A PERSONAL DIETARY AND BALANCE STUDY DURING WEIGHT REDUCTION

by

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INTRODUCTION

Investigation of family histories reveals a tendency to overeat which, in some cases, leads to obesity and results in disease. Life insurance companies and physicians are increasingly aware of this situation and often recommend a loss of weight to improve health and prevent disease. Information is limited, however, as to the effects upon the body of a low caloric intake over a long period of time.

Believing that reduction of weight was desirable in the case of the writer, this study was planned to determine the effects of a carefully controlled reducing diet when there is a family tendency toward increased weight developing into diabetes with advancing age.

REVIEW OF LITERATURE

Lusk (1928) referred to some early studies of Rubner made in 1879 in which 1500 gm. of "good white bread" containing 104.4 gm. of protein provided sufficient calories for a working man to maintain nitrogen equilibrium. Lusk also noted that Moritz in 1908 recommended from 1.5 to 2.5 liters of milk daily as a diet for obesity. Some body nitrogen was lost during this study, but the subjects did not report any weakness. Nitrogen balance could not be obtained by Thomas, according to Lusk, on a diet of bananas and sugar eaten in quantities sufficient to provide a total daily intake of 4.32 gm. of nitrogen and 2741 Calories. However, this study lasted for only three days which was probably insufficient time to allow the body to adjust to the low nitrogen level of the diet.

Strang, McClugage, and Evans (1931) reported the results of a nitrogen balance study during a dietary correction for overweight in which five obese persons served as subjects. These authors found that during the early weeks of rigid dieting their patients lost body nitrogen to the extent of 3 to 6 gm. per day before re-establishment of nitrogen equilibrium. They concluded that nitrogen metabolism in obesity was normal and that it could be maintained at ordinary levels on markedly sub-caloric diets, provided a protein intake of 1 gm. per kg. of ideal body weight were assured. They further advised one-half gm. of carbohydrate for each gm. of protein in the diet.

In a study of eight obese patients, Keeton and Dickson (1933) stated, in contrast to the observation of Strang et al., that the excretion of nitrogen in obesity differed strikingly from normal. The majority of their subjects remained in positive nitrogen balance when 50 to 90 gm. of protein were fed daily. Even when the diets were insufficient in energy and the food supplied minimal quantities of protein, the nitrogen loss remained small. These authors suggested that patients developing a negative nitrogen balance easily on a reduced protein intake had less severe obesity. It appeared that the loss of nitrogen by any subject could not be predicted and was not essential to loss of weight. The basal metabolic rates were determined frequently and found to be normal for these eight obese subjects.

The Scandinavian workers, Forbeck and Leegaard (1934), studied 13 obese patients receiving a diet of 700 to 800 Calories daily. These subjects showed uniform loss of weight of about 160 to 215 gm. per capita per day and were reported to be in nitrogen equilibrium with a protein supply of 1 gm. per kg. of ideal weight. The basal metabolism of these subjects was normal.

Harrop (1934) used as a continuous reducing diet one or two large ripe bananas with one glass whole milk for both breakfast and lunch. This was followed by a more liberal but still restricted evening meal, making a total intake of 1000 to 1200 Calories daily. A second type of reducing diet used by Harrop was still more severe. It consisted of only 6 large bananas and 1000 cc. skimmed milk daily for periods of from 10 days to 2 weeks. This was alternated with intervals on more liberal diets. Nitrogen balance was attained in six out of ten cases with the more strict second diet both at the end of one week and again at the end of two weeks. The nitrogen loss in no case exceeded 2 gm. a day.

Rose (1935) referred to studies on overweight college women at the University of Illinois in which it was often necessary to reduce the caloric intake per day to 1000 Calories or less in order to bring about satisfactory loss of weight. It was believed this low caloric diet resulted in no injury to health, if the subject lived a well regulated life, including a suitable amount of sleep, fresh air, exercise, and food adequate in every dietary essential except energy.

Campbell (1935) studied 27 obese patients ranging from 14 to 67 years of age, 21 of whom were women. The basal metabolism was normal for all but four of these subjects. Campbell was able to maintain his patients in nitrogen balance at all times for periods of 4 to 50 weeks by supplying 2 gm. of protein per kg. of body weight daily and calories ranging from 20 per cent above to 39 per cent below the basal requirements. Campbell's subjects remained in excellent health and performed their usual work while eating these diets. All indicated a feeling of increased energy during the study.

A report by Keeton and Bone (1935) suggested that obese patients confined to the hospital lost weight equally rapidly whether the diet contained 90 or 13 gm. of protein daily on diets ranging from 30 to 48 per cent below basal requirements for energy. Basal metabolism was not affected in these same subjects even with prolonged periods of under nutrition.

A detailed study was made by Sainsburg and Smith (1937) at the University of Arizona on 12 obese women over a period of six days in order to determine the effects on the body of a skimmed milk and banana reducing diet in common use. These subjects used one quart of skimmed milk and six bananas for their daily diet. Nitrogen balances were conducted for 4-day periods on the entire group and 4-day calcium and phosphorus balances on eight of the subjects. All except one person showed a negative nitrogen balance while on the diet. In every case the balances for calcium and phosphorus were positive. Each subject indicated the diet was filling but increasingly monotonous and distasteful. One-half of them felt discomfort from gas and five were definitely constipated while eating these foods.

In a recent publication, Pittman and Kunerth (1939) reported that a medium-protein diet, in which meat furnished 85 per cent of the nitrogen, improved appreciably the utilization of nitrogen, calcium, and phosphorus by normal human subjects when compared with the results of a low-protein diet similar in other respects. In some cases negative balances became positive and in others they were less negative with the increased amount of protein in the diet.

PROCEDURE

Three 7-day nitrogen, calcium, and phosphorus balance studies were conducted on one subject, who was also the writer. The first was made while she was eating her customary diet and the second and third each at the conclusion of an 11-week period on a reducing diet. The energy value of the food eaten was also determined during each balance period.

Subject

The subject was a young woman personally interested in reduction of weight because of a recent rapid gain of several pounds and a family history of diabetes following a period of overweight. She had a record of chronic constipation often accompanied with gas, causing headaches and a feeling of fatigue. Accompanying the gain in weight prior to this study, there were periods of mental sluggishness and an increased desire to sleep. Colds were common during the winter months.

A thorough physical examination, including basal metabolism, was made a short time before beginning the study. The subject was found to be free from any glandular deficiency and in good health, although judged by the physician to be 30 pounds overweight on the basis of height, weight, and age charts for women. She was regarded as somewhat lateral in build, and, if ten per cent be added to her optimal weight as a correction for her type of build, she might be considered only 17 pounds overweight at the beginning of the reduction experiment (Table 1).

During the first balance study when the normal diet was eaten, the subject was a student in summer school and leading a rather sedentary life. During the reduction periods which followed in the fall and in the winter, she roomed at a "teacherage" only a short distance from the school building where she taught a full schedule of high school classes, including one daily 60-minute physical training class. This was the only exercise taken consistently during these periods.

A second basal metabolism test was made shortly after the completion of the second balance period on the reducing diet. A Roth-Benedict portable respiration apparatus was used for making the tests. The oxygen consumption for a 6-minute period was measured and from this the heat given off per hour by the body was computed after corrections were made for temperature and barometric pressure.

Table 1. Personal data concerning the subject.

