博士（人間科学）学位論文

Exploring Effective Strategies for Promoting Recommended Physical Activity

推奨身体活動促進のための効果的な支援方策の提案

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Dedication

I dedicate this dissertation to my family:

To my wonderful parents and loving brothers and sisters for all of your love, support, understanding, and patience throughout my life.

To my grandparents for all your generous support and encouragement.

Acknowledgment

I would like to express my gratitude to all those who gave me the possibility to complete this dissertation. I am very grateful to my committee members, Dr. Isao Muraoka, Dr. Yoshio Nakamura, and Dr. Katsuo Yamazaki for their continual support and encouragement throughout this process. I would like to gratefully and sincerely thank to Dr. Koichiro Oka, who has been my great advisor. Without his great guidance, generous support, and extreme patience, I would never have been able to accomplish this process.

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CHAPTER 1

INTRODUCTION

Physical inactivity is a major modifiable risk factor for many preventable diseases and is widespread throughout many industrialized nations (US Department of Health and Human Services,1996). In industrialized countries, physical inactivity is associated with considerable economic burden, with 1.5-3.0% of total direct healthcare costs being accounted for by physical inactivity (Oldridge, 2008). Thus, promoting engagement in regular physical activity is now a national health priority for disease prevention policy. The benefits of physical activity on health are well-established. Regular physical activity decreases the risk of cardiovascular disease, stroke, hypertension, diabetes mellitus, obesity, some forms of cancer, osteoporosis, and improved mood states including depression and anxiety (Kesaniemi et al., 2001; US Department of Health and Human Services, 1996).

Recommended Physical Activity

In general, the recommended amount or level of physical activity is believed to confer general health promotion and disease preventive benefits. International public health guidelines for adults recommend obtaining at least 30 minutes

of moderate-intensity physical activity (3-6 metabolic equivalents: METs) five or more days per week (Commonwealth Department of Health and Aged Care, 1999; Department of Health, 1996; Pate et al., 1995; US Department of Health and Human Services, 1996).

In Japan, the guidelines on health promotion and recommendations for physical activity and exercise, the Exercise and Physical Activity Reference for Health Promotion 2006 (EPAR2006), were published in 2006 (Ishikawa-Takata & Tabata, 2007; Ministry of Health, Labour and Welfare, 2006a). The recommended level of physical activity was determined by a systematic review of 84 English and Japanese published articles which assessed the primary preventive impact of physical activity on lifestyle-related diseases, all-cause and cardiovascular mortality (Ishikawa-Takata & Tabata, 2007; Ministry of Health, Labour and Welfare, 2006a).

The current guidelines are more focused on daily physical activity above 3 METs, which include both lifestyle physical activity and exercise as opposed to the former traditional exercise guidelines (Ministry of Health, Labour and Welfare, 1993). In the present recommendation, every adult should accumulate 23 METs-hour per week (METs-hour is a unit that expresses the quantity of physical activity; it is calculated by multiplying the intensity of the activity, or MET, by the

duration of the activity) of physical activity to prevent chronic diseases and to obtain numerous health benefits (Ishikawa-Takata & Tabata, 2007; Ministry of Health, Labour and Welfare, 2006a). Approximately 60 minutes of physical activity at an intensity of 3.3 METs (e.g. walking) seven days per week, 420 minutes per week, is equivalent to this recommended value, which is almost three fold as higher quantity than those of other international public health guidelines on physical activity, 150 minutes per week (Commonwealth Department of Health and Aged Care, 1999; Department of Health, 1996; Pate et al., 1995; US Department of Health and Human Services, 1996).

Recommended Physical Activity and Quality of Life

Health-related quality of life (HRQOL) refers to the perception of overall satisfaction with life and involves the measurement of functional status in the domains of physical, cognitive, emotional, and social health, and becomes a fundamental assessment in understanding the health status of a population (Mishoe & Maclean, 2001; Ware & Sherbourne, 1992). Improving HRQOL is widely accepted one of the major goals of a national health promotion and disease prevention initiative such as Healthy People 2010 in the United States (US) and National Health Promotion in the 21st Century campaign (Healthy

Japan 21) in Japan (Panel of Production Movement of National Health in the 21st Century, 2000; US Department of Health and Human Services, 2000). According to the US Surgeon General's Report (US Department of Health and Human Services, 1996), regular physical activity appears to improve HRQOL by enhancing psychological well-being and by improving physical functioning.

