Food Intake and Weight Changes of Youths on an Exploring Expedition

A. M. W. Porter, M.B., B.S.*

In the summer of 1956 an expedition of the British Schools Exploring Society, consisting of 9 leaders and 50 boys, spent six weeks in central Iceland. The purpose of these annual expeditions is to provide selected schoolboys with a training in self-reliance and leadership, and with a chance to participate in scientific work in the field.

The opportunity was taken during the 1956 expedition to record frequent weighings on the 50 schoolboys. The resulting data yield information on the calorie intake required by youths doing hard work in a cool climate.

EXPERIMENTAL

Environment

The base camp was situated near Langjokull glacier in the middle of a large lava plain; this region is intersected by fast-flowing and ice-cold glacial rivers. Every member lived under canvas throughout the expedition, and all tents, food, etc., were carried in packs on the back. The summer of 1956 was a relatively fine one, and the temperature rarely fell below freezing except on the glacier. Table I shows the mean weekly maximum and minimum temperatures at the base camp.

Type of Work

The 50 boys may be conveniently divided into two groups. The first consisted of 28 "marchers," who worked hard but intermittently; a day's march entailed carrying a pack of 15 to 30 kg for a distance varying from 15 to 30 km at a speed of about 5 km per hour. The duration of the marches ranged from 5 to 15 days; the total number of days spent marching by each boy in this group averaged 19 but varied widely, depending on the length of the interludes in base camp.

The second group comprised 20 "surveyors," whose work was more continuous but less strenuous than that of the "marchers" and was estimated as being equivalent to marching about 13 km a day with a 5 kg pack. The remaining two boys sustained injuries and spent the greater part of the expedition in base camp.

Diet

The daily ration for each subject weighed 30 ounces; its composition was originally fixed by the late Surgeon Commander Murray Levick on the basis of his antarctic experiences, and was composed by weight of 61 per cent carbohydrate, 20 per cent fat, and 19 per cent protein. The standard daily ration in oz/man/day was: biscuits 12, pemmican 2, cheese 4, margarine 2, sugar 2, dried vegetables 2.5, chocolate 2, oatmeal 2, raisins 1, salt 0.25, tea 0.25, and one tablet of ascorbic acid (50 mg). This ration was reputed to provide 3,638 calories a day. Although the original method of calculation is not clear, this figure agrees closely with one derived from the tables of McCance and Widdowson;[1] occasional supplements in base camp increased the over-all mean daily intake to about 3,670 calories a day.

The rations proved acceptable to all, there was no plate waste, and opportunities for unofficial supplementation were rare; it would be reasonable therefore to conclude that a fixed calorie intake applied to all members.

Method of Weighing

A steelyard scale, calibrated to quarter

* Formerly Medical Officer, British Schools Exploring Society.

TABLE I

Mean Weekly Maximum and Minimum Temperatures at Base Camp

Period	Temperature (°F) Maximum	Minimum
Aug. 6–12	54.5	38.8
13–19	58.9	40.9
20–26	52.6	38.8
Aug. 27–Sept. 2	52.0	32.7
Sept. 3– 9	52.9	41.1
10–11	45.9	32.1

kilograms, was suspended from metal struts and the subject to be weighed sat in a boatswain's chair of known weight. The whole apparatus was surrounded by a windbreak of canvas in order to avoid swaying.

Unfortunately it did not prove practical to check the absolute accuracy of the scale, but its type and simplicity excluded the possibility of any gross error; moreover, for the purposes of the investigation, the absolute accuracy of the scale was of less importance than its consistency in measuring *change* of weight. Two observers only were concerned with all the weighings throughout the expedition, and when they both on the same occasion repeatedly, but independently, weighed a group, it was found that the range of variation of the readings did not exceed 0.5 kg for any one subject.

Each person, wearing underwear only, was weighed as opportunity offered at approximately weekly intervals; every effort was made to weigh a "marcher" immediately before and after a march. The frequent weighing in the field of so many subjects made it difficult to standardize conditions, such as the time of the day in relationship to meals, but errors of 0.5 kg or more were probably rare.

RESULTS

In Table II will be found the mean and standard deviations of the ages, heights, and initial body weights of the 50 subjects.

Changes in Body Weight

The "Marchers:" Examination of the weight charts of the subjects in this group shows that their body weights responded to the different phases of the expedition in a similar and consistent manner, permitting the following generalizations: (1) During the intervals between marches there occurred either a check in the rate of loss of weight or an actual regaining of weight. (2) While on the march there was a loss of weight or a decrease in the previous rate of gain. (3) During the period immediately following the end of the expedition there was a rapid regaining of weight.

