Original Article

Assessing physical activity in an Asian country: Low energy expenditure and exercise frequency among adults in Taiwan

Jackson Pui Man Wai PhD[1], Chi Pang Wen MD DrPH[2], Hui Ting Chan MS[2], Po Huang Chiang PhD [2], Min Kuang Tsai MS[2], Shan Pou Tsai PhD[3] and Hsing-Yi Chang DrPH[2]

[1]*Laboratory for Exercise Physiology Research, Institute of Sports Science, National Taiwan Sport University, Taoyuan, Taiwan.*
[2]*Center for Health Policy Research and Development, National Health Research Institutes, Miaoli, Taiwan*
[3]*Johns Hopkins School of Medicine, Baltimore, MD, USA*

Leisure-time physical activity (LTPA) has been closely related to health improvement. The under-appreciation for energy output by nutritionists stems in part from limited data expressed in caloric equivalent. We converted the frequency, duration, and intensity of LTPA, reported from 15,390 adults in the Taiwan National Health Interview Survey 2001, into kilocalories (kcal). Half of Taiwanese adults admit to no LTPA. Women, lower education or income, younger age, smokers and chewers of betel quid; exercised significantly less than their counterparts. Less than 1/5 (18.9%) of the population in Taiwan was physically active at ≥750 kcal/week, and only 1/7 (13.9%) reached a more desirable goal of ≥1,000 kcal/week, compared with 1/3 in the U.S. The most disconcerting finding was the Taiwan unique U-shaped prevalence for males, with the 25-44 age group being the least active, ≥65 age group being the most active; and S-shaped for females, lowest at age 18-24 years and highest at the two older groups (45-64 and ≥65 years). LTPA was under-appreciated, particularly among the most productive work force (25-44-year group), who exercised with a prevalence only 1/4 of their U.S. counterparts. Expressing LTPA in kcal makes direct comparison easier. Invoking a goal of ≥750 kcal/week for Asians, attainable by exercising 4 hours/week, can facilitate nutritionists in assessing LTPA adequacy. Currently, 4/5 of adults in Taiwan failed to reach this goal. Recognizing the concept of cumulative energy expenditure, in contrast to disciplined daily work for 5 or more days, will encourage the infrequent exercisers such as "weekend warriors" to continue with their activities.

Key Words: Exercise, Kilocalorie, Leisure-time physical activity, Prevalence

INTRODUCTION

Weight maintenance aims for reaching energy balance between energy intake and output. While nutritionists spend their career concerned about energy intake, the relative importance of energy output has been under-appreciated. Part of this has been the lack of exercise data expressed in caloric equivalent,[1,2] particularly among those who failed to meet the recommended exercise requirement. Not knowing the actual deficit in energy expenditure made their counseling on levels of needed exercise an educated guess. In this study we analyzed the national prevalence data on leisure-time physical activity (LTPA), and expressed them in caloric equivalent to facilitate energy balance calculation.

The importance of LTPA is highlighted in the U.S. Healthy People 2010, where it is listed as one of the ten leading health indicators. Healthy People is a national agenda for reducing the most significant preventable threats to health.[3] Although the overall benefits of physical activities have been well documented and such information accessible to the public, more specific LTPA-related health benefits identified in recent literature has received relatively little attention among Asians.[4] In Taiwan, adult physical activities have been dominated by spectator sports with national aspirations for Olympic gold medals or victories from major league players. While these competitive professional activities have been extremely popular and have provided the public the illusion of involvement in physical activity, they are no substitutes for daily LTPA at the grass roots levels. Preoccupied with the political agenda, the Taiwanese society has difficulty making national fitness a high priority among national agenda.

There are four categories of physical activity: occupation, transportation, housework (in and around home), and discretionary/leisure time.[5] LTPA is in the center of

Corresponding Author: Chi-Pang Wen, 35 Keyan Road, Zhunan, Miaoli County 350, National Health Research Institutes
Tel: 886-37-246-166 ext. 36318
Fax: 886-37-586-261
Email: cwengood@nhri.org.tw
Manuscript received 18 May 2007. Initial review completed 4 November 2007. Revision accepted 13 February 2008.

Table 1. MET* assignment varied by levels of breathing efforts

	MET* value			
	No Change in breathing	Slight increase in breathing	Significant increase in breathing	Out of Breath
1. Slow walking	2.5	3.3	3.8	3.8
2. Brisk walking/jogging/running	3.3	3.8	5.8	7.4
3. Rope jumping	4.0	8.0	10.0	12.0
4. Swimming	2.5	4.0	7.0	10.0
5. Calisthenics/Chinese shadow boxing/martial arts	2.5	3.8	3.8	3.8
6. Ball games	3.0	4.5	5.5	7.5
7. Aerobics	2.5	5.0	7.0	8.5
8. Chinese folk dancing/ballroom dancing	3.0	4.5	5.5	7.0
9. Bicycling	4.0	6.0	8.0	10.0
10. Hiking/mountain climbing	4.0	4.0	5.0	6.0
11. Weight training/resistance exercise	3.0	4.5	6.0	8.0
12. Stair climbing	4.0	5.0	6.5	8.0
13. Hula hoop	2.5	3.5	5.0	5.5
14. Others	3.0	4.5	6.0	8.0

*MET: Metabolic equivalent

attention because it requires conscientious efforts in everyday life and, as such, it has been most closely related to improved health outcome.[6-10] Most LTPA data reported have been expressed in frequency and time duration form, while the health advantages of LTPA were related, in addition, to intensity.[11-19] Without the intensity consideration, comparing differences in LTPA has been difficult and oftentimes misleading when based directly on frequency or duration. There could be as much as three- to four-folds differences between jogging and walking slowly in terms of energy consumption for the same frequency or duration.

Kilocalorie (kcal) in this paper is used as a summary index for quantifying LTPA, assimilating duration, frequency and intensity. It is a readily understandable yardstick, with its equivalent number seen in the food labeling and diet menus. Furthermore, expressing in kcal has a major advantage as it enables one to compare between individuals and between studies. Exercisers expending ≥1,000 kcal/week have been shown to reduce mortality rates.[6,11,13,20-23] This is achievable by brisk walking for 30 minutes a day, 5 days a week.[6] The U.S. Surgeon General has indicated such a goal for the American public.[6] This pragmatic goal is convertible with dietary intake, and yet, LTPA data for the nation as a whole or for the individuals has rarely been reported in the kcal form.[1,2] By converting nationally representative LTPA data in Taiwan into weekly energy expenditure form (kcal/week), we compared those meeting 750 kcal/week with those meeting conventional recommendations, 30 minutes a day on most days of the week (at least five days), as suggested by the Centers for Disease Control and Prevention (CDC)[24] and by the World Health Organization (WHO).[25] Considering the smaller body size of Asians, ≥750 kcal/week was used in stead of the ≥1,000 kcal/week.