Item	Period I	Period II	Period III
Age in years to nearest birthday	33	34	34
Height in cm.	159	159	159
Weight in kg.	71.0	66.8	63.6
Type of build	lateral	lateral	lateral
Basal metabolic rate in percentage compared with the DuBois standard as modified by Boothby	+ 0.33		- 6.0
Activity	sedentary	sedentary	sedentary
Average hours sleep	7.8	8.0	7.6

Diet

At the time of the first balance study, the subject was sharing an apartment with a close relative who was also overweight and accustomed to eating the family food. No special diet was planned for this period, as it was desired that the food be freely chosen and representative of the customary habits of eating. The foods actually eaten during the week are shown in Table 2. Following the completion of this part of the study, a reducing diet was calculated, which was believed to be adequate in all nutrients and sufficiently low in energy value that a gradual loss of weight might be expected. The food was planned to supply 1500 Calories daily.

The first 1000 Calories of this reducing diet were designed to furnish certain protective foods which would insure the adequacy of the diet except for energy. The foods included each day were: one pint of milk; one egg; two vegetables besides potatoes, preferably one green or one yellow; two fruits, preferably one fresh and one citrus or tomatoes, fresh or canned; and one whole-grain product. To these was added one serving of meat daily for the sake of satiety and to insure a fairly high protein intake, which some investigators recommend for reducing diets (Campbell, 1935). By the aid of tables of food composition (Rose, 1937, and Daniel and Munsell, 1937), the protein, minerals, and vitamins were calculated to be in excess of the standards set by Sherman (1937). The amounts and kinds of food eaten during periods II and III are shown in Tables 3 and 4.

Table 2. Menus for regular diet eaten during Period I.

Day Date	Breakfast Foods	gm.	Lunch Foods	gm.	Dinner Foods	gm.
Thurs. 7/7/38	Pep	16	Salmon salad	41	Frankfurters	49
	Rice krispies	30	Potato	89	Beans, string	97
	Apple sauce	150	Beet pickles	14	Lettuce, head	44
	Milk	110	Egg	18	Tomato, fresh	94
			Liver, fried	45	Bread, w.w.	78
			Bread, w.w.	29	Butter	15
			Butter	10	Jam	20
			Apricots, fresh	125	Milk	136
			Milk	163		
			Lemon juice	86		
			Sugar	13		
Fri. 7/8/38	Pep	15	Potatoes, fried	159	Egg	61
	Rice krispies	20	Tomato, fresh	58	Gravy, milk	128
	Raisins	15	Bread, w.w.	62	Beans, string	37
	Apple sauce	35	Milk	89	Tomato, fresh	86
	Milk	120	Ice cream	136	Bread, w.w.	61
			Doughnuts	71	Butter	20
			Orange juice	74	Crackers, soda	8
			Sugar	28	Apple sauce	142
			Apple, raw	54	Milk	140
Sat. 7/9/38	Pep	12	Egg	57	Fish, fried	134
	Rice krispies	18	Tomato, fresh	62	Tomato, fresh	98
	Apple sauce	142	Corn, yellow	112	Rice and raisins	123
	Muskmelons	212	Bread, white	41	Buttermilk	254
	Milk	136	Butter	10	Muskmelon	201
			Jam	61	Bread, wh.	59
			Peaches, fresh	116	Butter	20
			Cookies	65	Milk	103
			Milk	242	Crackers, soda	15
			Orange	82		
			Sugar	10		
Sun. 7/10/38	Shredded wheat	28	Rice and raisins	78	Sardines	127
	Milk	71	Bread, cr.w.	23	Tomato, fresh	56
	Muskmelon	174	Crackers, soda	50	Beans, string	100
			Jello, grape	177	Bread, cr.w.	72
			Sandwich spread	50	Butter	15
			Buttermilk	188	Peanut butter	26
			Milk	84	Cookies	25
			Lemon juice	105	Grapes, fresh	66
			Sugar	15	Peaches, fresh	71
					Jam	45
					Milk	120

Table 2. (Cont.)

Day Date	Breakfast		Lunch		Dinner	
	Foods	gm.	Foods	gm.	Foods	gm.
Mon. 7/11/38	Shredded wheat	29	Lettuce, head	59	Sardines	113
	Milk	123	Sandwich spread	31	Corn, yellow	83
	Apple sauce	235	Bread, w.w.	75	Beans, string	45
			Milk	215	Tomato, fresh	130
			Jello, grape	128	Bread, cr.w.	60
			Peaches, fresh	121	Butter	15
			Cookies	67	Crackers	25
			Orange juice	104	Milk	220
			Sugar	15	Cookies	49
					Cantaloupe	170
Tues. 7/12/38	Orange juice	100	Potato salad	162	Liver	136
	Shredded wheat	28	Cucumber	40	Gravy	87
	Toast, w.w.	28	Tomato, fresh	106	Beets	100
	Butter	16	Bread, w.w.	77	Lettuce	42
			Raisins	11	Bread, wh.	37
			Walnuts	5	Butter	20
			Cookies	5	Milk	250
			Ice cream	185	Cantaloupe	296
Wed. 7/13/38	Shredded wheat	28	Corn	100	Egg	57
	Rice krispies	17	Tomato sauce	14	Gravy	132
	Tomato juice	167	Beets	98	Bread, w.w.	68
	Milk	218	Milk	135	Tomato, fresh	48
			Red raspberries	100	Lettuce	54
			Crackers	51	Cantaloupe	191
			Sugar	16	Butter	12
			Lemon juice	70	Peanut butter	30

Table 3. Menus for reducing diet eaten during Period II.

Day Date	Breakfast		Lunch		Dinner	
	Foods	gm.	Foods	gm.	Foods	gm.
Thurs. 11/10/38	Shredded wheat	27	Egg	48	Roast, beef	131
	Toast, w.w.	38	Spinach	106	Carrots	100
	Grapefruit	107	Bread, w.w.	38	Tomato, fresh	122
	Milk	244	Butter	13	Bread, w.w.	38
			Apple	159	Orange	161
			Milk	244	Apple	81
Fri. 11/11/38	Shredded wheat	27	Salmon	58	Frankfurters	80
	Toast, w.w.	38	Tomato, fresh	122	Cabbage	37
	milk	244	Egg	43	Carrot	100
			Bread, w.w.	38	Corn	97
			Butter	13	Bread, w.w.	38
			Milk	244	Pineapple	104
			Apple	159		
Sat. 11/12/38	Shredded wheat	27	Fish	97	Rabbit, baked	49
	Orange	79	Egg	50	Carrot, raw	73
	Toast, w.w.	35	Corn	96	Green pepper	15
	Milk	244	Tomato	70	Cottage cheese	91
			Celery	80	Beans, string	82
			Bread, w.w.	57	Apple, raw	131
			Butter	13	Milk	244
Sun. 11/13/38	Shredded wheat	27	Egg	58	Milk	244
	Toast, w.w.	38	Lettuce	70	Bread, w.w.	19
	Orange	153	Potato	150	Chicken	131
	Milk	244	Corn	97	Apple	131
			Butter	13	Beans, string	82
Mon. 11/14/38	Shredded wheat	27	Egg	55	Pork chop	58
	Toast, w.w.	37	Cottage cheese	33	Sw. potato	74
	Grapefruit	107	Corn	71	Tomato, fresh	122
	Milk	244	Lettuce	71	Bread, w.w.	37
			Bread, w.w.	37	Peaches	120
			Butter	13		
			Milk	244		
			Apple	200		

Table 3. Menus for Subject B arranged in order of beginning of day.

