ROYAL MARINE TRAINING - ENERGY REQUIREMENTS AND NUTRITIONAL INTAKES

Surgeon Commander D. C. C. Alexander, A. J. Allsopp, J. Wright,
Dr. R. J. Pethybridge and Dr. Douglas J. Smith
Institute of Naval Medicine
Alverstoke, Gosport, Hampshire, PO12 2DL, UK

INTRODUCTION

Throughout the 1980's it had become apparent that a very high incidence of injuries and infections amongst Royal Marine (RM) recruits was a major contribution to training losses, demonstrated by much back-trooping and discharge. The Institute of Naval Medicine (INM) was tasked to investigate the causes of these losses and where possible to produce solutions so that unnecessary wastage could be avoided. A series of multi-disciplinary studies commenced in 1988 to look at many aspects of recruit life. The aim of the nutritional studies was to determine both the energy and nutrient intake, and the energy and nutrient requirement of recruits undergoing the physically demanding 30 week course.

In 1981, INM provided a theoretical estimation of energy expenditure determined through study of the physical activity as outlined in the course programme (1). The average daily energy expenditure was estimated to be 4200 Kcals. A major increase over the Ration Scale Allowance (2900 Kcals net) was recommended on this basis, but a more detailed study was required of the feeding habits of recruits before full implementation of this increase could be achieved.

METHODS

The study was performed in three parts:

Study 1 - Intake from the Dining Hall. Accurate intake was determined by a 'double-plated weighed meals inventory' method on one troop of (initially) 46 recruits on three occasions during training (weeks 5, 19 and 28/29), chosen to be representative of the whole course. Subjects also completed a check list for additional items such as bread, butter, etc. Items eaten were separated into basic menu items which were then weighed to determine all intake, (i.e. original plate minus wastage, bones, fact, etc. left on the second plate). The net weight, together with items from the check lists were then coded for nutritional analysis on an individual basis using the UK National Nutrient Databank (Royal Society of Chemistry and MIFF). Where necessary recipes were obtained from the catering staff. During one 24 hour period (three meals), aliquots of food from the whole troop were collected, homogenized and analyzed directly for total nutrient content.

Study 2 - Snacking. Foods and beverages obtained from non-service sources were believed to play a major role in the recruit's diet. In order to quantify the degree of snacking, details of all eating and drinking occasions were recorded by the same subjects as in Study 1 in a diary-questionnaire. This data provided a detailed description of the product, including size or volume, the amount if any discarded, the place of purchase and the time of consumption.

Study 3 - Vitamin status. Bloods were collected for the analysis of vitamin status on entry (week 1) and toward the end of each of the three weeks in which Studies 1 & 2 were conducted. Aliquots of whole blood and centrifuged plasma were prepared and sent to Switzerland for analysis by Hoffmann LaRoche, Basel.

Study 4 - Energy Expenditure. The O^{18}, H^2 double labeled water technique was used to assess energy expenditure over a period of 2 weeks, on three occasions, commencing on the first days of Studies 1 & 2.

Study 5 - Anthropometry. Anthropometric measures of height, body weight and % body fat from skin-fold thickness (2) were conducted in weeks 1, 4, 12, 18, and 26.

