THE FOOD INTAKE, ACTIVITY PATTERN AND ENERGY EXPENDITURE OF MALE INDIAN STUDENTS*

J. BOOYENS AND VALERIE M. DE WAAL, *Department of Physiology, University College, Durban*

A great deal of evidence exists in support of the view that a sedentary way of life manifests itself in over-nutrition with accompanying obesity, which in turn is associated with a rising death rate from degenerative vascular and metabolic diseases.[1] In South Africa, where the death rate from degenerative vascular disease has assumed epidemic proportions in the White population,[2] it is surprising that with the exception of a study by Wyndham *et al.*[3] on the 24-hour metabolism of medical students at the University of the Witwatersrand, no studies have been conducted to assess the relationship between food intake, energy expenditure and activity pattern for any other sections of the South African population. As a step in this direction, a study was made of the food intake and energy expenditure over a 1-week period of 11 Indian male 3rd-year university students.

METHODS

Eleven final-year male students acted as subjects. Information about their age, height and weight is given in Table I. Before the commencement of the experimental period the students were instructed in the techniques of recording food and liquid intake and in keeping a record of their minute-to-minute activities. Care was taken to ensure that all the subjects were well versed in these techniques before the experimental period was begun.

Food Intake

Each subject weighed and recorded every item of food eaten and all liquids consumed during a period of 7 consecutive days. Hanson dietetic scales, accurate to 1 G, were used by all the subjects. From the total values obtained, the average daily intake of calories, protein, fat, carbohydrate, calcium, iron, vitamin A, thiamine, riboflavin, niacin and vitamin C was calculated for each subject, using the National Nutrition Research Institute's tables on the composition of Indian foods.

TABLE I. AGE, HEIGHT AND WEIGHT OF SUBJECTS

Subject	*Age (yrs)*	*Height (in.)*	*Weight (lb.)*
Y.K.	22	69	135
C.S.	25	68	176
O.I.A.	21	67·5	117
M.S.M.	22	75	208
J.V.M.	24	65·5	124
S.A.K.	23	66·5	109
A.E.	23	64	109
M.I.K.	23	70	135
S.S.	22	68	116
S.U.	22	68	116
D.M.C.	23	67·5	153
Average	22·7	68·1	136·2

Activity Pattern

Printed sheets, similar to those which are described by Durnin and Passmore,[4] were used by the subjects to record the activities they undertook on a minute-to-minute basis for the entire 7-day experimental period during which their food intake was measured. The total time spent on the various activities was calculated by each subject at the end

*Date received: 3 October 1968.

TABLE II. AVERAGE DAILY CALORIE AND NUTRIENT INTAKE AND MEASURED ENERGY EXPENDITURE OF SUBJECTS AND RELATIVE VALUES OF RECOMMENDED ALLOWANCES

Subject	*Calories*		*Protein*	*Fat*	*CHO*	*Ca*	*Fe*	*Vit. A*	*Thia-mine*	*Ribo-flavin*	*Niacin*	*Vit. C*
	Expend.	*Intake*	*G*	*G*	*G*	*mg.*	*mg.*	*IU*	*mg.*	*mg.*	*mg.*	*mg.*
Y.K.	2,486	2,236	54	68	373	573	10·35	3,351	2·54	1·29	7·85	139·1
C.S.	2,178	1,785	57	64	100	754	10·38	2,395	·69	1·68	9·19	26·1
O.I.A.	2,458	2,556	43	85	302	439	10·81	3,423	·99	1·11	9·95	10·5
M.S.M.	2,249	1,856	123	69	239	781	12·13	2,584	3·20	1·54	10·47	21·5
J.V.M.	2,103	1,285	43	45	192	432	9·89	1,819	1·08	·99	4·33	28·3
S.A.K.	2,548	1,857	61	76	230	347	9·98	2,832	1·14	1·56	8·62	43·6
A.E.	2,401	2,002	60	66	298	548	13·05	4,335	·86	1·09	10·21	64·2
M.I.K.	2,746	2,294	60	70	344	648	29·41	2,603	1·23	1·48	12·34	95·3
S.S.	2,143	2,807	70	56	237	473	10·53	2,237	·75	2·46	14·29	29·3
S.U.	2,172	2,244	73	85	320	1,099	16·66	5,786	1·19	2·73	12·40	32·2
D.M.C.	3,024	1,547	61	55	204	651	11·69	4,198	·69	1·65	12·90	72·2
Average	2,357	2,043	64	122	415	613	13·00	3,233	1·00	1·00	10·00	51·0
Recommended allowance*		3,000	65			700	9·0	4,000	1·0	1·6	15	40
†		2,750	80			800	12·0	5,000	1·1	1·6	11	20