Day	Luncheon	Dinner	Breakfast	Between meals
1	Fried potatoes Carrot and raisin salad Lettuce sandwich Grapes	Baked ham Scalloped potatoes Green beans Sliced tomatoes Bread Butter Peaches Cake Cookies	Oranges Shredded wheat Cream Sugar	Coca-cola
2	Kidney bean salad Potatoes Green beans Bread Butter Cookies Apricots	Cabbage Creamed potatoes Lime-grape salad Muffins Butter Apple Betty Chocolate macaroons	Oranges Bacon Fried egg Muffin Butter	Coca-cola
3	Frankfurters Sauerkraut Peas Toasted cheese sandwiches Cocoanut cream pie	Bacon Waffles Butter Syrup Brown Betty	Apricots Shredded wheat Cream Sugar	Candy
4	Steak Mashed potatoes Lettuce salad Bread Butter Pickle Cake Ice cream Chocolate sauce	Devilled eggs Cheese sandwiches Cake	Tomato juice Shredded wheat Cream Sugar Toast Butter Jam	
5	Corned beef hash Peas Lettuce salad Bread Butter Jam Apple Betty	Creamed salmon Macaroni Stuffed peppers Buttered carrots Cabbage slaw Bread Butter Jam Canned pears	Oranges Grapenuts Cream Sugar Toast Butter Jam	
6	Baked eggs and bacon Macaroni salad Fried apples Bread Butter Jam Tapioca cream Chocolate cake	Cheese fondue Sweet potatoes Spiced apples Tomatoes Bread Butter Tapioca cream Cake	Oranges Shredded wheat Cream Sugar Toast Butter Jam	Coca-cola
7	Meat - gravy Sweet potatoes Peas Tomatoes Bread Butter Jam Peaches	Bacon Waffles Syrup Watermelon Cocoanut macaroons	Grapefruit Shredded wheat Cream Sugar Toast Butter Jam	

Table 3. (Cont.)

Day Date	Breakfast Foods	gm.	Lunch Foods	gm.	Dinner Foods	gm.
Tues. 11/15/38	Shredded wheat	27	Egg	47	Roast beef	110
	Toast, w.w.	37	Beets	110	Lima beans	81
	Orange	126	Bread, w.w.	37	Carrots, raw	100
	Milk	244	Butter	13	Green pepper	30
			Milk	244	Bread, w.w.	37
			Apple, raw	177	Peaches	130
Wed. 11/16/39	Shredded wheat	27	Egg	72	Frankfurters	80
	Toast, w.w.	37	Carrots	75	Turnips	72
	Grapefruit	106	Lettuce, head	72	Hominy	100
	Milk	244	Bread, w.w.	54	Banana	101
			Butter	13		
			Apples	144		
			Pineapple	65		
			Milk	244		

Table 4. Menus for reducing diet eaten during Period III.

Day Date	Breakfast Foods	gm.	Lunch Foods	gm.	Dinner Foods	gm.
Thurs. 4/20/39	Shredded wheat	27	Egg	59	Salmon	34
	Tomato juice	184	Cabbage, raw	193	Potato salad	174
	Milk	244	Lettuce, head	110	Cr. cabbage	118
			Apple, fresh	100	Beans, string	156
			Orange	112	Peaches	156
			Milk	244		
Fri. 4/21/39	Shredded wheat	27	Egg	59	Meat loaf	69
	Tomato juice	184	Lettuce, leaf	100	Corn	80
	Milk	244	Vegetable soup	279	Carrot, fresh	46
			Peaches	156	Lettuce, head	39
			Apple, raw	129	Peas	83
			Milk	244	Bread, w.w.	38
					Butter	7
					Peaches	156

Table 3. Vitamin A determinations on unsaponifiable fraction of butter by the blue color test.

Butter	Sample	Setting of instrument	D	C gm. butter per 100 ml.	l	E 1% 1 cm. (D ÷ cl)	E 1% 1 cm. / E 1% 1 cm. x 100% pure	Vitamin A per gram butter: 1 γ = 10^{-6} g.	Vitamin A per gram butter: Average	Vitamin A per gram butter: γ x 1.56	Vitamin A per gram butter fat	
		mμ	as read		cm.		% vitamin A	γ	γ	I. U.	γ	I. U.
Commercial Sample	A	583	0.66	37.50	1.5	0.0117	0.000450	4.50				
		620	1.05	37.50	1.5	0.0186	0.000372	3.72				
	B	583	0.42	25.00	1.5	0.0112	0.000431	4.31				
		620	0.47	25.00	1.5	0.0126	0.000252	2.52	3.76	5.87	5	8
Emily 197 Colostrum	A	583	1.12	14.28	1.5	0.0522	0.002009	20.09				
		620	1.48	14.28	1.5	0.0690	0.001380	13.80				
	B	583	0.52	7.14	1.5	0.0486	0.001869	18.69				
		620	0.85	7.14	1.5	0.0794	0.001588	15.88	17.12	26.71	19	29
Emily 5th day	A	583	0.56	24.19	1.5	0.0154	0.000592	5.92				
		620	0.68	24.19	1.5	0.0187	0.000374	3.74				
	B	583	0.50	20.83	1.5	0.0160	0.000615	6.15				
		620	0.76	20.83	1.5	0.0243	0.000486	4.86	5.17	8.07	6	9
Emily 30th day	A	583	0.24	21.42	1.5	0.0074	0.000284	2.84				
		620	0.40	21.42	1.5	0.0124	0.000248	2.48				
	B	583	0.36	30.00	1.5	0.0080	0.000307	3.07				
		620	0.59	30.00	1.5	0.0131	0.000262	2.62	2.75	4.29	3	5
Tipsy 342 Colostrum	A	583	0.24	6.58	1.5	0.0243	0.000934	9.34				
		620	0.43	6.58	1.5	0.0435	0.000870	8.70				
	B	583	0.34	7.81	1.5	0.0290	0.001115	11.15				
		620	0.45	7.81	1.5	0.0384	0.000894	8.94	9.53	14.87	12	19
Tipsy 5th day	A	583	0.66	30.00	1.5	0.0146	0.000561	5.61				
		620	1.07	30.00	1.5	0.0237	0.000474	4.74				
	B	583	0.67	30.00	1.5	0.0148	0.000596	5.69				
		620	1.04	30.00	1.5	0.0231	0.000462	4.62	5.17	8.07	6	9
Titan 3[illegible] Colostrum	A	583	0.61	10.00	1.5	0.0406	0.001561	15.61				
		620	0.93	10.00	1.5	0.0620	0.001240	12.40				
	B	583	0.62	10.00	1.5	0.0413	0.001588	15.88				
		620	0.86	10.00	1.5	0.0573	0.001146	11.46	13.84	21.59	16	25
Titan 5th day	A	583	0.40	24.19	1.5	0.0110	0.000423	4.23				
		620	0.61	24.19	1.5	0.0168	0.000336	3.36				
	B	583	0.52	25.86	1.5	0.0134	0.000515	5.15				
		620	0.74	25.86	1.5	0.0190	0.000380	3.80	4.14	6.46	5	8
Titan 30th day	A	583	0.27	20.60	2.5	0.0052	0.000200	2.00				
		620	0.40	20.60	2.5	0.0077	0.000154	1.54				
	B	583	0.27	45.45	1.5	0.0039	0.000150	1.50				
		620	0.39	45.45	1.5	0.0057	0.000114	1.14	1.55	2.42	2	3

Table 4. (Cont.)

