducting the amount of edible waste, the diet furnished 0.75 gram of calcium and 1.13 grams of phosphorus per capita per day or 1.08 grams of calcium and 1.62 grams of phosphorus per 3,000 Calories.

Gallemore (1932) studied the calcium intake of 25 college women as indicated by calcium output, basing her data on the assumption that unless the intake is very low a normal adult tends to adjust his mineral metabolism to his supply. This study covered a four-day period in the fall and another four-day period in the winter, during which the subjects ate their customary diet. The majority apparently received amounts of calcium well above the Sherman standard



of 0.68 gram per 70 kilograms of body weight. This was apparently explained by the fact that liberal amounts of milk were included in the diets. The average calcium consumption for all subjects calculated to 70 kilograms of body weight for the fall period was 1.062 grams per day and for the winter period, 1.108 grams per day. The daily average for both periods for all subjects amounted to 1.085 grams per 70 kilograms.

Fletcher (1933), continuing the work begun by Gallemore (1932), studied the phosphorus in the diets of 30 college women. Her data on intake were indicated by output in urine and feces. Her first series of experiments consisted of a four-day period in the fall and another in the spring, using 25 subjects eating a freely chosen diet. In a later series of experiments conducted during the summer, five college women ate a freely chosen diet for a four-day period. This was followed by another four-day period in which no milk and cheese were used and in another in which no animal protein foods were eaten. She found the average phosphorus intake of the 25 women to be 1.39 grams per 70 kilograms in the fall and 1.40 grams per 70 kilograms in the winter. In series II, the freely chosen diet furnished an average of 1.40 grams of phosphorus; the milk-free diet, 1.11 grams; and the protein-low diet, 0.82 gram per 70 kilograms per day.

Kramer and Gillum (1938) reported an investigation of the calcium and the phosphorus outputs of 23 healthy college women. In period I, a freely chosen diet was used. In period II, milk and cheese were omitted, and in period III, the diet contained no high-protein foods of animal origin. In the last period only seven subjects were used. Following the methods of Gallemore (1932) and of Fletcher (1933) and assuming the output to be equivalent to the intake, they found that the freely chosen diets eaten in the first period furnished 1.09 grams of calcium and 1.26 grams of phosphorus per 70 kilograms per day. In the second period, the no-milk diet furnished 0.58 gram of calcium and 0.94 gram of phosphorus per 70 kilograms. In the third period in which no high-protein foods of animal origin were used, the diet furnished only 0.45 gram of calcium and 0.77 gram of phosphorus per 70 kilograms.

#### PROCEDURE

Two normal young college women majoring in home economics served as subjects for an eight-week dietary study during which the food and the water intake of each individual was measured quantitatively. The diets were freely chosen. No restrictions were made other than that the weights of all foods eaten should be recorded and a sample

of each be furnished for analysis.

Both subjects were in good physical condition as determined by an examination by a college physician and basal metabolism tests. Subject A was short but of medium build. She was 147 centimeters tall, weighed 48.3 kilograms, and was 25 years old. Her basal rate ranged from a high of -4.2 per cent to a low of -9.9 per cent with an average of -7.1 per cent when compared with the DuBois standard (table 1). Subject L, 24 years old, 159 centimeters tall, and weighing 50.3 kilograms was regarded as linear in build. Her basal metabolism was approximately constant ranging from -7.4 per cent to -7.5 per cent and averaging -7.45 per cent (table 1). Both subjects were well within the range of normality with respect to basal metabolism and apparently in other respects. Each was regarded as moderately active.

The young women did light housekeeping, living in a small apartment, seven blocks from the college. They walked this distance in the morning and again at noon, with an occasional evening trip to the campus. Each worked in an office at the college as an employee of the National Youth Administration, spending an average of 11 hours per week in this way. They also did their housework and prepared from two to three meals a day in the apartment.

Every morning upon rising, the subjects weighed



TABLE 1. PERSONAL DATA

Subject	A	L
Class	Senior	Senior
Age in years	25	24
Height in cm.	147	159
Weight in kg.		
Range	47.0 - 49.7	50.0 - 52.5
Average	48.3	50.3
Predicted	52.3	55.9
Type of build	Medium	Linear
Basal metabolic rate in percent compared with the DuBois standard		
Range	-4.2 to -9.9	-7.4 to -7.5
Average	-7.1	-7.45
Health	Normal	Normal
Activity	Moderate	Moderate
Average hours of sleep per day	7.0	7.0
Average hours of study per day	5.0	6.5

themselves under approximately the same conditions. The average of these weights was used for all computations. The variation from day to day was slight (table 1). During the week, three meals were eaten each day at regular intervals for five days. The young women did not eat breakfast on Sunday but ate an unusually large meal at noon which was generally followed by a light meal in the evening eaten at irregular hours. A further exception to their usual eating habits was the Saturday night supper, which was somewhat irregular both as to content and time of eating.

Frequently on any day extra foods were eaten, particularly before going to bed at night. These were varied in nature, sometimes being as simple as a prepared breakfast food served with milk and again consisting of less desirable foods, as Coca Cola, ice cream, candy, sandwiches, or coffee alone, and in various combinations. The menus showing the foods chosen by these subjects appear in table 2.

Water was consumed in known amounts. An ample quantity was weighed out each day for each subject. At the end of the 24-hour day another weight was obtained for the container and its contents, and the difference considered to be the amount of water the subject had consumed from this source. As the plan was primarily to determine the content of a freely chosen diet, it was essential that no restrictions

TABLE 2. MENUS SERVED JANUARY 12 TO MARCH 8, 1937

Day Date	Breakfast	Lunch	Dinner	Between meals	
				Food	Subject using
Tues. Jan.12	Egg Orange Toast Butter Coffee Cream	Peanut sandwich Raw carrot Fruit salad Cocoa	Ham Mashed potatoes Cabbage salad Gravy Ice cream Cookies	Cookies Cream Coffee	A L L A L
Wed. Jan.13	Orange Nut roll Milk Coffee	Lunch ham Brown beans Raw carrot Whole wheat bread Butter Ovaltine Cookies	Macaroni-Cheese Tomatoes Celery Whole wheat bread Butter Fruit salad Coffee Cream Rot hots	Celery Coffee Cream	A L A L L
Thurs. Jan.14	Oranges Ovaltine Bread Butter	Macaroni-Cheese Green beans Celery Whole wheat bread Butter Gooseberry sauce	Ham Green beans Cabbage salad Mince meat pie Rolls Butter Coffee Cream	Ham sandwich Ripe olive Pickle Cream Coffee	A L A L A L A L
Fri. Jan.15	Tomato juice Top milk Coffee	Macaroni-Cheese Rolls Butter Ovaltine Apple	Meat-Vegetable casserole Cabbage salad Rolls Oleo Mince meat pie Coffee		
Sat. Jan.16	Grapefruit Sweet roll Cream Coffee	Toasted cheese sandwich Raw carrot Salad dressing Chocolate cake Fudge candy	Vegetable soup Ritz chips Orange Cream Coffee	Coffee Candy Salad Cake	A L A L A
Sun. Jan.17		Pop corn Coffee Cream	Ham Mashed potatoes Green beans Gravy Cabbage salad Bread Butter Fruit salad Chocolate cake Coffee Cream	Coca Cola	L
Mon. Jan.18	Orange Sweet Roll Cream Coffee	Vegetable casse- role Cracked wheat bread Lettuce Salad dressing Oleo Ice cream Coffee Cream	Meat casserole Fried potatoes Raw carrot Salad dressing Whole wheat bread Butter Ovaltine Divinity candy	Chocolate candy Ritz crackers Doughnut Coffee	A L A A A