*Recommendation of National Nutrition Board.[5]
†Recommendation of Medical Research Council (Davidson and Passmore).[6]

of each day. From values for the entire 7-day period the average time spent daily on the various activities was calculated for each subject.

Energy Expenditure

This was determined for each of the activities recorded by the subjects. At least 2 expired air samples were obtained from each subject over an accurately timed period using a Douglas bag, rubber mouthpiece and nose-clip. Samples of the expired air were collected in rubber bags for oxygen extraction analysis. A Servomex oxygen analyser, which was calibrated daily by using pure nitrogen and atmospheric air, was used for the oxygen extraction measurements. The minute volume of expired air was measured by using a standard dry-gas meter. All expired air volumes were corrected to standard temperature and pressure. For the calculation of calorie expenditure an energy equivalent of 4·825 kcal./litre of oxygen consumed was assumed. In addition to the actual measurement of the energy expenditure for the individual subjects on the various activities, their energy expenditures were also calculated by using the average values for energy expenditure on various activities which are given by Durnin and Passmore.[4] This was done in order to assess the accuracy of calculated energy expenditure.

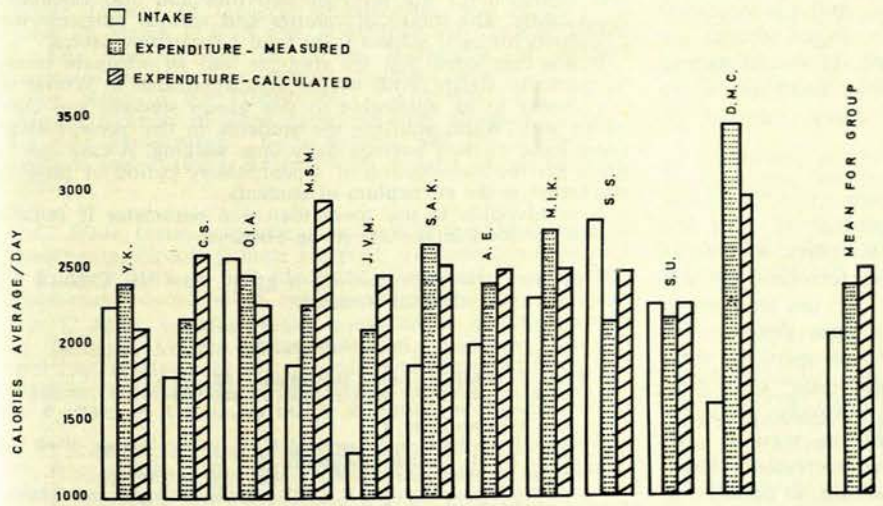

Fig. 1. A comparison between the average daily calorie intake and estimated and calculated calorie expenditure.

RESULTS AND DISCUSSION

Food Intake

Table II gives the average calculated intake of calories, protein, fat, carbohydrate, calcium, iron, vitamin A, thiamine, riboflavin, niacin and vitamin C for the individual subjects. This table also gives the daily recommended intake values for these nutrients according to the recommendation of both the South African National Nutrition Board[5] and the Medical Research Council,[6] as applied to moderately active men and men doing light work, respectively, for a body-weight of 160 lb. With the exception of vitamin C, the average nutrient intakes recorded were slightly lower than the recommended allowance values, but, when it is taken into consideration that the average body-weight of the students was only 131 lb. as compared with the 160 lb. of the reference man, and also that the values which have been adopted in the recommended allowances leave a wide safety margin, it would appear that the intake of the nutrients studied was sufficiently high.