Day Date	Breakfast Foods	gm.	Lunch Foods	gm.	Dinner Foods	gm.
Sat. 4/22/39	Shredded wheat	27	Beans, baked	162	Steak, beef	74
	Toast, w.w.	38	Potatoes	144	Egg	52
	Butter	7	Bread, w.w.	38	Lettuce, head	82
	Orange	110	Peaches	176	Asparagus	114
	Tomato juice	184	Milk	244		
	Milk	244				
Sun. 4/23/39	Shredded wheat	27	Egg	45	Meat loaf	136
	Toast, w.w.	19	Lettuce, head	43	Peas	106
	Prunes	62	Beans, string	67	Cr. potatoes	108
	Milk	244	Peas	81	Lettuce, head	119
			Bread, w.w.	38	Bread, w.w.	38
			Pears	152	Strawberries	109
			Milk	244	Milk	244
Mon. 4/24/39	Shredded wheat	27	Egg	60	Steak, beef	50
	Tomato juice	185	Cr. asparagus	142	Potato	88
	Milk	244	Hash	93	Asparagus	145
			Celery	71	Carrot, fresh	61
			Bread, w.w.	38	Lettuce, head	63
			Butter	14	Cucumber, fresh	68
			Apple, fresh	147	Bread, w.w.	13
			Milk	244		
Tues. 4/25/39	Shredded wheat	27	Egg	54	Salmon	83
	Grapefruit		Macaroni and		Potato	103
	juice	203	cheese	131	Beets	80
	Milk	244	Beans, kidney	91	Corn	123
			Celery	40	Carrots, fresh	69
			Milk	244	Apples, fresh	112
			Orange	104	Apricots	143
Wed. 4/26/39	Shredded wheat	27	Egg	48	Steak, beef	
	Tomato juice	233	Beans, string	131	with rice	153
	Milk	244	Lettuce, head	80	Carrots, fresh	45
			Corn	165	Lettuce, head	54
			Bread, w.w.	38	Banana	106
			Butter	14	Orange	71
			Apple, fresh	120		
			Apricots	200		
			Milk	244		

Care was taken to consume sufficient liquid to maintain the body in a normal condition. At the times the three balance studies were being conducted all the drinking water was weighed. A standard measuring cup was used on other occasions to give an approximate measure of the water consumed. Coffee and tea were considered as liquids and measured in the same way as water.

Plan of Experiment

The experiment was divided into three parts. A 7-day nitrogen, calcium, and phosphorus balance study, during which the caloric intake was measured, was conducted at the beginning of the study while the subject was eating her regular diet. The food during this period was chosen as nearly as possible in accordance with the family customs of eating. The remaining two parts of the experiment were divided into two reducing periods of 12 weeks each. A ten-week rest interval, which included Thanksgiving and Christmas, was allowed between the two reducing periods. During this time the caloric intake was increased to the calculated requirement to maintain the weight attained at the end of the first 12 weeks on the reduction diet. When the subject was not on an actual balance study, records of food intake were obtained from approximate measures of food eaten and the liquids were measured by cups.

The daily weight during the entire study was taken without clothing on the same bathroom scale each morning before breakfast. The condition of health each day was recorded as judged by personal reactions. The daily records also included major activities and hours of sleep.

Another balance study was carried on during the last week of each of the two reducing periods making a total of three for the entire experiment.

Care of Samples

Food. While the balance studies were in progress, each serving of food was weighed on a Harvard trip balance of 1000-gram capacity. One-tenth of the amount of each food eaten was reserved as a sample for analysis. These food aliquots, with the exception of butter, were collected in beakers, one for each 24-hour day, and a drop of formaldehyde added to prevent spoilage. The daily samples were made into weekly composites, the drying of which was a continuous process after the first 24 hours, each day's portion being added as soon as the collection was complete.

Butter was made into a separate composite for the week and held in a refrigerator until its energy value was determined. This simplified the process of drying the food, as fat does not assume a constant weight with the conditions under which these samples were handled.

A gas-heated oven at approximately 60° C. was used for drying the samples. The drying process was continued until the weight was approximately constant, differing less than two grams in two successive weighings 24 hours apart. The dried food was then ground in a food chopper, using the medium knife, 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 an electric oven at a temperature of 80° C. It was then stored in a desiccator until analyzed.

Urine. Urine collections were divided into 24-hour units, extending from 6:00 a.m. one morning to 6:00 a.m. the next day. Collections were made in glass bottles under a layer of toluene. A day's collections were mixed well and the measure, specific gravity, and temperature taken. One-tenth of the amount of each 24-hour collection was reserved for analysis and acidified with 5 cc. C. P. hydrochloric acid. The daily aliquots of urine were combined to make a composite sample for the week which was stored at room temperature.

Feces. To mark the feces, No. 00 gelatin capsules containing carmine were taken one-half hour before breakfast at the beginning and again at the end of each balance period. Collections were made in paraffin-coated cardboard boxes with tight covers. All collections were weighed and transferred to a flask containing 100 cc. C. P. hydrochloric acid. Distilled water was used as needed to remove all material from the boxes. The total fecal collection was digested by heating on an electric hot plate at a temperature not in excess of 250° C. until the suspension was of even consistency. This required three or more hours of moderate boiling. After cooling slightly, the mixture was forced through a fine sieve.

The cellulose that would not go through this sieve was dried, ground fine in a mortar, and added to the digest, which was then made up to a convenient volume with distilled water and stored in a glass-stoppered bottle at room temperature until analyzed.

Methods of Analysis

The samples of food, urine, and feces collected from the balance studies were analyzed for nitrogen, calcium, phosphorus, and energy. The Gunning-Arnold modification of the Kjeldahl procedure was used for determining nitrogen. Calcium was obtained volumetrically by a modified McCrudden method as stated by the Association of Official Agricultural Chemists (1935). Phosphorus was determined gravimetrically by the Neumann method (1902) as modified by Lundell and Hoffman (1923) and McCandless and Burton (1924). All analyses were made in triplicate. The accuracy of the techniques was proved by analysis of materials of known composition.

The oxy-calorimeter, originated by Benedict and Fox (1925), was used to determine the caloric value of the food eaten. The oxy-calorimeter has a limit of error of not more than three per cent, which was considered sufficiently accurate for this study.

The principle of this machine is based upon the fact that dry organic material burns readily in pure oxygen if the carbon dioxide is rapidly removed. The purpose is to measure the amount of oxygen used in the process of combustion. It is possible to calculate the caloric value of the substance burned in the oxy-calorimeter from the liters of oxygen required for its combustion by the use of tables which have been prepared for this purpose. It is, however, necessary to know the nature of the food stuffs contained in the sample, as the calories per liter of oxygen are dependent upon the kind of material being burned. These values are obtained from samples originally burned in a bomb calorimeter to determine their heats of combustion. The latter combined with the molecular weights of the substances involved in the chemical process make it possible to derive the caloric values of a liter of oxygen used in burning a sample in the oxy-calorimeter.