From the findings of numerous epidemiological studies, the benefits of the recommended level of physical activity on physiological health indicators such as morbidity and mortality of chronic diseases are well-accepted (Kesaniemi et al., 2001; US Department of Health and Human Services, 1996). Such evidences can provide a rationale for proceeding to the promotion of physical activity for health (Sallis, Owen, & Fotheringham, 2000). On the other hand, association between the recommended level of physical activity and HRQOL is still not obvious. A few previous studies in other countries found that the recommended level of physical activity might affect HRQOL by influencing two main components: physical functioning and well-being (Brown et al., 2003; US Department of Health and Human Services, 1996; Vuillemin et al., 2005). However, few studies have examined the association between the current Japanese recommendation for physical activity and HRQOL in Japanese adults. In addition, the beneficial effect

of exercise on HRQOL was mainly found in special populations (Dias, Dias, & Ramos, 2003; Menard et al., 2004; Painter, Krasnoff, Paul, & Ascher, 2001; Stewart et al., 2003). Thus, the association between the recommended level of physical activity and HRQOL in the general population was still not obvious.

Prevalence of Recommended Physical Activity

Accurate estimating the prevalence of meeting physical activity recommendation on a population level is required for planning the public health initiatives that the need to identify and diffuse effective intervention strategies to promote physical activity is exceedingly evident. In many industrialized counties, 50% or more of adult population are not sufficiently active enough even at recommended level to receive many of health benefits and disease prevention (Centers for Disease Control and Prevention: CDC, 2003, 2005; Cerin, Leslie, Bauman, & Owen, 2005; Hillsdon et al., 2001; Macera et al., 2005; Martin, Morrow, Jackson, & Dunn, 2000; US Department of Health and Human Services, 1996). In Japan, the proportion of Japanese adults meeting this new recommendation has not yet been determined.

Correlates of Recommended Physical Activity

In order to increase the proportion of individuals engaged in the recommended level of physical activity, it is essential to identify the correlates of participation in physical activity in order to (1) target at-risk populations and (2) develop tailored interventions and relevant policy (Sallis et al., 2000). First, describing sociodemographic correlates of meeting physical activity recommendation, such as gender, age, marital status, and socioeconomic status, is useful for identifying characteristics of people who are most in need of intervention (Sallis et al., 2000). Previous studies have found that among sociodemographic variables, participating in physical activity was positively related with being male, younger, more educated, a non-smoker, and earning a higher income (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Trost et al., 2002). These studies, however, have investigated the correlates of participation in physical activity.

A limited number of studies in the US and European countries have investigated the correlates of meeting the recommended level of physical activity in middle-aged adults (Bertrais et al., 2004; Cerin et al., 2005; Macera et al., 2005; Martin et al., 2000), the elderly (Kaplan, Newsom, McFarland, & Lu, 2001), persons with a disability (Boslaugh & Andresen, 2006), and ethnic minorities (Bopp et al., 2006;

Wilbur, Chandler, Dancy, & Lee, 2003a, 2003b). Although age and gender seemed to be consistent correlates of attaining the physical activity recommendation in adults, other correlates—such as marital status, educational level, employment status, and household income level—still produced mixed findings (Bertrais et al., 2004; Bopp et al., 2006; Boslaugh & Andresen, 2006; Cerin et al., 2005; Kaplan et al., 2001; Macera et al., 2005; Martin et al., 2000; Wilbur et al., 2003a, 2003b). Additionally, few studies have examined the demographic correlates of meeting the physical activity recommendation on EPAR2006 in the Japanese population.

