A STUDY OF THE MINIMUM CALCIUM REQUIREMENTS OF ADULT MEN  

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THREE FIGURES

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Useful dietary standards for any nutrient can be established only after a consideration of two factors: (a) the influence of the level of intake of the nutrient on the health of the individual; and (b) the availability to the individual of the nutrient in question. Failure to consider the second factor may lead to unrealistic recommendations which disillusion those who take them seriously and find them unattainable, and might lead to a distorted agricultural program, waste of resources, and actual losses in food production. Economic status as well as actual food production must be considered important factors in determining the actual food available.

Dietary allowances in the United States can afford to be generous for most nutrients and are generally recognized to be so. When the supplies of certain nutrients are limited, however, more emphasis must be placed upon food economics.
than on "safety allowances." In this case attempts should be directed toward solving the most pressing nutritional problems, since small improvements in intake will yield large dividends in terms of health. This approach requires considerable knowledge of the nutritional state of the people, their food habits, the quantity and quality of food available, the educational system, agriculture, and so forth. Many populations have lived for long periods of time and developed a high degree of culture and ability to do hard physical labor, although their diets appear to be marginal in respect to certain nutrients. More complete studies of such groups should be an important source of basic information in nutritional science and should help in providing solutions to their own problems.

There is considerable concern over the limited milk supplies in most tropical and subtropical countries, where numerous obstacles must be overcome if milk production is to be increased. These programs will be costly, since often the climate, the land, and the degree of technological development are unsuited for the production and distribution of milk. Nutritional benefits must be great to justify the expansion of a dairy industry under such conditions, and careful study by nutritionists as well as agriculturalists is necessary.

In most dietaries the calcium intake is closely related to the milk intake. This paper records a study of the calcium metabolism of a group of adult Peruvian men whose dietary intake of milk had been low over an extended period of time.

**EXPERIMENTAL**

The 10 volunteers who served as subjects were inmates of the Central Penitentiary of Lima. They ranged from 30 to 56 years of age. A medical history of each revealed no chronic or recent illnesses. No serious abnormalities or overt signs or symptoms of nutritional deficiencies were found on physical examination. A few minor signs were seen which might be attributed to inadequate intake of certain nutrients.
Conjunctival vascularization was found in the majority of the subjects. Five were considered to have greasy skin in the area around the nose and two showed fairly definite hyperkeratosis on the elbows and other parts of the arms. All but three had several carious teeth. The number of missing teeth varied from two to 19; average, 8.5 missing teeth per person. The average weight was 69.9 kg (range, 56 to 89) and the average height was 1.67 m (range, 1.61 to 1.78). None of the men was obese and 6 were rather thin. All were working at their usual jobs in the prison shops.

The subjects had been imprisoned for periods varying from two to 20 years. During this time they had received the prison diet plus occasional food gifts brought in by their families. The usual prison diet was judged to be adequate in calories. It consisted principally of rice, bread, potatoes, spaghetti, and beans. Meat was served once a day in limited amounts. Some vegetables, such as carrots, cabbage, squash, sweet potatoes, and so forth, were served fairly frequently but green leafy vegetables were practically absent from the diet. Fruits other than bananas were also rare. The only milk received was in one serving of chocolate once a week in place of the usual black coffee or tea. While this diet was supplemented with gifts from outside to a variable extent, milk and green vegetables were not common gifts. Fruits, cookies, and so forth, were more usual. This diet was obviously low in several nutrients when compared to the National Research Council's recommended dietary allowances (Food and Nutrition Board, '48). Calcium, riboflavin, animal protein and ascorbic acid were probably the most limiting. Beans and some yellow vegetables would make carotene, thiamine and niacin less of a problem. The prison doctor reported that some symptoms and signs of deficiency diseases were occasionally seen. It is clear, however, that the diet must have been sufficient to maintain the men in reasonable health over long periods of time.

The amount of sunlight irradiation regularly available may have been of some importance in this study. Ordinarily
there is practically no direct sunlight in Lima from May or June to October but full sunlight during the rest of the year. This study was made in February and March and all but one of the subjects, Ro, had daily access to the prison yard for varying periods of time.

A special room in the penitentiary was equipped with a stove, refrigerator, and so forth, and served as a kitchen and dining room. All meals were prepared and consumed here. The diets were measured with standard cups or spoons after preparation or, in some cases, the items were weighed prior to preparation. A separate complete diet was prepared each day for analysis. All subjects received the same amount of food each day, with the exceptions of bread, cookies, jelly, margarine or butter, and sugar candy, which were allowed ad libitum in order to allow for variation in the caloric intake. These were analyzed separately and the amount consumed was recorded in order to calculate the total daily intakes. Water intakes, a fairly important source of calcium in Lima, were also measured and the calcium content included in the total intake.

