CALCIUM INTAKE OF COLLEGE WOMEN AS INDICATED BY CALCIUM OUTPUT

by

DOROTHY ISABEL GALLEMORE

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INTRODUCTION

Many investigations have been made to determine the kinds and amounts of foods which should be in the diet to give sufficient calcium. Standard figures determined by careful balance studies are available and represent the expenditure of calcium under conditions of closely restricted intake and are valuable for comparison. Dietary recommendations have been made based upon these standards.

It sometimes seems important to know whether or not the dietary practices of people are good. Interesting group dietary studies have been made but of course do not show the actual intake of each subject. Individual weighed dietary studies are sometimes used but could hardly be conducted without influencing the subjects' free choice of food. It seemed of interest to plan to study the intake of college women eating their usual diets. This can be done by determining the calcium output. Unless the intake is at a very low level the normal adult tends to adjust his calcium metabolism to his calcium supply, so that studies of the calcium eliminated would be an indication of the calcium intake.

REVIEW OF LITERATURE

The minimum calcium requirement of Sherman (9) is 0.45

gram per 70 kilograms of body weight per day representing the expenditure under conditions of closely restricted intake and the standard allowance is 0.68 gram per day allowing 50 per cent extra for safety. Few investigations have been made to check upon actual individual diets to determine whether or not they contain this recommended amount of calcium.

Sherman (9) has made an intensive study of the calcium requirements of man and states that calcium is one of the limiting factors in a large proportion of our staple foods and that a freely chosen food supply may not always furnish the needed amounts of calcium. A study (9) of 224 presumably typical American dietaries showed that the diets were more often deficient in calcium than in any other chemical element. It is generally known that the demands for calcium by the growing child, the pregnant woman, and the lactating woman exceed those of the normal adult. Sherman and Hawley (11) have set the calcium standard for children at 1.0 gram or more per child per day and furthermore believe that 1.0 gram or more per man per day is advisable in all cases in which the group of people to be fed includes any growing children.

Since milk is an excellent source of calcium its mention here in relation to calcium requirement would seem justifiable. One quart of milk will supply 1.176 grams calcium

(7) which is approximately the 1.0 gram standard of Sherman and Hawley (11). One pint of milk would supply 0.588 gram calcium which with the calcium of the other foods in the diet would approximate the Sherman standard of 0.68 gram (9). However, Sherman (10) states that "it would seem a mistake to limit the recommendation of a quart of milk per day to the ages from infancy to puberty. Undoubtedly it would better be extended, probably to all ages. Certainly it seems to me the boy should have his quart of milk per day until he is a man full grown, and the girl should continue to take her quart of milk per day until as a woman she has weaned her last child."

In his studies of nitrogen, Chittenden (4) states that nitrogen outgo tends to keep pace with the income of nitrogen, the body of the normal adult always striving to maintain a condition of nitrogen equilibrium. Interesting nitrogen studies, using output as an index of intake, have been made upon male college students by Chittenden (4) and more recently upon medical students by Borgstrom (1) and Brooks (3).

In principle, calcium is equally well adapted to investigation by the method of quantitative determination of calcium output, in urine and feces (8). Women would likewise be as suitable for such an experiment as are men. It seemed worth while to add to the rather scanty data existing

relative to the calcium in the diet of college women. The purpose of this experiment therefore was to determine the calcium elimination of college women, as an index of the calcium intake under conditions customary to them.

EXPERIMENTAL PROCEDURE

Twenty-five college women willingly agreed to be the subjects for this experiment. Eleven of this number were graduate students and all were taking home economics courses. All subjects apparently were in good health and were engaged in the usual college activities. Each subject listed the activities of the day on sheets provided for this purpose. For a 4-day period during October or November and again for a 4-day period during January or February these subjects made complete collections of urine and feces. Daily records were kept by the subjects which indicated the foods eaten. Sample copies of the activity and food sheets are shown. The subjects were asked to follow their customary food habits and in most cases were not informed as to the exact nature of the experiment, lest it influence the choice of food.

The subjects selected the 4-day periods at times convenient for them and when no interruption of regular activities or habits would occur. Every subject weighed at least once during each period and the weights recorded.

