Status of physical activity in the Japanese population

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Abstract Physical activity surveillance at a population level is important. The National Health and Nutrition Survey of Japan has been carried out annually, and two kinds of assessments for physical activity are included in the survey: total step counts per day, measured by a pedometer, and questions on exercise habits. From peak values seen in 1998 - 2000, time trends display a decline of age-adjusted mean steps per day, and the average percentage of regular exercisers has increased only in the age group of 50 years old or higher. As for standard or target values of physical activity, the Dietary Reference Intakes (DRIs) for Japanese presents standard values of physical activity levels (total energy expenditure divided by basal metabolic rate) for each gender and age group. The moderate value of physical activity level for adults is 1.75. Furthermore, the Exercise and Physical Activity Guide for Health Promotion 2006 (Exercise Guide 2006) was released based on the "Exercise and Physical Activity Reference for Health Promotion 2006" (EPAR2006). The reference values were set as 23 MET-hours/week for physical activity and 4 MET-hours/week for exercise. The former value is equivalent to 8000 to 10000 daily steps. Thus, Japan has established target values for physical activity and exercise habits, and daily steps have been investigated in the Japanese population. However, the target or standard values of physical activity are not sufficiently linked to the nationwide surveillance of actual levels of physical activity. Therefore, development of physical activity evaluation methods for Japanese is necessary.

Keywords : National Health and Nutrition Survey of Japan, Dietary Reference Intakes for Japanese, Exercise Guide 2006, physical activity surveillance, accelerometer, pedometer

Introduction

Physical activity (PA) surveillance at a population level is important in the field of public health, as it provides the basic information for the planning, implementation, and evaluation of public health practices. PA is defined as any bodily movement, produced by skeletal muscles, resulting in energy expenditure (EE) above the resting level¹⁾. PA consists of exercise and non-exercise PA, also termed non-exercise activity thermogenesis (NEAT)²⁾. The value of NEAT is usually much larger than that of exercise-induced EE, and varies substantially between individuals. Regarding intensity, PA can be classified into moderate-to-vigorous (MVPA), and lower intensity (sleep, sedentary behavior, or light PA)³⁻⁵⁾.

Results of the National Health and Nutrition Survey of Japan

Physical activity. The National Nutrition Survey has been conducted annually in Japan since 1945 by the Ministry of Health, continuing as the Ministry of Health, Labour and Welfare since 2001⁶⁾. At first, the survey was

carried out in the Tokyo Metropolitan area under the direction of the Allied Forces. It dictated the collection of fundamental information for health promotion, mainly from the viewpoint of lifestyle, from the Japanese population. Based on the Health Promotion Law, which replaced the Nutrition Improvement Law in 2003, the survey has been changed and expanded to the National Health and Nutrition Survey of Japan (NHNS-J). In the annual survey, target populations are selected from the entire national population aged 1 year and over by stratified random sampling; approximately 6000 households in 300 areas are randomly selected from enumerated districts based on the population census. The main components of data collection are household dietary surveys, individual physical examinations (e.g. anthropometry, blood testing), and questionnaires on the lifestyle habits of the households' individuals.

Two kinds of assessments for PA are included in the NHNS-J: total step counts per day, measured by a pedometer, and questions on exercise habits. Total step counts are an index of MVPA in adults⁷⁾ and in children⁸⁾, and have been monitored since 1989.

According to the NHNS-J in 2010⁹⁾, Japanese men took 7174 ± 4685 (mean $\pm$ SD) steps per day and women took 6176 ± 3728 steps per day (Table 1); men took more steps

per day than women across all age groups¹⁰). Steps per day were lower in older age groups among men, whereas among women, the highest steps per day were seen in the 40- to 49-year-old age group. These average step counts are higher than those reported by the US nationwide survey, the National Health and Nutrition Examination Survey (NHANES)¹¹), but lower than those obtained from randomly selected samples in Australia¹²) and those from representative samples of the Belgian population¹³). From peak values seen in 1998 - 2000, time trends displayed a decline of age-adjusted mean steps per day (-529 steps per day among men and -857 steps per day among women) by 2007¹⁰). The time trends, with more recent data added, are shown in Fig. 1.

Data on exercise habits, however, display a different trend. In the NHNS-J, if a person exercises more than twice weekly, for 30 minutes or longer, over a 1-year period, that person is regarded as a regular exerciser⁶). The

percentage of the population considered regular exercisers according to the recent NHNS-J, broken down by age groups, is shown in Table 2; time trends from 1997 to 2010 are shown in Fig. 2⁹). The average percentage of regular exercisers has apparently increased; however, this increase was seen in the age group of 50 years old or higher, while the younger age groups have seen their percentage of regular exercisers decrease. The younger age groups average a lower percentage of regular exercisers than the older groups.

Physical activity level. The Recommended Dietary Allowance (RDA) in Japan was first established in 1970, and revisions have been made every 5 years by the Ministry of Health and Welfare. The seventh revision was entitled “Dietary Reference Intakes for Japanese (DRIs-J) 2005” by the Ministry of Health, Labour and Welfare, based on the Health Promotion Law. The current version

Table 1. Average daily steps in each gender and age category in 2010⁹).