MATERIALS AND METHODS

Sample Design

Physical activity data from the 2001 National Health Interview Survey in Taiwan (NHIS-TW) was analyzed. The survey selected a nationally representative sample from non-institutionalized 18-80-year old adults by using a stratified and multistage probability cluster sampling design. A total of 16,132 individuals were home-interviewed by trained staff with a success rate of 93.8%. Details on the method of sampling and study design have been published elsewhere.[26]

Leisure-Time Physical Activity Assessment

We divided age into four groups: 18-24; 25-44; 45-64; as well as 65 and above. They represented the young (post-high-school), the young adult, the older adult and the elderly. These classifications made interpretation of age-group comparison feasible and meaningful. Each subject was first asked as to whether they had engaged in any "leisure-time physical activity" in the past two weeks, such as jogging, shadow boxing or dancing. Those responded positively were then further asked to select up to 3 activities in the past two weeks, out of a list of 14 categories of LTPA, which included slow walking, brisk walking/ jogging/ running, rope jumping, swimming, calisthenics/ Chinese shadow boxing/ martial arts, ball games, aerobic dancing, folk dancing/ ballroom dancing, bicycling, hiking/ mountain climbing, weight training /resistance exercise, stair climbing, hula hoops, and others. Details for each of the three activities were enlisted, including frequency, duration and associated breathing efforts. Four levels of breathing efforts were available for selection: "no change in breathing", "slight increase in breathing", "significant increase in breathing" and "out of breath". We therefore made use of the perceived breathing level associated with each reported physical activity to estimate the pacing or the intensity of the exerciser (see next section). Some respondents who reported 'very limited' to either one of the following SF-36 physical functioning items: lift/carry groceries, climb one flight, squat, walk one block, or bathe/dress also reported unusually high perceived breathing levels while engaging in low effort physical activities. These respondents with abnormal physical function (n=696) were excluded from analysis for their exercise intensity were erroneously overestimated by using subjective self-reported perceived breathing levels.

However, there is a wide range of pacing within one category, for instance, the brisk walking/jogging/running

Table 2. Age-specific prevalence (%) of inactive (no LTPA), and active with LTPA for leisure-time physical activities in Taiwan.

Age	Number of subjects	Inactive (no LTPA) % (S.E.)	Active with LTPA (kcal/week) < 500 % (S.E.)	≥ 500 % (S.E.)	≥ 750 % (S.E.)	≥ 1000 % (S.E.)	≥ 2000 % (S.E.)	≥ 3000 % (S.E.)	Individual energy expenditure (kcal/week) Physically active Mean*	(S.E.)	Median	Active and inactive adults Mean**	(S.E.)	Median
Males†	**7,671**	**50.7 (0.6)**	**19.3 (0.5)**	**30.0 (0.5)**	**22.2 (0.5)**	**16.8 (0.4)**	**6.3 (0.3)**	**2.6 (0.2)**	**976**	**(15.8)**	**659**	**482**	**(9.6)**	**0**
18-24	1,279	38.3 (1.4)	24.8 (1.2)	36.9 (1.3)	27.2 (1.2)	20.3 (1.1)	8.0 (0.8)	3.4 (0.5)	976	(34.6)	650	602	(25.1)	251
25-44‡	3,365	58.0 (0.9)	20.6 (0.7)	21.4 (0.7)	14.8 (0.6)	10.3 (0.5)	3.3 (0.3)	1.0 (0.2)	754	(20.2)	513	316	(10.6)	0
45-64	2,122	51.1 (1.1)	15.8 (0.8)	33.1 (1.0)	24.7 (0.9)	18.8 (0.8)	7.2 (0.6)	3.1 (0.4)	1,080	(32.1)	764	528	(19.6)	0
≥ 65	905	39.8 (1.6)	15.0 (1.2)	45.2 (1.7)	37.1 (1.6)	31.1 (1.5)	12.9 (1.1)	6.3 (0.8)	1,356	(50.7)	1,015	816	(37.6)	366
Females†	**7,719**	**50.3 (0.6)**	**26.5 (0.5)**	**23.2 (0.5)**	**15.5 (0.4)**	**11.0 (0.4)**	**3.2 (0.2)**	**1.0 (0.1)**	**701**	**(12.2)**	**456**	**349**	**(7.2)**	**0**
18-24	1,254	51.9 (1.4)	32.9 (1.3)	15.2 (1.0)	8.5 (0.8)	5.8 (0.7)	1.5 (0.3)	0.4 (0.2)	492	(23.1)	318	237	(13.1)	0
25-44‡	3,458	53.3 (0.8)	29.9 (0.8)	16.8 (0.6)	10.2 (0.5)	6.8 (0.4)	1.7 (0.2)	0.5 (0.1)	549	(15.8)	341	257	(8.7)	0
45-64	2,242	46.9 (1.1)	19.7 (0.8)	33.3 (1.0)	24.4 (0.9)	17.7 (0.8)	5.5 (0.5)	1.8 (0.3)	940	(25.3)	650	499	(16.7)	123
≥ 65	765	43.9 (1.8)	20.4 (1.5)	35.7 (1.7)	24.8 (1.6)	18.7 (1.4)	5.1 (0.8)	1.8 (0.5)	907	(39.5)	653	508	(27.5)	191
Total	**15,390**	**50.5 (0.4)**	**22.9 (0.3)**	**26.6 (0.4)**	**18.9 (0.3)**	**13.9 (0.3)**	**4.7 (0.2)**	**1.8 (0.1)**	**838**	**(10.1)**	**544**	**415**	**(6.0)**	**0**
18-24	2,533	45.0 (1.0)	28.8 (0.9)	26.2 (0.9)	18.0 (0.8)	13.2 (0.7)	4.8 (0.4)	1.9 (0.3)	766	(22.9)	474	421	(14.7)	91
25-44‡	6,823	55.6 (0.6)	25.3 (0.5)	19.0 (0.5)	12.5 (0.4)	8.5 (0.3)	2.5 (0.2)	0.7 (0.1)	645	(12.8)	419	286	(6.9)	0
45-64	4,364	48.9 (0.8)	17.8 (0.6)	33.2 (0.7)	24.6 (0.7)	18.1 (0.6)	6.4 (0.4)	2.5 (0.2)	1,005	(20.2)	711	513	(12.8)	61
≥ 65	1,670	41.7 (1.2)	17.5 (0.9)	40.8 (1.2)	31.5 (1.1)	25.4 (1.1)	9.3 (0.7)	4.2 (0.5)	1,158	(34.0)	842	675	(24.3)	278

*: The mean value between physically active male and female was statistically significant. (p<0.05)
**: The mean value between our study group and total Taiwan adults was statistically significant. (p<0.05)
†: All of the prevalence between male and female was statistically significant excluding inactive groups. (p<0.05)
‡: All of the prevalence among different age groups compared with 25-44 age group was statistically significant excluding ≥2000 and ≥3000 age 18-24 female. (p<0.05)

Table 3. Prevalence (%) of leisure-time physical activities by selected demographic characteristics among adults in Taiwan