TABLE 2. (continued)

Day / Date	Breakfast	Lunch	Dinner	Between meals	
				Food	Subject using
Tues. Jan.19	Grapefruit Doughnut Coffee Cream	Potato salad Lettuce Whole wheat bread Butter Tea Cream Sugar	Brown beans with meat Fried parsnips Whole wheat bread Oleo Ovaltine Doughnut Apple	Parsnips Goodbar	A L A
Wed. Jan.20	Orange Doughnut Coffee Cream	Peanut butter sandwich Meat and vegetable casserole Raw carrot Salad dressing Cocoa	Stuffed peppers Sweet potatoes Bread Butter Gooseberry sauce Cocoa	Coffee	L
Thurs. Jan.21	Orange Egg Toast Oleo Coffee Cream	Cream of tomato soup Meat loaf Raw carrot Ritz crackers Coffee Cream	Meat loaf Sweet potato Lettuce Salad dressing Bread Oleo Fruit jello Coffee Cream	Coffee Cream Apple	A L L A L
Fri. Jan.22	Orange Egg Toast Oleo Coffee Cream	Creamed salmon Raw carrot Toast Fruit salad Cookies	Beef loaf Green beans Mashed potatoes Gravy Whole wheat bread Oleo Peaches Cookies Coffee Cream	Candy bar	A
Sat. Jan.23	Peaches Toast Butter Cocoa	Weiner sandwich Pickles Tomato catsup Pineapple-carrot jello salad Oleo Cookies Ice cream Coffee Cream	None	Coffee Cream Salad	L L L
Sun. Jan.24	None	Banana salad Sausage Waffles Butter Coffee	Turkey Dressing Potatoes Gravy Tomato salad Radishes Bread Butter Cranberries Ice cream Coffee (not eaten by A)	Ice cream Cookies	A A
Mon. Jan.25	Banana Sausage Egg Toast Oleo Coffee Cream	Meat and vegeta- ble casserole Oleo Bread Ice cream Coffee Cream	Vegetable casserole Lettuce salad Rolls Oleo Ice cream Ice cream Cookies Coffee Cream	Coffee	L



TABLE 2. (continued)

Day Date	Breakfast	Lunch	Dinner	Between meals	
				Food	Subject using
Tues. Jan. 26	:Prunes :Toast :Oleo :Cocoa	:Beans-frankfurters :Raw carrot :Catsup :Apple :Coffee :Cream	:Sausage :Stuffed pepper :Raw carrot :Salad dressing :Whole wheat bread :Oleo :Coffee :Cream	:Frankfurter :Whole wheat : bread :Oleo :Candy :Coffee :Cream	: A L : A L : A L : A L : A L : L
Wed. Jan. 27	:Grapefruit :Cream of : Wheat :Toast :Oleo :Coffee :Cream :Milk	:None	:Ham :Potatoes :Peas :Rolls :Oleo :Chocolate tapioca :Coffee :Cream	:Cake :Coffee :Cream	: A L : A L : L
Thurs. Jan. 28	:Grapefruit :Egg :Toast :Oleo :Coffee :Cream	:Creamed salmon :Cabbage salad :Toast :Chocolate tapioca :Coffee :Cream	:Meat :Dressing :Peas :Boiled potatoes :Gravy :Bread	:Prunes	: A
Fri. Jan. 29	:Prunes :Pineapple : roll :Coffee :Cream	:Potato salad :Bread :Oleo :Ice cream :Cake :Ovaltine	:Ham casserole :Cabbage salad :Bread :Oleo :Ice cream		
Sat. Jan. 30	:Tomato : juice :Ovaltine	:Ham sandwich :Raw carrots :Salad dressing :Apple :Divinity :Milk	:Ham sandwich :Ice cream :Cherry Coca Cola :Coffee :Cream	:Divinity :Chocolate : candy :Doughnut :Cookie :Caramel candy	: L : A L : L : A L : A
Sun. Jan. 31	:None	:Ham :Sweet potatoes :Green beans :Brown beans :French rolls :Chocolate ice : cream :Apple sauce cake :Coffee :Cream	:Chicken :Dressing :Potatoes :Gravy :Peas :Bread :Apple sauce cake :Coffee	:Cookie :Hamburger :Coffee :Cream	: L : L : L : L
Mon. Feb. 1	:Grapefruit :French : roll :Coffee :Cream	:Peanut butter- : jelly sandwich :Banana :Cookies	:Vegetable casserole :Whole wheat bread :Apple :Applesauce cake :Coffee :Cream	:Chicken :Cookie :Apple	: L : A L : L

TABLE 2. (continued)

Day Date	Breakfast	Lunch	Dinner	Between meals	
				Food	Subject using
Tues. Feb. 2	Pineapple roll Cocoa	Creamed chicken Toast Apple Coffee Cream	Salmon Toast Apple Coffee Cream (Not eaten by A)	Cherry coke	L
Wed. Feb. 3	Tomato juice Coffee Cream	Toasted cheese sandwich Ice cream Coffee Cream	Chili Crackers Ice cream Coffee Cream		
Thrus. Feb. 4	Tomato juice Coffee Cream	Tomatoes-Spaghetti Green beans Lettuce salad Bread Butter Pecan roll Cocoa	Chili Crackers Chocolate candy (Not eaten by A)	Crackers Cookies	A L
Fri. Feb. 5	Tomato juice Pecan roll Coffee Cream	Toasted cheese sandwich Raw carrot Banana-Cream Cookies Coffee	Dumplings Green beans Lettuce salad Bread Butter Ice cream Coffee Cream	Cookies Potato salad Potato chips Pickles Liverworst sandwich Coffee	A L L L L L
Sat. Feb. 6	Tomato juice	Creamed eggs Raw carrot Toast Salad dressing Peaches Cake Coffee Cream	Chili Crackers Catsup Coffee Cream (Not eaten by A)	Coffee Grapefruit Strawberry sundae Ham sandwich Olives Pickles Potato chips	A A A L L L L
Sun. Feb. 7	Grapefruit	Hamburger Potato chips Catsup Coke	Turkey Dressing Potatoes Gravy Corn Rolls Salad Butter Cherry pie Sherbet Coffee Cream	Fruit salad Cocoa Applesauce cake	A A A
Mon. Feb. 8	Grapefruit Coffee Cream	Vegetable soup Fruit salad Crackers Iced cocoa	Dumplings Buttered carrots Bread Butter Ice cream Cake Coffee Cream	Candy	A

TABLE 2. (continued)

Day Date	Breakfast	Lunch	Dinner	Between meals	
				Food	Subject using
Tues. Feb. 9	Grapefruit Pineapple roll Coffee Cream	Peanut butter sandwich Lettuce salad Ice cream Coffee Cream	Hamburger Buttered cabbage Green beans Gravy Whole wheat bread Coffee Cream	Cookie	A
Wed. Feb. 10	Tomato juice Egg Toast Butter Coffee Cream	Meat-vegetable stew Crackers Fruit salad Coffee Cream Cookies	Liver Gravy Onions Whole wheat bread Ice cream Coffee Cream		
Thurs. Feb. 11		Cheese sandwich Cabbage-fruit salad Ice cream Ovaltine	Potato soup Crackers Fruit salad Coffee Cream	Green River Coca Cola Coffee Cream Marshmallows Prunes	A L A L L L L A L
Fri. Feb. 12	Grapefruit Coffee Cream	Oyster soup Celery Crackers Banana Cream Coffee	Egg noodles Fruit salad Whole wheat bread Butter Cookies Coffee Cream		
Sat. Feb. 13	Prunes Toast Butter Coffee Cream	Jello salad Milk Chocolate cake Bananas-cream Coffee Cream		Apple Celery	A L A L
Sun. Feb. 14	Apple		Pork Potatoes Raw carrot Catsup Spiced apple Milk Bread	Chocolate candy Ice cream	A L A L
Mon. Feb. 15	Grapefruit Toast Butter Cocoa	Vegetable soup Raw carrot Crackers Raspberry sherbet	Pork Potatoes Cabbage Cracked wheat bread Spiced apple Doughnut	Spiced apple	L

