

Endogenous Calcium in the Feces of Adult Man and the Amount of Calcium Absorbed from Food

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AT PRESENT, no method is known for finding the amount of calcium absorbed from an entire diet, although methods for determining the amount of calcium absorbed from food added to a basal diet and from radioactive calcium salts are known and have been used. Feces contain so-called "endogenous" calcium, as well as calcium not absorbed from the food. If an estimate of endogenous calcium could be made, the amount of calcium unabsorbed and the amount absorbed from the whole diet could be calculated.

The endogenous calcium in the feces is made up mainly of calcium from digestive juices. After studying the literature, the authors¹ estimated that about 500 mg of calcium per day is secreted into the digestive tract. This is close to a similar estimate of 650 mg made by Stearns.² Only a part of this appears in the feces, because much of it is reabsorbed. The endogenous fraction of fecal calcium may also contain some calcium which has been secreted directly through the wall of the digestive tract. Recent research indicates that this amount is negligible.

The amount of endogenous calcium in the feces of human beings has been studied with the use of Ca⁴⁵ by Blau *et al.*³ They studied two subjects and concluded that one subject lost 91 mg and the other 117 mg per day of calcium in the feces from endogenous sources. There is no assurance, however, that these

were normal values, since both subjects were suffering from bone disease.

The determination of endogenous calcium from the fecal calcium of subjects on a calcium-free diet is not feasible, since, even with the addition of a salt mixture and pure vitamins, no calcium-free diet has been devised which is palatable and adequate. The object of the present study was to find the amount of calcium in the feces at a zero intake without feeding a calcium-free diet. The plan was to find the calcium content of the feces at many different intakes of calcium, plot fecal calcium on calcium intake per day, and extrapolate the resulting curve to zero intake. Data for this are available in the many calcium balance studies already made.

AN ESTIMATE OF ENDOGENOUS CALCIUM IN THE FECES

The literature was reviewed for studies on adults in which values for the calcium content of the food and of the feces were reported. Only those experiments were included in which the experimental periods were of acceptable length. A period of six days was considered sufficient, provided the subject had been living on a diet the calcium content of which differed by no more than 200 mg from the experimental one. If an experiment did not fulfill the latter provision, the authors accepted the data if an additional three-day preliminary period for adjustment was employed. No studies on abnormal subjects were included. Those studies in which citrate, magnesium chloride, and sodium phosphate were fed, and in which there were large amounts of food containing phytates and oxalates, were omitted. Suitable data were collected from 51 reports published before January 1953.

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In some experiments the collection periods were much longer and the resulting values more characteristic than in others. For that reason, a weighting system was devised. Those experimental periods from 6 through 11 days in length were given a weighting of one; those from 12 through 17 days given two; and those from 18 through 23 days given three. Experiments which extended beyond 23 days on one level of intake were given no additional weighting because a higher weighting would allow one subject to affect the results too much. A single set of food and fecal values for one subject with a weighting of one is called a "subject-period," and 1226 of them were used. Some do not appear in Figure 1 and Table I because the intakes were above those plotted or listed.

For each 25-mg range of intake, the mean food and fecal values were found, and the fecal values were plotted against the intake values. A curve was fitted to the data by inspection and extrapolated to zero intake. At zero intake the amount in the feces was about 75 mg (Fig. 1). This, then, may be said to represent the endogenous calcium excretion. The value of 75 mg is not an exact one, but is probably not far from the true value for the mean for a large number of people. No doubt the value varies considerably from individual to individual.

The method of finding the endogenous calcium by extrapolating fecal values to zero intake is a valid one only if the amount of endogenous calcium in the feces is constant for adults. Studies on cattle⁴ with radioactive calcium show that the amount of endogenous calcium does not change during the years of maturity, although it increases in old age, and that it is little affected by the diet⁵ being consumed at the time of the experiment. Growing rats⁶ which had been living on a high calcium diet long enough to build up a large reserve excreted more endogenous calcium than those animals with poor stores when both were given radioactive calcium. Whether this would apply to human adults is not known. Even if the stores of adults affect the endogenous calcium, this may not invalidate the method of using a curve extrapolated to zero,

provided the stores of the subjects do not vary in relationship to the calcium content of the experimental diet, but in a random fashion. If the stores affect the amount of endogenous calcium, the deviation from the mean of 75 mg for individuals would be much wider than if that variable were not playing a part.