Selected **Characteristics**	**Number of subjects**	**Inactive (no LTPA)**	**Active with LTPA (kcal/week)**							
			< 750		**≥ 750**		**≥ 1000**		**≥ 2000**		**≥ 3000**	
		% (S.E.)	%	(S.E.)	%	(S.E.)	%	(S.E.)	%	(S.E.)	%	(S.E.)
Males												
Education (25-64 yrs)	**5,485**											
Junior and below	2,126	68.0 (1.0)	17.8	(0.8)	14.3	(0.8)	11.1	(0.7)	3.8	(0.4)	1.7	(0.3)
Senior/vocational	1,767	56.6* (1.2)	26.6*	(1.1)	16.8*	(0.9)	11.6	(0.8)	4.4	(0.5)	1.8	(0.3)
College and above	1,592	37.1* (1.2)	36.4*	(1.2)	26.5*	(1.1)	19.1*	(1.0)	6.7*	(0.6)	1.9	(0.3)
Income (NT$/year) (25-64 yrs)	**5,456**											
<240,000	1,448	62.0 (1.3)	20.3	(1.1)	17.7	(1.0)	14.2	(0.9)	5.5	(0.6)	2.1	(0.4)
240,000 – <480,000	1,941	62.0 (1.1)	24.0	(1.0)	14.1*	(0.8)	9.3*	(0.7)	3.1*	(0.4)	1.3	(0.3)
480,000 – <960,000	1,781	46.3* (1.2)	31.7*	(1.1)	22.0*	(1.0)	16.1	(0.9)	6.0	(0.6)	2.0	(0.3)
960,000	286	32.5* (2.8)	34.6*	(2.8)	32.9*	(2.8)	22.7*	(2.5)	6.3	(1.4)	2.1	(0.8)
Chewing status	**6,786**											
Non-chewer	5,329	45.0 (0.7)	29.6	(0.6)	25.4	(0.6)	19.4	(0.5)	7.0	(0.4)	2.9	(0.2)
Ex-chewer	336	58.6* (2.7)	26.8	(2.4)	14.6*	(1.9)	11.0*	(1.7)	3.9*	(1.1)	1.2*	(0.6)
Current chewer	1,121	72.2* (1.3)	17.0*	(1.1)	10.8*	(0.9)	7.9*	(0.8)	3.7*	(0.6)	1.2*	(0.3)
Smoking status	**7,658**											
Non-smoker	3,566	42.5 (0.8)	29.8	(0.8)	27.7	(0.7)	20.8	(0.7)	7.3	(0.4)	2.9	(0.3)
Ex-smoker	510	37.8 (2.1)	29.4	(2.0)	32.7	(2.1)	25.9*	(1.9)	11.8*	(1.4)	5.1*	(1.0)
Current smoker	3,582	60.5* (0.8)	24.1*	(0.7)	15.4*	(0.6)	11.4*	(0.5)	4.6*	(0.3)	1.8*	(0.2)
Females												
Education (25-64 yrs)	**5,696**											
Junior and below	2,694	56.8 (1.0)	26.5	(0.9)	16.7	(0.7)	11.8	(0.6)	3.7	(0.4)	1.3	(0.2)
Senior / vocational	1,769	49.0* (1.2)	37.0*	(1.1)	14.0	(0.8)	9.9	(0.7)	3.2	(0.4)	0.9	(0.2)
College and above	1,233	40.2* (1.4)	43.4*	(1.4)	16.4	(1.1)	11.1	(0.9)	2.4	(0.4)	0.6	(0.2)
Income (NT$/year) (25-64 yrs)	**5,660**											
<240,000	3,399	52.7 (0.9)	29.9	(0.8)	17.4	(0.6)	12.1	(0.6)	3.6	(0.3)	1.1	(0.2)
240,000–<480,000	1,520	52.0 (1.3)	36.9*	(1.2)	11.1*	(0.8)	7.8*	(0.7)	2.5	(0.4)	0.9	(0.2)
480,000–<960,000	670	39.3* (1.9)	41.9*	(1.9)	18.8	(1.5)	13.3	(1.3)	3.1	(0.7)	1.0	(0.4)
960,000	71	35.2* (5.7)	46.5*	(5.9)	18.3	(4.6)	12.7	(3.9)	5.6	(2.7)	2.8	(2.0)
Chewing status	**7,630**											
Non-chewer	7,517	49.9 (0.6)	34.3	(0.5)	15.8	(0.4)	11.2	(0.4)	3.2	(0.2)	1.0	(0.1)
Ex-chewer	10	60.0 (15.5)	40.0	(15.5)	0.0	-	0.0	-	0.0	-	0.0	-
Current chewer	103	71.8* (4.4)	23.3*	(4.2)	4.9*	(2.1)	4.9*	(2.1)	1.0*	(1.0)	0.0	-
Smoking status	**7,717**											
Non-smoker	7,360	49.9 (0.6)	34.4	(0.6)	15.7	(0.4)	11.1	(0.4)	3.2	(0.2)	1.0	(0.1)
Ex-smoker	34	52.9 (8.6)	29.4	(7.8)	17.6	(6.5)	17.6	(6.5)	8.8	(4.9)	—	
Current smoker	323	58.8* (2.7)	29.1	(2.5)	12.1	(1.8)	8.0	(1.5)	2.2	(0.8)	0.9	(0.5)

*: The prevalence within different groups (education, income, chewing status, smoking status) was statistically significant with regard to "junior and below", "<240,000", "none-chewer", "and non-smoker" as the reference group. (p<0.05)

category may include activities with paces that ranged from brisk walking (3.5 miles/hour or 5.6 km/hour) to jogging (5.7 miles/hour or 9.2 km/hour) to running (7.5 miles/hour or 12 km/hour); likewise, the ball games category may include the low-intensity golf ball game to moderate-intensity double-tennis to vigorous-intensity single-tennis or basketball matches.

Energy Expenditure Estimation

One metabolic equivalent (MET) has been defined as the energy expenditure expended during quiet sitting, which is 1.2 kcal/min for a 70-kg individual or 3.5 ml O_2 consumed per kilogram of body weight per minute. For each physical activity, a MET value was assigned according to the levels of perceived breathing efforts, as shown in Table 1. This table adopted the classification by Ainsworth et al.[27] with some modifications to reflect cultural differences, based on locally collected data.[28] For example, slow walk with "no change in breathing" or "slight increase in breathing" received an assignment of 2.5 and 3.3 MET, corresponding to Ainsworth's classification at speeds of 2.0 miles/hour (3.2 km/hour) and 3.0 miles/hour

(4.8 km/hour). Without specifying the types of ball games in the questionnaire, an average MET value was assigned to represent several commonly played ball games in Taiwan. For example, breathing level at 'no change' reflected participation in low energy activity like golf (3.0 MET) or bowling (3.0 MET); while at 'out of breath' involved the playing of racket ball (7.0 MET), badminton (7.0 MET), single tennis (8.0 MET), or basketball (8.0 MET). Leisure-time physical activity energy expenditure for a given individual was the sum of energy expenditure for each physical activity on a weekly basis (kcal/week), which was obtained by multiplying its MET [kcal/(hour·kg)] by weekly frequency (total number of sessions for the past two weeks divided by two), duration per session (in hour), and body weight (in kg). Time was given by the interviewee to the nearest minute. Weight was self-reported, and the validity of self-reported weight has been discussed elsewhere.[26]

Individual whose weekly LTPA energy level exceeded 6,000 kcal/week (n = 46) were excluded from this analysis. This is because, barring a reporting error, such an excessively high energy level was only possible when the energy expenditure came from work related activities or from a workout by professional athletes in training. Neither situation should have been included as LTPA. The final study sample included 15,390 subjects. Respondents with disabilities were excluded when abnormal physical function was indicated in SF-36 as "very limited" to lift/carry groceries, climb one flight, squat, walk one block, or bathe/dress." Beyond these overt disabilities, we did not exclude any other with known diseases, as we were developing national prevalence on ambulatory, non-institutionalized adult population.