TABLE 2. (continued)

Day Date	Breakfast	Lunch	Dinner	Between meals	
					Subject using
Tues Feb.16	Tomato juice Sweet roll Coffee Cream	Kraut-Frank- furters Whole wheat bread Oleo Coffee Cream Milk	Beef Potatoes Gravy Celery Tomatoes Bread Butter Pickles Pumpkin pie Apple butter Candy Coffee Cream	Candy	L
Wed. Feb.17	Tomato juice Toast Oleo Cocoa		Hash Salad dressing Raw carrot Cracked wheat bread Oleo Ovaltine Cookies	Bran Cream Cookie	A L A L L
Thurs. Feb.18	Grapefruit Coffee Cream	Bacon Kraut-Frank- furters Beans Cracked wheat bread Oleo Ice cream Cookies	Pork Beans Whole wheat bread Bran Cream Candy	Apples Cookies 4 Hundred	L L A
Fri. Feb.19	Tomato juice Egg Whole wheat bread Coffee Oleo Cream	Cheese sandwich Lettuce-cottage cheese salad Cocoa	Meat Sardines Brussels sprouts Rolls Butter Lime salad Ginger bread (Not eaten by L)	Strawberry preserves Ice cream Cookie Coffee	A L L L
Sat. Feb.20	Tomato juice Bran Milk Coffee Cream	Pork Potatoes Peas Whole wheat bread Oleo Cake Tapioca cream	Meat sandwich Cheese Orange Tomato juice Coffee Cream		
Sun. Feb.21	Orange (L) Tomato juice (A)	Cheese sandwich	Duck Dressing Potatoes Gravy Peas Lettuce salad Cranberries Bread Butter Coffee (Not eaten by A)	Coffee Cake Milk Tapioca cream Meat sandwich Coffee	L A A A L L
Mon. Feb.22		Veal-cheese sandwich Cocoa Cake	Pork Potatoes Banana salad Bread Oleo	Tea Cookies	A L L



TABLE 2. (continued)

Day Date	Breakfast	Lunch	Dinner	Between meals	
				Food	Subject using
:Tues. :Feb.23	:Orange :Sweet roll :Cocoa	:Creamed egg :Toast :Banana salad :Cake	:Hamburger :Gravy :Potatoes :Whole wheat bread :Oleo :Fruit cup :Cake :Coffee	:Apple	: L
:Wed. :Feb.24	:Tomato : juice :Bran :Cream :Coffee :Milk	:Bacon :Beans :Graham bread :Butter :Ice cream :Cocoa	:Potato soup :Crackers :Pickles :Celery :Cake	:Coffee :Cream :Apple	: L : L : A
:Thurs. :Feb.25	:Apple :Sweet roll :Coffee :Cream	:Bacon :Beans :Pickles :Bread :Butter :Pickled peaches :Coffee :Cream	:Gooseliver : sandwich :Potato chips :Tomato salad :Olives :Pickles :Chocolate sundae :Coffee :Cream :Nuts		
:Fri. :Feb.26	:Apple :Toast :Butter :Coffee :Cream	:Bacon :Beans :Frankfurters :Raw carrots :Catsup :White bread :Butter :Pickled peaches :Coffee	:Mackerel :Fried potatoes :Carrot-lettuce : salad :Bread :Butter :Cocoa	:Coffee :Cream :Goodbar	: L : L : A : L
:Sat. :Feb.27	:None	:Roast beef :Potatoes :Corn :Gravy :Lettuce :Apricots :Chocolate cake :Coffee :Cream	:Beef :Lettuce :Bread :Cake :Chocolate milk : (Not eaten by L)	:Steak sandwich :Coffee :Cream	: L : L : L
:Sun. :Feb.28	:None	:Mackerel sandwich :Potato salad :Carrot :Roll	:Gooseliver sandwich :Potato chips :Tomatoes :Coffee :Olives :Cream :Coke : (Not eaten by A)	:Coffee	: A
:Mon. :Mar. 1	:Apple :Toast :Butter :Cocoa	:Vegetable soup :Crackers :Milk :Coffee :Cream :Ice cream :Cookies	:Liver :Onions :Potatoes :Gravy :Cabbage salad :Banana jello		

TABLE 2. (continued)

Day Date	Breakfast	Lunch	Dinner	Between meals	
				Food	Subject Using
Tues. Mar. 2	Grapefruit Bran Milk Coffee Cream	Pineapple Cookies	Cream of tomato soup Crackers Pineapple juice (L) Caramel candy Strawberry soda (A)	Grape soda Pineapple	L A
Wed. Mar. 3	Grapefruit Egg Bread Butter Coffee Cream	Peanut butter- jelly sandwich Ovaltine Coffee Cream	Beef steak Potatoes Cabbage Gravy Bread Butter Fruit salad		
Thurs. Mar. 4	Grapefruit Cream of Wheat Milk Toast Butter Coffee	Potato salad Bread Butter Fruit salad	Hamburger Gravy Breaded tomatoes Potato salad Raw carrot Apple Coffee Cream	Honey-almond Grape juice	A L A L
Fri. Mar. 5	Grapefruit Egg Toast Butter Coffee Cream	Cheese sandwich Pineapple Cookies Baby Ruth candy bar Cocoa	Frankfurters Cabbage Bread Catsup Plackberries	Cherry coke Bran Cream	A L A L A L
Sat. Mar. 6	Grapefruit Toast Butter Coffee	Lunch ham Milk Banana (A)	Fried chicken Potatoes Tomatoes Lima beans Bread Gravy Butter Fruit cup (Not eaten by A)	Bread Butter Jelly Banana Coffee	A A A A A
Sun. Mar. 7	None	None	Steak Gravy Potatoes Lettuce-bean salad Coffee Cream	Ice cream Caramel candy	L A L
Mon. Mar. 8	Tomato juice Toast Butter Coffee Cream	Creamed beef Toast Pickles	Lunch ham Fried potatoes Green beans Tomatoes Lettuce salad Sherbet Nut rolls Coffee Cream	Pickles	L

be placed on drinking from fountains at such times as desired. After preliminary determinations, one swallow of water obtained by drinking from a fountain was estimated to be approximately 10 grams and this value was used throughout the study to estimate the amount of water obtained in this way. The total water intake was regarded as the sum of the water used from the weighed container and that secured by estimating the consumption from drinking fountains.

A Harvard trip balance of 1,000-gram capacity and a large torsion balance of 4,536-gram capacity were used for weighing food and water. These were checked against each other to insure agreement. The weight of each serving of food was recorded and the weights of any additional servings were added to the original total. Any food that was served but not eaten was weighed and the amount subtracted from the original weight.

