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Daily energy intake, energy expenditure and activity patterns of selected Malaysian sportsmen

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ABSTRACT

Seventeen members of the national sepaktakraw squad undergoing centralised training participated in a comprehensive study to determine their daily food intake, activity patterns and energy requirements. Food intake was recorded as a mean of 3-days weighed food intake and the nutrient contents were calculated using a local food composition table. The energy cost of standardised activities was determined by indirect calorimetry while time and motion study was used to estimate the daily energy expenditure of each subject. The mean daily energy intake was 2784±373 kcal (11.6±1.6 MJ) while the mean daily energy expenditure was 3004±298 kcal (12.6±1.2 MJ), with a negative energy balance of 220 kcal ((0.9 MJ). Intake of other nutrients were adequate when compared with the Malaysian RDA, with the exception of niacin. The results of the activity pattern study indicated that the subjects spent about 80% of the day doing light activities while 20% of the day was devoted to their training programme comprising of moderate to heavy activities. This data set represents the first of its kind in Malaysia and should provide impetus for further research in this area which would help establish dietary guidelines for Malaysian sportsmen.

INTRODUCTION

Provision of sufficient nutrients and energy to meet metabolic needs for optimal functioning of the body constitutes what one refers to as a ‘nutritionally-adequate’ diet. In the development and maintenance of top physical performance, diet plays a vital role, a fact recognised long before nutrition became a science of its own. Despite intense interest and effort in research related to optimal performance, the dietary regime to support such achievements requires a level of nutrition knowledge and practice that may not be present (Nowak & Knudsen, 1988). Nutritionists have often been confronted with questions such as (1) Does participation in physical activity affect nutrient requirements? and (2) Can manipulation of diet potentiate physical performance? Current belief is that neither the questions nor the answers are as straightforward as in the past (Barr, 1987). Factors affecting requirements for and availability of nutrients include physical and nutritional status, age, and genetic make-up of individuals. These are further compounded by man’s ability to adapt according to his needs, thus making effective analysis of the relationship of diet to optimal performance much more difficult than it has been envisaged (Ismail, 1988).

Although sports development has gained momentum in Malaysia in recent years, little is known of the nutritional well-being of national sportsmen. The purpose of this study was to (a) assess nutritional adequacy of diets during training as compared to the current Recommended Dietary Allowance (RDA) for Malaysia, (Teoh, 1975), and (b) to provide the much needed baseline data on dietary intake and energy requirements that may be used as a guideline for similar sporting activities. It should be mentioned that the data presented here form part of a bigger project aimed at assessing the overall nutritional status of national sportsmen.

SUBJECTS AND METHODS

Subjects

Twenty-two members of the national sepaktakraw squad aged 20-28 years were recruited for the study. Only 17 subjects met the requirements of the experimental protocol which was carried out during a 10-day centralised training session at the Kampung Pandan Sports Centre, Kuala Lumpur. A trained nutritionist stayed with the national squad throughout the study period.

Methods

Anthropometry

The height and body weight of subjects (barefoot and in light clothing) were measured to the nearest 0.5cm and 0.1kg respectively, using the Seca weighing balance with attachment for measuring height. Skinfold thickness measurements were taken using the Harpenden Calipers (British Indicators, UK) at 4 sites as recommended by Durnin and Rahaman (1967). Fat content as a percentage of body weight, was calculated from the sum of 4 measurements of skinfold thickness (Durnin & Womersley, 1974). The body mass index (kg/m^2) and lean body mass (kg) were also calculated for each subject.

Food Intake

Subjects were instructed on the procedures involved in recording food intake. A 3-day weighed food intake data was compiled by providing a dietary scale (Kubota model, 1kg ± 5g) on each table at the dining room and a nutritionist was in attendance during meal times to assist the subjects. All food was provided by a caterer and subjects did not have access to other foods. The nutrient composition of the meals was calculated using a local food composition table (Tee *et al*, 1988) and reported as a mean of 3 days' food intake. To assess adequacy in nutrient intake, the results obtained were compared with the Malaysian RDA (Teoh, 1975).

Activity Pattern

Subjects were instructed to accurately fill the diary card in order to provide, as detailed as possible, information on their daily activity patterns (Durnin & Passmore, 1967). Day time activities were constantly monitored by a trained nutritionist, and subjects were individually questioned in cases where irregularities in recording were encountered. Their activities were classified broadly into three categories: light, moderate and heavy. A 3-days' activity record was compiled for each subject on similar days when their food intake was measured. The activity pattern data were reported as a mean of 3-days' activity records.

Energy Expenditure

The energy cost of some standardised activities was measured by indirect calorimetry using the Douglas bag technique. The energy cost (kcal/min) was calculated using the Weir formula (1949). The detailed protocol is similar to that reported in earlier studies (Ismail & Chi, 1987; Ismail & Zawiah, 1988a). The limited time available during the centralised training does not permit us to measure all subjects and thus, only five subjects with closely - matched body weights (mean 64.9 kg) were studied. The values obtained were used to calculate the energy expenditure for the group, since it matches well with the reference value for men (65.0 kg). The energy cost of activities that was not measured was derived from the table suggested by Durnin and Passmore (1967). The total daily energy expenditure (TDEE) was calculated by summing up the energy cost for each activity (adjusted for body weight) multiplied by the mean duration of that activity for each subject. The energy balance was determined from the mean of 3-days' energy intake minus the mean of 3-days' energy expenditure.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS-PC+) computer programme. Results are presented as mean $\pm$ SD and range.