Date _____

Name _____

	Where Eaten	Foods Eaten	Approx. Amt.	Calculations
Breakfast				
Lunch				
Dinner				
Between Meals				

Date _____

Name _____

Time	Activity	No. of Minutes

The total urine of the 4-day period for each subject was collected and measured. Collections of urine were made from 7 A.M. of the first day until 7 A.M. of the fifth day. The urine was measured and samples saved for analysis. Carmine was used to mark the feces of the periods of the experiment. The feces were dried at a low temperature to a constant weight, weighed, pulverized to pass through a fine sieve and stored in labeled, air-tight glass bottles.

Quantitative calcium determinations were made upon 150 cubic centimeters of urine for each subject for each period. Quantitative calcium determinations were made on approximately 2.0 grams of feces for each subject for each period. All determinations were made in duplicate or triplicate. The volumetric method of McCrudden (6) was used, with modifications according to Shohl (12) and Shohl and Pedley (13).

Total calcium of urine was determined by dividing the total volume by 150 and the resulting factor was multiplied by the average calcium in 150 cubic centimeters. Total calcium of feces was determined by multiplying average calcium in one gram of feces by total number of grams of feces. Total calcium elimination for one period consisted of total calcium in urine plus total calcium in feces. The total calcium elimination was divided by four to give the total calcium elimination for one day.

Counts were made of the servings of high calcium foods

reported by each subject on the daily dietary sheets. Tables and charts were prepared showing the daily calcium elimination of the subjects, together with averages, with relation to accepted standards, 70 kilograms of body weight, servings of high calcium foods reported by the subjects, and the type of meals, whether set menus or freely chosen by the subjects.

TABLE I

DATA FOR PERIOD I - FALL

Subject Initials	Av. Wt. kilo.	Vol. Urine cc.	Ca 150 cc. Urine grams	Total Ca grams	Wt. Feces Dried grams	Ca 1 gram grams	Total Ca Feces grams	Total Ca 4 day Period grams
1. ML	49.0	5050	0.007	0.236	114.0	0.024	2.736	2.972
2. RMc	73.5	4505	0.010	0.300	100.5	0.028	2.814	3.114
3. RC	56.2	5820	0.012	0.466	110.5	0.016	1.768	2.234
4. ME	54.4	5515	0.003	0.110	126.0	0.036	4.536	4.646
5. WJ	49.9	5175	0.018	0.621	73.8	0.033	2.435	3.056
6. SM	58.1	2490	0.054	0.896	87.0	0.042	3.654	4.550
7. GJ	52.2	5290	0.018	0.635	74.0	0.029	2.146	2.781
8. HB	55.3	7770	0.010	0.518	86.0	0.025	2.150	2.668
9. GB	57.6	2965	0.046	0.909	116.5	0.026	3.029	3.938
10. FH	70.3	3250	0.015	0.325	109.5	0.017	1.862	2.187
11. LR	51.7	6590	0.005	0.220	93.0	0.034	3.162	3.382
12. LG	56.7	4775	0.015	0.477	91.5	0.025	2.288	2.765
13. HD	57.2	7810	0.009	0.469	99.5	0.034	3.383	3.852
14. IG	57.6	8895	0.014	0.830	142.0	0.031	4.402	5.232
15. NS	56.7	4525	0.011	0.332	109.0	0.034	3.706	4.038
16. HE	56.2	3900	0.036	0.936	95.0	0.023	2.185	3.121
17. EF	58.1	3125	0.027	0.562	68.5	0.034	2.329	2.891
18. SS	48.1	5790	0.015	0.579	89.5	0.050	4.475	5.054
19. MR	58.5	2730	0.021	0.382	54.0	0.020	1.080	1.462
20. EN	42.6	3500	0.014	0.327	29.5	0.043	1.269	1.596
21. ZL	60.3	3915	0.037	0.966	91.0	0.023	2.093	3.059
22. AB	55.3	3180	0.043	0.912	61.0	0.033	2.013	2.925
23. RR	51.7	6100	0.009	0.366	99.0	0.029	2.871	3.237
24. DB	54.0	3195	0.037	0.788	77.0	0.037	2.849	3.637
25. ZMc	62.1	4560	0.005	0.152	131.5	0.029	3.814	3.966