When any food was eaten away from the apartment, a duplicate serving was obtained and brought home for sampling. Most of these meals were eaten in cafes where the servings were fairly well standardized so it is believed that no large error was introduced by using these values. In the other cases, it was possible for the subjects to serve the duplicate themselves so the quantities were as similar as could be expected when judged merely by the eye.

One-tenth of the weight of each serving of food was saved for analysis. These samples were made into weekly composites, one for each subject. The food aliquots, with the exception of butter and oleomargarine, were collected in beakers, one for each 24-hour day for each subject. The samples were preserved with a drop of formaldehyde to prevent spoilage while drying. The drying of each week's composite was a continuous process after the first 24 hours, each day's portion being added as soon as the collection was completed.

Butter and oleomargarine were made into a separate composite for each subject and held in a refrigerator until their energy value was determined. This simplified the process of drying as fat does not assume a constant weight with the conditions under which these foods were dried.

The samples were dried at approximately 60° C. in a gas-heated oven. The drying process was continued until the weight differed less than two grams  $\pm$  in two successive weighings made 24 hours apart. Then the dried food was ground in a food chopper after which it was sifted through a 20-mesh sieve. The coarser particles were reground in a mortar until sufficiently fine to pass through the sieve. The powdered samples were stored in glass-stoppered bottles.

Just before analysis, a portion of the dried sample, well mixed according to accepted methods, was transferred to



a weighing bottle and heated for three hours in a Freas electric oven at a temperature of 80° C. It was then stored in a desiccator until analyzed.

The calcium was obtained volumetrically by a modified McCrudden method as stated by the Association of Official Agricultural Chemists (1931). Phosphorus was determined gravimetrically by the Neumann method (1903) as modified by Lundell and Hoffman (1923) and McCandless and Burton (1924). Analyses were made in triplicate. The accuracy of the technique was proved by analysis of materials of known composition.

## RESULTS AND DISCUSSION

The calcium findings are shown in table 3. The average calcium intake for each subject for each week, each day, and per kilogram per day is indicated.

Subject A consumed an average of 4.361 grams of calcium a week which amounted to 0.623 gram per day or 12.9 milligrams per kilogram daily. Considerable variation in calcium intake from week to week is shown by this subject. The lowest consumption (0.477 gram) occurred in the second week of the study and the highest intake (0.827 gram) in the fifth week. The difference of 0.350 gram amounted to 73 per cent calculated on the low value. However, in weeks one,

TABLE 3. CALCIUM FINDINGS

Subject	Week	Dried food other than visible fat*	Calcium per gram dried food	Total calcium			
				Per week	Per capita per day	Per 70kg per day	Per kg. per day
		gm.	gm.	gm.	gm.	gm.	mg.
A (48.3 kg.)	1	2743	0.0015	4.115	0.588	0.85	12.17
	2	2568	0.0013	3.338	0.477	0.69	9.88
	3	2877	0.0014	4.028	0.575	0.83	11.90
	4	2282	0.0018	4.108	0.587	0.85	12.15
	5	2227	0.0026	5.790	0.827	1.20	17.12
	6	2282	0.0022	5.020	0.717	1.04	14.84
	7	2320	0.0019	4.408	0.630	0.91	13.04
	8	2267	0.0018	4.081	0.583	0.84	12.07
		Average	2446	0.0018	4.361	0.623	0.90
		Standard per day			0.469		
L (50.3 kg.)	1	2717	0.0019	5.162	0.737	1.03	14.65
	2	2963	0.0015	4.445	0.635	0.88	12.62
	3	3273	0.0014	4.582	0.655	0.91	13.02
	4	2912	0.0016	4.659	0.666	0.93	13.24
	5	2442	0.0018	4.396	0.628	0.87	12.49
	6	2533	0.0017	4.306	0.615	0.86	12.24
	7	2563	0.0018	4.613	0.659	0.92	13.10
	8	2684	0.0016	4.294	0.613	0.85	12.19
		Average	2760	0.0017	4.557	0.651	0.91
		Standard per day			0.489		

\* Visible fat was not included in this study as it was practically devoid of calcium

$S_{1+2}$  = STANDARD CALCULATED TO INDIVIDUAL WEIGHTS  
 $S$  = STANDARD PER ADULT MALE UNIT  
 $A$  = SUBJECT A  
 $L$  = SUBJECT L  
 $\square$  5 SMALL SQUARES  $\Rightarrow$  0.1 GRAM

GRAMS

2.0

1.6

1.2

0.8

0.4

0

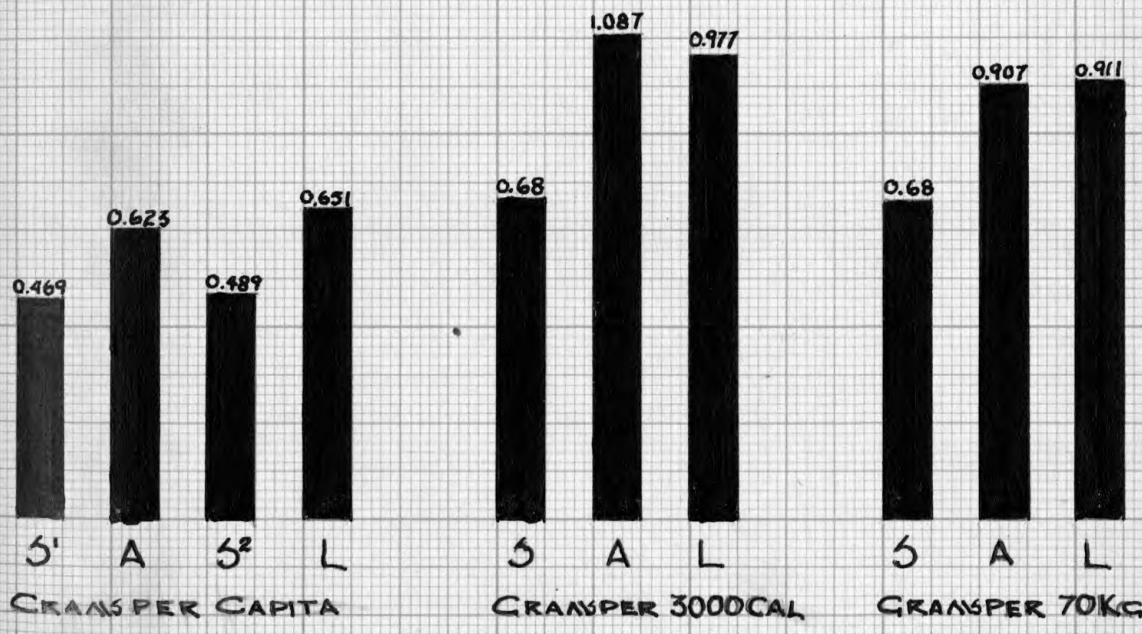


FIGURE 1.