TABLE II

Mean and Standard Deviations of the Ages, Heights, and Initial Body Weights of the 50 Subjects

	Mean	Stnd. Dev.
Age	18.1 years	0.7
Initial body weight	64.0 kg	6.6
Height	177 cm	6.0

Figure 1 shows an actual weight chart which illustrates these points, and in Table III may be found the frequency of different rates of weight change in relation to the number of marches. It will be seen that the most frequent rates of weight change were losses of 0.1 and 0.2 kg a day.

Whether a "marcher" had an over-all gain or loss of weight during the expedition depended largely on the total number of days he spent marching. Of those who were out for more than half of the six weeks, 10 out of 15 lost weight, the mean loss being 1.3 kg and the maximum 5.0 kg. The remaining 13 subjects, who were out for less than half the time, had

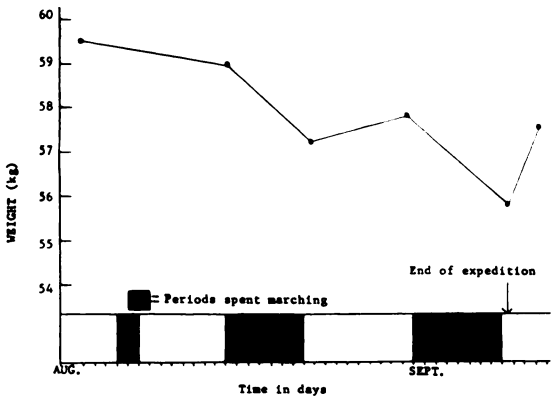

Fig. 1. The body weight chart of a "marcher," demonstrating typical fluctuations during the expedition.

TABLE III

Frequency of Different Rates of Weight Change in Relation to Number of Marches (Total of 41 Marches by 28 Boys)

No. marches	Weight change (kg/day)
1	+0.2
1	+0.1
7	0.0
13	−0.1
12	−0.2
6	−0.3
1	−0.4

a mean gain of 1.4 kg, and only one lost weight.

The "Surveyors:" The body weights of the subjects in this group showed only minor fluctuations, and the majority finished the expedition at the same weight as they started; in contrast, the two boys confined to base camp finished 4.0 kg and 2.5 kg heavier than their initial weight.

Rate of Regaining Weight: Unfortunately it was possible to follow up the weights for only two days after the end of the expedition. During this short time, when virtually unlimited food was available, a rapid and universal increase in weight was demonstrated. The "marchers" regained a mean of 1.7 kg and the "surveyors" a mean of 1.2 kg; 12 boys, of whom 9 had been "marchers," regained as much as 2.5–3.0 kg.

DISCUSSION

The 50 subjects of this investigation were all volunteers selected by an interviewing committee from 350 applicants and were drawn for the most part from British public and grammar schools.

It will be shown in another paper that their physiques or somatotypes differed from those of a control group of public-school boys. The "explorers" had a significantly lower rating in endomorphy and a higher one in ectomorphy (Sheldon's classification[8]); it is very unlikely that this difference was due to a bias on the part of the selection committee. Such an expedition seems, therefore, to have a particular appeal for the leaner members of the schoolboy community. Hehir[3] noted that during the siege of Kuts loss of weight was maximal in those who began the siege with a superabundance of fat. It is probable, therefore, that any weight losses recorded for our predominantly ectomorphic subjects were minimal and might well have been greater if the group had not differed from the general population in respect to physique.

From the information provided by Passmore and Durnin[6] in their review of the literature pertaining to human energy expenditure, it can be deduced that a man carrying a load of 21 kg at a speed of 5 km an hour over a smooth surface expends energy at a rate of about 5 cal/min. In view of the very rough surface of the block lava and boulders, the "marchers" probably exceeded this figure, their energy expenditure being comparable to such heavy tasks as drilling coal (5.8 cal/min) and sawing softwood (6.3 cal/min). The work expended by a subject during a march must, therefore, be rated as high, for in addition to carrying a heavy pack across country for up to seven hours a day, there were the everyday chores of life to perform, such as pitching camp, fetching water, and cooking. The importance of this "nonoccupational" type of activity in influencing calorie requirements has been pointed out by the Food and Agricultural Committee of the United Nations;[2] this committee also estimated the calorie intake of youths in a normal state of health and activity to be 3,800 cal/day. Widdowson, Edholm, and McCance[9] showed that the energy expenditure of cadets at a military establishment was about 3,420 cal/day and that, contrary to expectation, the cadets were not leading lives of intense activity, much of the day being devoted to sedentary occupations.