The goal of being physically active at expending 750-kcal/week is based on the smaller body size of Asians, averaging a 60-kg person to participate in a moderate activity (e.g. 5-MET physical activity) for 5 sessions/week, with 30-minute/session.[24,29] The U.S. Surgeon General recommended a goal of 1,000 kcal/week, mainly for Caucasians, by stating that:[6] 'Based on these studies, it is reasonable to conclude that activity leading to an increase in daily expenditure of approximately 150 kilocalories/day (equivalent to about 1,000 kilocalories/week) is associated with substantial health benefits and that the activity does not need to be vigorous to achieve benefit.

"Weekend warrior" in this paper refers to those working people who do not do exercise during work days but engage in strenuous activities during weekend. To what extent these people, not having the discipline of daily exercise for 5 or more days a week, met the recommended goal has yet been assessed.[30]

Statistical Analysis

All analyses were carried out using SAS version 8.02.[31] Because the sample was nationally representative, the percentages calculated on Table 2 were national prevalence, using the formula $s.e. = \sqrt{p(1-p)/N}$ for standard error (S.E.). Test for difference was conducted under the assumption of binomial distribution. The prevalence of LTPA adds up to 100% by summing ["Inactive (No LTPA)", <500 and ≥500, under "Active with LTPA"].

RESULTS

Table 2 shows the age-specific LTPA prevalence of the inactive, minimally active (<500 kcal/week) and physically active (≥750 kcal/week), ≥1,000, ≥2,000 to ≥3,000 kcal for males, females and combined total. The corresponding proportion for the combined males and females was 50.5%, 22.9%, 18.9%, 13.9%, 4.7% and 1.8%, respectively. Three out of four adults in Taiwan (73.4%) were either inactive or minimally active, with slightly more females inactive (76.9%) than males (70.0%). Differences were tested between males and females. The difference for all age groups spending ≥750 kcal/week was 43% higher for males (22.2%) than females (15.5%), and for spending ≥1,000 kcal/week, 53% higher for males than females (16.8% versus 11.0%), both differences were statistically significant (p<0.05). For those active with LTPA, males spent 275 kcal (mean: 976 versus 701 kcal) or 203 kcal (median: 482 versus 349 kcal) more per week than females. The most sedentary age group was the 25-44-year group (80.9%=55.6%+25.3%), and the least inactive was the elderly at ≥65 years (59.2%=41.7%+ 17.5%). A large difference in this inactive group (21.7%) existed between the young adult and the elderly.

When the physically active group (expending ≥750 kcal/week in Figure 1 and ≥1,000 kcal/week in Figure 2) was plotted by their age distribution, males showed a U-shaped- and females showed a S-shaped distribution. The U-shaped male distribution was the result of the middle-aged adult age group, 25-44 years, which had the lowest (14.8%) and the oldest age group, ≥65 years, which had the highest (37.1%) LTPA energy expenditures. The S-shaped female distribution was because the youngest age group, 18-24 years, had the lowest (8.5%), and the two older adult groups, 45-64 and ≥65 years, had equally high LTPA energy expenditures (24.4% and 24.8%, respectively).

The median weekly energy expenditure for those physically active was 544 kcal, or 78 kcal/day, with 94 for males and 65 for females. Males spent 45% more energy than females. This energy spent increased with increasing age above age 25: from 73 to 145 kcal/day among males and from 49 to 93 kcal/day among females. The median expenditure for the entire population of Taiwan, combining the physically active and the inactive, was 0 kcal. This is because half of the population in Taiwan was physically inactive. Table 2 shows the prevalence of LTPA for selected demographic groups. Education and income were clearly related with LTPA energy levels. As education or income levels increased, so did the participation rate of LTPA levels. College-educated males were nearly twice as physically active (26.5%) as those with junior high (14.3%), and those making more than NT$960,000/year (32.9%) were nearly twice as high as those making less than NT$240,000/year (17.7%) or those making NT$240,000-480,000/year (14.1%). The reverse was true for the likelihood of being inactive, with 37.1% inactivity for college-educated males and 68.0% for junior high or below. The relationship between education and LTPA was much more clear-cut among males than among females.

Current chewers of betel quid had the least LTPA (10.8%) at ≥750 kcal/week level, when compared with

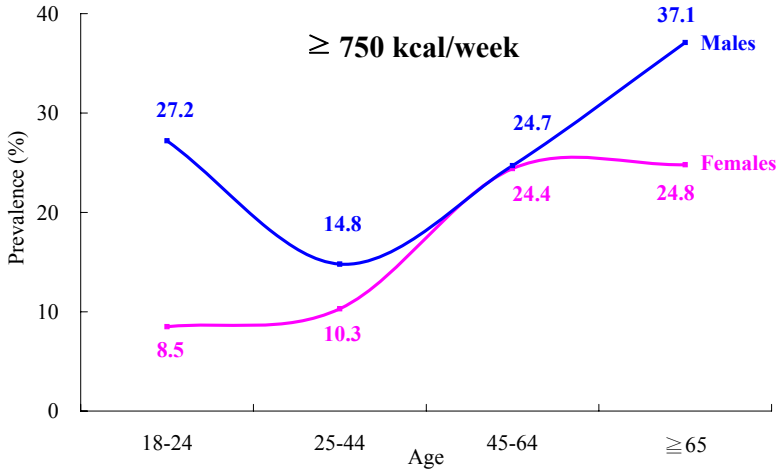

Figure 1. Prevalence of leisure-time physical activity by gender and age groups for those expending ≥750 kcal/week

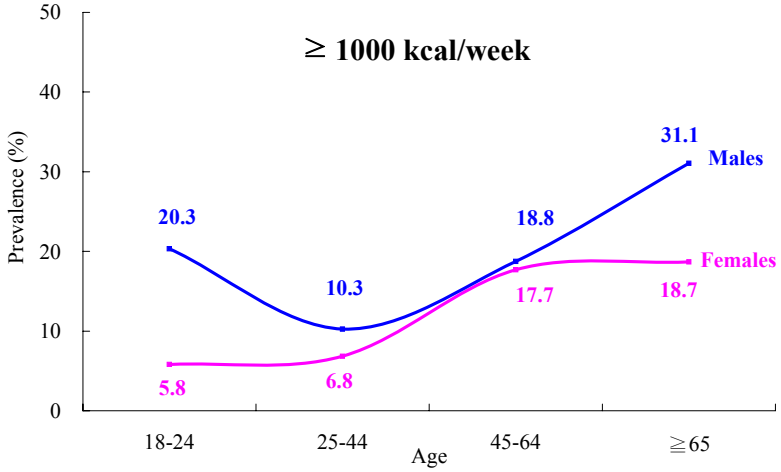

Figure 2. Prevalence of leisure-time physical activity by gender and age groups for those expending ≥1000 kcal/week