Age	Men			Women		
	n	Mean steps $\pm$ SD		n	Mean steps $\pm$ SD	
Overall	3,290	7,174	$\pm$ 4,685	3,851	6,176	$\pm$ 3,728
20-29	274	8,322	$\pm$ 4,833	314	7,104	$\pm$ 4,075
30-39	474	8,278	$\pm$ 4,901	555	6,669	$\pm$ 3,361
40-49	488	7,873	$\pm$ 4,576	548	6,986	$\pm$ 3,414
50-59	520	7,684	$\pm$ 4,368	620	7,184	$\pm$ 3,624
60-69	705	7,092	$\pm$ 4,379	820	6,234	$\pm$ 3,612
70+	659	4,890	$\pm$ 4,362	824	3,872	$\pm$ 3,183
SD: Standard deviation						

A

B

Fig. 1 Time trends for mean steps per day by age groups among Japanese men (A) and Japanese women (B)⁹).

Table 2. Percentages of adults with regular exercise habits in each gender and age category in 2010⁹⁾.

	Men			Women	
Age	n	%		n	%
Overall	1,963	34.8		2,658	28.5
20-29	126	28.6		158	10.8
30-39	218	24.8		376	16.8
40-49	237	19.4		359	15.0
50-59	324	26.2		456	30.7
60-69	531	42.6		625	38.4
70+	527	45.0		684	35.7

A

B

Fig. 2 Time trends for percentages of regular exercisers by age groups among Japanese men (A) and Japanese women (B)⁹⁾.

is the DRIs-J 2010¹⁴⁾.

The DRIs-J presents estimated energy requirements (EER)¹⁵⁾, in addition to recommended intakes for 34 separate nutrients. The EER for an individual is defined as the average dietary energy intake that is necessary to maintain good health and body weight balance in a healthy adult of a defined age, gender, weight, height, and physical activity level (PAL). EER is calculated as the basal metabolic rate, multiplied by the PAL; the PAL is an index of the sum of every kind of PA, adjusted for the basal metabolic rate.

PAL values are determined by measured total energy expenditure, itself evaluated by the doubly labeled water (DLW) method. This method uses isotope oxygen-18 (¹⁸O), which is very expensive, and analyses of urine samples, which are rather delicate¹⁶⁾. This makes it difficult to use the DLW method in a large, randomized population sample. Therefore, 139 healthy Japanese men and women, aged 20 to 59 years, living in 4 districts of

Japan were investigated to obtain standard values for PAL in the Japanese population¹⁷⁾. The average value of PAL was near 1.75, with 1.60 and 1.90 corresponding to the 25th percentile and the 75th percentile, respectively. The representative value of 1.75 is comparable to those values obtained in the general populations of developed countries; and other studies among Japanese adults appear to support this value¹⁸⁻²¹⁾. There were no significant differences in PAL among age groups and genders¹⁷⁾, although Speakman and Westerterp reported small gender differences in 528 subjects who underwent PAL measurement in Maastricht, the Netherlands²²⁾. Regarding possible regional differences in PAL, Miyoshi et al used the dataset of the NHNS-J to ensure that the mean value of daily steps remained essentially constant across all types of residential areas, and was determined by the size of the municipality, when the data were analyzed for subjects aged 40–59 years²³⁾.

Prediction of levels of physical activity. The DRIs-J 2010 shows the typical time use (time spent in the activity) for each category of PAL. These values are based on a yet-to-be published study using the DLW method to determine PAL, and time spent in activities recorded by the National Institute of Health and Nutrition in Japan. The activity record used for this data is cumbersome; therefore, a validation study with development of a questionnaire for the prediction of PAL is necessary.

To date, two questionnaires, the International Physical Activity Questionnaire (IPAQ) and the Japan Arteriosclerosis Longitudinal Study Physical Activity Questionnaire (JALSPAQ), have been validated using the DLW method^{17,24} of measuring PAL in Japanese adults. The individuals in the highly active category, as assessed by IPAQ, showed significantly higher PAL values compared with the 2 categories of less active adults¹⁷. However, PAL values among the insufficient and sufficiently active categories were not significantly different. As assessed by JALSPAQ, the categories of moderate and vigorous PA, and PA during work (i.e. occupational tasks and housework), were related to PAL values²⁴. However, the PA components (i.e. PA domain and category of PA intensity) that differentiated sedentary from moderately active subjects were unclear. Thus, the prediction of PAL values in less active individuals needs improvement.