It might therefore be anticipated that our subjects would lose weight while marching on an intake of about 3,640 cal/day, and in fact a loss of between 0.1 and 0.2 kg/day was demonstrated for the majority. It can be deduced from information provided by Morgulis,[5] about a group of fasters, that the initial rate of weight loss in complete starvation is

about 0.9 kg/day. Thus the rate of loss of weight of the "marchers" was not excessive, but it does nonetheless provide a clear indication that the daily calorie intake was insufficient for their energy demands. Further support for this conclusion is provided by the fact that, after an initial latent period, the majority of "marchers" became very hungry and remained so for the rest of the expedition.

It is possible that a small proportion of the body weight loss occurring while on the march was due to a temporary state of dehydration, which only slowly corrected itself on return to base camp and consequently influenced the readings. However, there was no "clinical" evidence to support this, and ample fluids were usually readily available.

The 20 subjects in the survey group seemed to find the rations more satisfying than the "marchers," and it has already been noted that their body weights did not alter appreciably throughout the expedition.

Although the maintenance of a steady body weight by adults may be taken to indicate that they are receiving an adequate calorie intake, no such assumption can be made for a group of youths who are still close in time to the adolescent growth spurt and have recently exchanged a relatively sedentary life for one of hard work and exertion. It must be suspected that if the rations had been entirely adequate for the needs of the "surveyors," a trend to gain weight, such as Rosenbaum[7] demonstrated for British army recruits following "call-up," would have occurred; no such trend was discernible.

The conclusion that the mean daily intake of 3,670 calories was not quite sufficient for the subjects in this group is supported by the behavior of their body weights at the end of the expedition, for Benedict *et al.*[1] showed that a rapid regaining of weight occurs at the termination of a period of reduced diet.

In view of the above findings the Society implemented a scheme to provide an increased ration scale for the 1957 expedition.

SUMMARY

The opportunity was taken during an expedition to central Iceland to record at frequent intervals the body weights of the 50 schoolboy members. These subjects could be divided into two groups: 28 "marchers" who worked hard but intermittently, and 20 "surveyors" whose task was less strenuous but more continuous.

The ration scale provided an intake of about 3,640 cal/day for all the subjects; at base camp the rations were occasionally supplemented to increase the over-all mean intake to about 3,670 cal/day.

The majority of subjects lost weight while out on a march; the most frequent rates of loss were 0.1 and 0.2 kg/day. Only minor fluctuations occurred in the body weights of the "surveyors."

It is concluded that the ration scale was inadequate for the "marchers" and of doubtful adequacy for the "surveyors."

ACKNOWLEDGMENT

I am very grateful to Dr. H. B. Jones for his assistance in the field work and to Dr. H. E. Lewis and Dr. J. Tanner for their helpful suggestions and continued interest in the investigation. My particular thanks are due to all members of the expedition for their cheerful cooperation.

Deepfield, Old Green Lane
Camberley, Surrey, England

REFERENCES

1. Benedict, F. G., Miles, W. R., Roth, P., and Smith, H. M.: Human vitality and efficiency under prolonged restricted diet. *Carnegie Inst. Wash. Publ.* 280: 229, 1919.

2. Food and Agricultural Committee of the United Nations: Calorie requirements. *FAO Nutrition Studies* 5: 26, 1950.

3. Hehir, P.: Effects of chronic starvation in the siege of Kuts. *Brit. M. J.* 1: 865, 1922.

4. McCance, R. A. and Widdowson, E. M.: The chemical composition of foods. *Med. Research Council (Brit.), Spec. Rep. Ser.* 235: 1946.

5. Morgulis, S.: *Fasting and Undernutrition.* Dutton, New York, 1923, p. 90.

6. Passmore, R. and Durnin, J. V. G. A.: Human

energy expenditure. *Physiol. Rev.* 35: 801, 1955.

7. ROSENBAUM, S.: Heights and weights of the army intake, 1951. *J. Roy. Statist. Soc., Series A* 117: III, 346, 1954.
8. SHELDON, W. H., STEVENS, S. S., and TUCKER, W. B.: *The Varieties of Human Physique.* Harper, New York, 1940.
9. WIDDOWSON, E. M., EDHOLM, O. G., and MCCANCE, R. A.: The food intake and energy expenditure of cadets in training. *Brit. J. Nutrition* 8: 147, 1954.