The basal diet was similar to the typical prison diet but somewhat more varied and better prepared. Rice was eaten in large amounts twice daily. Potatoes, spaghetti, sweet potatoes, and bread were the other chief foods. Each subject received 100 gm of meat per day and usually a small serving of beans. Soup prepared with a beef bone was eaten for each lunch. Carrots, squash, beets, onions, tomatoes, and other such vegetables were used in moderate amounts. Some fruit, excluding citrus fruits, was allowed twice a day. Coffee or tea was served with every meal. Green vegetables and milk or milk products were completely excluded from the diet except when milk was added as a supplement. This diet was therefore similar to the prison diet but carotene and ascorbic acid were supplied in larger amounts.

The experiment was divided into 5 periods. The first three days on the basal diet were allowed for adjustment to the diet and to gain experience with respect to the amounts of food
CALCIUM REQUIREMENTS OF ADULTS

To be prepared. Complete urine and fecal collections were then begun. Periods I to III were 10-day periods on the basal diet with none, one cup, and two cups of milk daily, respectively. Period IV was a 6-day period on the basal diet following the highest level of milk intake. During the 5th period of 10 days some of the moderate sources of calcium such as carrots, beans, and the soup bone were removed from the menu and the intake of meat raised to 300 gm per day. This gave a protein intake of approximately 70 gm per day and decreased the calcium intake slightly.

The samples of urine and feces were discarded for a 24-hour period after each change in diet in order to minimize the influence of the previous diet. This is not always sufficient time, as is discussed below, but the use of fecal markers was avoided for fear of losing the cooperation of the subjects. Their cooperation was exceedingly good, although some of the subjects started the experiment convinced that unknown and dangerous procedures would be tried. For this reason, only one blood sample was taken. The total urine, feces, and diet samples were homogenized in a Waring Blender with distilled water. Aliquots were then combined to give representative samples for the second to 5th day and the 6th to 10th day during each 10-day period. Two balances were thus obtained in subperiods of 4 and 5 days each for 4 diets and one of 4 days in period IV. Samples were discarded for two days after the change from the highest level of calcium to the basal diet. Aliquots of the feces and diet were ashed and taken up in dilute HCl for calcium determination by permanganate titration of the oxalate. The calcium in the urine was precipitated directly. Protein was determined on all samples by the macro-Kjeldahl method using selenium and copper as catalysts.

RESULTS

In figure 1 the total calcium and urinary calcium excretions of each subject have been plotted against the intake. Appropriate regression lines for each set of data have been
calculated and are shown. Only the 7 subperiods on the basal diet (omitting the two periods on the high meat diet) are included in the urinary data. The reason for omitting these will be discussed below. All 9 subperiods are included

Fig. 1. The relation between calcium intake and output in the various subjects. Lower curves, urinary excretion; upper curves, total excretion. "r" = coefficient of correlation. Open circles, basal diet with or without milk supplements; solid circles, high meat diet (data not included in urinary curves).
in the total excretion (subject Ba. did not participate in the final two) and it is apparent that the data from the high meat diet fall in the expected position and are not markedly different from the values obtained with the basal diet.

The points of interest in the results relating total excretion to intake are: (1) the coefficient of correlation, \( r \), indicating the reliability of the data. The values are high considering the few points in each line; (2) the point at which the regression line crosses the \( y \) axis. This would be the predicted excretion at zero calcium intake assuming that the relationship would hold if extended that far. These values in milligrams are given by the constant "\( a \)" in the equation \( y = bx + a \). In a few instances these are actually negative values but in such cases they are not greatly different from zero. Extension of the line to this extent does not, of course, give reliable values and may not be justified, but we consider the small values obtained worthy of note and discussion; (3) the point at which \( y = x \), where excretion equals intake, is the estimated calcium requirement for equilibrium and would prevent calcium depletion. Assuming the body made no further adjustments to the intake, calcium would be lost at levels less than this and stored at higher intakes. These values, indicated for each subject in table 1, varied from 596 mg per day for one subject to negative values for three subjects, which may be considered as zero. The data show 5 subjects with requirements of less than 200 mg per day, 4 with requirements between 300 and 400 mg per day, and one with a requirement of approximately 600 mg per day. This last subject had received numerous calcium salt injections prior to the study, a popular therapy in Lima for colds and other minor illnesses.