The combustion chamber consists of a pyrex glass chimney containing an atmosphere rich in oxygen supplied from a spirometer. The current of air enters the chamber at the top, leaves at the bottom, and passes through soda lime where the carbon dioxide, which is formed in combustion, is completely absorbed. A u-bend in the tube is cooled by immersing in ice water in order to counteract the heat of combustion and equalize the temperature of the spirometer and the circuit. The air is returned to the top of the chamber by means of a small rotary blower, permitting it to make a complete circuit.

The oxygen, as the supply is used in combustion, decreases inside the circulation system. The inflow of oxygen from the spirometer into the main current makes up the loss resulting in a fall of the level in the spirometer bell. The volume of oxygen consumed is shown by reading this fall on a millimeter scale attached to the spirometer.

Care was taken to see that no leaks were present in the circulating system whereby oxygen might escape and that the thermometers and soda lime were in good condition for efficient work.

In determining the caloric value of the diet, one gram of the oven-dry material was weighed accurately and placed in nickel crucibles. A small amount of powdered pumice stone was sprinkled over the top to insure combustion when ignited. The average of three determinations, which agreed within two per cent, was used. One-half gram portions of fat were burned after mixing into a thick paste with pumice. The paste was shaped into a peak, and the glass rod used in mixing was left in the sample during combustion.

Often flecks of carbon remained in the crucible after the combustion process was completed, as complete oxidation was difficult to secure. Correction was made for this (Table 5) by weighing the crucible at the end of the combustion period and again after ignition. The loss of weight occurring was due to the burning of residual carbon. Each milligram of carbon was regarded as equivalent to 1.9 cc. of oxygen. This correction was made as needed.

When a substance containing nitrogen is burned, free nitrogen is liberated as gas. Where there is a confined volume of oxygen such as in the combustion taking place in the oxy-calorimeter, the amount of oxygen measured will always be less than that of the true volume used in the process of combustion. Therefore, a correction must be made for the nitrogen content of the food. To do this,

Table 5. Method of calculating the energy value of a food sample.[1]

Data:

Temperature of soda lime	28.0 C.
Temperature of spirometer bell	28.7 C.
Barometric pressure	738.8 mm.
Factor for correction for temperature and pressure	0.851
Volume of oxygen before combustion	233.0 ml.
Volume of oxygen after combustion	188.4 ml.
Volume of oxygen used	44.6 ml.
Weight of crucible after combustion	7.2439 gm.
Weight of crucible after burning to constant weight over flame	7.2260 gm.
Weight of residual carbon	18.0 mg.
Weight of nitrogen per gram of sample	0.016374 gm.
Weight of sample burned	1.0 gm.

Calculation:

(44.6 x 0.8510) = 37.89 mm. oxygen used corrected for temperature and pressure.

(37.89 x 20.73[2]) - 5[3] = 785 cc. oxygen used in combustion process corrected for fuse.

18 x 1.9[4] - 34 cc. oxygen equivalent to residual carbon.

0.016374 x 800.5[5] = 13 cc. oxygen equivalent to nitrogen.

785 + 34 + 13 = 832 cc. oxygen used corrected for nitrogen and carbon.

832 cc. oxygen = 0.832 liter.

0.832 x 4.825[6] = 4.01 calories per gram of food sample.

1. The calculations for fat were made in the same manner except that a factor of 4.7 instead of 4.825 was used as the caloric value per liter of oxygen.

2.	Volume of spirometer bell in cc. per mm. of length	20.73
3.	Cc. oxygen consumed by iron wire fuse	5.00
4.	Cc. oxygen equivalent to one gm. carbon	1.90
5.	Cc. oxygen equivalent to one gm. nitrogen	800.50
6.	Calories per liter of oxygen when sample of mixed food is burned	4.825

the nitrogen contained in a corresponding sample was determined by the Kjeldahl-Gunning procedure. Oxygen was added to the amount measured in the proportion of 800.5 cc. for each gram nitrogen.

A fuse of iron wire was used to ignite the sample of food to be burned. This was set off by means of an electric current. Five cubic centimeters of oxygen were subtracted from the total oxygen used, as a correction for that involved in burning the wire fuse.

The liters of oxygen measured were corrected for temperature and barometric pressure prevailing at the time of the test. Further corrections were made for residual carbon, nitrogen in the sample, and the wire fuse. This amount, expressed in milliliters was assumed to be the total oxygen used in the combustion process (Benedict and Fox, 1925). A sample calculation is indicated in Table 5.

RESULTS AND DISCUSSION

Period I

The results of the first study conducted while the subject was eating her customary diet are shown in Tables 6, 7, and 8, and Fig. 1. The mean caloric intake was 2006 Calories per day throughout the week, or 28.2 Calories per kilogram (Table 6). This was somewhat lower than was expected, as the energy value of the diet for this period had been estimated at 2300 Calories daily or 31 Calories per kilogram. This overestimation may be attributed to the fact that calculations were made from tables of food composition which were based on mean rather than the actual values for the foods in question.

From the beginning to the end of this 7-day period, there was a loss of 1.75 pounds, or approximately 0.8 kilogram, in weight, although the day-to-day fluctuations were considerable as was to be expected with a normal person. It was interesting to note that the subject continued to lose for the next two weeks after the completion of this first part of the study while she remained on her regular diet and performed the duties of a summer school student. She reported a tendency to loss of weight every summer during hot weather, which may have been a factor in these results.

The basal metabolism was determined at this time. It was found to be + 0.33 per cent (Table 1) according to the DuBois standard as modified by Boothby when compared with the calculated value based on actual body weight and estimated body surface. It may be considered within the range of high normal.

The nitrogen balance was decidedly negative, amounting to 19.8 gm. loss for the week or 2.82 gm. per day (Table 7). This was equivalent to -39.9 mg. per kg. daily. The protein intake of 50.4 gm. daily was low for this period, supplying only 0.71 gm. per kg. Urinary nitrogen represented 84.4 per cent of the total output.

The average daily intake of calcium was 1.034 gm. On this amount the calcium balance was negative to the extent of 0.404 gm. per week or 0.058 gm. per day, which meant a loss of 0.8 mg. per kg. This negative calcium balance was hard to explain as milk, an excellent source

Table 6. Caloric intakes for the three periods.

Period	Dry food other than visible fat		Visible fat		Calories: From food other than visible fat	From visible fat	Total	Mean/day	Mean/kg./day
	gm.	Cal./gm.	gm.	Cal./gm.	Per wk.	Per wk.	Per wk.		
I	3447	3.48	84	9.40	13236	806	14042	2006	28.2 (71.0 kg.)
II	2350	3.80	55	8.66	8910	476	9386	1341	20.1 (66.8 kg.)
III	2459	4.28	42	8.97	10525	377	10902	1557	24.5 (63.6 kg.)

Table 7. Mean nitrogen, calcium, and phosphorus findings.