Table 4. Proportion of Taiwan adults meeting CDC physical activity recommendations, classified by energy expenditure above or below 750 kcal/week

		Meeting 750 kcal/week	Not meeting 750 kcal/week	Total
Males		**22.2** (N=1,706)	77.8 (N=2,078)	100.0 (N=3,784)
Meeting either moderate or vigorous requirement	Yes	14.6	3.8	**18.4**
	No	7.6	74.0	81.6
Females		**15.5** (N=1,199)	84.5 (N=2,638)	100.0 (N=3,837)
Meeting either moderate or vigorous requirement	Yes	13.1	7.4	**20.4**
	No	2.5	77.1	79.6
All		**18.9** (N=4,716)	81.1 (N=2,905)	100.0 (N=7,621)
Meeting either moderate or vigorous requirement*	Yes	13.8	5.6	**19.4**
	No	5.0	75.6	80.6

(1) Vigorous requirement was met when one had MET ≥6 related leisure-time physical activity for 3 times or more a week and for 20 minutes or more each time.
(2) Moderate requirement was met when one had MET < 6 related leisure-time physical activity for 5 times or more a week and for 30 minutes or more each time.
(3) *: means (1) or (2) was met.

non-chewers (25.4%) or ex-chewers (14.6%). Similarly, current smokers had the least LTPA (15.4%) at ≥750 kcal/week level, when compared with non-smoker (27.7%) or ex-smoker (32.7%). Current chewers and smokers were the most inactive (72.2% for chewers and 60.5% for smokers). The levels of LTPA of ex-smokers (32.7%) were higher than non-smokers, but ex-chewers (14.6%) were lower than non-chewers (25.4%).

When the Taiwanese LTPA data were evaluated against CDC recommendation in Table 4, one out of five, or 19.4%, met the requirement for either moderate or vigorous intensity requirement, 30 minutes a day for most days of the week (at least 5 days). In contrast, 18.9% met the 750 kcal/week requirement, not too much different from 19.4% of CDC requirement. Nevertheless, more than one quarter (5.6%/19.4%, or 28.9%) of those meeting CDC recommendation had energy deficit in reaching 750 kcal/week, and vice versa (5.0%/18.9%, or 26.4%).

Table 5 analyzed the reasons behind those who failed to meet CDC requirements from an energy expenditure standpoint. To meet the CDC criteria, two elements are required: frequency of 20 times a month or more (5 times/week X 4 weeks) and duration of 10 hours (600 minutes) a month or more (30 minutes/week X 20). Only 6.7% of those spending ≥750 kcal/week did not put in 10 hours of LTPA, but only 1.4% of those spending ≥750 kcal/week met the 20 times per month frequency requirement. By considering the duration requirement, two thirds (68.3%) of those exercising 10 hours or more a month, three quarters (73.6%) of those exercising 12 hours a month, and nine out of ten (90.7%) of those exercising 16 hours or more, would have met 750 kcal/week requirement. In other words, if one put in 4 hours a week, almost all (nine out of ten) would have achieved the target of ≥750 kcal/week.

DISCUSSION

More than 80% or 4 out of 5 adult Taiwanese do not engage in sufficient exercise to meet the CDC/WHO "minimal' goal on LTPA. Half of Taiwanese adults admitted to no LTPA at all, with women exercising less than men. People with lower education exercised less than those with higher education and younger people exercised less than older people. Only 1/7 reached a desirable recommended goal of ≥1,000 kcal/week, in contrast to 1/3 in the U.S.[32] Leisure-time physical activity were under-appreciated, particularly among the most productive work force (25-44-year group), as they exercised the least among all age groups. This group in the U.S. showed prevalence (34.3% at 1,000 kcal/week) four times higher than that in Taiwan (8.5%).[32]

Males, higher educated, higher income, non-smokers, and non-chewers of betel quid had more LTPA than their counterparts. That unhealthy behaviors tend to cluster

Table 5. Analysis of the reasons behind those who failed to meet CDC/WHO recommended guidelines, comparing whether energy expenditure was below or above 750 kcal/week

	Active with LTPA	
	< 750 kcal/week	**≥ 750 kcal/week**
Cumulative duration		
【1】Not meeting moderate or vigorous requirement		
Total (hours/30 days)	**3,857 (100%)**	**776 (100%)**
< 4	1,147 (29.7 %)	0 (0.0 %)
4－9.9	2,250 (58.3 %)	52 (6.7 %)
10－11.9	140 (3.6 %)	30 (3.9 %)
12－15.9	225 (5.8 %)	170 (21.9 %)
16－19.9	82 (2.1 %)	200 (25.8 %)
20	13 (0.3 %)	324 (41.8 %)
【2】Meeting moderate or vigorous requirement		
Total (hours/30 days)	**853** (100%)	**2,108 (100%)**
< 4	0 (0.0%)	0 (0.0%)
4－9.9	0 (0.0%)	0 (0.0%)
10－11.9	174 (20.4%)	23 (1.1%)
12－15.9	525 (61.5%)	182 (8.6%)
16－19.9	94 (11.0%)	169 (8.0%)
20	60 (7.0%)	1,734 (82.2%)
【1】+【2】		
≥ 10 hours	1,313 (31.7%)	2,832 (68.3%)
≥ 12 hours	999 (26.4%)	2,779 (73.6%)
≥ 16 hours	249 (9.3%)	2,427 (90.7%)
Frequency (times/30 days)		
≤ 8 times/30 days	2,243 (58.2 %)	329 (42.4 %)
9－12 times/30 days	554 (14.4 %)	221 (28.5 %)
13－16 times/30 days	304 (7.9 %)	182 (23.5 %)
17－19 times/30 days	37 (1.0 %)	33 (4.3 %)
20－29 times/30 days	616 (16.0 %)	8 (1.0 %)
30 times/30 days	103 (2.7 %)	3 (0.4 %)

among the least healthy group, mostly in the lower socio-economic class is not surprising, but it reminded us of our efforts to narrow such a disparity. To effectively change or reduce the unhealthy behaviors among those with less education is a challenge and requires paradigm shifts and the adoption of new strategies in our ways to communicate with those in need.