RESULTS

Intake from the Dining Hall. Energy provided by food eaten in the dining hall was estimated to be an average per recruit per day of 2530 Kcals in week five, 2760 Kcals in week nineteen and 2710 Kcals in week 28/29). From the raw data it was possible to deduce patterns of attendance for means amongst the troop. In week five 84%, in week nineteen 87%, and week 28/29 only 65% of all possible means were attended. Attendance rates at breakfast were consistently lower than for the other two meals. Some 40% of energy was supplied by fat and 49% by carbohydrate. Protein and fibre intakes were some 94 and 28 gms per man per day, respectively. Snacking. Diary-questionnaires (completed in week 5) of 14 subjects were randomly selected for early analysis. Intakes of foods and beverages from non-Service sources amounted to an average of 2175 Kcals per man per day. The average reported weekly personal expenditure on these foodstuffs for all subjects was £23.00 in week 5 and £19.10 in week 28/29. Total Energy Intake. Amalgamation of dining hall intakes with non-Service intakes amounts to 4845 Kcals per man per day, of which only 55% is derived from Service (dining hall) foods, while the remainder is purchased privately. Energy Expenditure. The majority of the urine samples collected in this study remain to be analyzed. However, an initial, crude assessment of 8 subjects in week 5 gave a mean expenditure of 400K Kcals (S.D. 1250). Although further analysis is required, this is in line with the values in Studies 1 plus 2. Changes in Body Weight. Total body weight increased insignificantly from week 1 (69.1 kg) to week 26 (72.4 kg), whereas % fat fell from an initial mean level of 12.2% to 10.2% in week 12, before increasing again to 12.7% at week 26. Vitamin status. Mean values of all the vitamins measured with the exception of folate were within the normal range throughout the study. Folate levels appeared to fall throughout the course.

DISCUSSION

The RM recruit has been shown to derive a maximum of 2760 Kcals from dining hall food. This figure is close to the Ration Scale target. Foods and beverages purchased privately boosted total energy intake by 81% to 4845 Kcals per man per day for the 14 subjects whose diary-questionnaires were analyzed. From a survey of expenditure for the whole troop the snacking performed by this sub-group appears to be representative of the whole troop at the two occasions surveyed. Assessments of energy expenditure lend support to a figure of over 4000 Kcals.

The anthropometric study showed that against a background intake of 4845 Kcals there is no increase in body fat, but that there is a 4% increase in fat free mass (taken to be muscle) in the first 12 weeks of training. It is reasonable to assume therefore that the total average intake of 4845 Kcals is an equilibrium value between actual intake and actual expenditure.

The intake of fat from the dining hall is a little on the high side, but further analysis of the diary data is required to estimate the overall contribution of fat and carbohydrate to energy supply.

CONCLUSIONS AND RECOMMENDATIONS

Modification to current feeding practices is required to allow a greater energy intake to be derived. Since the final meal is presently served at 1700 it is little surprise that young men, still growing and pursuing a physically strenuous programme of work consume large quantities of foods and beverages in the late evening. This fact alone indicates a severe need for an additional meal at about that time. However it would be imprudent nutritionally to make-up all the energy shortfall in one single episode. If more food was to be available at the current 3 meals, and dining hall attendance rates were to increase, a further increase in intake would be brought about so long as the training programme allowed adequate time for digestion and absorption. The time interval between meals is great and thus provision of a mid-morning and mid -afternoon snack could be a simple method of providing an additional 300-400 Kcals per occasion.

There is yet insufficient evidence that the overall composition of the diet is deleterious to performance. In considering the composition of the diet, and in particular the additional snack-meals required, attention should be paid to increasing the overall proportion of energy derived from complex carbohydrates and decreasing that derived from fat. A high carbohydrate diet is important to ensure that muscle glycogen stores are replenished after periods of intense exercise.

The production of high carbohydrate diets which will, inevitably, be of low energy density can only be brought about by high volumes of foods. Thus recruits will need to be allowed additional time to eat the greater quantities involved. In the formulation of such diets care needs to be taken to avoid enriching the carbohydrate with fat to increase both its energy supply and its palatability. If the meals provided in the evening were to be the high carbohydrate ones, sufficient time throughout the night would allow glycogen repletion. To ensure the diet is palatable, providing 55% of total energy from carbohydrates and 30% from fat would appear a reasonable goal.

A report on these finding has very recently been sent to the Royal Marines who are now assessing, with us, the most effective method of implementing these recommendations within their current supply, manpower and finance limitations.

REFERENCES

1. INM Letter 610/9 dated 20 July 1981.
2. Durnin, J.V. G.A. and Wormesley, J. Body fat assessed from total body density and its estimation from skinfold thickness: Measurements on 481 men and women aged from 16 to 72 years. Brit J. Nutr., 32: 77, 1974.