RESULTS

The physical characteristics of the subjects are shown in Table 1. Out of the 17 subjects studied, only 2 subjects weighed less than 60.0 kg while the range indicated (53.0 and 74.6 kg) were the two extreme body weight recorded in this study. Their body mass index (kg/m^2) ranged from 18.8-24.9, body fat from 9.2-18.7% and lean body mass from 46.6-6 1.0 kg.

The results of nutrient intake as compared to the Malaysian RDA are shown in Table 2. Based on mean values for the group the intake of nutrients other than calories was adequate. The results also revealed that the percentage contribution of protein, fat and carbohydrate to energy intake was 13%, 25% and 62% respectively. It is also worth noting that the diets provided were rich in iron, vitamin A and vitamin C.

Table 1. Physical characteristics of subjects

Parameters	Mean (n=17)	SD	Range
Age (yr)	23.9	2.4	20-28
Weight (kg)	64.7	4.9	53.0-74.6
Height (m)	1.73	0.05	1.65-1.80
BMI (kg/m^2)	21.6	1.6	18.8-24.9
Body Fat * (%)	15.2	2.8	9.2-18.7
LBM (kg)	54.8	3.4	46.6-61.0

* 4 sites only (Durnin and Rahaman, 1967)

Table 2. Mean daily nutrient intakes of subjects

Nutrients	Mean (n=17)	SD	Range	RDA*	%RDA*	%<RDA*
Energy (kcal)	2784	373	2347-3731	3510**	79	94(16)
Protein (g)	94.0	13.7	73.5-119.8	65**	145	0
Fat (g)	78.4	12.0	56.2-100.7	-	-	-
Carbohydrate (g)	426	73	317-619	-	-	-
Calcium (mg)	713	146	432-955	450	158	6(1)
Iron (mg)	31.0	6.4	21.9-43.6	9	344	0
Vitamin A/RE (μg)	2023	580	1340-3374	750	270	0
Thiamine (mg)	1.5	0.3	1.1-2.2	1.0	150	0
Riboflavin (mg)	2.5	0.6	1.7-4.0	1.5	167	0
Niacin Equiv. (mg)	19.5	4.9	9.7-27.0	16.7	117	35 (6)
Vitamin C (mg)	100	60	20-240	30	333	6(1)

* RDA Malaysia (Teoh, 1975)

** Adjusted for body weight (65 kg). Energy - 54 kcal/kg, Protein - 1.0 gm/kg. Values in parentheses indicate number of subjects.

The time spent on various daily activities during the centralized training period is shown in Table 3. The mean time spent in light activities such as sleeping, sitting activities, standing inactive, walking and personal necessities accounted for 1160 minutes (approximately 19 hours) or 80% of the day, while moderate to heavy activities related to training accounted for about 5 hours (280 minutes) or 20% of the daily activities.

The energy costs (kcal/min) of the more common daily activities as measured using the Douglas bag techniques are shown in Table 4. The mean values obtained for lying, sitting, standing, praying, walking and going up and down the stairs were 0.94, 1.18, 1.41, 1.79, 2.93 and 4.18 kcal/min, respectively. For activities that were not measured, values were adopted from Durnin and Passmore (1967). The energy balance reported as a mean of 3-days' intake and expenditure is shown in Table 5. The results indicated a negative balance with energy expenditure exceeding intake by about 220 kcal (0.9 MJ).

Table 3. Mean daily activity pattern (min/day) of subjects

Activities	Mean (n = 17)	SD	Range
Lying/sleep	497 (345)*	54	387 - 633
Sitting activities	347 (24.0)	63	244 – 452
Standing (inactive)	93 **(6.5)**	23	52— 120
Walking (normal pace)	149 }	17	117— 171
	(10.8)		
Up & down Stairs	6 }	2	5-10
Praying	8 }	13	0-37
	(4.7)		
Personal Necessities	59 }	20	27-100
Moderate Exercises	105 (7.3)	5	100-110
Running	10. (0.7)	0	10
Jogging	54 (3.8)	15	40-70
Training	104 (7.2)	62	45-180
Weight Lifting	8 (0.5)	7	0-15

*Values in parentheses indicate % of day

Table 4. Energy cost (kcal/min) of common daily activities of subjects

Activities	n	Mean	SD	Range
Lying (inactive)	5	0.94	0.08	0.88-1.08
Sitting (inactive)	5	1.18	0.05	1.13-1.25
Standing (inactive)	5	1.41	0.06	1.35-1.50
Praying	5	1.79	0.07	1.71-1.88
Walking (normal pace)	5	2.93	0.14	2.79-3.11
Up & Down stairs	5	4.18	0.17	3.98-4.34

Note:
Values (kcal/min) adapted from Durnin and Passmore (1967) were as follows:
Personal necessities - 2.8 kcal, Training - 4.0 kcal. Moderate Exercises - 5.0 kcal.
Jogging - 5.0 kcal, Running - 7.0 kcal, weight lifting - 8.0 kcal.