UNIVERSAL CROSS SECTION PAPER

COMPARISON OF THE CALCIUM FINDINGS OF THIS STUDY WITH THE SHERMAN STANDARD



O—O A—— = AVERAGE FOR A  
 X---X L----- = AVERAGE FOR L

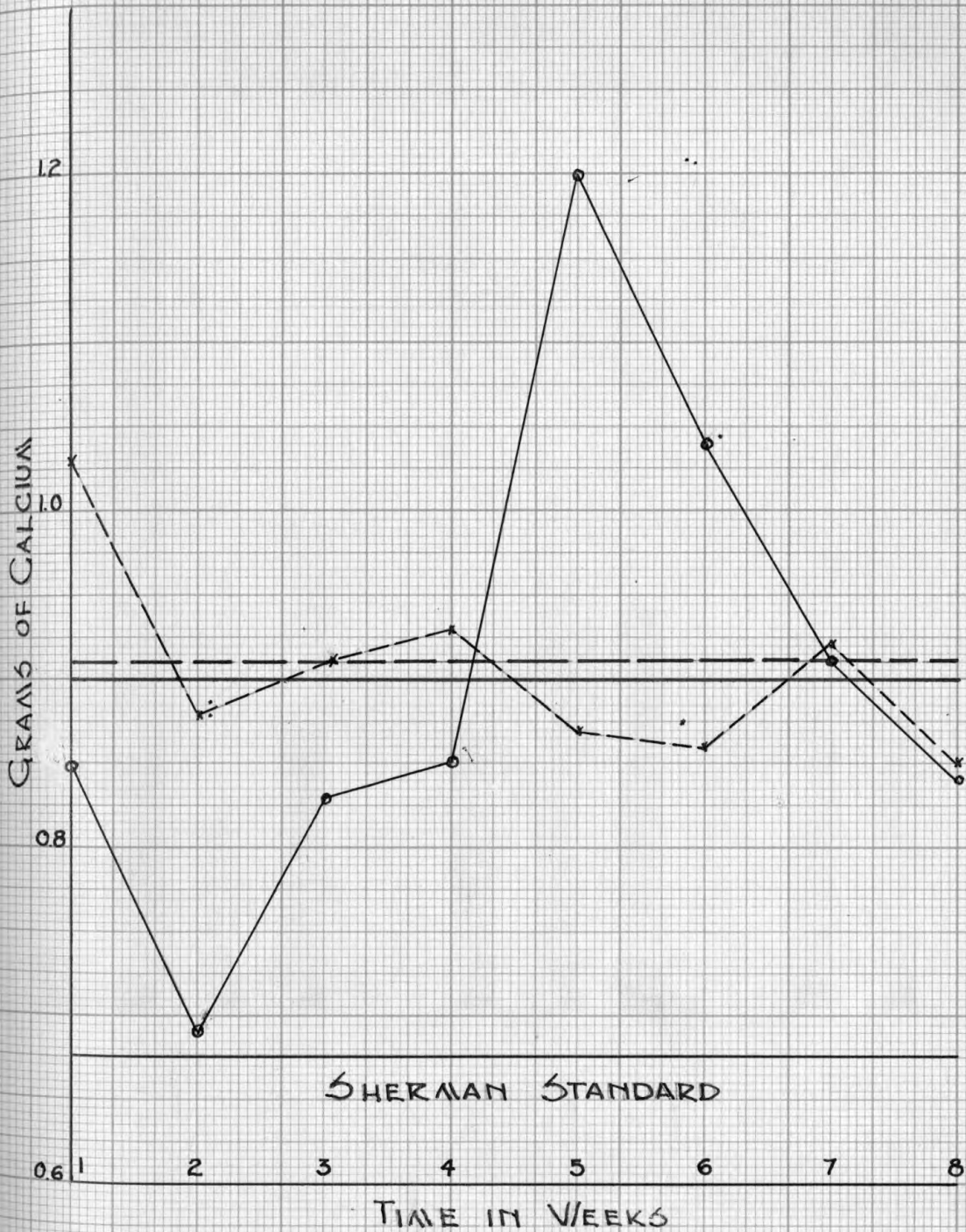


FIGURE 2

UNIVERSAL CROSS SECTION PAPER

ACTUAL AND AVERAGE CALCIUM INTAKE PER 70 KILOGRAMS FOR AN EIGHT WEEK PERIOD



three, four, and eight the consumption was quite uniform, varying only from 0.575 to 0.588 gram per day which is a negligible difference.

Subject L's intake averaged 4.557 grams of calcium per week, or 0.651 gram per day and 12.9 milligrams per kilogram. This is but slightly higher than the total for subject A and is the same per unit of weight, being 12.9 milligrams per kilogram for both subjects. The differences from week to week in calcium intake were less extreme for this subject than for A, ranging from 0.613 to 0.737 gram, a difference of 0.124 gram or 20.2 per cent calculated on the low value.

The phosphorus intake of subject A (table 4) averaged 6.973 grams per week, or 0.996 gram per day and 20.6 milligrams daily per kilogram. This is lower than the phosphorus intake of subject L which was 7.438 grams per week, 1.063 grams per day, and 21.1 milligrams per kilogram. The highest phosphorus intake of 1.196 grams by subject A is practically identical with subject L's high of 1.194 grams per day. However, the lowest average intake of subject A for any one day is slightly less than that of subject L, being 0.864 gram and 0.914 gram respectively.

When the per capita intake is calculated to intake per 3,000 Calories, A's consumption of both calcium and phosphorus was higher, though not markedly so (table 5). Per

TABLE 4. PHOSPHORUS FINDINGS

Subject	Week	Dried food other than visable fat*	Phosphorus per gram dried food	Total phosphorus			
				Per week	Per capita per day	Per 70 kg. per day	Per kg. per day
		gm.	gm.	gm.	gm.	gm.	mg.
A (48.3 kg.)	1	2743	0.00256	7.022	1.003	1.45	20.77
	2	2568	0.00263	6.754	0.965	1.40	19.98
	3	2877	0.00239	6.876	0.982	1.42	20.33
	4	2282	0.00265	6.047	0.864	1.25	17.89
	5	2227	0.00299	6.659	0.951	1.38	19.69
	6	2282	0.00367	8.375	1.196	1.73	24.76
	7	2320	0.00333	7.726	1.104	1.60	22.86
	8	2267	0.00279	6.325	0.904	1.31	18.72
		Average			6.973	0.996	1.44
	Standard per day				0.954		
L (50.3 kg.)	1	2717	0.00240	6.521	0.932	1.30	18.53
	2	2963	0.00261	7.733	1.105	1.54	21.97
	3	3273	0.00232	7.593	1.085	1.50	21.57
	4	2912	0.00252	7.338	1.048	1.46	20.83
	5	2442	0.00262	6.398	0.914	1.27	18.17
	6	2533	0.00330	8.359	1.194	1.66	23.74
	7	2563	0.00317	8.125	1.161	1.62	23.08
	8	2684	0.00277	7.435	1.062	1.48	21.11
		Average			7.438	1.063	1.48
	Standard per day				0.949		

\* Visible fat was not included in this study as it was practically devoid of phosphorus.