TABLE II

DATA FOR PERIOD II - WINTER

Subject Initials	Av. Wt. Kilo.	Vol. Urine cc.	Ca 150 cc. Urine grams	Total Ca Urine grams	Wt. Feces Dried grams	Ca 1 gram grams	Total Ca Feces grams	Total Ca 4 day Period grams
1. ML	49.9	4390	0.015	0.439	74.5	0.024	1.788	2.227
2. RMc	73.9	4230	0.020	0.564	112.0	0.041	4.592	5.156
3. RC	55.8	7730	0.016	0.825	74.0	0.041	3.034	3.859
4. ME	56.2	4390	0.011	0.322	85.5	0.034	2.907	3.229
5. WJ	50.8	4225	0.033	0.929	101.0	0.040	4.040	4.969
6. SM	59.0	3515	0.030	0.703	126.5	0.042	5.313	6.016
7. GJ	54.9	3310	0.026	0.574	66.0	0.036	2.376	2.950
8. HB	56.2	6590	0.018	0.791	105.0	0.038	3.990	4.781
9. GB	59.4	3080	0.053	1.088	80.0	0.031	2.480	3.568
10. FH	68.5	3765	0.021	0.527	86.0	0.029	2.494	3.021
11. LR	53.0	5925	0.007	0.277	76.0	0.049	3.724	4.001
12. LG	58.5	3660	0.028	0.683	95.0	0.030	2.850	3.533
13. HD	59.0	10405	0.005	0.347	96.0	0.034	3.264	3.611
14. IG	63.0	5946	0.017	0.677	74.0	0.042	3.108	3.785
15. NS	58.1	4050	0.012	0.324	104.5	0.039	4.076	4.400
16. HE	57.2	2840	0.034	0.644	95.5	0.023	2.197	2.841
17. EF	59.4	3450	0.038	0.874	57.0	0.044	2.508	3.382
18. SS	55.8	6030	0.026	1.045	79.5	0.048	3.816	4.861
19. MR	58.5	2670	0.028	0.498	64.0	0.019	1.216	1.714
20. EN	43.1	4810	0.023	0.738	51.5	0.056	2.884	3.622
21. ZL	62.1	3970	0.022	0.582	125.0	0.015	1.875	2.457
22. AB	55.8	3260	0.036	0.782	45.0	0.030	1.350	2.132
23. RR	51.7	7160	0.003	0.143	94.5	0.043	4.064	4.207
24. DB	54.0	2970	0.027	0.535	39.5	0.036	1.422	1.957
25. ZMc	64.4	3810	0.017	0.432	83.0	0.040	3.320	3.752

TABLE III

CALCIUM OUTPUT PER DAY

Subject Initials	Period I: Average Daily Calcium grams	Period I: Av. Ca Daily per 70 kilo. grams	Period II: Average Daily Calcium grams	Period II: Av. Ca Daily per 70 kilo. grams
1. ML	0.743	1.061	0.555	0.779
2. RMc	0.778	0.741	1.289	1.412
3. RC	0.558	0.695	0.964	1.209
4. ME	1.161	1.494	0.807	1.005
5. WJ	0.764	1.072	1.242	1.711
6. SM	1.137	1.369	1.504	1.784
7. GJ	0.695	0.932	0.737	0.940
8. HB	0.667	0.844	1.195	1.488
9. GB	0.984	1.196	0.892	1.051
10. FH	0.546	0.544	0.755	0.772
11. LR	0.845	1.144	1.000	1.321
12. LG	0.691	0.853	0.883	1.058
13. HD	0.963	1.178	0.902	1.070
14. IG	1.308	1.590	0.946	1.051
15. NS	1.009	1.246	1.100	1.325
16. HE	0.780	0.972	0.710	0.869
17. EF	0.722	0.870	0.845	0.996
18. SS	1.263	1.838	1.215	1.524
19. MR	0.365	0.437	0.428	0.504
20. EN	0.399	0.656	0.905	1.470
21. ZL	0.764	0.887	0.614	0.692
22. AB	0.731	0.925	0.533	0.669
23. RR	0.809	1.095	1.051	1.423
24. DB	0.909	1.178	0.489	0.634
25. ZMc	0.991	1.117	0.938	1.020
Averages	0.823	1.037	0.900	1.111