As far as the intake of carbohydrate and fat is concerned, it is recommended that carbohydrate should supply 55 - 65% of the total calories of the diet.[6] The subjects in this study had an average daily total carbohydrate consumption of 415 G, which would give them a value for calories derivated from carbohydrate which falls within the recommended range.

It has been pointed out that the pattern of fat consumption appears to be peculiar to a population; for instance, in Japan 8%, in Spain 22% and in the USA 41% of the

TABLE III. AVERAGE PERCENTAGE OF TIME SPENT DAILY AT VARIOUS ACTIVITIES, MEASURED CALORIE COST AT THESE ACTIVITIES AND TOTAL AVERAGE DAILY ENERGY EXPENDITURES

	Sleeping and lying		*Sitting relaxed*		*Sitting occupied*		*Standing occupied*		*Walking own pace*		*Washing and dressing*		*Climbing stairs*		*Recreation*		*Total energy expenditure*	
Subject	*Time %*	*Cal. cost kcal./ min.*	*Time %*	*Cal. cost kcal./ min.*	*Time %*	*Cal. cost kcal./ min.*	*Time %*	*Cal. cost kcal./ min.*	*Time %*	*Cal. cost kcal./ min.*	*Time %*	*Cal. cost kcal./ min.*	*Time %*	*Cal. cost kcal./ min.*	*Time %*	*Cal. cost kcal./ min.*	*Est.*	*Calculated**
Y.K.	39·2	592	11·9	258	25·4	569	9·4	243	11·4	705	2·7	117	—	—	—	—	2,484	2,109
C.S.	54·8	855	3·3	65	27·4	605	2·8	83	10·0	456	1·4	80	0·1	10	0·2	21	2,175	2,591
O.I.A.	39·1	544	21·0	456	11·4	262	10·8	277	14·1	744	1·3	62	—	—	2·3	110	2,455	2,253
M.S.M.	33·4	521	15·3	269	27·2	570	9·4	238	11·3	528	2·8	77	—	—	0·6	43	2,246	2,830
J.V.M.	31·9	460	18·6	293	18·5	399	12·2	227	13·1	548	3·4	70	2·2	99	0·1	6	2,102	2,425
S.A.K.	30·2	373	5·5	89	33·6	788	11·8	289	14·9	700	1·9	92	—	—	2·1	224	2,555	2,516
A.E.	31·1	448	7·2	133	33·9	732	4·4	102	17·3	684	4·5	162	1·6	138	—	—	2,399	2,471
M.I.K.	36·0	550	12·9	249	19·9	416	2·7	61	23·1	1,308	4·9	110	0·4	42	0·1	9	2,745	2,486
S.S.	36·6	551	19·2	321	23·0	398	10·3	210	9·7	420	0·8	22	—	—	0·4	18	1,940	2,489
S.U.	30·3	381	8·3	160	39·0	784	12·5	271	7·6	494	1·7	38	0·6	42	—	—	2,170	2,253
D.M.C.	40·8	651	8·6	182	22·0	627	2·0	64	25·2	1,419	1·3	62	0·1	8	—	—	3,013	2,972
Average	36·7	538·7	12·0	225	25·6	559·1	8·0	187·7	14·3	727·8	2·4	81·1	0·5	30·8	0·5	39·2	2,389	2,490

*From the energy expenditure values given by Durnin and Passmore.[6]

total dietary calories are derived from fat.[6] In the present group studied, the average daily fat consumption was found to be 122 G, which is within the expected limits when it is taken into consideration that Indians commonly cook in oil or ghee.