Nearly two thirds of "physically active exercisers" fell short of reaching 750 kcal a week, 30.6% out of 49.5%, a lower end of energy expenditure needed for realizing health benefits, as their median expenditure was 544 kcal/week. Such a small fraction has serious economic and public health implications. It seems that few Taiwanese are aware of the ever-increasing discovery of health benefits from LTPA from epidemiological studies. These benefits include, among others, the reduction of cardiovascular and respiratory diseases,[10,19,22,33,34] reduction of type 2 diabetes,[9,34,35] and reduction of certain cancers.[10,13-15,18,23,36-38] Furthermore, being physically fit will enable us to contain the spiraling medical expenditure[39,40] and to improve quality of life and lengthen our life expectancy.[11,12,16,20,21,41,42]

One of the most disconcerting findings is the low levels of LTPA among young adults, as reflected in the U-shaped and S-shaped age distribution of prevalence. Only one out of eight in the most productive "young adult" age group, age 25-44 years, was active at the minimal level (750 kcal/week), less than one third the number of their U.S. counterparts, and only one out of twelve met the 1,000 kcal/week goal recommended by U.S. Surgeon General,[6] less than one quarter the number of their U.S. counterparts. There were 50% more physically active "young adults" (38.1%) than the elderly (age 65 or older) in the U.S. (22.3%), but physically active "young adults" (8.5%) were only one third of the physically active elderly in Taiwan (25.4%), a striking Asian phenomenon. Leisure-time physical activity, both prevalence and energy levels, decrease with increasing age, in America as well as in European countries.[3, 20] This decrease with age is normally expected, considering the loss of strength and stamina as part of the aging process. In contrast, the reverse was the case in Taiwan: the older one gets, from 44 years on, the more exercise one is engaged in, with regard to frequency, duration and in energy consumption. Such a paradoxical phenomenon emerged among Asians for two obvious reasons: increasing availability of time for exercise as they neared their retirement age and beyond, and the increasing concern for physical ailments during the aging process. It should be noted that this phenomenon arose not so much from higher frequency or intensity of exercise by the elderly but from the lower frequency of exercise by the young adults in Taiwan. These elderly increased their exercise level to those in the U.S., from the much lower level at younger ages. The amount of energy spent by the elderly was twice more than younger people (842 kcal vs. 419 kcal), even though the elderly chose to do more of the low intensity exercise, such as shadow boxing, mountain climbing or walking. This revelation is possible because we were able to compare the spent calories, which is an index of a combination of exercise duration and intensity.

The young adults in Taiwan (age 25-44 group) complained that they do not have time to exercise. They need to work long hours, take care of small children, and are pre-occupied with business pressure. Although these complaints were valid and provided good excuses in their justification for not exercising, such pressure from work or from family was similarly experienced by the young adults in the U.S., who demonstrated four times more LTPA than their counterparts. Without the exercising peers, however, the absence of social support or fitness environment in Taiwan makes the pursuit of LTPA much more difficult.

Those with higher income and better education participated more in LTPA than their counterpart, by a factor of two. Such a difference in behavioral has created and widened the health disparity already existed between the rich and the poor. Physical inactivity joins the long list life style risk factors more prevalent among the lower socio-economic class in Taiwan. Smokers of tobacco and chewers of betel quid exercised less than half than non-smokers or non-chewers, and among those exercised, they spent less energy than their counterparts. The discovery that those with unhealthy behavior, such as smokers and chewers, showed less physical activity has been reported,[43] but not among Asians. The magnitude of the differences was large and its related health consequences from relative inactivity should not be overlooked. To what extent this contributed to the increased mortality observed among smokers and chewers remain to be studied, including the fact that chewers were found to be more overweight or obese than non-chewers. On the other hand, it is encouraging to note that when these smokers or chewers quit, they became more physically active, doubling the proportion of exercisers, from 15.4% to 32.7%. It could be deduced from this observation that those smokers who exercised had a better chance of quitting, and physical activity should be an integral part of smoking cessation.

The expression of LTPA in kcal/week is a simple, easily understood summary indicator, and more closely approximates expected health benefits than data conventionally expressed from a combination of frequency, duration or intensity.[11,44] Previously, when we applauded someone who expressed that he/she has been engaged in regular exercise, we stopped short of questioning its adequacy. We were not able to distinguish whether the energy expenditure was sufficient or to what extent his or her level of activity realized expected health benefits. With the use of kcal, the gap between the current LTPA in practice and the desirable one or the gap between two groups such as Taiwan and the U.S can be quantified and efforts to bridge the gap measured. For example, mortality risks were reportedly lowered among those exercisers expending ≥1,000 kcal/week,[6,11,13,20-23,42] which can be achieved by following the CDC recommendation in brisk walking for 30-minute/day for 5 days a week.[6] This ≥1,000 kcal/week is a goal suggested in the U.S. Surgeon General's report as an optimal level of energy consumption in LTPA, and yet only 1 out of 7, or 13.9%, adults in Taiwan reached it. When we lowered the goal to 750 kcal/week, four out of five adults in Taiwan still failed to meet it. While ≥1,000 kcal/week is a suggested goal,

LTPA as high as 2,000 kcal/week was reported to be a level able to reduce some cancer risks.[15,18,23,33,45] Those classified as physically active in Taiwan need to quadruple their energy level to realize this health benefits, as they currently expended 78 kcal/day or 550 kcal/week. Identifying this large gap, as many as four-folds, among those who claimed to be physically active illustrated the power of kcal.

Negative energy balance can lead to weight reduction, but relying on LTPA to reduce weight takes time. For example, 10,000 steps a day consumes 300 kcal, and would take more than three weeks to reach 7,000 kcal, an equivalent of 1 kilogram. For the sedentary person in Taiwan (median energy expenditure of 0 kcal) to become "physically active" (median expenditure of 544 kcal), as shown in this survey, it would take 13 weeks to reduce one kilogram of body weight. It is obvious that a much more exercise is needed, an average of 4 hours instead of 2 hours a week, among those exercisers in order to tip the energy balance for weight purposes.

Given the CDC recommendation of moderate physical activity for 5 or more days/week and 30 or more minutes/day,[6] it will be of interest to see to what extent people in Taiwan has achieved that. At the same time, we were interested in comparing between the proposed ≥750 kcal/week target in this study and the CDC recommendation when applied to Taiwan. Our result showed that the two approaches, the CDC recommendation and the 750 kcal/week, appeared to be nearly identical, 18.9% versus 19.4%, implying either criteria seemed to be sufficient. However, this study was able to identify subtle differences between the two approached: a sizable portion of those meeting CDC recommendation had energy deficit in reaching 750 kcal/week, and vice versa. More than one quarter (28.9%) of those meeting CDC did not reach 750 kcal/week, and this may reflect potential weakness of CDC approach. On the other hand, majority of those meeting 750 kcal/week but not meeting CDC criteria, was the result of failure to meet the daily discipline of 5-day-per-week CDC requirement (98.6%). While US CDC included in its recommendation for cumulating several short sessions (e.g. 10 minutes) to satisfy the daily 30-minute session because of "similar cardiorespiratory fitness gains",[24] such a flexible rule of cumulative effort is useful and encouraging people to exercise more frequently, such a cumulative approach has not been extended to its current 5-day-per-week requirement. By assuming fitness benefits remain identical as long as energy expenditure was similar, regardless of the frequency of exercise as to whether it was conducted within a day or within a month, this study found that by exercising 4 hours or more a week, nine out of ten would have achieved the energy target, 750 kcal/week. Promoting the energy target to meet could duly credit and encourage the so-called "weekend warriors",[30] who otherwise would have been counted as not meeting the CDC requirement in frequency term. These "weekend warrior" are working people who could not find time to do exercise during the workweek but pursue more strenuous activities during weekend, or limited number of evenings during weekdays.[30] Thus, encouraging the 750 kcal/week pragmatic goal for the Asians, achievable by 4-hour/week exercise not only promoted the activity in a very specific way but also provided a measurable target that was hitherto confusing to the Asians.