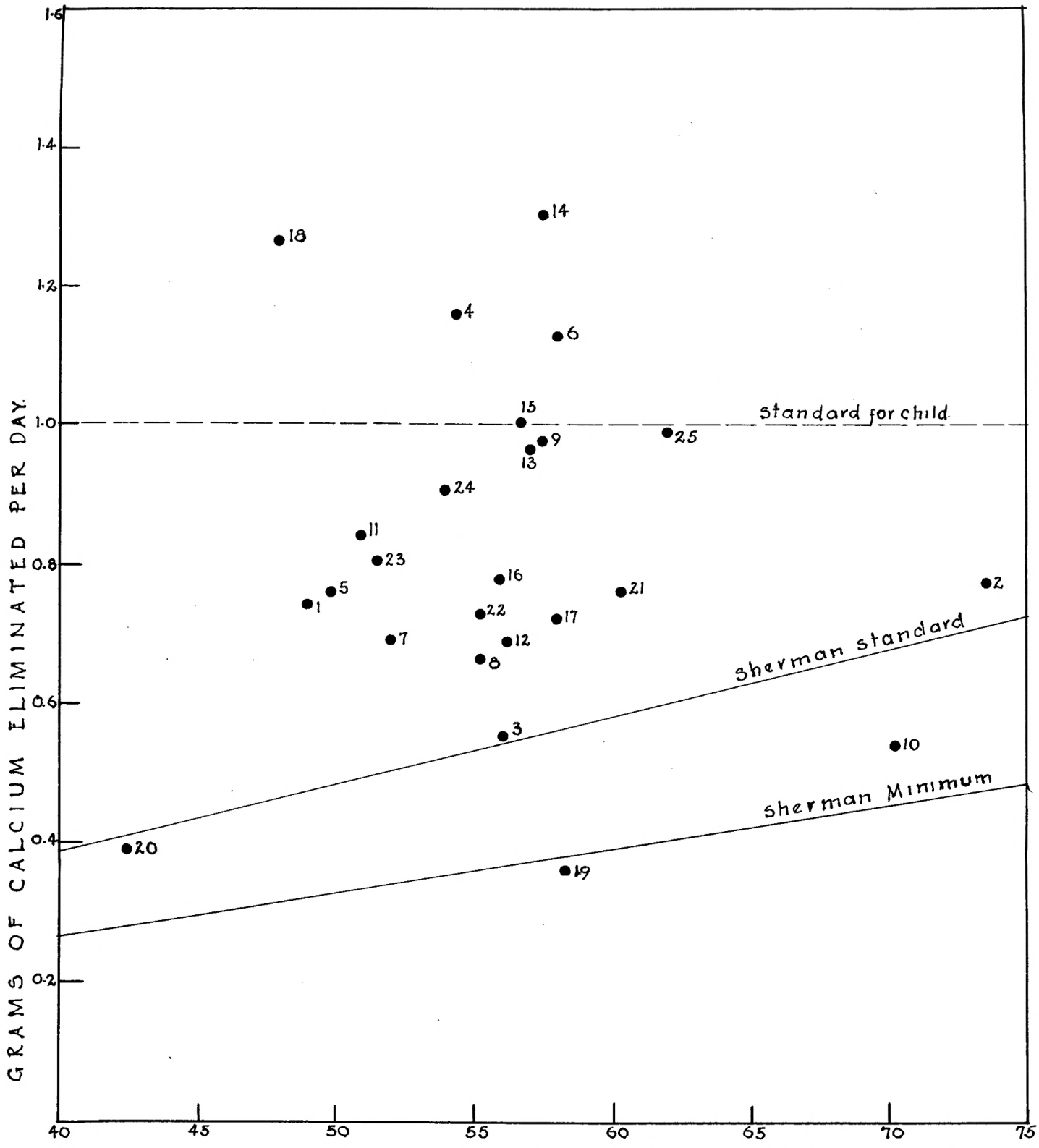

FIG. 1.