Period	Weight	Intake			Output: Urine			Output: Feces			Output: Total			Balance		
		Per wk.	Per day	Per kg. per day	Per wk.	Per day	Per kg. per day	Per wk.	Per day	Per kg. per day	Per wk.	Per day	Per kg. per day	Per wk.	Per day	Per kg. per day
	kg.	gm.	gm.	mg.	gm.	gm.	mg.	gm.	gm.	mg.	gm.	gm.	mg.	gm.	gm.	mg.
Nitrogen																
I	71	56.44	8.06	113.3	64.29	9.18	129.3	11.93	1.70	23.9	76.22	10.88	153.2	-19.78	-2.82	-39.9
II	66.8	87.14	12.44	186.2	81.02	11.57	173.2	11.98	1.71	25.6	93.00	13.28	198.8	-5.86	-0.84	-12.6
III	63.6	78.69	11.24	176.7	72.31	10.33	162.4	10.71	1.53	24.0	83.02	11.86	186.4	-4.34	-0.62	- 9.7
Calcium																
I	71	7.24	1.03	14.6	0.64	0.09	1.30	7.00	1.00	14.0	7.64	1.09	15.3	-0.404	-0.058	-0.8
II	66.8	7.26	1.04	15.4	0.87	0.12	1.85	7.63	1.09	15.7	8.517	1.21	17.5	-1.245	-0.177	-2.1
III	63.6	8.46	1.21	18.8	0.80	0.11	1.77	7.99	1.14	17.5	8.788	1.26	19.7	-0.320	-0.047	-0.9
Phosphorus																
I	71	11.03	1.58	22.2	5.42	0.77	10.9	5.20	0.74	10.5	10.626	1.52	21.46	+0.414	+0.059	+0.8
II	66.8	9.52	1.36	20.3	4.84	0.69	10.3	5.46	0.78	11.7	10.30	1.47	22.0	-0.678	-0.111	-1.7
III	63.6	10.58	1.54	24.2	5.14	0.74	11.1	5.21	0.74	11.7	10.35	1.48	22.8	+0.226	-0.061	+1.4

of calcium, had been used freely in the diet, not only at the time of the study but throughout the entire lifetime of the subject. The milk averaged approximately two cups daily and was the chief source of calcium in the diet. Urinary calcium accounted for only 8.4 per cent of the loss from the body.

The phosphorus excretion, resulting in a positive balance for this mineral, did not parallel either nitrogen or calcium (Table 7). The subject stored 0.414 gm. phosphorus a week, which was equivalent to a retention of 0.059 gm. a day or 0.8 mg. per kg. of body weight daily. The phosphorus excreted in the urine amounted to 51.0 per cent of the total mean daily output.

McCollum, Keiles, and Day (1939) suggest that the calcium-phosphorus ratio in the diet is an important factor in usage of both calcium and phosphorus. It appears that the optimal ratio of calcium to phosphorus in the diet varies with different ages and conditions of living. For the adult, a ratio of one part of calcium to two parts of phosphorus in the daily diet is commonly accepted as desirable. This is indicated by the standards of 0.68 gm. of calcium and 1.32 gm. of phosphorus per day suggested

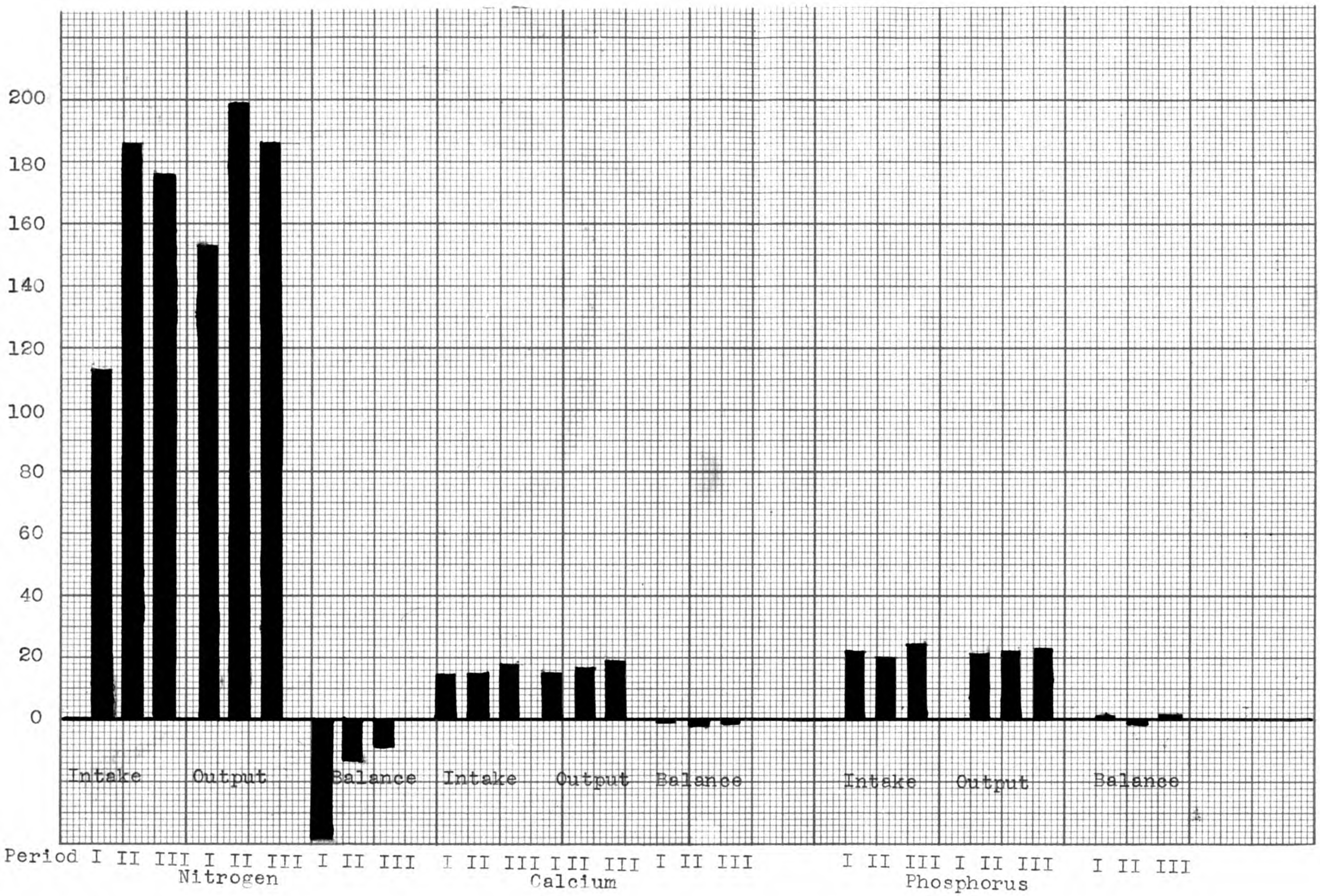

Fig. 1. Mean daily intake, output, and balance expressed as mg. per kg. for nitrogen, calcium, and phosphorus during Periods I, II, and III.

for an adequate diet for the adult male unit. In this particular period of the study, the diet supplied 1.034 gm. of calcium and 1.576 gm. of phosphorus daily, a ratio of 1.0:1.6 (Table 7).

Vitamin D may also be a factor affecting calcium and phosphorus retention. A deficiency of this vitamin was not probable in the case of the subject, however, as she spent a part of every noon hour in the direct rays of a July sun in Kansas, which must have permitted formation of vitamin D from cholesterol in the skin. In addition, the diet included a pint of milk daily which contained some vitamin D. Her butter intake, also a source of vitamin D, averaged 12 gm. daily, and 5 eggs were eaten during the week. According to Chaney and Ahlborn (1939), 1 gm. of ordinary milk contains from 0.0 to 0.1 U.S.P. units of vitamin D, whereas butter varies from 0.4 to 1.5 and egg yolk from 0.45 to 5.0 units per gm. Receiving vitamin D from these various sources, it would appear that the subject had no shortage of this vitamin during the week of the investigation, although no satisfactory adult standard for vitamin D was available for comparison at the time of the study.