The urinary calcium excretion shows in general an excellent correlation with calcium intake. As expected, 4 or 5 urine collections are more accurate than fecal collections in most subjects. Considerable differences may be noted in the magnitude of the urinary calcium and in the slope of the regression lines obtained. The highest urinary values were
obtained with subjects Car., St., and Ro. As has been noted, Car. is known to have received calcium injections, which might easily account for this high excretion. Subjects St. and Ro. were also unique in that they, as well as Ba., were accorded certain prison privileges not received by the other subjects. It is considered likely that a better dietary history and thus better calcium stores could account for these somewhat higher calcium excretion values. The urinary excretion of subject Dies. is also of interest. The regression line has a slope of only 0.05, 5% of the dietary calcium appearing as increased urinary excretion, whereas for all of the other subjects the value was between 10 and 19%. It will be noted also that in this subject the slope of the regression line relating total intake to excretion is very high, at 0.94. This subject retained approximately 6% of the dietary calcium at all the levels of intake.

It may be noted that the estimated total excretion at zero intake is in nearly every case accounted for by the estimated urinary excretion. In several subjects the estimated urinary output at zero intake exceeds somewhat the estimated total

<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>WEIGHT</th>
<th>HEIGHT</th>
<th>ESTIMATED REQUIREMENT</th>
<th>MEAN RETENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba.</td>
<td>72</td>
<td>163</td>
<td>101</td>
<td>13</td>
</tr>
<tr>
<td>Car.</td>
<td>83</td>
<td>169</td>
<td>596</td>
<td>12</td>
</tr>
<tr>
<td>St.</td>
<td>89</td>
<td>178</td>
<td>310</td>
<td>30</td>
</tr>
<tr>
<td>Dies.</td>
<td>74</td>
<td>171</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Hua.</td>
<td>61</td>
<td>164</td>
<td>309</td>
<td>30</td>
</tr>
<tr>
<td>Ech.</td>
<td>59</td>
<td>161</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Her.</td>
<td>79</td>
<td>161</td>
<td>377</td>
<td>16</td>
</tr>
<tr>
<td>Ma.</td>
<td>59</td>
<td>162</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Di.</td>
<td>56</td>
<td>172</td>
<td>168</td>
<td>30</td>
</tr>
<tr>
<td>Ro.</td>
<td>65</td>
<td>174</td>
<td>304</td>
<td>19</td>
</tr>
</tbody>
</table>
output, but these differences are well within the limits of error of the data.

The combined data for all subjects in all periods have been plotted in figure 2. The line, $y = x$, has also been drawn to indicate the relation of the data to calcium balance. Points falling above the line $y = x$ represent negative balance, points below indicate calcium storage, and the intersection of this line with the true regression line is the estimated average intake required to give calcium balance. Clearly, most of the points, regardless of intake, are in the area of positive balance. The mean requirement is estimated to be 126 mg of calcium per person per day. The estimated total excretion at zero intake is estimated as 20 mg per day.

With each change of diet, the urine and fecal samples were discarded for a 24-hour period. It is well known that this may not be sufficient time to prevent completely the influence of the previous diet. In two periods the calcium
of the diet was adjusted upward, and if fecal excretions were delayed an apparent retention of calcium would be obtained. It is apparent that this was true with subject Her. (fig. 1) where considerable differences in excretion were noted in the two periods on the same diet and the higher excretion occurred each time in the second period. There are 12 values in all in which it appears that one might justifiably discard the lower value obtained in the first period. A recalculation was made without these values. Rather surprisingly, the remaining data have a regression line with the equation, \( y = 0.905x - 0.9 \); i.e., an average excretion of 90.5% of the dietary calcium instead of approximately 84.3% (retention 9.5% compared to 15.7%), but the line is tipped to give a zero equilibrium requirement; that is, the regression line does not cross the line \( y = x \). Similarly, an omission of the data from subject Car., who appears unusual in this group because of his higher calcium intakes, fails to influence markedly the over-all conclusions.