CALCIUM ELIMINATION OF SUBJECTS PERIOD I - FALL

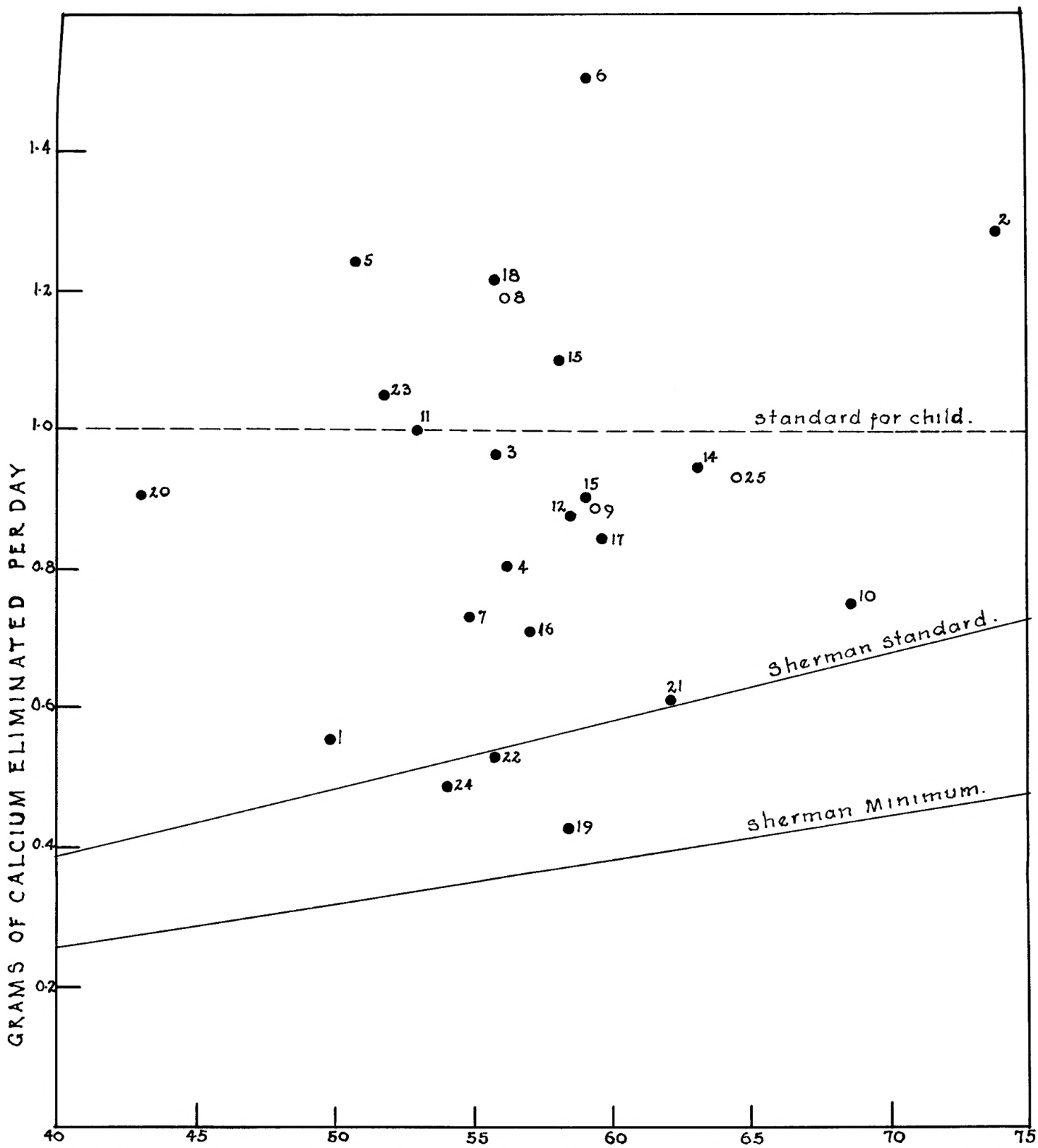

FIG. 2.

CALCIUM ELIMINATION OF SUBJECTS PERIOD II-WINTER

SUBJECTS DIVIDED INTO FIVE GROUPS ACCORDING TO ELIMINATION OF CALCIUM GROUP I. BEING THE LOWEST.