This study is subject to a number of limitations. First, NHIS data are interviewed self-report, subject to recall and social desirability bias. Recalling past 2 weeks or past 30 days may or may not be representative of LTPA for the whole year. Recalling for the past two weeks, rather than past 30 days, could yield more accurate information. On the other hand, recording 30 days of LTPA will be more informative and accurate than recording past two weeks if someone is an infrequent exerciser within a month. Secondly, the exercise intensity, with MET assigned based on Ainsworth compendium,[27] is subject to misclassifications, when compared with results from direct monitoring,[2] such as the use of an accelerometer.[39] Nevertheless, such an assignment MET is widely used and has been the standard practice in community studies. Thirdly, the sample sizes among age/racial/ethnic populations were intended to be nationally representative, but size limitation can result in wide data variability and imprecise estimates in these populations. Last, we only studied LTPA in this paper. The four domains of physical activity: LTPA, occupational, commuting, and household activities constituted one's entire energy balance. Nevertheless, LTPA was the one domain the individual has control over and the one domain most closely related to health benefits.

In conclusion, LTPA was under-appreciated in Taiwan, particularly among the most productive work force (25-44-year group), who exercised less than 1/4 of their U.S. counterparts. Expressing LTPA in kcal has the advantage of making direct comparison easier or setting national policy goal. Invoking a goal of 750 kcal/week or more for Asians, which is attainable by exercising 4 hours/week, can facilitate nutritionists in assessing LTPA adequacy. Currently, 4/5 of adults in Taiwan failed to reach that goal. Recognizing this concept of cumulative energy expenditure, in contrast to requiring the discipline of daily work for 5 or more days, will encourage the infrequent exercisers such as the "weekend warriors" to continue with their activities.

CONTRIBUTORS

JPM Wai was responsible for the conception and design, data analysis and interpretation, preparation of draft manuscript, doing revisions and providing critique. CP Wen was responsible for the conception and design, data analysis and interpretation, preparation of draft manuscript, doing revisions or providing critique, overall and sectional scientific management. HT Chan, PH Chiang, and MK Tsai were responsible for doing the field, data collection or compilation work and data analysis. SP Tsai was responsible for data analysis and interpretation, preparation of draft manuscript, doing revisions and providing critique. H-Y Chang was responsible for doing the field, data collection and compilation work. The data in this study came from published NHIS data and would have no need for approval from institutional ethics committee.

AUTHOR DISCLOSURES

Jackson Pui Man Wai, Chi Pang Wen, Hui Ting Chan, Po Huang Chiang, Min Kuang Tsai, Shan Pou Tsai and Hsing-Yi Chang, no conflicts of interest.

REFERENCES

1. CDC. Prevalence of physical activity including lifestyle activities among adults-United States, 2000-2001. MMWR Morb Mortal Wkly Rep. 2003;52:764-69.
2. Crespo CJ, Keteyian SJ, Heath GW, Sempos CT. Leisure-time physical activity among US adults. Results from the Third National Health and Nutrition Examination Survey. Arch Intern Med. 1996;156:93-98.
3. U.S. Department of Health and Human Services. Healthy People 2010: What are the leading health indicators? [cited 2007 Jun 8]. Available from http://www.healthypeople.gov /LHI/lhiwhat.htm.
4. Lin YC, Wen CP, FACSM. Leisure-time physical activity among adults: Results from 2001 National Health Interview Survey in Taiwan. Med Sci Sports Exerc. 2006;38: S377-78.
5. Transportation Research Board/Institute of Medicine of the National Academies. Does the built environmental influence physical activity? Examining the evidence. Transportation Research Board Special Report 282, Washington, D.C. 2005.
6. U.S. Department of Health and Human Services. Physical Activity and Health: A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotions, 1996.
7. CDC. Physical activity trends-United States, 1990-1998. MMWR Morb Mortal Wkly Rep. 2001;50:166-69.
8. Task Force on Community Preventive Services. The guide to community preventive services: physical activity. Atlanta, GA: US Department of Health and Human Services, CDC.2001. [cited 2007 Jun 8] Available from http://www. thecommunityguide.org/pa.
9. Sigal R, Kenny G, Wasserman D, Castaneda-Sceppa C, White R. Physical activity/exercise and type 2 diabetes. A consensus statement from the American Diabetes Association. Diabetes Care. 2006;29:1433-38.
10. Biesma RG, Schouten LJ, Dirx MJ, Goldbohm RA, van den Brandt PA. Physical activity and risk of ovarian cancer: Results from the Netherlands Cohort Study (the Netherlands). Cancer Causes Control. 2006;17:109-15.
11. Lee IM, Skerrett PJ. Physical activity and all-cause mortality: What is the dose-response relation? Med Sci Sports Exerc. 2001;33:S459-71.
12. Lee IM, Hsieh CC, Paffenbarger RS Jr. Exercise intensity and longevity in men. The Harvard Alimni Health Study. JAMA. 1995;273:1179-84.
13. Lee IM, Rexrode KM, NR Cook, Hennekens CH, Buring JE. Physical activity and breast cancer risk: the Women's Health Study (United States). Cancer Causes Control. 2001;12:137-45.
14. Lee IM, Sesso HD , Paffenbarger RS Jr. Physical activity and risk of lung cancer. Inter J Epidemiol. 1999;28:620-25.
15. Martinez ME, Giovannucci E, Spiegelman D, Hunter DJ, Willett WC, Colditz GA. Leisure-time physical activity, body size, and colon cancer in women. Nurses' Health Study Research Group. J Natl Cancer Inst. 1997;89:948-55.
16. Schnohr P, Parner J, Lange P. Mortality in joggers: Population based study of 4,658 men. BMJ. 2000 321:602-03.
17. Shephard RJ. Absolute versus relative intensity of physical activity in a dose-response context. Med Sci Sports Exerc. 2001;33:S400-18.
18. Thune I, Furberg AS. Physical activity and cancer risk: dose-response and cancer, all sites and site-specific. Med Sci Sports Exerc. 2001;33:S530-50; discussion S609-10.
19. Church T, Earnest C, Skinner J, Blair S. Effects of different doses of physical activity on cardiorespiratory fitness among sedentary, overweight or obese postmenopausal women with elevated blood pressure. A randomized controlled trial. JAMA. 2007;297:2081-91.
20. Manini TM, Everhart JE, Patel KV, Everhart JE, Patel, KV, Schoeller DA, et al. Daily activity energy expenditure and mortality among older adults. JAMA. 2006;296:171-9.
21. Lee IM, Sesso HD, Oguma Y, Paffenbarger RS Jr. The "weekend warrior" and risk of mortality. Am J Epidemio. 2004;160:636-41.
22. Lee IM, Paffenbarger RS Jr. Physical activity and stroke incidence: the Harvard Alumni Health Study. Stroke. 1998;29:2049-54.
23. Lee IM, Paffenbarger RS Jr, Hsieh C. Physical activity and risk of developing colorectal cancer among college alumni. J Natl Cancer Inst. 1991;83:1324-29.
24. CDC. Adult participation in recommended levels of physical activity - United States, 2001and 2003. MMWR Morb Mortal Wkly Rep. 2005;54:1208-12.
25. World Health Organization. Global strategy on diet, physical activity and health. World Health Assembly 2002 (Resolution WHA55.23): [cited 2007 Jun 8] Available from http://www.who.int/dietphysicalactivity/strategy/ eb11344/strategy_english_web.pdf
26. Shih YT, Hung YT, Chang HY, Liu JP, Lin HS, Chang MC, et al. The design, contents, operation and the characteristics of the respondents of the 2001 National Health Interview Survey in Taiwan. Taiwan J Public Health. 2003; 22:419-30.
27. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32:498-04.
28. Wai JPM. The accuracy and estimation of metabolic equivalent (MET) in adult males. J Chinese Nutr Soc. 2000; 25:99-07.
29. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA. 1995;273:402-07.
30. Judy K, Sandra AH, Harold WK. Characteristics of a “Weekend Warrior”: Results from two national surveys. Med Sci Sports Exerc. 2007;39:796-800.
31. SAS Institute Inc. SAS/STAT user’s guide, version 8, Cary, North Carolina: SAS Institute Inc, 1999.
32. Wen CP, Wai JPM, Chan HT, Chan YC, Chiang PH, Cheng TY. Evaluating the physical activity policy in Taiwan: comparison of the prevalence of physical activity between Taiwan and the U.S. Taiwan J Public Health. 2007: 26:386-99.
33. Richardson C, Kriska A, Lantz P, Hayward R. Physical activity and mortality across cardiovascular disease risk groups. Med Sci Sports Exerc. 2004;36:1923-29.
34. Bussuk S, Manson J. Epidemiological evidence for the role of physical activity in reducing risk of type 2 diabetes and cardiovascular disease. J Appl Physiol. 2005;99:1193-04.
35. LaMonte M, Blair S, Church T. Physical activity and diabetes prevention. J Appl Physiol. 2005;99:1205-13.
36. Colditz GA, Cannuscio CC, Frazier AL. Physical activity and reduced risk for colon cancer: Implications for prevention. Cancer Causes Control. 1997;8:649-67.
37. Michna L, Wagner G, Lou YR, Xie JG, Peng QY, Lin Y, et al. Inhibitory effects of voluntary running wheel exercise on UVB-induced skin carcinogenesis in SKH-1 mice. Carcinogenesis. 2006;27:2108-15.