Next, a better understanding of psychological, social, and environmental factors that influence physical activity is also expected to provide beneficial information, clarification of target variables on intervention, which allow researchers to focus on modifying these variables and thus intervene more effectively (Sallis et al., 2000). Previously, numerous studies reported that engagement in regular physical activity was associated with various factors--demographic, psychological, social, and environmental factors-- (Trost et al., 2002). Many of those have focused on only one domain (Trost et al., 2002). More recently, ecological perspective, stressing that behavior is influenced by a complex interaction of factors across multiple

levels, is increasingly emphasized on identifying correlates of physical activity participation (Giles-Corti, Timperio, Bull, & Pikora, 2005; Sallis & Owen, 2002). However, only a few of previous studies simultaneously included factors across psychological, social, and environmental domains; thus, including factors across these domains may prevent overestimating the impact of each factor on physical activity behavior and allow the researchers to compare their relative contributions (Booth et al., 2000; Burton, Turrell, Oldenburg, & Sallis, 2005; Eyler, 2003; Duncan & Mummery, 2005; Giles-Corti & Donovan, 2002; Granner et al., 2007; King et al., 2000; Wilcox et al., 2003).

In these studies, which were conducted on a diverse sample of adults (Burton et al., 2005; Duncan & Mummery, 2005; Giles-Corti & Donovan, 2002; Granner et al., 2007) and specific subgroups of adults at particular risk for inactivity (Booth et al., 2000; Eyler, 2003; King et al., 2000; Wilcox et al., 2003), self-efficacy and several types of social support from family and friends were often reported as strong correlates of attaining the recommended physical activity level (Booth et al., 2000; Burton et al., 2005; Duncan & Mummery, 2005; Giles-Corti & Donovan, 2002; Granner et al., 2007). However, the strength and direction of the association of many other factors, especially on environmental factors, regarding

attaining the recommended level of physical activity still varied across these previous multivariable studies (Booth et al., 2000; Burton et al., 2005; Duncan & Mummery, 2005; Eyler, 2003; Giles-Corti & Donovan, 2002; Granner et al., 2007; King et al., 2000; Wilcox et al., 2003). Thus, more comprehensive and extensive investigations may help clarify these conflicting results. Further, some previous studies reported that psychological and social factors had made relatively higher contributions to physical activity behavior than environmental factors (Burton et al., 2005; Giles-Corti & Donovan, 2002; Granner et al., 2007). However, in order to make a conclusive statement regarding the magnitude of the association of those factors, it is apparent that more studies are required. Finally, almost all of the previous studies were conducted in the US and Australia. Few studies have examined psychological, social, and environmental correlates of meeting the physical activity recommendation in the Japanese population.

Purpose of Current Study

As identified above, few studies on the new Japanese recommendation for physical activity have been conducted. Additionally, systematic and basic research approaches are necessary for developing effective population-based

intervention to increase engagement in recommended physical activity at population level and consequently, improve public health. Thus, the current study purposed to explore the effective approaches for promoting physical activity at recommended level on the basis of results in following three studies;

1. Recommended level of physical activity and health-related quality of life among Japanese adults
2. Prevalence and demographic correlates of meeting physical activity recommendation among Japanese adults
3. Relative contributions of psychological, social, and environmental factors to meeting physical activity recommendation among Japanese adults

CHAPTER 2

RECOMMENDED LEVEL OF PHYSICAL ACTIVITY AND HEALTH-RELATED QUALITY OF LIFE AMONG JAPANESE ADULTS

Purpose

The present study was proposed to examine whether the recommended level of physical activity would be associated with HRQOL in the general Japanese middle-aged population.