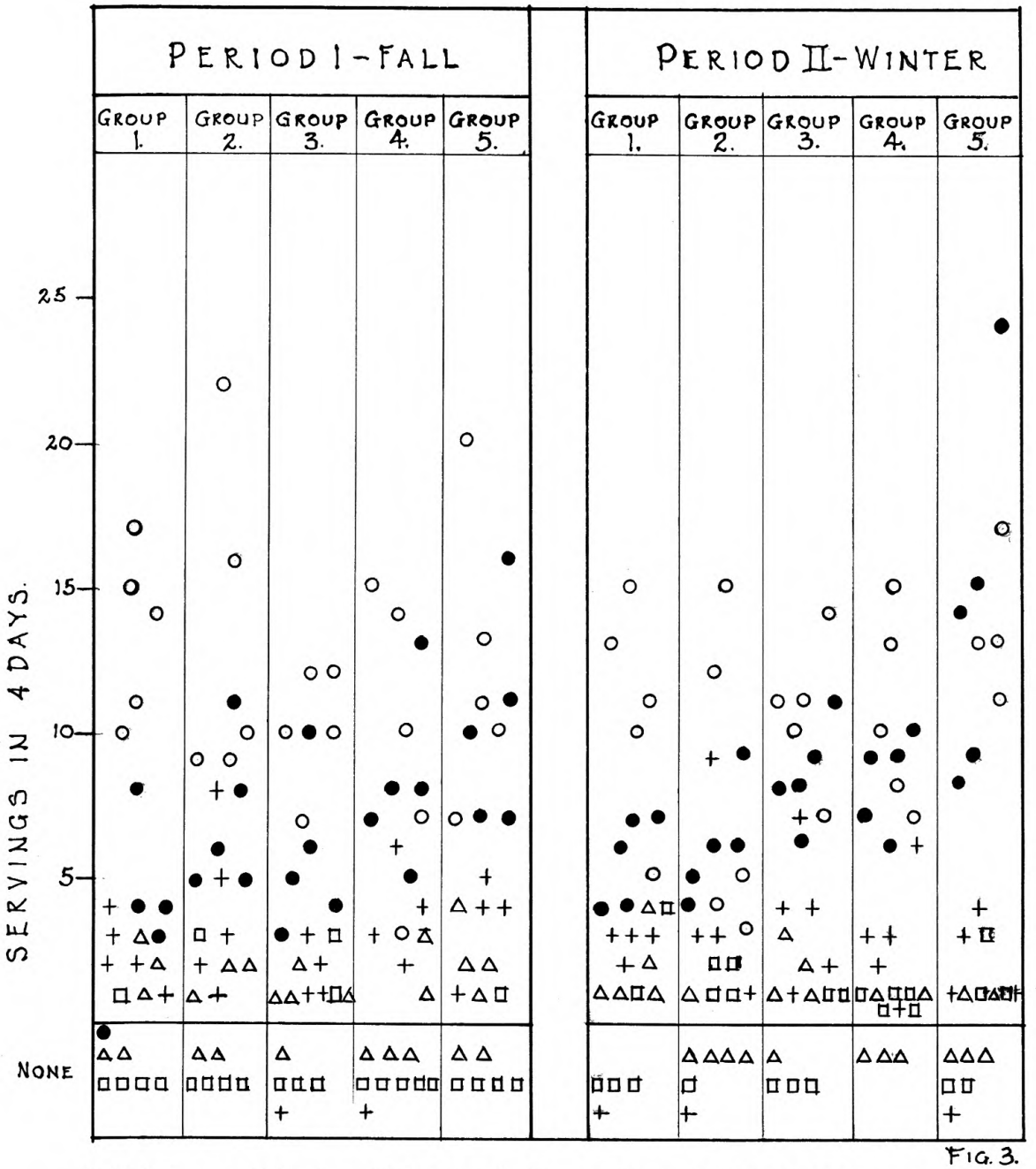

FIG. 3.

● MILK. △ CHEESE □ NUTS + SPINACH, TURNIPS, CAULIFLOWER, CARROTS, CABBAGE
○ FRUITS.

REPORTED SERVINGS OF HIGH CALCIUM FOODS IN FOUR DAYS.