McCollum et al. (1939) maintain that when large amounts of magnesium are present in the diet it is difficult for the body to utilize calcium. No tests were made to determine the amount of magnesium in this diet, but it is unlikely that it was present in undue proportions. Large quantities of cellulose were eaten, however, in the form of fruits, vegetables, and whole grain products (Table 2) which, according to McCollum et al. (1939), may lessen the retention of both of these minerals. The diet was quite free from oxalic acid, another factor believed to lessen the utilization of calcium (McCollum et al., 1939).

Table 8. Liquid intakes for periods I, II, and III, (excluding liquid contained in food).

	Period		
	I	II	III
	gm.	gm.	gm.
Water	14984.7	8786.3	8104.3
Coffee, tea	304.0	3420.4	2552.9
Total	15288.7	12206.7	10657.2
Mean per day	2185.5	1743.8	1522.4

The daily volume of urine was 1286 cc. which was 898 cc. less than the total liquid intake (Table 8) excluding that contained in the food. The fact that the weather was warm would help to explain this difference, as at such times the losses of liquids through the skin are increased.

Period II

The results of the second part of the study conducted after 11 weeks on the reducing diet indicated a mean intake of 1341 Calories daily (Table 2). The weight had dropped during these 12 weeks to 66.8 kg. (Fig. 2), a loss of 4.2 kg. (10 lb.). During the actual week of the balance study, there was a loss of 3.0 lb. or 1.4 kg. It was interesting to observe that this week of rather rapid decline in weight followed four weeks with no loss. This is believed to occur frequently during long periods on reducing diets. The calories were 33.2 per cent lower than in Period I, averaging 20.1 per kg. per day. No feeling of hunger or discomfort was noted by the subject with the decrease in energy.

The nitrogen balance was less negative during this period than when the regular diet was eaten (Table 7). It dropped to -5.86 gm. for the week or -0.84 gm. per day. This amounted to -12.6 mg. per kg. per day in comparison with -39.7 for the first week of the study. The subject consumed 77.7 gm. protein daily during this time which furnished 1.16 gm. per kg. The daily nitrogen intake was 38.8 per cent or 4.38 gm. higher than in Period I.

The output of nitrogen in the feces was almost identical with that of Period I (Table 7) even though the wet fecal weight for the week was 244 gm. lower. This is in agreement with Pittman and Kunerth (1939) who found fecal nitrogen quite constant irrespective of the amount of protein in the diet, indicating that the nitrogen so excreted had little relation to variations in intake. Urinary nitrogen accounted for 87.1 per cent of the daily excretion, an increase of 2.39 gm. per day over that of the first period. Such a difference was to be expected with a higher intake of protein.

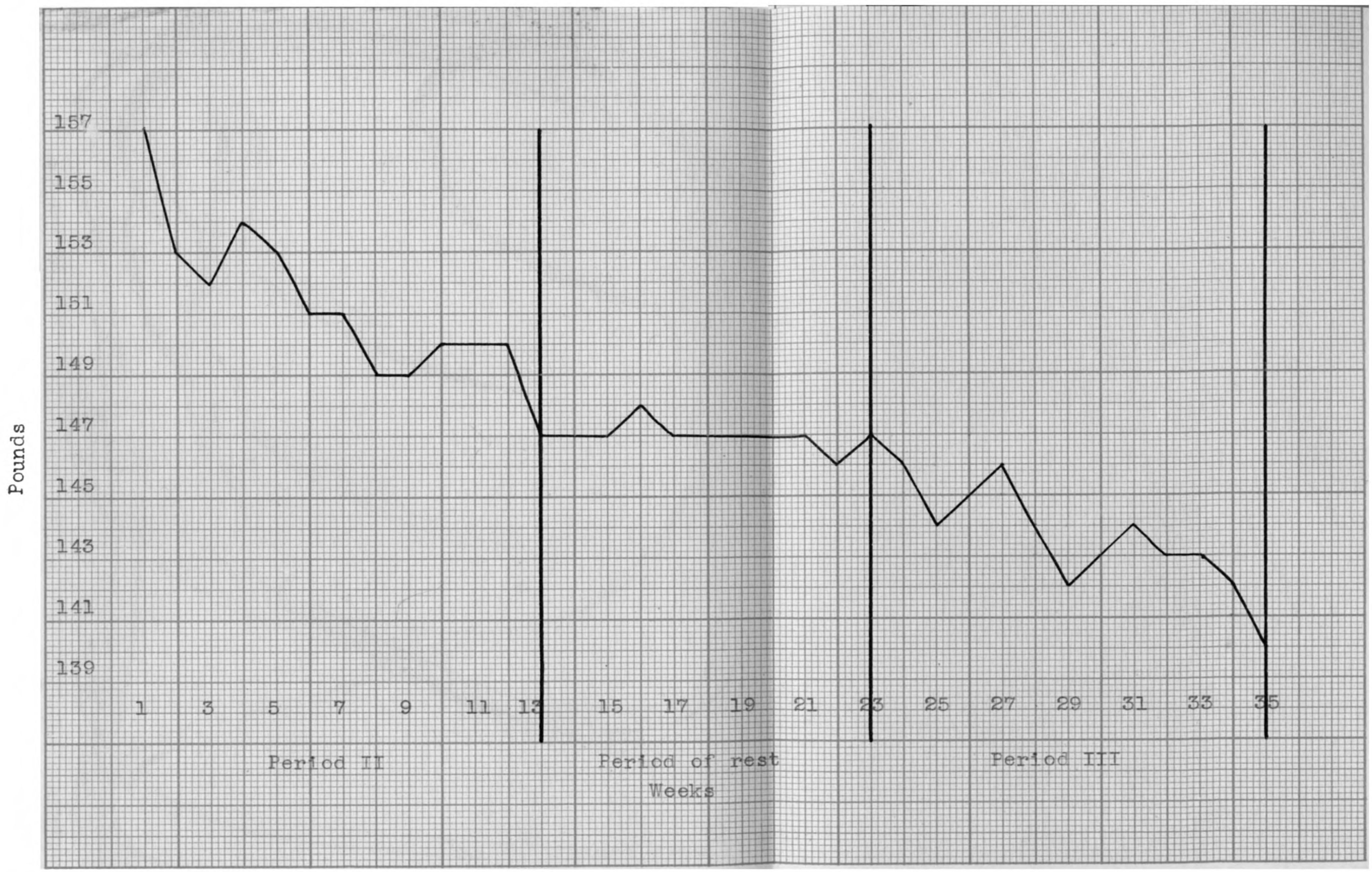

Fig. 2. Loss in pounds on reducing diet.

The calcium balance was much more negative than that of Period I (Table 7). The subject ate 1.037 gm. calcium per day, only 0.003 gm. more than that consumed in the first balance study. She excreted daily an excess over intake of 2.1 mg. per kg. Urinary calcium increased to 10.2 per cent of the total amount excreted. Fecal calcium was also somewhat higher on the reducing diet, but the difference was slight.