S = STANDARD

A = SUBJECT A

L = SUBJECT L

5 SMALL SQUARES  $\rightleftharpoons$  0.1 GRAM

GRAMS

2.0

1.6

1.2

0.8

0.4

0

0.954

0.996

0.949

1.063

1.32

1.757

1.596

1.32

1.452

1.487

S A S L

GRAMS PER CAPITA

S A L

GRAMS PER 3000 CAL

S A L

GRAMS PER 70 KG

FIGURE 3

UNIVERSAL CROSS SECTION PAPER

COMPARISON OF THE PHOSPHORUS FINDINGS OF THIS STUDY WITH THE SHERMAN STANDARD



o ——— o A ——— = AVERAGE FOR A  
 x ——— x L ——— = AVERAGE FOR L

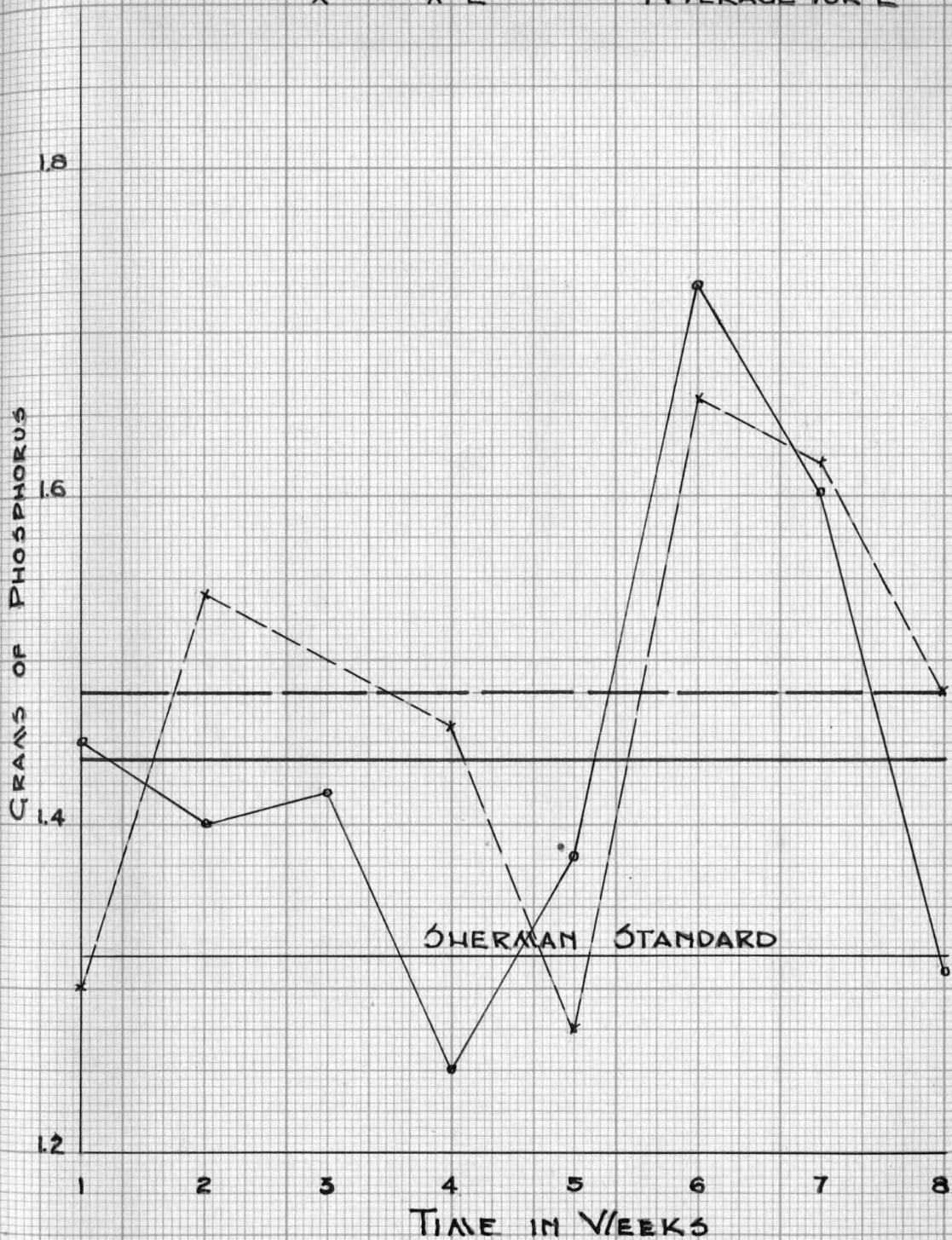


FIGURE 4

UNIVERSAL CROSS SECTION PAPER

ACTUAL AND AVERAGE PHOSPHORUS INTAKES PER 70 KILOGRAMS FOR AN EIGHT WEEK PERIOD

TABLE 5. COMPARISON OF RESULTS OF THIS STUDY  
WITH THE ADULT MALE STANDARD \*

Mineral	Unit	This study		Standard Sherman
		Subject A	Subject L	
Calcium	Per capita	0.623 gm.	0.651 gm.	0.68 gm.
	Per 3,000 Cal.	1.087 gm.	0.977 gm.	0.68 gm.
	Per 100 Cal.	0.036 gm.	0.033 gm.	0.023 gm.
	Per 70 kg.	0.907 gm.	0.911 gm.	0.68 gm.
	Per kg.	12.900 mg.	12.940 mg.	9.71 mg.
Phosphorus	Per capita	0.996 gm.	1.063 gm.	1.32 gm.
	Per 3,000 Cal.	1.737 gm.	1.596 gm.	1.32 gm.
	Per 100 Cal.	0.058 gm.	0.053 gm.	0.044 gm.
	Per 70 kg.	1.452 gm.	1.487 gm.	1.32 gm.
	Per kg.	20.630 mg.	21.130 mg.	18.86 mg.

\* A person weighing 70 kg. engaged in moderately active work using 3,000 Calories per day.

100 Calories, subject A consumed 0.036 gram and subject L, 0.033 gram of calcium daily. The phosphorus amounted to 0.058 gram per 100 Calories for subject A and 0.053 gram for subject L.

On the basis of weight, both subjects consumed almost identical amounts of calcium and phosphorus which amounted to 0.907 gram of calcium daily for subject A and 0.911 gram for subject L per 70 kilograms or 12.9 milligrams of calcium per kilogram for both subjects.

Phosphorus showed the same trend, subject A consuming an average of 1.452 grams of phosphorus per 70 kilograms per day, while subject L consumed 1.487 grams. These provided 20.6 milligrams per kilogram for subject A and 21.1 milligrams for subject L.

The results of this investigation were compared in table 6 with those of other studies available for calcium and phosphorus consumption of college women. Of the dietary studies of the inventory type for the groups of subjects included in this comparison, seven showed a higher average calcium intake per capita than that of either subject A or L while four consumed smaller amounts.

Per 3,000 Calories, only two studies, those of Ryder (1932) and of Wheeler et al (1935), used more calcium than subject A while three, Ryder (1932), Wheeler et al (1935),

TABLE 6. RESULTS OF DIETARY STUDIES SHOWING THE DAILY CALCIUM AND THE PHOSPHORUS INTAKES OF COLLEGE WOMEN COMPARED WITH THIS STUDY AND THE STANDARD FOR THE ADULT MALE UNIT

Kind of Study	Date	Worker	Location	Period	Findings					
					Calcium			Phosphorus		
					Per capita	Per 3000 Cal.	Per 70 kg.	Per capita	Per 3000 Cal.	Per 70 kg.
					gm.	gm.	gm.	gm.	gm.	gm.
Group (inventory type)	1917	Borthwick	Montana State College		0.56			1.28		
	1926	Kramer and Grundmeir	Kansas State College			0.61			1.32	
	1929	Grace	Oregon State College				"above standard"			
	1930	Trump	Kansas State College	I	0.68	0.87		1.19	1.53	
				II	0.86	0.94		1.46	1.60	
	1932	Ryder	Kansas State College		0.79	1.30	0.95	1.97	1.97	2.37
	1932	Shirley	Kansas State College		0.78	0.84		1.38	1.47	
	1934	Jackson	Kansas State College		0.53	0.68		0.98	1.25	
	1934	Conard	Kansas State College		0.50	0.54		0.92	1.05	
	1934	Goddard et al.	U. of Calif. at Los Angeles	I	0.51	0.41		1.34	1.08	
II				0.75	0.90		1.15	1.38		
1935	Wheeler and Mallay	Vassar		0.92	1.15		1.32	1.65		
1936	Schermerhorn	Kansas State College		0.75	1.08	0.87	1.13	1.62	1.31	
Individual (excreta analyzed)	1932	Gallemore	Kansas State College	I			1.062			
				II			1.108			
	1933	Fletcher	Kansas State College	I						1.39
				II						1.40
1937	Kramer and Gillum	Kansas State College				1.09			1.26	
Individual (diet analyzed)	1932	Coons and Schiefelbusch	Oklahoma A. and M. College		0.93	1.40		1.19	1.79	
	1937	This study	Kansas State College							
				Subject A	0.623	1.087	0.907	0.996	1.737	1.452
				Subject L	0.651	0.977	0.911	1.063	1.596	1.487
Average	0.667	1.032	0.909	1.030	1.667	1.470				
Standard		Sherman		0.68	0.68	0.68	1.32	1.32	1.32	