Methods

Participants

The current study used a sample comprising 1211 male and female respondents to a cross-sectional survey on the association between sports and health. The survey was provided by the Japan Sports Industries Federation in September 2006. The set sample size and parameters were approximately 1200 male and female adults aged between 20 and 59 years, with an equivalent number of males and females in each age bracket. Of approximately 230,000 registrants for the Internet research service, potential respondents were randomly selected in accordance with the set sample size and parameters and were invited to participate in an Internet-based survey via e-mail. Internet-based questionnaires were placed in a protected area of a web site and the potential respondents

received the URL in an invitation e-mail. Reward points for the Internet service were provided as incentives for participation. All respondents voluntarily completed and signed an online Institutional Review Board-approved letter of informed consent and demographic data information. The demographic data included gender, age, marital status, educational level, and household income level. In addition, the following measures were administered.

Measurements

Physical activity. The short version of the International Physical Activity Questionnaire (IPAQ) was utilized to estimate the amount of physical activity that the participants engaged in. The IPAQ has been used in several countries (Craig et al., 2003). This self-administered questionnaire was designed to be utilized by adults aged between 18 and 65 years. It identifies the frequency and duration of walking, moderate and vigorous physical activity, and sedentary activity during the past week (Craig et al., 2003). The one-week test-retest reliability of the short, self-administered Japanese version of IPAQ is good (Spearman r = 0.72–0.93). The criterion validity for the Japanese version of IPAQ against the accelerometer is acceptable (Spearman r = 0.39; Murase et al., 2002). However, the validity of the Internet-based Japanese version of IPAQ has not yet been tested.

The short-form data were utilized to estimate the total weekly physical activity level (METs-hour/week) by weighting the reported hours per week within each of the three activity categories: low, moderate, and high by MET energy expenditure estimates assigned to each category of activity. The current national guidelines for exercise in Japan recommend 23 METs-hour/week of physical activity (Ishikawa-Takata & Tabata, 2007; Ministry of Health, Labour and Welfare, 2006a). Based on the estimated total weekly physical activity level, respondents were assigned to one of three (mutually exclusive and exhaustive) groups. Individuals who reported no physical activity were assigned to the inactive group; those who reported physical activity that was less than the recommended level but greater than nothing were assigned to the insufficient group; and those who reported 23 or more METs-hour/week of physical activity were assigned to the recommended group.

HRQOL. The Japanese version of the Medical Outcomes Study (MOS) Short Form 8-Item Health Survey (SF-8) was administered to assess the HRQOL. The SF-8 consists of 8 items and is the most recent version of the MOS short form health surveys. Similarly to the MOS 36-item short form health survey (SF-36), the SF-8 is divided into an 8-dimension health profile: physical functioning (PF), role functioning- physical (RP),

bodily pain (BP), general health perception (GH), vitality (VT), social functioning (SF), role functioning-emotional (RE) and mental health (MH), and comparable estimates of summary scores for the physical and mental components of health (PCS, MCS). Each item of the SF-8 is assessed by a 5- or 6-point Likert scale. The 8-domain scaled scores range from 0 to 100, with 100 representing optimal health and functioning (Ware, Kosinski, Dewey, & Gandek, 2001). The 8-domain summary scores, PCS and MCS, have been normalized to the Japanese population. The reliability of the Japanese version of the SF-8 by an alternate-forms method was adequate (Spearman r = 0.70–0.88; Ware et al., 2001; Fukuhara & Suzukamo, 2004). The Japanese version of the SF-8 meets the standard criteria for content and the construct and criterion validity (Fukuhara & Suzukamo, 2004). The practical advantage of SF-8 is briefly to assess and directly compare the eight scores produced by the SF-36. The correlation coefficient of each 8-domain scale score between SF-8 and SF-36 was strong (Spearman r = 0.56–0.87; Fukuhara & Suzukamo, 2004). The validity of the original Internet-based English version of the SF-8 was examined by comparing the results obtained via the Internet, through a telephone interview, and a mail survey. All eight dimensions and two summary scores obtained via the Internet were significantly lower than those obtained by telephone

interview and comparable to those obtained by the mail survey, with the exceptions of RP, GH, RE, and PCS (Fukuhara & Suzukamo, 2004). Nevertheless, the validity of the Internet-based Japanese version of the SF-8 has not yet been investigated.