TABLE IV

REPORTED SERVINGS OF HIGH CALCIUM FOODS

	Amount of Calcium	Subjects having free choice of food: No. of Subjects	Average Servings per subject: Milk	Cheese	Nuts	Veg.	Fruits	Subjects eating set meals: No. of Subjects	Average Servings per subject: Milk	Cheese	Nuts	Veg.	Fruits
Period I	1 gram of Ca or more	3	11.0	1.6	0.3	3.3	12.6	2	9.0	1	0	3.5	11.5
	1 gram to Sherman Standard	7	6.8	1.8	0.4	3.1	8.8	10	6.3	0.4	0.4	2.3	13.5
	Sherman Standard to Sherman Min.	0	-	-	-	-	-	2	6.0	0.5	0.5	2.5	12.5
	Below Sherman Min.	0	-	-	-	-	-	1	0.0	2.0	0.0	3.0	11.0
Period II	1 gram of Ca or more	2	10.5	0.0	2.0	3.5	15.0	6	12.0	0.5	0.6	2.0	10.0
	1 gram to Sherman Standard	8	8.0	0.7	0.8	4.0	7.2	6	6.0	1.0	1.3	1.5	12.5
	Sherman Standard to Sherman Min.	2	7.0	2.5	0.0	3.0	8.0	1	4.0	1.0	0.0	3.0	15.0
	Below Sherman Min.	0	-	-	-	-	-	0	-	-	-	-	-

TABLE V

CALCIUM ELIMINATION AS RELATED TO
PLAN OF FOOD SERVICE

	Average Calcium per 70 Kilograms		
	Period I - Fall	Period II - Winter	Average
All Subjects	1.062	1.108	1.085
Subjects choosing food	1.185	1.039	1.112
Subjects eating set meals	0.939	1.177	1.058

DISCUSSION

Table I shows the data collected on every subject for the first 4-day period. The figures show a variation of from 42.6 to 73.5 kilograms in the weights of the subjects, the average weight for all subjects being 56.1 kilograms. The volume of urine represents the entire amount for the 4-day period and varied from 2490 to 8895 cubic centimeters. An analysis of 150 cubic centimeters of the urine of each subject showed a variation of 0.003 gram to 0.054 gram of calcium, the range of total calcium in the urine being from 0.110 gram to 0.966 gram. For the feces, dried to constant weight, there was a variation in amount of 29.5 to 142.0 grams. An analysis of 1 gram of the feces of each subject showed a variation of 0.016 gram to 0.050 gram, the range of total calcium in the feces being from 1.080 to 4.536 grams. The total calcium for the first period ranged from 1.462 to 5.232 grams.

Table II shows the data collected on every subject for the second 4-day period. The variation in weight was from 43.1 to 73.9 kilograms. The average weight for all subjects for this period was 57.5 kilograms and represents a slightly greater average than for the first period. The volume of urine varied from 2670 to 10,405 cubic centimeters. The calcium in 150 cubic centimeters varied from 0.003 gram to

0.053 gram, the range of total calcium in the urine being from 0.143 to 1.045 grams. For the feces, dried at constant weight, there was a variation in amount of 39.5 to 126.5 grams. The calcium in 1.0 gram of feces for each subject varied from 0.015 gram to 0.056 gram, the range of total calcium in the feces being from 1.422 to 5.313 grams. The total calcium for the second 4-day period ranged from 1.714 to 6.016 grams.

Table III shows figures for the two periods, including for each subject the average daily calcium eliminated and average daily calcium calculated in terms of 70 kilograms of body weight. This latter calculation was necessary for comparisons on account of the great variation in body weight among the subjects. These figures may be taken as an index of the calcium intake of the subjects. For the first period the daily calcium varied from 0.365 to 1.308 grams with an average of 0.823 gram. The daily calcium per 70 kilograms varied from 0.437 to 1.838 grams with an average of 1.037 grams. For the second period the daily calcium varied from 0.428 to 1.504 grams with an average of 0.900 gram, and the daily calcium per 70 kilograms varied from 0.504 to 1.784 grams with an average of 1.111 grams.

Figures 1 and 2 show the relative position of the subjects as to calcium elimination for the two periods. The number beside each point corresponds with the subjects'

number as given in Table I. For comparison lines have been constructed corresponding to the Sherman (9) minimum requirement of 0.45 gram of calcium per 70 kilograms, the Sherman (9) standard of 0.68 gram of calcium per 70 kilograms, and the Sherman and Hawley (11) standard for the child of 1.0 gram of calcium per day.

For the first period (Figure 1), 5 subjects are observed to have 1.0 gram or more of calcium, 17 are between the Sherman standard and the standard for the child, 2 are between the Sherman minimum and the standard, and 1 subject is below the Sherman minimum. It is noteworthy that a large portion of the subjects appear to be using calcium well in excess of the Sherman standard. On the other hand, it is not desirable to find even one subject below the Sherman minimum. For the second period (Figure 2) 8 subjects are observed to have 1.0 gram or more of calcium, 14 are between the Sherman standard and the standard for the child, 3 are between the Sherman minimum and the standard, and no subjects are below the Sherman minimum. In each case 3 subjects or about one-eighth of the group, appear to be consuming calcium in quantity below the Sherman standard.