and Schermerhorn (1936), used more than subject L. This may be attributed to the fact that the subjects used in this study had a low caloric intake (Cox, 1937). Data did not permit calculating the calcium intake per 70 kilograms of body weight except for the groups of Ryder (1932) and Schermerhorn (1936). In comparison with their findings, subjects A and L of this study consumed more calcium per 70 kilograms than the subjects of Schermerhorn's group but less than those of Ryder's.

When the phosphorus intake of subjects A and L is compared with the findings of the inventory group studies, it is found that nine of the 11 groups consumed more per capita than either of these subjects.

On the basis of intake of phosphorus per 3,000 Calories only one of the 11 groups had a higher intake than subject A, while four consumed more than subject L. Again this may be attributed to the low caloric intakes by the subjects of this study.

When compared on the basis of 70 kilograms of body weight, the present study also indicated phosphorus intakes higher than Schermerhorn's subjects but lower than Ryder's.

When this study is compared with the ones of Gallemore (1932), Fletcher (1933), and Kramer and Gillum (1937) in which the individual is studied, after calculating to 70



kilograms of body weight, the calcium intake is seen to be somewhat lower and the phosphorus intake somewhat higher for both subjects A and L. However, in their investigations these workers based the intakes upon analysis of excreta (table 6) rather than on food eaten.

The study of Coons and Schiefelbusch (1932) involved analysis of the individual diets so was directly comparable with this one because of similarity of the methods used. Their results for 18 Oklahoma college women showed the average intakes of both calcium and of phosphorus to be somewhat higher both per capita and per 3,000 Calories than either of the individual intakes of these two Kansas women.

Calculated either on the basis of 70 kilograms of body weight or of 3,000 Calories per day, the subjects of the present investigation consumed more calcium and more phosphorus than the Sherman standard for the adult male unit. This amounted to approximately a 33 per cent excess for calcium and an 11 per cent excess for phosphorus per 70 kilograms while per 3,000 Calories, the excess was approximately 52 per cent and 26 per cent respectively.

In table 7 the relationship between the calcium and the phosphorus of the diets and their caloric value is shown. It may be noted that in the third week when the food of subject A furnished the greatest number of Calories, it ranked

TABLE 7. RELATION OF CALCIUM AND PHOSPHORUS TO THE CALORIC  
VALUE OF THE DIET

Subject	Week	Calories		Calcium		Phosphorus	
		Per day	Rank <sup>1</sup>	Per day	Rank	Per day	Rank
A (48.3 kg.)	1	1924	2	0.588	4	1.003	3
	2	1917	3	0.477	8	0.965	5
	3	2061	1	0.575	7	0.982	4
	4	1606	4	0.587	5	0.864	8
	5	1589	5	0.827	1	0.951	6
	6	1582	6	0.717	2	1.196	1
	7	1559	7	0.630	3	1.104	2
	8	1522	8	0.583	6	0.904	7
	Av.	1720		0.623		0.996	
L (50.3 kg.)	1	1929	5	0.737	1	0.932	7
	2	2263	2	0.635	5	1.105	3
	3	2326	1	0.655	4	1.085	4
	4	2129	3	0.666	2	1.048	6
	5	1671	8	0.628	6	0.914	8
	6	1916	6	0.615	7	1.194	1
	7	1947	4	0.659	3	1.161	2
	8	1802	7	0.613	8	1.062	5
	Av.	1998		0.651		1.063	

1. Ranked according to amount

seventh in calcium and fourth in phosphorus. In the fifth week, when the food of this subject was highest in calcium, it was fifth in Calories and sixth in phosphorus. The food of the sixth week was highest in phosphorus but the sixth in caloric value and second in calcium.

The diet of subject L showed a similar tendency. The week in which the caloric intake of this subject was greatest ranked fourth as a source of calcium and also of phosphorus. When the intake of calcium was highest, the diet was seventh in phosphorus and fifth in energy. The week in which the phosphorus intake was at its peak was sixth in energy and seventh in calcium.

A further study of these diets shows that in 53 per cent of the cases, when the diet was in the upper half for Calories, it was in the lower half for calcium and phosphorus. It would seem that when the diet is high in calcium and phosphorus it tends to run low in energy.

The subjects had apparently used their knowledge of foods and nutrition to plan colorful, variable, and attractive menus (table 2). The average daily milk intake (table 8) was only 0.35 pint for subject A and 0.27 pint for subject L. This is much lower than the standard of one pint a day commonly recommended. Although additional milk was used in ice cream which was served an average of 0.4 time a day

TABLE 8. FOOD HABITS AS DETERMINED BY FREQUENCY OF OCCURRENCE OF CERTAIN FOODS  
IN THE DIET DURING AN EIGHT-WEEK PERIOD

Food	Subject A		Subject L		Standard per day
	Total times occurring	Av. times per day	Total times occurring	Av. times per day	
Cheese	11	0.2	12	0.2	
Coffee, tea, or Coca Cola	83	1.5	124	2.2	Not in ex- cess of 1
Eating between meals	40	0.7	47	0.8	
Eggs	12	0.2	10	0.2	1
Fruits					
Citrus including tomatoes	43	0.8	52	0.9	1
Other	48	0.8	51	0.9	1
Ice cream	21	0.4	17	0.3	
Milk in cups*	39	0.7	31	0.6	2
Meat, fish, or poultry	49	0.9	64	1.1	1
Vegetables					
Other than potatoes and tomatoes	79	1.4	85	1.5	2
Green and yellow	69	1.2	71	1.3	1
Potatoes	33	0.6	35	0.6	
Whole grain products	33	0.6	34	0.6	1

\* Assuming the amount taken at one time as equivalent to one cupful.



for subject A and 0.3 time for subject L, this was not nearly enough to raise the amount to the accepted standard.

Whole grain products, consisting chiefly of bread with an occasional breakfast cereal, were served an average of 0.6 time daily for both subjects. This was little more than half the recommendation of one serving per day which is accepted as the minimum for an adequate diet.

It has been customary to recommend two servings of vegetables each day beside potatoes, one of these leafy and preferably one raw. Green or yellow vegetables were served an average of 1.2 times per day for subject A and 1.3 times for subject L. Carrots, a good source of calcium, were used frequently in the diets. The total number of times vegetables other than potatoes were served during the eight weeks studied was 79 for A and 85 for L. Potatoes were used an average of 0.6 serving per day by each subject.

Subject A averaged 1.6 servings of fruit daily while subject L averaged 1.8 servings (table 8). These were but little lower than the customary standard of two servings daily, one of them citrus fruit or tomato. The latter were eaten 43 times by subject A and 52 times by subject L during the eight-week study and averaged 0.8 serving and 0.9 serving respectively per day for the two subjects. While in one sense tomatoes are not a fruit, they have been so classified

in this tabulation.