Statistical analysis

For the analysis, respondents with incomplete information for all study variables (n = 39) and extreme estimated physical activity level from IPAQ (n = 20) were excluded. Consequently, 1152 individuals were available for data analysis. A chi-squared test was utilized to compare differences in categorical variables among the physical activity groups. Additionally, a multivariate analysis of variances (MANOVA) was conducted to determine the differences in the SF-8 measures among each demographic group. The univariate analyses and Tukey's post hoc tests were performed following significant multivariate effects.

The primary analysis was stratified by gender. Multivariate analyses of covariance (MANCOVAs) were utilized to examine differences in multidimensional scales of the SF-8, with physical activity levels as the between-group factor and age, marital status, household income level, and educational level as covariates. Significant multivariate effects were followed up with the Bonferroni-adjusted univariate analysis of variances (ANOVA). The alpha level was set at .05. The

Statistical Package for Social Science (SPSS) for Windows 14.0 was utilized to compute the statistics (SPSS, 2005).

Results

Basic characteristics of respondents

In the present study, 575 males and 577 females were classified into three groups according to physical activity level. The average age was comparable across the three physical activity groups. Males (n = 158, 27.5%) were more likely to meet the recommended level of physical activity than females (n = 126, 21.9%). Similarly, females (n = 175, 33.0%) were more likely to be inactive than males (n = 144, 25.0%). Those differences seemed to be driven by the 20- and 50-year age groups. Although the number of those who attain the recommended level and who are deemed inactive was relatively similar in the 30- and 40-year age groups across gender, the likelihood of engagement in the recommended level of physical activity in females in the 20- and 50-year age groups (22.1%, 25.7%) was significantly lower than those in males in corresponding groups (37.0%, 30.5%). Additionally, 35.2% of younger (20–29 years) and 30.6% of older (50–59 years) respondents in females were physically inactive, whereas the same results were observed in 22.6% and 22.0% in males, respectively. The number of those who engaged in an

insufficient level of physical activity was similar across genders (male: n = 274, 47.5%; female: n = 276, 47.8%). The respondents who met the recommended level of activity were less likely to be in the 30-year age group for both males and females. Table 1 and Table 2 present the demographic characteristics of the study population stratified by physical activity level and gender.

Effects of demographic characteristics on HRQOL

Regarding the 8-domain scales scores, a one-way MANOVA was conducted to examine the group differences in the SF-8 measures for each demographic variable. The multivariate effects for gender (Wilk's $\lambda = .954$, $p = .000$), marital status (Male: Wilk's $\lambda = .958$, $p = .002$; Female: Wilk's $\lambda = .964$, $p = .007$), and age level (Male: Wilk's $\lambda = .921$, $p = .004$; Female: Wilk's $\lambda = .929$, $p = .012$) were significant.

With respect to gender, the univariate analyses indicated significant differences in RP, BP, GH, SF, and MH. Males had significantly higher RP, BP, GH, SF, and MH than females. For marital status, the univariate analyses indicated significant differences for RE and MH in males and MH in females. The married males had significantly higher RE and MH scores than the unmarried males. Married females also had significantly higher MH than the unmarried females. With regard to age level, the univariate analyses indicated significant differences for

Table 1

Respondent Characteristics Among Three Physical Activity Groups in Males

	Male (n=575, 49.9%)		
	Recommended	Insufficient	Inactive
N	158	273	144
%	27.5	47.5	25.0
Mean Age (SD)	38.7(12.2)	40.1(10.8)	39.2(9.9)
Age group N (%)			
20-29	54 (37.0)	59 (40.4)	33 (22.6)
30-39	28 (19.5)	77 (53.5)	39 (27.0)
40-49	33 (22.9)	70 (48.6)	41 (28.5)
50-59	43 (30.5)	67 (47.5)	41 (22.0)
Marital status N (%)			
Married	90 (26.6)	160 (47.3)	88 (26.0)
Unmarried	68 (28.7)	113 (47.7)	56 (23.6)
Educational level N (%)			
≥college graduate	103 (28.3)	178 (48.9)	83 (22.8)
2-years college or equivalent	11 (15.1)	36 (49.3)	26 (35.6)
≤high school	43 (32.1)	57 (42.5)	38 (25.4)
Other	1 (25.0)	2 (50.0)	1 (25.0)
Household income level N (%)			
<3,000,000 yen	27 (31.4)	39 (45.3)	20 (23.3)
<5,000,000 yen	40 (26.5)	64 (42.4)	47 (31.1)
<7,000,000 yen	28 (24.8)	54 (47.8)	31 (27.4)
<10,000,000 yen	38 (25.5)	78 (52.3)	33 (22.2)
<15,000,000 yen	19 (32.8)	31 (53.4)	8 (13.8)
≥15,000,000 yen	6 (33.3)	7 (38.9)	5 (27.8)