38. Monninkhof E, Elias S, Vlems F, van der Tweel I, Schuit A, Voskuil D, et al. Physical activity and breast Cancer: A systematic review. Epidemiology. 2007;18:137-57.
39. Martinson B, Crain A, Pronk N, O'Connor P, Maciosek M. Changes in physical activity and short-term changes in health care charges: A prospective cohort study of older adults. Prev Med. 2003;27:319-26.
40. Weiss J, Froelicher V, Myers J, Heidenreich P. Health-Care Costs and Exercise Capacity. Chest. 2004;126:608-13.
41. Black CD, McCully KK. Time course of exercise induced alterations in daily activity in chronic fatigue syndrome. Dyn Med. 2005;4:10-11.
42. Matthews C, Jurj A, Shu XO, Li HL, Yang G, Li Q, et al. Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. Am J Epidemiol. 2007;165:1343-50.
43. Kaczynski AT, Manske SR, Mannell RC, Grewal K. Smoking and physical activity: a systematic review. Am J Health Behav. 2008:32:93-110.
44. Dong L, Block G, Mandel S. Activities contributing to total energy expenditure in the United States: Results from the NHAPS Study. Int J Behav Nutr Phys Act. 2004;1:4.
45. U.S. Department of Health and Human Services and Department of Agriculture. Dietary guidelines for Americans 2005. 2005: [cited 2007 Jun 8] Available from http://www.healthierus.gov/dietaryguidelines/.

Original Article

Assessing physical activity in an Asian country: Low energy expenditure and exercise frequency among adults in Taiwan

Jackson Pui Man Wai PhD[1], Chi Pang Wen MD DrPH[2], Hui Ting Chan MS[2], Po Huang Chiang PhD [2], Min Kuang Tsai MS[2], Shan Pou Tsai PhD[3] and Hsing-Yi Chang DrPH[2]

[1]*Laboratory for Exercise Physiology Research, Institute of Sports Science, National Taiwan Sport University, Taoyuan, Taiwan.*
[2]*Center for Health Policy Research and Development, National Health Research Institutes, Miaoli, Taiwan*
[3]*Johns Hopkins School of Medicine, Baltimore, MD, USA*

臺灣民眾運動習慣及盛行率之分析

背景：運動對健康的好處毋庸置疑，在亞洲以實證數據及國際定義為依據之全民運動盛行率報告仍付之闕如。**目的**：瞭解臺灣民眾運動的盛行率及其相關因素，並轉換成以卡路里 (kcal) 為指標。**方法**：對象為 2001 年國民健康訪問調查共 15,390 位成人，根據對運動問題之答案，估計其運動強度的 MET 值 (metabolic equivalent)，依運動頻率、時間及強度換算成 kcal 而加以分析。**結果**：半數以上的成人自認完全不運動。女性、低教育程度、低收入、較年輕族群及吸菸、嚼檳榔者，其運動習慣及運動量明顯較少。依是否達到每週 750 kcal 之運動熱量來評估，臺灣成人有運動的盛行率不到總人口的 1/5 (18.9%)。達到較理想的每週 1000 kcal 的運動量，只有總人口的 1/7 (13.9%)，是美國有運動的盛行率三分之一。男性各年齡層的運動盛行率以青壯年 (25-44 歲者) 有運動的最少，老年(65 歲以上)有運動的最多，呈現臺灣特有的 U 型曲線；女性各年齡層運動盛行率，運動最少的族群是在 18-24 歲及 25-44 歲，45 歲之後才昇高，呈現 S 型曲線。運動在臺灣普遍不受到重視，特別是在 25-44 歲的族群，其盛行率只有美國的 1/4。**結論**：目前臺灣民眾運動習慣偏低且運動量嚴重不足，達到每週消耗 750 kcal 低竿的運動人口不到全體的 1/5。本研究並提出「每週運動若能消耗 ≥750 kcal，亦即運動時間要能每週**累積≥4 小時**」之新目標，以方便宣導運動的新指標，這個“累積”的概念，和以往硬性規定每週至少 5 天以上的宣導不同，可以鼓勵非規律運動者，如集中在週末運動的所謂－“週末勇士”達到促進健康運動量的目標。

關鍵字：運動、卡路里、休閒運動、盛行率