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A Study on Assessment of Physical Activity in Workers

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Abstract

In this study, we calculated physical activity scores, according to the time spent and energy expenditure in daily life.

The subjects were 290 volunteers who were 53 students of the University, and 237 workers. Examinations were made twice at an interval of about 6 months in a test-retest examination.

Physical activity scores were calculated from the life activity index of the "Japanese Nutritive Requirement"[1]. The amount of energy expenditure was calculated from the time spent, and base metabolism during activity of each subject.

The physical activity scores obtained in the test and retest examinations showed a high correlation ($r=0.86$), confirming our recently developed questionnaire's ability to yield reproducible results. Our results show no sex difference in energy expenditure and Japanese Nutritive Requirement. Therefore, the method of calculation of energy expended per day (according to physical activity score) is highly objective and great deal of confidence can be placed in it.

Introduction

It is important for each individual to know the exact amount of daily physical activity in order to maintain a healthy life. Also, it is extremely important to improve one's dietary habit and to have an appropriate amount of daily exercise.

Until recently, the amount of daily physical activity has been studied in the field of preventive medicine for protection from geriatric disease which is thought to be caused by a lack of physical activity.

As a result, it has been reported that a certain amount of daily physical activity is suggestible, especially for protection from chronic diseases, which include high-blood pressure, myocardial infarction and arrhythmia[2-5].

Originally, the measurement of energy of the human was made by the calculation of heat energy as the direct calorimetry, and also by the calculation of expiration gas metabolism as the indirect calorimetry. Yet both of these are basic experiments which have been done only indoors. In our country, an experiment which requires a long period of time, such as the calculation of amount of energy expenditure in a day, has been carried out by combining the results from time examination, basic metabolism examination and Relative Metabolic Rate (RMR) examination. In other countries, these daily energy experiments have been done with a combination of metabolic rate (METS) and

time examination. Two reports suggested that the METS method is suitable for the prescription of movement, however, it is not suitable for the evaluation of the daily energy expenditure[6,7]. Since the RMR method requires that the subjects be restricted for long time, much effort and a long period of time for the data processing, a new, simpler method is desired. A prominent correlation between the heart rate and oxygen uptake was demonstrated by Astrand *et al.*[8] and Asmussen *et al.*[9] Using this relationship Yamamoto *et al.*[10] and Tsubouchi *et al.*[11] showed that an effective correlation existed between the accepted values of RMR and those obtained by energy expenditure.

Wessel *et al.*[12], Reiff *et al.*[13] and Taylor *et al.*[14] have developed a method which involved taking daily energy expenditures calculated from the answers in the questionnaires. However, since the contents of the questionnaire and method used in interviews differed among the subjects, standardization of the examination method and contents is expected.

In this study, we interviewed the subjects in order to investigate the time spent on daily life activities. We attempted to clarify daily energy expenditure in order to calculate the physical activity score from these times.

Method

The subjects were 290 volunteers. Table 1 shows their average age and their occupations; there were 53 students and 237 workers.

From the check-up examination, it was made clear that none of the subjects had any disease that would limit their physical activity. The same examinations were conducted twice with an interval of about 6 months. In order to run the examination smoothly, we explained the contents of the examination in detail to all the subjects a week before.

Table 2 shows the contents of the questionnaires. This table list the 21 activities which were considered to constitute the time spent in a day. The right side column of this table shows each of the living activities. These 21 living activities were classified according to their intensity, as one of 8 types (A 1-A 8) as follows:
A 1 (No. 1, 60), A 2 (No. 11, 15, 23, 24, 35, 36, 40), A 3 (No. 12, 31, 34), A 4 (No. 13, 21, 22, 51), A 5 (No. 52), A 6 (No. 14, 53), A 7 (No. 32), A 8 (No. 33). We also calculated the sum of the time expenditures (T 1-T 8) for each type of living activity. With reference to mean relative metabolic rate (RMR), for each of the 8 classifications, the following

Table 1. The number of the subject according to occupations and mean age.

	N	Age			N	Age	
Male		Mean	S. D.	Female		Mean	S. D.
Office Worker	14	29.9	6.1	Office Worker	24	29.2	8.0
Managerial Class	24	51.0	9.7	Housewife	18	42.6	10.1
Research Worker	9	38.0	4.3	Student	16	21.3	2.4
Clinician	15	33.5	5.8	Assistant of Nurse	23	42.9	10.9
Technician	13	25.3	4.3	Nurse	49	25.4	4.9
Roentogenologist	13	28.5	4.5	Obstetrical Nurse	9	26.6	2.6
Engineer	8	24.6	6.3	Roentogenologist	9	25.0	2.6
Student	37	24.1	3.3	Cook	9	21.3	1.0

Table 2. The items of activity per day.