Table 2

Respondent Characteristics Among Three Physical Activity Groups in Females

	Female (n=577, 50.1%)		
	Recommended	Insufficient	Inactive
N	126	276	175
%	21.9	47.8	30.3
Mean Age (SD)	40.1(11.9)	39.5(10.5)	38.3(10.9)
Age group N (%)			
20-29	32 (22.1)	62 (42.7)	51 (35.2)
30-39	25 (17.2)	75 (51.7)	45 (31.0)
40-49	32 (22.4)	76 (53.2)	35 (24.5)
50-59	37 (25.7)	63 (43.8)	44 (30.6)
Marital status N (%)			
Married	89 (22.7)	181 (46.2)	122 (31.1)
Unmarried	37 (20.0)	95 (51.3)	53 (28.7)
Educational level N (%)			
≥college graduate	43 (22.5)	104 (54.5)	44 (23.0)
2-years college or equivalent	45 (20.6)	109 (49.8)	65 (29.7)
≤high school	38 (23.9)	58 (36.5)	63 (39.6)
Other	0 (00.0)	5 (62.5)	3 (37.5)
Household income level N (%)			
<3,000,000 yen	18 (20.2)	40 (44.9)	31 (34.8)
<5,000,000 yen	41 (23.0)	71 (39.9)	66 (37.1)
<7,000,000 yen	29 (24.2)	63 (52.5)	28 (23.3)
<10,000,000 yen	22 (18.2)	65 (53.7)	34 (28.1)
<15,000,000 yen	13 (23.6)	30 (54.6)	12 (21.8)
≥15,000,000 yen	3 (21.4)	7 (50.0)	4 (28.6)

BP, SF, RE, and MH in males and MH in females. The RE for the 50-year age group was significantly higher than for the other three groups (20-, 30-, and 40-year age groups); the MH for the 50-year age group was significantly higher than that for the 20- and 30-year age groups. The MH for the 20-year age group was significantly lower than that for the 40- and 50-year age groups.

Likewise, gender (Wilk's $\lambda = .989$, $p = .002$), age level (Male: Wilk's $\lambda = .946$, $p = .000$; Female: Wilk's $\lambda = .962$, $p = .001$), and marital status (Male: Wilk's $\lambda = .964$, $p = .000$; Female: Wilk's $\lambda = .977$, $p = .001$) achieved statistical significance in the multivariate effects of PCS and MCS. The males had significantly higher PCS scores than the females. The married males had significantly higher PCS and MCS scores than the unmarried males. The married females also had significantly higher MCS than the unmarried females. In the case of the males, the MCS for the 50-year age group were significantly higher than those for the 20- and 30-year age groups; and the PCS for the 20-year age group were significantly higher than those for the 40- and 50-year age groups. In females, the MCS for the 20-year age group were significantly lower than those for the 40- and 50-year age groups.

Effects of physical activity level on HRQOL

Regarding the 8-domain scales scores, the between-physical activity group differences were investigated among all demographic variables. For both genders, all eight domains of the SF-8 were slightly higher in the recommended group than in the inactive group, with the exception of BP in females. However, the difference in scores between the recommended and inactive groups was relatively small, ranging from 3.11 to 0.59 points for males and 3.06 to 0.49 points for females. Moreover, for both genders, the differences between the recommended and insufficient groups were much smaller than those between the recommended and the inactive groups.