Subjects Car. and St. were the largest men on experiment and had the highest requirements according to the above calculations. Intakes and excretions were therefore calculated on a per kilogram of body weight basis to see if the variation might be reduced. This relation (fig. 3), treated as in the previous figure, does not improve the correlation. The coefficient of correlation in figure 3 is \( +0.869 \), compared to \( +0.874 \) in figure 2. As suggested by Mitchell and Curzon ('39) and Steggerda and Mitchell ('46), this should not be taken to mean that body size has no effect on calcium requirements, but that individual variations due to other causes are more important than differences in body size. The estimated requirement in figure 3 is higher than that obtained from the data shown in figure 2. Whereas 126 mg per day or 1.8 mg/kg (average weight, 69.9 kg) was obtained by the first method of calculation, the value required to maintain equilibrium is 3.25 mg per kilogram per day in figure 3, and the estimated excretion at zero intake is 0.91 mg/kg/day. These figures may be compared with those obtained by Mitch-
ELL and Curzon ('39), which were 3.1 mg/kg at zero intake and 9.75 mg/kg at equilibrium. It is of some interest that the slopes of the regression lines in these two studies are similar and that approximately three times the minimum excretion is required to attain equilibrium in both instances.

The curves are nearly parallel but ours lie at a lower plane.

It was suggested above that the urinary excretion of calcium was influenced by the high meat diet. The effect of this diet may be shown by comparing the two periods on the basal diet when the intake was comparable. This is done in table 2. It will be observed that, whereas the total average balance was only improved 10 mg, from 19 to 29, by the meat diet,
there was considerable shift in the distribution in feces and urine. Fecal excretion was less and urinary excretion higher on the meat diet. Changes of this magnitude in balance do not alter the over-all relation shown in figure 2 to any great extent, but with the larger values for urinary excretion the regression lines in figure 1 would be markedly changed by these two high values at the lower limit of the data.

The calculation of calcium balance has not been used in these studies. A calcium balance is obtained by the difference in two large numbers to yield a small number. Relatively small errors in the total intake or excretion became large percentage errors in the resulting balance. The percentage utilization of added calcium, however, may be calculated by the method of Steggerda and Mitchell (41), which consists of dividing the increment in calcium retention by the increment in intake at any two levels of intake. These values have been shown in table 1 and range from 6 to 30%. One might expect from the literature that those subjects with the lower requirements, i.e., lower calcium stores, might also show the most efficient utilization. This was not found to be true.

Blood samples were obtained during the last two days of experiment. The measurement of hemoglobin, hematocrit, total serum proteins and calcium revealed measurements within the normal range.

**DISCUSSION**

Minimum calcium requirements may be estimated in several ways from the data presented. One may average the

### TABLE 2

<table>
<thead>
<tr>
<th>DIET</th>
<th>INTAKE mg/day</th>
<th>TOTAL OUTPUT mg/day</th>
<th>BALANCE mg/day</th>
<th>Fecal Excretion mg/day % of total</th>
<th>Urinary Excretion mg/day % of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td>362</td>
<td>345</td>
<td>+19</td>
<td>214</td>
<td>62</td>
</tr>
<tr>
<td>Plus meat</td>
<td>338</td>
<td>309</td>
<td>+29</td>
<td>165</td>
<td>54</td>
</tr>
</tbody>
</table>
individual requirements estimated in figure 1, which range from 596 to 0 mg per day. The mean requirement is 216 mg per day. Calculations from combining the data in figures 2 and 3 give values of 126 and 227 mg per day (3.25 mg × 69.9 kg). Each of these values is so low as to indicate that calcium deficiency could scarcely be produced in these adult men on their usual diets. While we have not attempted in this study to obtain minimum intakes by severe and unusual restriction of the diet, it is clear that it would have been difficult to obtain diets of natural foods containing less than the requirements estimated here. In regions of soft water supplies, lower intakes would result. The water used in Lima was found to contain approximately 70 mg of calcium per liter. Water taken as drinking water supplied up to 104 mg of calcium per day. The total contribution was undoubtedly greater, however, since the same water was used in cooking.

One subject of this group appeared to have the relatively high requirement of about 600 mg per day. It is important to note that this subject must have had rather high calcium stores due to calcium salt injections, and this individual difference may therefore be fairly attributed to past calcium intakes rather than to an idiosyncrasy in calcium metabolism. Estimated requirements of 300 mg in two subjects may also be related to higher calcium intakes. In most of the subjects calcium excretion appeared to be essentially a linear function of intake, decreasing to essentially zero at zero intake.