Cheese, regarded as a good source of both calcium and phosphorus, was eaten only 11 times by subject A and 12 times by subject L during the study.

The egg consumption of both subjects was low when compared with the recommendation of one egg per person per day. Each subject averaged only 0.2 of an egg a day, A having eaten 12 eggs and L, 10 eggs as such during the period studied.

Meat, fish, and poultry were eaten a total of 49 times by subject A and 64 times by subject L. These averaged 0.9 a serving a day for A and 1.1 servings for L and followed closely the food rule of one serving of meat a day.

Considerable eating between meals is indicated (table 8). It amounted to an average of 0.7 time daily for subject A and 0.8 time for subject L. Often more than one food was consumed at a time, as ham sandwiches, ripe olives, pickles, and coffee with cream. Again the choice of food might be a breakfast food with milk alone or followed by a cookie. An apple or a banana sometimes was eaten in this way. Candy appeared occasionally as a between-meal food.

The total liquid intake of each subject (table 9) was low according to the accepted standard of 6 to 8 glasses per day. It averaged 5 glasses daily for subject A and 6.5

TABLE 9. LIQUID INTAKE

Kind	Total for eight-week period	
	Subject A	Subject L
	gm.	gm.
Water	38833.5	46007.2
Coffee, tea, Coco Cola	13839.2	22034.5
Total	52672.7	68041.7
Average per day		
Grams	940.6	1215.0
Glasses *	5.0	6.5

\* 1 glass = 185 gm.

glasses for subject L. Coffee, Coca Cola, and tea were consumed an average of 1.5 times daily by subject A and 2.2 times by subject L. These beverages appeared to form too large a proportion of the total liquid. The intake of water as such was relatively low.

The cost of the diet appeared to be directly proportional both to the intake and to whether or not the food was prepared at home. Subject A had a slightly lower food consumption (tables 3 and 4) and ate a larger proportion of her meals at home. As a result, the average cost of her diet was \$0.27 per day while that of subject L was \$0.33 per day. This amounted to 1.1 cents and 1.7 cents respectively per 100 Calories.

### CONCLUSIONS

The freely chosen diets of two Kansas State College women studied over an eight-week period were found to contain more calcium and phosphorus per day than the amounts suggested by Sherman as the standard for the adult male unit.

When two college women equipped with a knowledge of foods and nutrition were allowed to choose their own food, they supplied generous amounts of both calcium and phosphorus, two elements believed to be needed in considerable quantity by college women who, as a rule, are still growing.



Although milk, eggs, and cheese, good sources of both calcium and phosphorus, were consumed in smaller amounts than are commonly recommended, carrots and other vegetables were used liberally enabling these two subjects to include generous amounts of these elements in their diets.

This study suggests higher calcium and phosphorus intakes than are commonly recommended for women of college age.

## ACKNOWLEDGMENT

The writer wishes to express her sincere appreciation to Dr. Martha S. Pittman, head of the Department of Food Economics and Nutrition, and to Miss Bernice L. Kunerth, instructor in the same department, for direction of this research, and to the two young women whose cooperation made this investigation possible.

## LITERATURE CITED

1. Association of Official Agricultural Chemists.  
Official and tentative methods of analysis of the  
Association of Official Agricultural Chemists.  
third ed., Washington, D.C. 532 p. 1931.
2. Borthwick, Alberta.  
A contribution to the standardization of conditions  
in college halls for women. J. Home Ec. 9:139-140.  
1917.
3. Conard, Frances Rebecca.  
Nutritive value and cost of food consumed by women  
in a college sorority. Group V. Unpublished  
thesis, Kansas State College of Agriculture and  
Applied Science. 34 p. 1934.
4. Coons, C. M. and Schiefelbusch, A.T.  
The diets of college women in relation to their  
basal metabolism. J. Nutrition, 5:459-465. 1932.
5. Cox, Grace Lillian.  
The energy and the protein intake of two college  
women. Unpublished thesis, Kansas State College  
of Agriculture and Applied Science. 55 p. 1937.
6. Fletcher, Mary Genevieve.  
Phosphorus intake of college women as indicated  
by phosphorus output. Unpublished thesis, Kansas  
State College of Agriculture and Applied Science.  
37 p. 1933.
7. Gallemore, Dorothy Isabel.  
Calcium intake of college women as indicated by  
calcium output. Unpublished thesis, Kansas State  
College of Agriculture and Applied Science. 28 p.  
1932.
8. Goddard, Vera R., Gardner, M., Gibson, T., Harbour, H.,  
and Hardison, J.  
Food economy in a university dormitory managed at  
moderate cost. J. Am. Diet. Assn. 9:353. 1934.

9. Grace, M.V.  
Consumption and cost of food for college women at Oregon State College. J. Home Ec. 21:785. 1929.
10. Hawley, Edith.  
Economics of food consumption. New York. McGraw-Hill. 335 p. 1932.
11. Jackson, Jean L.  
A study of the nutritive value and cost of food consumed by a group of college women in a sorority. Unpublished thesis, Kansas State College of Agriculture and Applied Science. 41 p. 1934.
12. Kramer, Martha M. and Grundmeir, Edith.  
Food selection and expenditure in a college community. J. Home Ec. 18:18-25. 1926.
13. Kramer, M.M. and Gillum, Isabel.  
Animal products as sources of protein, calcium, and phosphorus in the human diet. J. Am. Diet. Assn. 14:256-260. 1938.
14. Lundell, G.E.F. and Hoffman, J.I.  
Notes on the determination of phosphorus. J. Ind. and Eng. Chem. 15:44. 1923.
15. McCandless, J.N. and Burton, J.Q.  
Sources of error in the determination of phosphoric acid by the molybdate magnesia method. J. Ind. and Eng. Chem. 16:1267. 1924.
16. McCrudden, F.H.  
Determination of calcium in the presence of manganese and phosphates; The determination of calcium in urine. J. Biol. Chem. 10:187. 1911-1912.
17. Neumann, A.E.  
Infache Veraschung Methods (Sauregemisch-Veraschung) Zeitschr. Physiol. Chem. 37:115. 1902-1903.
18. Ryder, Mary Grace.  
A study of the nutritive value of food served to a group of college girls living in a residence hall. Unpublished thesis, Kansas State College of Agriculture and Applied Science. 32 p. 1932.



19. Schermerhorn, Mae.  
A study of the nutritive value of the food consumed by a cooperative group of college women living in a residence hall. Unpublished thesis, Kansas State College of Agriculture and Applied Science. 51 p. 1936.
20. Sherman, H.C.  
Calcium requirement of maintenance in man. J. Biol. Chem. 44:21-27. 1920, a.
21. Sherman, H.C.  
Phosphorus requirement of maintenance in man. J. Biol. Chem. 41:173-179. 1920, b.
22. Shirley, Sophia M.  
A study of the nutritive value and cost of food consumed by certain organized groups of college students. Unpublished thesis, Kansas State College of Agriculture and Applied Science. 53 p. 1932.
23. Trump, Ethel.  
The effects of supervision of the planning of meals and the purchasing of food on the dietary practices and food expenditure of organized groups. Unpublished thesis, Kansas State College of Agriculture and Applied Science. 46 p. 1930.
24. Wheeler, Ruth and Mallay, Ruth.  
A study of the food freely selected by a college cooperative housekeeping group. J. Am. Diet. Assn. 10:453-458. 1935.