Division of life	Contents of Activities	No.
Sleep	Sleep	01
	Sitting	11
	Standing	12
Work	Walking	13
	Heavy Muscle work	14
	Driving Cars	15
	on foot	21
	by Bicycle	22
Commuting	by Car or Motorcycle	23
	by Bus or Train	24
	Care of Oneself	31
	House Keeping	32
Home	Care of Children or Others Bath	33
	Bath	34
	TV, Reading, Conversation	35
	Amusements	36
Meal	Including Tea or Drinking	40
Exercise	Light (Walking, Gardening)	51
	Moderate (Golf, Baseball)	52
	Vigorous (Jogging, Swimming)	53
Rest	Lying in Bed or on the Floor	60

scores (S 1-S 8) were assigned: S 1=0.0, S 2=0.3, S 4=1.4, S 5=1.8, S 6=3.1, S 7=0.7, S 8=1.1.

Physical activity scores were calculated according to the following equation: Physical activity score= (S×T)/60.

The daily energy expenditure (EN) of individual was calculated according to the following equations:

E 1=(Physical Activity Score/[(1440−T 1/60]+1.2)×(1440−T 1)×BW×BM

E 2=1.2×rest time (No. 60)×BW×BM/60

E 3=0.9×sleeping time (No. 1)×BW×BM/60

EN=E 1+E 2+E 3

BW: body weight (kg), BM: basal metabolism (kcal/kg/min)

Results

The physical activity score obtained in this examination showed a high correlation between test and retest (R=0.86), comfirming our recently developed questonnaire's ability to yield reproducible results. Figure 1 shows physical activity scores according to their occupations, and Figure 2 shows kilocalories of energy used in a day.

The occupation which indicated the highest rate of the physical activity score and the energy expenditure was the engineer (14.4 points, 2641 Kcal) for males, and the cook for females (20.9 points, 2322 Kcal). In this examination, the female cook showed the highest

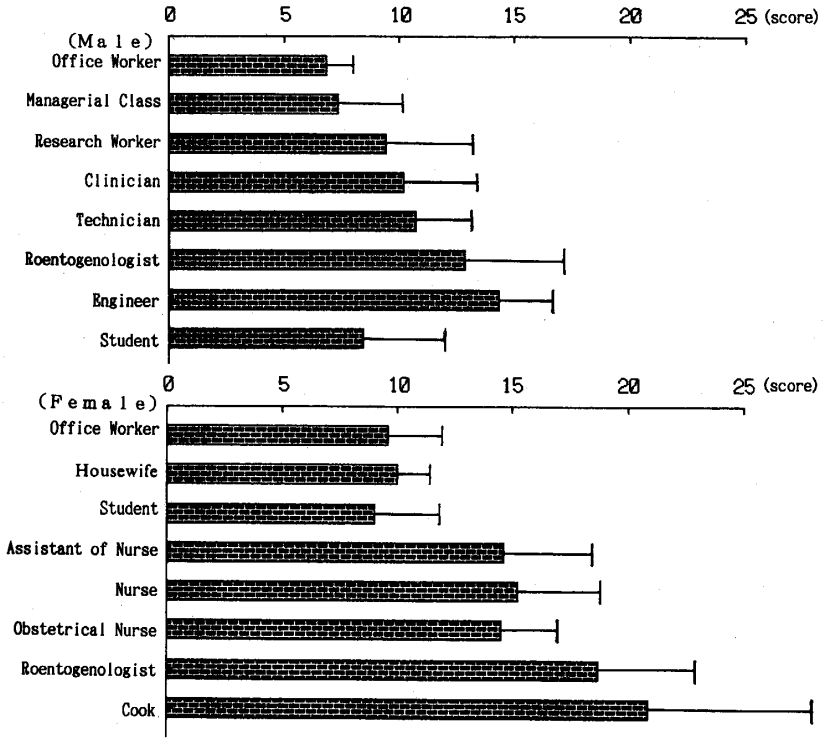

Fig. 1 The physical activity score of the subjects according to the classification of their occupations.