The physical activity groups were found to differ significantly only in regard to age, [Male: $F(8.561) = 3.788$, $p = .000$; Female: $F(8.563) = 2.592$, $p = .009$]. Marital status, household income level, and educational level failed to achieve statistical significance in the multivariate model. Therefore, only age was included as a covariate in all subsequent analysis. A one-way MANCOVA was conducted to examine the group differences in the SF-8 measures. The multivariate effects for physical activity level were significant (Male: Wilk's $\lambda = .943$, $p = .007$; Female: Wilk's $\lambda = .923$, $p = .000$). The univariate analyses indicated

significant differences for PF [Male: $F(2.568) = 6.62$, $p = .001$; Female: $F(2.570) = 7.59$, $p = .001$], GH [Male: $F(2.568) = 7.09$, $p = .001$; Female: $F(2.570) = 5.55$, $p = .004$], and VT [Male: $F(2.568) = 8.36$, $p = .000$; Female: $F(2.570) = 5.66$, $p = .004$] in both genders. Across both genders, the recommended group had significantly higher PF scores than the inactive group. Additionally, across both genders, the recommended group had significantly higher GH scores than the insufficient and inactive groups ($p < .05$). Moreover, the males in the recommended group had a significantly higher VT score than those in the insufficient and inactive groups of males, which was only higher than those for females in the inactive group ($p < .05$). Across both genders, the insufficient group had significantly higher PF than the inactive group ($p < .05$).

With regard to PCS and MCS, only age level achieved statistical significance in the multivariate model [Male: $F(2.567) = 8.724$, $p = .000$; Female: $F(2.569) = 7.619$, $p = .001$]. Thus, only age was included as a covariate in all subsequent analyses. A one-way MANCOVA was utilized to examine the group differences in PCS and MCS. The multivariate effects for physical activity level were significant only in males (Wilk's $\lambda = .975$, $p = .005$). The univariate analyses indicated significant differences for PCS [$F(2.568) = 6.600$, $p = .005$].

The recommended group had significantly higher PCS scores than the inactive group ($p = .001$). All significant differences persisted, despite the adjustment of age. The results of the MANCOVAs and univariate analyses for physical activity level and HRQOL measures were presented in Table 3.

Table 3

Unadjusted HRQOL Measures in Respondents Among Physical Activity Groups Stratified by Gender

	Physical Activity Group				
Male mean (SD)	Recommended	Insufficient	Inactive	$F^{\S}$	#
PF	50.82 (4.31)	49.74 (6.89)	47.96 (8.99)	6.61**	b**, c*
RP	50.87 (4.57)	50.24 (5.49)	49.42 (6.25)	2.64	
BP	51.64 (7.57)	51.69 (7.77)	50.37 (8.45)	1.48	
GH	50.36 (6.96)	47.99 (6.68)	47.89 (6.86)	7.02**	a**, b**
VT	50.84 (6.74)	48.57 (6.85)	47.73 (7.51)	8.34***	a**, b**
SF	48.83 (8.49)	48.79 (7.93)	47.24 (8.81)	1.91	
RE	48.83 (7.46)	48.83 (6.47)	48.27 (6.75)	0.41	
MH	49.16 (7.68)	48.72 (7.00)	48.46 (7.03)	0.56	
PCS	50.65 (4.89)	49.38 (6.60)	48.00 (6.68)	6.59**	b**
MCS	47.56 (8.58)	47.30 (7.31)	47.04 (7.22)	0.32	
Female mean (SD)					
PF	50.44 (4.57)	49.40 (6.24)	47.38 (9.36)	724**	b**, c*
RP	49.45 (5.37)	49.27 (6.16)	48.83 (7.26)	0.29	
BP	48.42 (8.06)	48.89 (8.18)	48.91 (8.55)	0.21	
GH	49.47 (7.30)	47.40 (7.15)	46.64 (7.10)	5.51*	a*, b**
VT	50.39 (6.40)	48.84 (6.90)	47.60 (7.29)	5.59*	b**
SF	47.23 (8.19)	47.21 (8.13)	46.58 (8.98)	0.14	
RE	48.89 (6.87)	48.08 (7.46)	48.01 (7.05)	0.56	
MH	47.76 (7.22)	46.85 (7.88)	47.16 (7.40)	0.72	
PCS	49.05 (6.42)	48.52 (6.67)	47.17 (7.84)	2.95	
MCS	47.13 (7.74)	46.20 (7.99)	46.46 (7.43)	0.63	