In 14 out of 25 instances the actual calcium elimination of the second period exceeded that of the first period. A close correlation between the calcium eliminated in the two periods is not noticed for the majority of the subjects.

The average figures for calcium eliminated by the subjects in this experiment (Table III), if taken as an index of the calcium in the diet, are commendable since 0.823 gram for the first period and 0.900 gram for the second period well exceed the Sherman standard of 0.68 gram.

Figure 3 shows the servings of high calcium foods in four days for the two periods. The 25 subjects were ranked and divided into 5 groups according to calcium elimination. For instance, the 5 subjects ranking lowest in actual calcium elimination were classified as group 1. Following the statement of Bronson (2) that "Calcium is found most abundantly in milk and cheese, in nuts, spinach, turnips, cauliflower, carrots, cabbage, and in most fruits" counts for these foods were made from the daily dietary sheets kept by each subject. It is recognized that these counts are but estimates for the exact composition of the prepared foods and the actual size of the servings are unknown. The kinds of foods are indicated by special symbols and the number of servings of each food are shown for each subject in each group. The term "milk" includes milk as a beverage, cream soups, cocoa, and ice cream. This figure distinctly shows that increased calcium is accompanied by an increase in number of servings of milk consumed. The subject showing the highest number of servings of milk showed the highest amount of calcium. The subject who consumed no milk was

the one subject to appear below the Sherman minimum requirement in Figure 1. There is seemingly little relation between the amount of calcium and other high calcium foods. However, the subjects consumed only small amounts of cheese, nuts, and high calcium vegetables.

Table IV divides the subjects as to their customary eating habits. Those subjects having "free choice" chose their food at the college cafeteria or prepared meals in their own apartments. Those subjects having "set meals" ate at boarding houses, the college dormitory, sorority houses, or the meals prepared for them in their own homes. It is to be observed again that the highest milk consumers of both groups for both periods showed the highest amounts of calcium. There is little difference to be observed between the subjects having free choice of food and those eating set meals. Again the food records are of somewhat doubtful value as they revealed but little concerning size of servings, a point which could account for lack of correlation with calcium elimination figures.

Table V shows the average calcium per 70 kilograms for both periods for all subjects and for those having free choice of food and those eating set meals. The subjects having free choice of food appear to have at least as much calcium on the average as those eating set meals.

The average for all subjects, per 70 kilograms, exceeds

the Sherman and Hawley standard of 1.0 gram of calcium per day for growing children. This is higher than usually expected for those past childhood. In both periods 88 per cent of the subjects showed calcium amounts above the Sherman standard. All of the subjects had had some training in nutrition which doubtless would be an important factor in explaining this superiority of the diet. The diets of these same subjects were not equally superior in protein intake, since 68 per cent of them in the fall and 84 per cent in the winter were below the Sherman standard for protein (5). This is in striking contrast with a statement (8) made more than a decade ago: "results of dietary studies indicate very strongly that the average American dietary contains a much more liberal margin of protein than of calcium, and that while the danger of a protein deficiency is rarely serious, the danger of a deficiency of calcium is very real."

SUMMARY AND CONCLUSIONS

A study of the calcium intake as indicated by calcium output was made with 25 college women as subjects. For a 4-day period in the fall and again for a 4-day period in the winter these subjects made complete collections of urine and feces. Daily records were kept by the subjects indicating the kinds and amounts of food eaten. Subjects were asked to follow their customary habits. Quantitative calcium deter-

minations were made so that total calcium output for each subject for each period could be calculated. The figures secured were compared with accepted standards for calcium intake. Counts were made of the high calcium foods reported.

The majority of the college women of this group were receiving in their diets amounts of calcium well above the Sherman standard. The fact that all of these subjects were home economics students may be a reason for this pronounced trend. This may be partly explained by the amount of milk used since the number of servings of milk reported was usually found to increase with the calcium output. Only 12 per cent of the subjects had calcium figures below the Sherman standard. Because a few of the subjects are below the desired standard it would seem a matter of concern to include sufficient high calcium foods in the diet.

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