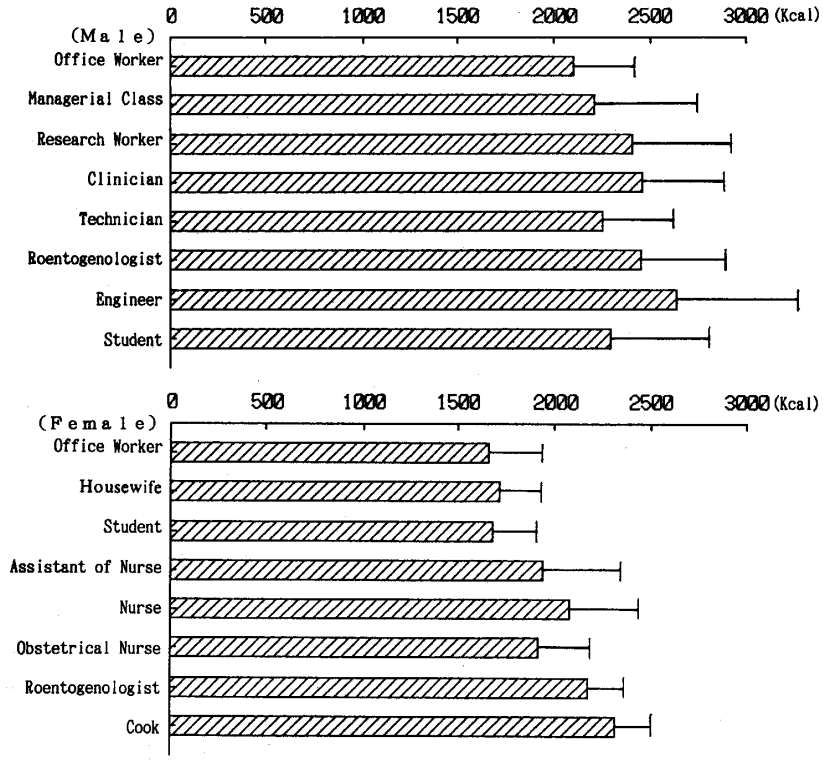

Fig. 2 The energy expended per day of the subjects according to the classification of their occupations.

Table 3. The correlation of energy expended per day and individual requirement which were obtained from "Japanese Nutritive Requirement".

	N	Energy Expended (Kcal±S.D.)	Requirment (Kcal±S.D.)	Correlation Coefficient
Male	133	2311±445	2259±219	0.589**
Female	157	1886±358	1915±247	0.699**
Total	290	2081±452	2073±290	0.731**

** $P<0.01$

physical activity among all occupations. While the occupations which scored the lowest in the physical activity score and energy expenditure were office worker (6.8 points, 2103 kcal), and the manager class (7.3 points, 2212 kcal) for males, and the student (9.0 points, 1684 kcal) and office worker (9.6 points, 1660 kcal) for females. Therefore, for both males and females, the office worker was recognized to be among the lowest in daily physical activity rate.

For male occupations, the engineer and the office worker showed the largest differences in physical activity score and energy expenditure (7.6 points, 538 kcal respectively). For females the differences between the cook and the student were 11.3 points and 662 kcal respectively. The findings show that the differences among females' occupations were much larger than that those in the males'.

Table 3 shows the relationship between energy expended in a day and the individual energy requirement from the "Japanese Nutritive Requirement". The Japanese male's nutritive requirement is 2259±219 kcal, and 1915±247 kcal for females. The results which we acquired from our examination seemed to show an appropriate distribution. They were, 2311±442 kcal for males and 1866±358 kcal for females. The Japanese Nutritive Requirement shows the approximate amount of energy gained from caloric intake. The calculation based on the physical activity score indicates the actual energy consumption. The insignificant difference between energy expenditure and Japanese Nutritive Requirement[1] revealed that the physical activities of the subjects in this experiment were at the standard level for Japanese.

Discussion

The Japanese Nutritive Requirement[1], the guideline for health and health education, has established widely used standards for the intensity of daily physical activity. There are the following four divisions: 1) light 2) moderate 3) slightly heavy 4) heavy. These divisions are important for the following reasons: 1) the calculation of the energy requirement is based on them. 2) they are required in order to determine the nutrient requirements (such as vitamins and protein) of the individual. 3) they are required to determine the level of physical activity to maintain and improve health. The methods used to obtain the daily physical activity divisions were based on interviews and include the following; 1) the subject was shown the four divisions of physical activity and instructed to select the one they felt applied to them. 2) the subject was questioned regarding their occupation and physical activities at work. 3) the subjects were questioned regarding the duration of physical activity and their lifestyles in general. If the interviewer was very familiar with the type of lifestyle and work activity of the subject it was possible to decide

on a daily physical activity division using the second method above in conjunction with a shorter supplimentary interview. If the subject was a member of the general population or a visitor to the hospital or athletic clubs then method three above was considered proper.

This study is concerned with the appropriateness of attempting to calculate the score of the physical activity from the life activity times. It is necessary to clearly indicate the range of values for each intensity level. Furthermore, these ranges of values appear to be related to the physiological index of heart rates, Tsubochi *et al.*[11]

The physical activity score obtained from the daily physical activity shows the different quantities of occupation-related physical activites. In this study the physical activity scores by occupation showed a higher value for females than for males. However, the energy expenditure of the males exceeds that of the females. The reason for this is the following. The calculation of energy expenditure in this study is founded on the basic metabolism. The body surface area, based on height and weight, is used to determine the basal metabolism. The higher body surface area of the male more then offsets the higher physical activity score of the female. Therefore daily energy expenditure is more related to the physical elements than to the quantity and type of activity.

The values of daily energy expenditure calculated in this study are similar to the values in the Japanese Nutritive Requirement and those calculated with the RMR method from the division of intensity of daily physical activity. This ascertains the adequacy and reliability of our method. The calculations of physical activity scores for a variety of occupations in this study may be used for the development of movement therapy and the prevention of adult disease. Two tasks remain. The divisions of the physical activity score must be widely applied and a food consumption questionnaire must be used to examine energy uptake. When these tasks are completed it may be possible to use the physical activity score as an index to maintain health.

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