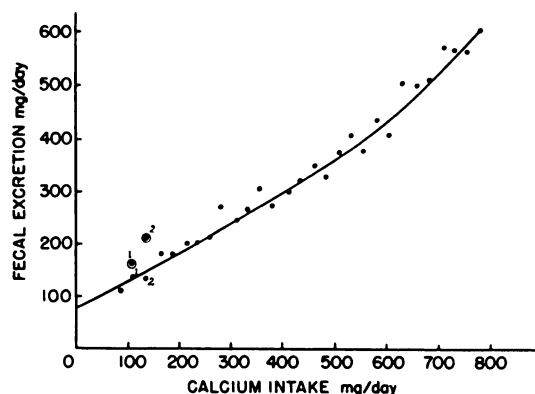


Fig. 1. The amount of calcium in the feces at each 25-mg range of food intake for 986 subject-periods.

¹ The circled dot is for a mean of 31 subject-periods falling into the 100–125 mg range of intake. The plain dot is for the mean with 3 subject-periods omitted because fecal values were unusually high.

² The circled dot is for a mean of 17 subject-periods falling into the 125–150 mg range of intake. The plain dot is for the mean with 2 subject-periods omitted because fecal values were unusually high.

AN ESTIMATE OF THE AMOUNT OF CALCIUM ABSORBED

The object of finding the amount of endogenous calcium in the feces was to use it in calculating the amount that is absorbed. The subject-periods were arranged in classes of 200 mg, ranging from zero intake to 1200 mg per day (Table I). The mean percentage absorbed when calculated from the difference between food and fecal values was determined; then this figure was corrected for endogenous fecal calcium, using the value of 75 mg. When this was done, the amount absorbed at intakes of 400 to 599 mg was 43 per cent. Beyond that point, the amount fell gradually as the intake increased: from an intake of 600 to 999 mg, 34 to 35 per cent of the calcium was absorbed, and from 1000 to 1199 mg, the amount absorbed dropped to a mean of 28 per cent. The largest number of subjects fell in the 400- to 599-mg intake level and, there-

TABLE I

The Amount of Calcium Absorbed at All Levels of Intake before and after Correction for 75 mg of Endogenous Calcium in the Feces

Intake <i>mg/day</i>	No. of subject- periods	% Absorbed (uncorrected)	% Absorbed (corrected)
0-199	105*	-18	38
200-399	267	14	42
400-599	359	28	43
600-799	250	24	35
800-999	94	24	34
1000-1199	81	21	28

* Five values for subjects with abnormally high losses of calcium have been omitted.

fore, the value for that range may be the best estimate.

The swing upward in the amount of calcium in the feces (Fig. 1) beginning at an intake of about 600 mg may be due either to a decrease in the percentage of calcium absorbed, or to an increase in the amount of endogenous calcium, or to both. In most cases, the workers who carried out the studies have made no report concerning the previous diet of the subjects; therefore, there is no way of knowing whether the subjects on the experimental diets in which high intakes were used had better stores than those placed on low intakes. The authors are inclined to believe (on the theory that subjects with high stores were randomly distributed) that this upward swing was due mainly to a decrease in the amount absorbed.

The values for the percentage of calcium absorbed agree fairly well with those found when a test-food is added to a basal diet. Ten experiments of this type were compiled, including 88 subjects whose total intake, after the addition of the test-food, lay between 400 and 1000 mg per day. The mean percentage of calcium absorbed was 34. The values found in the present study agree also with those found by Geissberger,⁷ who used radioactive calcium salts. He fed three adults 1.0 g of calcium gluconate containing Ca⁴⁵. After four days, two of them had excreted 65 per cent of the Ca⁴⁵ by way of the feces. Apparently they had absorbed about 35 per cent. No correction was made for Ca⁴⁵ absorbed, secreted in digestive juices and not reabsorbed.

In 1939, Mitchell and Curzon⁸ calculated a regression equation from a compilation of values taken from calcium balance studies in the literature, but for a different purpose. Their values cannot, therefore, be compared to the ones found in this study.

SUMMARY

The amount of calcium in the feces when the food contains none was found by plotting the fecal calcium of subjects reported in 51 studies in the literature against dietary calcium and extrapolating to zero. The feces were estimated to contain 75 mg per person per day of endogenous calcium. This figure was used in calculating the percentage of calcium absorbed in a compilation of reported studies which supplied intake and fecal values for calcium. The mean percentage absorbed on intakes from 400 to 599 mg per day was 43; on intakes from 600 to 999 mg, it was 34 to 35; and on intakes from 1000 to 1199 mg, it was 28.

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