Exercise Guide 2006

In 2006, the Ministry of Health, Labour and Welfare in Japan systematically reviewed published cohort studies on the relationship between PA and the later occurrence of lifestyle-related diseases. The Ministry used this information to set reference values for PA, exercise, and physical fitness for Japanese individuals aged 20 - 69 years as the “Exercise and Physical Activity Reference for Health Promotion 2006” (EPAR2006)^{25,26}. The reference values used the concept of the metabolic equivalent (MET), and were set as 23 MET-hours/week for PA and 4 MET-hours/week for exercise. These are equivalent to 8000 to 10000 daily steps (PA), and 35 minutes of jogging or playing tennis, or 1 hour of brisk walking, every week (exercise). Based on the EPAR2006, the “Exercise and Physical Activity Guide for Health Promotion 2006 -To Prevent Lifestyle-related Diseases- (Exercise Guide 2006)” was established²⁷. Whilst EPAR2006 was prepared for exercise professionals, the Exercise Guide 2006 was developed for the general population of the nation, in order to help individuals increase their levels of exercise and PA for their own health promotion. This guide also addresses how to relieve metabolic syndrome, a topic not included in the EPAR2006.

Problems in evaluation of MVPA

One of the serious drawbacks with using the Exercise

Guide 2006 is that a standard evaluation method for PA is not presented; some researchers have, therefore, used the IPAQ. For example, using IPAQ, Shibata et al reported that only 26.6% of respondents met the recommended activity level of 23 MET-hours/week²⁸. Differing results are obtained when the evaluation is made using an accelerometer-based activity monitor; however, such results are variable and dependent upon the type of accelerometer. Murakami et al also reported that 47.8 % of Japanese adults met the PA requirement of 23 MET-hours/week, using a triaxial accelerometer for evaluation (Actimarker EW4800; Panasonic Electric Works, Osaka, Japan)²⁹, with an epoch length of 1 minute. This same study indicated that the reference value of 23 MET-hours/week corresponded to between 8500 and 10000 steps per day, while Oshima et al reported 6534 steps per day in men and 6119 steps per day in women, using the Active style Pro 350IT (Omron Healthcare, Kyoto, Japan)³⁰, and Kumahara et al reported 10652 steps per day, using the Lifecorder (Suzuken, Nagoya, Japan)³¹. It should be noted that none of these studies accounted for the time length of the bouts of exercise (for example, 10-minute activity bouts are defined as 10 or more consecutive minutes above the relevant threshold, with allowances for interruptions of 1 or 2 minutes below the threshold), because EPAR2006 does not refer to individual bouts of exercise. MVPA results, based on the overall activity duration per day and results modified for bouts of exercise, are substantially different³².

The reasons for the variability seen in the daily steps required to meet the activity threshold are due to differences in pedometer functioning, in statistical analyses used to obtain the values, and in the prediction algorithms for intensity of PA in the individual monitors. In particular, the algorithms for prediction of MET values are very different between accelerometers. In addition, many accelerometers, including those marketed by Japanese companies to adults³³ and children^{34,35}, use algorithms that underestimate non-locomotive PA³⁶, leading to underestimation of total energy expenditure (TEE)^{18,20,37-41}. Non-locomotive PA, such as household activity, should play a significant role in increasing PAL and TEE under free-living conditions⁴², and needs to be accurately evaluated in order to predict sedentary behavior and light intensity level of activity^{4,5}.

Recently, an activity monitor that can predict non-locomotive PA (with the exception of cycling and stair climbing), as well as locomotive PA, was developed⁴³⁻⁴⁵. Several researchers, including Oshima et al,³⁰ have used this monitor for activity evaluation⁴⁶⁻⁴⁸. Among these researchers, Tanaka and Tanaka indicated that the relative contributions of non-locomotive PA were different among differing occupations, and locomotor measurements alone might substantially underestimate the habitual PA in certain workers (e.g. licensed cooks and garbage collectors)⁴⁸. In general, the pedometer is a fairly good device

for the evaluation of MVPA, but careful interpretation of the data is needed.

Problems in surveillance of PA in Japan

As described above, Japan has established target values for PA and standard values of PAL, presented in the DRIs-J. The NHNS-J investigated exercise habits and daily steps in the Japanese population. A very important problem, however, is that the target or standard values of PA are not sufficiently linked to the nationwide surveillance of actual activity levels. The Health Japan 21 and Exercise Guide are currently being revised and will be enforced in 2013. Thus, such linkage is necessary to utilize such guidelines and results of the surveillance.

Another difficulty arises from the paucity of objective data, such as PAL and MVPA, for PA in children, especially in a large sample that can indicate PA in the population at large. To address this, the Tokyo Metropolitan Government performed a large-scale pedometer survey in 2011⁴⁹⁾ (Table 3). This may be the largest pedometer study performed by any national or local government. The results can be used as a reference for children in Japan, as the step count is a good indicator of MVPA in Japanese children⁵⁰⁾. Such surveys should be performed on a more regular basis in both adults and children.

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Table 3. Average daily steps for students in the Tokyo Metropolis, 2010⁴⁸⁾.

	Men			Women	
Age	n	%		n	%
Overall	1,963	34.8		2,658	28.5
20-29	126	28.6		158	10.8
30-39	218	24.8		376	16.8
40-49	237	19.4		359	15.0
50-59	324	26.2		456	30.7
60-69	531	42.6		625	38.4
70+	527	45.0		684	35.7

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