The increased absorption of calcium observed on the high meat diet was to be expected on the basis of earlier work (Pittman and Kunerth, ’39; Kunerth and Pittman, ’39; McCance and Widdowson, ’42c); retention of calcium was not improved. That it was not, and the fact that the retentions on the basal diet were not unusually high, may be taken as partial evidence that the subjects were not in great need of additional calcium. The extensive review of Knapp (’47) fails to find an adequate explanation for the effect of protein in
increasing urinary calcium excretion, although in some cases this may be related to an increase in the acidity of the diet. This author rejects the belief of McCance and Widdowson ('42b) that urinary calcium is well correlated with calcium absorption and finds a better correlation with total calcium intake. Endogenous factors, presumably endocrine, were suggested as the cause of individual differences in urinary calcium excretion but the prior diet or calcium reserve was not considered as an influential factor.

In an excellent review article Holmes ('44-'45) concludes, principally on the basis of the data of Kinsman et al. ('39), that children probably have no maintenance requirement for calcium and that the calcium intake need not exceed that necessary to supply the calcium required for growth. Ellis and Mitchell ('33) also believe that in young animals calcium ions may be retained at such a rapid rate when intakes are low that the threshold of the kidneys and intestine may never be reached. Considerable data are available from animal studies and some on human beings to indicate that excretion of calcium certainly becomes very low and retention high after considerable periods on low calcium diets. Holmes' review as well as Mitchell's ('44) article on adaptation to undernutrition consider these data.

The present findings lead us to believe that adult men, like children, probably have a very small maintenance requirement for calcium. The evidence is strong that calcium excretion approached zero in the majority of these subjects at very low levels of intake. Certainly one would not expect depletion of the present calcium stores of these individuals on any diet they would be likely to receive.

Past work on quantitative needs for calcium has been reviewed several times (Leitch, '36-'37; Mitchell and Curzon, '39; Steggerda and Mitchell, '46; Sherman, '47; Stearns, '51) and is too extensive to be reviewed in detail here. Perhaps the best-known figure is that obtained in 1920 by Sherman of 0.45 gm per day for the 70-kg adult (6.4 mg/kg). More recent estimates are more nearly equal to 10 mg per kilogram per
day and some are higher (McCance and Widdowson, '42a; Roberts et al., '48). The mean estimated requirement of 0.7 gm per day or 10 mg per kilogram obtained by Steggerda and Mitchell ('46) has a coefficient of variation of 23% or approximately 0.15 gm per day. Ninety-nine per cent of the subjects from such a group should have requirements near 0.7 ± 0.3 gm, or from 0.4 to 1.0 gm per day. This is presumably one justification (see also Macleod and Sherman, '51) for the recent increase in the recommended allowances to 1 gm, from the earlier figure of 0.8 gm (Food and Nutrition Board, '48).

No description of the past dietary habits of the subjects used in the above studies is available but it is likely that they were generally well fed by current standards and had good calcium reserves. Less extensive but convincing data show that calcium equilibrium is attainable at much lower levels of intake (Nicholls and Nimalasuriya, '39; Basu et al., '39; Owen and Irving, '40; Potgeiter, '40) if the subjects have not received high calcium diets. Equilibrium was obtained at levels of from 2 to 4 mg of calcium per kilogram of body weight per day. These values approximate those obtained in this study. While the average stature of people in the tropics is less than that of North Americans and Europeans, Nicholls and Nimalasuriya ('39) estimate that the calcium content per unit of body weight is similar. The average size of our subjects was normal by U. S. standards. In his article on adaptation to under-nutrition, Mitchell ('44) logically relates low calcium excretions and low calcium requirements to smaller calcium reserves in the body. He points out, however, that evidence is lacking to answer the important question as to whether maximum calcium stores are desirable. At present there appears to be no evidence available to indicate the extent to which calcium reserves must be depleted in order to cause conservation of calcium of the order seen in these studies.

It may be questioned whether the studies mentioned above and others might not be more properly considered primarily
as estimates of past dietary habits of the subjects, rather than studies of calcium requirements in the real sense. It is well understood by all workers in the field that studies on protein requirements are simply estimates of the immediately preceding protein intake, unless the subjects are allowed to become adjusted to a low protein diet. That is, equilibrium may be obtained at any level of protein intake above the actual maintenance requirement. Logically the same principles should apply in studies on calcium requirements. That they have not been so applied is undoubtedly due to the time which would be involved. Nitrogen equilibrium at low levels of intake is obtained in a few days. Certainly much longer periods are required to deplete calcium stores. In the studies of Steggerda and Mitchell ('46) some subjects were kept on low intakes for as long as 250 days, during which time calcium losses were more or less constant. Few studies will equal or better this period, but it is not a large portion of adult life and it may not be long in terms of calcium loss. For practical reasons it therefore appears that data on minimum requirements can only be obtained with subjects with low calcium reserves. Clearly, further studies on the relation of these stores to rates of depletion and utilization and their effect on health are needed.