Table 5. Energy balance (kcal/day) of subjects

	Energy Intake	Energy Expenditure	Energy Balance
Mean (n = 17)	2784 (11.6)	3004 (12.6)	- 220 (0.9)
SD	373 (1.6)	298 (1.2)	
Range	2347 – 3731 (9.8 - 15.6)	2603 – 3486 (10.9 - 14.6)	

Values in parentheses indicate MJ/day

DISCUSSION

Anthropometric data revealed that although the mean body mass index (BMI, kg/m^2) were within normal range, three subjects could be classified as lean, (BMI <20) while none were overweight that is, BMI >25.0 (Garrow, 1981). Body fat percentage measured at 4 sites recorded a mean value of 15.2% as compared to 16.5% using a similar technique in male university students who weighed much less (mean weight = 55 kg) and were non-athletes (Ismail & Zawiah, 1988a). The results obtained were within the range (5-38%) as reported by Durnin and Womersley (1974) in their study among 92 males, aged between 20-29 years with body weight ranging from 50-116 kg. It should be noted however, that regular training could modify body composition and hence BMI, largely by decreasing body fat (Parizkova, 1963).

As indicated in the footnote of Table 2, the values for energy and protein requirements were adjusted to provide a meaningful comparison since using the current recommendations (Teoh, 1975) would result in underestimating the requirements of the subjects. The suggested changes were consistent with increased physical activities of sportsmen as well as to allow for their heavier body weights averaging 65.0 kg, as compared to 55.0 kg (moderate activity) stipulated in the current recommendations (Teoh, 1975). It should be noted, however, that although the mean energy intake indicated 79% adequacy, 16 (94%) out of the 17 subjects studied recorded a mean energy intake below the RDA.

The other limiting nutrient observed was niacin in which the diet of 6 subjects did not meet the RDA. The role of niacin, as a control agent that aids in converting protein to glucose and oxidises glucose to release controlled energy (William, 1982), makes it an important component in the diet of sportsmen. Supplementation is necessary only if the diet is unbalanced, however, judging from the overall results, the deficiency was probably due to inadequate intake of food sources rich in niacin by some subjects during the centralised training period. It was also interesting to note that the percentage contribution of protein, fat and carbohydrate to total energy intake of the subjects corresponds well to healthy eating guidelines of 10-15% for protein, 25-30% for fat and 60-70% for carbohydrates.

The activity patterns of subjects during centralised training revealed distinct differences as compared to other studies involving students, laboratory assistants, and clerks having predominantly sedentary lifestyles with moderate activity constituting only 1-2% of their daily activity patterns (Ismail & Zawiah, 1988a, 1988b). The need to monitor nutrient requirements of sportsmen to cope with the extra work load is fully justified, and that variations in requirements for various sports are expected.

The energy costs (kcal/min) of the various daily activities were consistently higher when compared to the findings in earlier studies on adult Malaysians (Ismail & Zawiah, 1988b) and this was primarily due to the sportsmen's greater body weight. It was also interesting to note that the results were consistent with previously reported studies in Singapore (Saha *et al*, 1985; Banerjee & Saha, 1970) and in Thailand (Thongpraset & Chaivatsagool, 1985) indicating that energy costs at rest and at work in the tropics are lower than those reported in temperate climates (Passmore & Durnin, 1955). Further studies are needed to confirm these findings, since recommendation on energy requirements are based on data derived from daily energy expenditure studies. The results of this study also suggest that our sportsmen need not follow the high caloric recommendations meant for their foreign counterparts, as their physiological needs differ.

It is beyond the scope of this paper to discuss the sportsmen's physical performance in relation to dietary intake since their performance was not studied. Nonetheless, it is quite wrong to assume that subjects whose average intake were below estimated average requirements are actually in negative energy balance. The FAO/WHO/UNU report (1985) has emphasized that individuals adapt, within limits, to low-energy intake levels. This adaptation process occurs at a cost of reduced discretionary activity and, ultimately, lower work capacity. The only way to overcome this problem is to ensure that athletes nutritional requirements are met adequately. Any deficiency will inevitably lead to failure in sustaining optimum performance, a key factor to success in top-level competitions.

CONCLUSIONS

The results of this study suggested that there is a need to increase energy intake to match energy requirements. The introduction of energy-dense diets may help to reduce bulkiness which is common in Asian diets. Supplementation may not be necessary since the additional nutrients required will be present in the extra food eaten to meet energy needs, consistent with increased physical activities. It should also be stressed at this stage that nutritional conditioning, like physical conditioning is a continuous quest and that nutritionists/dietitians have a role to play in educating sportsmen on the importance of eating for training and the need for a sensible approach in preparing themselves for competitions. It is also highly recommended that more research be initiated to validate these initial findings and to help establish dietary guidelines for Malaysian sportsmen.

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