A smaller amount of phosphorus was eaten during this period (Table 7). The subject consumed 1.360 gm. of phosphorus daily compared with 1.576 for Period I, a difference of 0.216 gm. a day. Compared with the first diet (Period I), more phosphorus was excreted in the feces and less in the urine, while the total was only a little lower. Urinary phosphorus decreased to approximately 47 per cent of the total output.

The phosphorus excretion exceeded the intake resulting in a negative balance of 0.678 gm. a week or 0.111 gm. per day (Table 7). This was equivalent to a balance of - 1.67 mg. per kg. daily. The phosphorus metabolism more nearly paralleled that of calcium during this week. The proportion of calcium to phosphorus in the diet was increased slightly for this period, the ratio becoming 1.0:1.3 (Table 7).

As the balance for this period on the reducing diet fell in November, there was less exposure to the sun's rays and probably a corresponding decrease in formation of vitamin D through the skin compared with the first balance study made in midsummer. This doubtless meant that there was less vitamin D available, for the diet was no richer in this respect than in the previous study.

The volume of urine each day continued to be less than the liquid consumed other than that taken in food (Table 8). However, the difference was only 415 cc. daily during this period, about half of that noted during the summer. The cooler weather was doubtless a factor here. The wet weight of the feces was also lower, being 244 gm. less for this week than when on the regular diet. As noted earlier, the nitrogen content of the feces did not vary appreciably for the two periods.

Period III

The third balance study conducted during the last seven days of a second 12-week reduction diet averaged 1557 Calories daily, as shown in Table 6. This caloric intake more nearly approached that calculated, as experience in using the food composition tables had led to a more accurate measurement of the amounts of food necessary to supply a given number of calories.

During this 7-day study a 2-pound or 0.9-kilogram loss of weight occurred following two weeks with no loss. This reduction was not as great as had been noted in the week of Period II nor did it follow such a long time wherein the weight remained stationary.

The basal metabolic rate showed some change after 34 weeks on a reducing diet, dropping to -6.0 per cent (Table 1). This was a normal basal rate for a woman, but the lower level indicated at this time would be less conducive to loss of weight than that reported at the beginning of the study.

The nitrogen balance remained negative to the extent of 4.34 gm. loss for the week or 0.62 gm. for each day (Table 7). This was equivalent to a balance of -9.7 mg. per kg. per day, which was less negative than either of the other periods. The total daily protein intake was 70.2 gm. or 1.10 gm. for each kg. of body weight. It approximated closely the amount eaten during Period II (Table 7).

Urinary nitrogen represented 87.2 per cent of the total output being almost identical with that of Period II (87.1 per cent) but slightly higher than in Period I (84.4 per cent), in which a lower protein diet was eaten. The total net weight of the feces for the week was 183.7 gm. higher than in Period II, although the total fecal nitrogen was 1.22 gm. less for the week. The agreement with Pittman and Kunerth (1939) was less good in this case.

The calcium balance remained negative with a loss of 0.320 gm. per week or 0.047 gm. per day (Table 7). This amounted to -0.9 mg. per kg. per day, which was less negative than Period II but slightly more so than Period I. During this week 9.09 per cent of the calcium was excreted through the urine, only slightly less than in Period II, in which urinary calcium amounted to 10.2 per cent. The excretion through the feces was greater than either of the other periods being 19.7 mg. per kg.

The phosphorus balance was more positive than in Period I. There was a retention of 0.226 gm. per week or 0.061 gm. per day, which amounted to +1.41 mg. per kg. for the week. The daily intake of phosphorus was 24.2 mg.

per kg. during this period, the highest observed on this basis at any time, although the total intake was lower than in Period I. Output of phosphorus in the urine was higher in mg. per kg. than in either of the other periods, although this was not uniformly true of total output through this channel. The ratio of calcium to phosphorus in the diet was in the proportion of 1.0:1.3, which was the same as in Period II.

This balance was conducted in April when the subject was busy with indoor school duties and had almost no time to spend in the direct rays of the sun. The sources of vitamin D in the food were little different from those of Period II, as the same type of diet was used in both reduction periods. Under these circumstances, doubtless the total vitamin D available was less than in Period I.

The daily mean output of urine was 714 gm. greater than the intake of liquids during this week (Table 8), the first time this had been noted. The volume was never indicative of the content of nitrogen, calcium, and phosphorus.

Observations Made Between Balance Periods

A total of 17 lb. or approximately 8 kg. of weight was lost during the time of this study which covered a period of 34 weeks (Table 10). The first 12-week period on the reducing diet with a lower caloric intake showed a loss of 10 lb., and the second a loss of 7 lb. The sum of these was the amount considered desirable to lose in the case of this subject.

Contrary to records of many reduction studies, there was a rapid loss of weight during the first week on the low caloric intake. This may have been due to a complete change of diet following a two-week vacation trip during which the food was extremely high in carbohydrate. The subject also reported a 3-day period of mild diarrhea prior to beginning the reduction diet. As it was August, the warm weather doubtless affected the condition of health and may have caused the loss of weight.

There was no change in weight during the 10-week rest period (Fig. 2) except the usual day-to-day fluctuations that always occurred with this subject. No abnormal physical symptoms were noted at this time.

Daily records for the 34 weeks showed freedom from constipation and excess gas which had been chronic for many years. There was an increased feeling of good health, both physically and mentally. From early childhood the subject had suffered from colds during most of the winter months. This condition was improved to the extent that only two colds occurred after beginning the reduction diet, and both of them were mild and of short duration. While this may have been merely a circumstance, at least the reducing regime had no adverse effect on colds.

The frequency of occurrence of certain foods regarded as essential for an adequate diet as they were used during the weeks of the three balance studies is shown in Table 9. While a decrease occurred in servings of fruits, including citrus varieties and tomatoes, during the periods in which the reducing diet was eaten, practically all the other items were used more often. It appeared that the reducing diets, as judged by frequency of occurrence of these essential foods, were superior in quality to the regular diet which was typical of the family eating habits.

Table 9. Frequency of occurrence of certain foods during the three balance studies.

Food	Diet: Period I: Times occurring: Total	Per day	Period II: Times occurring: Total	Per day	Period III: Times occurring: Total	Per day	Daily standard
Eggs	4	0.5	7	1.0	7	1.0	4 per week
Fruits	38	5.4	24	3.4	25	3.5	2
Citrus including tomatoes	18	2.5	11	1.5	10	1.4	1
Others	20	2.9	13	1.9	15	2.1	1
Milk in cups	13	1.9	14	2.0	14	2.0	2
Meat, fish, or poultry	7	1.0	9	1.3	8	1.1	1
Vegetables	18	2.5	25	3.5	39	5.6	2
Other than potato	15	2.1	23	3.3	33	4.7	1
Green or yellow	6	0.9	11	1.5	15	2.1	1
Potato	3	0.4	2	0.3	6	0.9	1
Whole grain products	14	2.0	25	3.5	15	2.3	1

CONCLUSIONS

The reduction diet, which contained all the food essentials but was low in calories, appeared to improve nitrogen retention slightly and to have no effect upon calcium. The results of the phosphorus balances were inconsistent.

This particular adult subject apparently did not maintain calcium balance on a daily intake of more than one gram of calcium with either the regular or reducing diet.

By means of a controlled reducing diet, the subject was able to attain a gradual loss of weight with a feeling of improved health while doing her regular work.

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