In this regard the extensive work of Sherman and his associates (Sherman and Campbell, '35; Campbell, Pearson and Sherman, '43; Sherman, '47) is important. Rats were shown to be significantly benefitted by levels of calcium in the diet higher than those necessary for reasonable health. However, from the point of view of adult calcium requirements it is not clear from these studies whether the adult animal is benefitted from high intakes if the intake is adequate during pregnancy, lactation, and growth, since the animals were fed the same diet during growth and during the adult periods. Requirements are known to be high during growth, and the adverse effect of the lower calcium diet can be more logically assigned to effects during this period than during adulthood. Kane and McCay ('47) have found calcium re-
quirements of rats to be relatively high during old age, and McCay ('49) comments on the fact that elderly human subjects apparently retain calcium to a greater degree than does the rat. The well-known differences in calcium utilization between rats and human beings (see Holmes, '44-'45) may make the former a poor species for calcium studies. The nutrition of the aged is an important area for investigation which will undoubtedly receive considerable study and may pose its own special problems.

In the final analysis nutritional standards should be related to health. Calcium deficiency probably occurs and could be easily explained, during pregnancy, lactation and growth this type of deficiency need not be discussed here. Little evidence can be found that adult man, in contradistinction to adult women, suffers from calcium deficiency or is benefitted by large calcium stores. Osteomalacia is reported as being widespread in the Orient but Maxwell ('35) says only that, "Naturally men suffer less than women." All of the cases studied by Hannon et al. ('34) and Liu et al. ('35), were women who had gone through several pregnancies, except for one 18-year-old girl. These cases responded readily to vitamin D but not to high levels of calcium. This would therefore appear to have been primarily a vitamin D deficiency rather than a calcium deficiency. Snapper ('50) states that primary calcium deficiency is extremely rare and that osteomalacia responds to vitamin D but not to calcium. Albright and Reifenstein ('48) state that they "are cognizant of no single case of osteomalacia in the United States due to simple lack of vitamin D" and one may presume that this statement may be extended to include calcium deficiency. Osteoporosis, which is widespread in the United States, is defined as a disease of tissue metabolism rather than of calcium metabolism and the same authors "do not believe that calcium lack per se causes osteoporosis" and suggest that "some of the osteopathies which have been attributed to lack of calcium and phosphorus in the diet are really due to protein starvation." Post-meno-
pausal and senile osteoporosis respond to hormone therapy but not to calcium and phosphorus. High protein diets are also recommended.

In conclusion, it would appear that the literature supports the results of this study, which indicate that normal adult man has very low calcium requirements. While we suspect that some readers will be inclined to dismiss these results as a demonstration of adaptation to low calcium diets, we do not believe this justified with respect to our subjects. One with very low requirements was of North European stock. The low excretions obtained are considered simply the normal metabolic adjustment to somewhat reduced calcium stores. It is a general principle that the body is relatively wasteful of nutrients in large supply and conserves those in short supply more efficiently. Adaptation in this sense must be clearly differentiated from the more extensive changes which may be involved in the acclimatization of a species to a new environment, such as the natural selection of the best-fitted individuals. While it is not to be doubted that this may happen to a population in a new nutritional environment, there is little evidence that this was a dominant factor in these studies. Perhaps the phrase “physiological regulation” (Adolph, ’43) has a connotation suggesting less permanent changes than “adaptation” and may therefore be preferred in describing these adjustments in metabolism.

SUMMARY AND CONCLUSIONS

1. It is emphasized that very critical examination of dietary standards in terms of costs and benefits is necessary in countries with short food supplies. Unrealistic recommendations are dangerous and serve no useful purpose.

2. Calcium excretions were studied in 10 adult male volunteers at several levels of calcium intake. These men were apparently healthy but had consumed diets of fairly low calcium content over long periods of time.

3. The average estimated calcium requirement to maintain balance in these men was between 100 and 200 mg per
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day, depending on the method of calculation. Evidence is presented that the maintenance requirement is related to calcium reserves.

4. These results are discussed in the light of prior estimates of calcium requirement. It is believed that all estimates of calcium requirements represent primarily a study of the previous dietary calcium intake.

5. A review of the literature reveals no solid evidence that calcium deficiency occurs in adult males.

6. The minimum calcium requirement of adult males is probably so low that deficiency is unlikely on most natural diets. When calcium supplies are limited, little effort should be made to increase the consumption of calcium by men. Available calcium should be reserved for children and women in the childbearing age.

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