The average daily calorie intake amounted to 2,043 kcal. The intake values for the individuals were, with the exception of 2 instances, lower than the values obtained for energy expenditure (Fig. 1). In one subject, D.M.C., a calorie intake value of nearly 1,500 kcal./day less than the value for energy expenditure was recorded over the 7-day period. This subject had, in fact, reduced by 2 lb. during the experimental period. Without exception, the subjects found that they were more 'conscious' of their food intake and dietary habits during the experimental period; this appeared to have caused an involuntary reduction in their food intake. This phenomenon has been reported repeatedly. Wyndham *et al.*[3] reported differences in excess of 1,000 kcal./day between calorie intake and expenditure in 2 of their 9 subjects.

It is a familiar observation that the daily calorie intake does not necessarily follow the daily expenditure pattern, but for persons in thermal equilibrium the energy expenditure should balance the intake over a period of one week.[4,7,8] These observations emphasize the possible inaccuracies liable to arise when the food intake is measured over too short a period, or when body-weight records are kept for an insufficient length of time. It would appear that in order to obtain reliable values of food intake for an individual, the expenditure of energy should be measured concurrently.

Activity Pattern and Energy Expenditure

Table III shows the average percentage of time the subjects spent on their various daily activities, as well as the average daily energy cost of these activities. As was the case in the study of Wyndham *et al.*,[3] the students in the present study spent most of their time sleeping and sitting, i.e. 75·3% of their total time was spent in these sedentary pursuits. Only 8% of their time was spent standing at a laboratory bench and relatively negligible percentages of their time were spent on washing and dressing, climbing stairs and on active recreation. However, they spent 14·3% of their time walking, in contrast to the 8% reported by Wyndham *et al.*[3] Walking constituted the greatest energy cost; 31% of the total energy expenditure was on this activity. Two reasons probably contributed to the relatively large energy cost of walking for this group: the University does not lie within easy access of public transport, which necessitates walking, and, further, probably fewer students in this group have private cars than those studied by Wyndham *et al.*[3] They pointed out that the students they studied spent a more sedentary life than clerks in the Fife coalfields. They made out a strong case in favour of introducing a compulsory daily period of physical education into a curriculum that is overburdened with teaching. The same holds true for the students in the present study. From Table III it can be seen that 4 of the 11 students did not take part in any active physical recreation whatsoever and that only 0·5% of their average daily time was spent by the group in physical recreation, which represented only 1·7% of their total average energy expenditure. We can, therefore, also urge that active physical recreation for students be encouraged, as it has now been well established that a minimum daily period of physical activity of a fairly strenuous nature is a prerequisite for the combating of obesity and cardiovascular diseases.[1]

SUMMARY

The food intake and activity patterns were recorded for 11 male Indian students over a 7-day period. Energy expenditure was estimated for the recorded activities and also calculated from tables. The intake of calories and various nutrients was calculated for each subject from food composition tables.

It was concluded that the students had an adequate intake of nutrients. Height/body-weight data applicable to Whites do not appear to be applicable to this group studied, and compared with White students the students in the present study spent more of their average daily time walking. A case can be made for the introduction of a compulsory period of physical recreation in the curriculum of students.

It is advisable to use more than one parameter if reliable values for food intake are to be obtained.

This work was supported by a grant from the Council for Scientific and Industrial Research.

REFERENCES

1. Mayer, J. (1968): J. Amer. Diet. Assoc., **52**, 13.
2. Coetzee, A. M. (1967): S. Afr. Med. J., **41**, 1229.
3. Wyndham, C. H., Walker, S. E. and Morrison, J. F. (1964): S. Afr. J. Lab. Clin. Med., **10**, 1.
4. Durnin, J. G. V. A. and Passmore, R. E. (1967): *Energy, Work and Leisure*, 1st ed. London: Heinemann.
5. National Nutrition Board (1956): S. Afr. Med. J., **30**, 108.
6. Davidson, S. and Passmore, R. (1963): *Human Nutrition and Dietetics*, 2nd ed. Edinburgh: E. & S. Livingstone.
7. Edholm, O. G., Fletcher, J. G., Widdowson, E. M. and McCance, R. A. (1955): Brit. J. Nutr., **9**, 286.
8. Edholm, O. G. (1961): Proc. Nutr. Soc., **20**, 71.