HRQOL: Health related quality of life scale, Short Form-8
PF: Physical functioning, RP: Role physical, BP: Bodily pain, GH: General health, VT: Vitality, SF: Social functioning, RE: Role emotional, MH: Mental health, PCS: Physical component summary, MCS: Mental component summary
[§]comparison in multidimensional scales of SF-8 among physical activity levels with covariate of age, marital status, educational level and income level
[#] Bonferroni-adjusted univariate multiple comparison
a: recommended vs. insufficient, b: recommended vs. inactive, c: insufficient vs. inactive
*** p<.000 ** p<.001 *p<.05

CHAPTER 3

PREVALENCE AND DEMOGRAPHIC CORRELATES OF MEETING PHYSICAL ACTIVITY RECOMMENDATION AMONG JAPANESE ADULTS

Purpose

The present study was purposed to examine the prevalence of attaining the Japanese recommended level of physical activity and primarily to identify demographic correlates of meeting the physical activity recommendation among the Japanese adults.

Methods

Participants

For the current study, the data sample consisted of 5253 male and female respondents to an internet-based cross-sectional survey, which was conducted via the Japanese Internet research service organization. This Internet research service organization owned approximately 264,000 voluntary registered samples and had detailed sample sociodemographic attributes available and was capable to target specific attributes according to each survey requirement. The set sample size and attributes in the current study were as follows: approximately 5000 male and female adults aged 20–79 years, with an equivalent number of males

and females in each age bracket. Potential respondents were randomly and automatically selected in accordance with the set sample size and attributes from the registered samples and were invited to participate in an Internet-based survey from the Internet research service organization via e-mail. Internet-based questionnaires were placed in a protected area of a web site and the potential respondents received the specific URL of the Internet research service organization in an invitation e-mail. The potential respondents could log on the protected area of a web site using their own login ID and password. Reward points valued at 80 yen were provided as incentives for participation from the Internet research service organization. All respondents voluntarily completed and signed an online Institutional Review Board-approved letter of informed consent and demographic data information. In addition, the following measures were administered.

Measurements

Physical activity. The IPAQ was utilized to estimate the amount of physical activity the participants engaged in. The IPAQ has been used in several countries (Craig et al., 2003). This self-administered questionnaire was designed to be utilized by adults aged 18 to 65 years, and it identifies the frequency and duration of walking, moderate and vigorous physical activity, and sedentary activity during the past week

(Craig et al., 2003). The test-retest reliability of the short, self-administered, Japanese version of the IPAQ is good (Spearman r = 0.72–0.93). The criterion validity for the Japanese version of the IPAQ against an accelerometer is acceptable (Spearman r = 0.39; Murase et al., 2002).

The short form data were utilized to estimate the total weekly physical activity, moderate to vigorous intensity activity, and walking level (METs-hour/week) by weighting the reported hours per week within each of three activity categories—walking, moderate, and vigorous activity—by MET energy expenditure estimates assigned to each category of activity. METs value to each activity category was obtained from the study of Craig et al. (2003). Current national guidelines for exercise in Japan recommend 23 METs-hour/week of physical activity (Ishikawa-Takata & Tabata, 2007; Ministry of Health, Labour and Welfare, 2006a). Based on each of their estimated total weekly physical activity, the moderate to vigorous intensity activity, and the walking level, respondents were assigned to one of three (mutually exclusive and exhaustive) groups. Those who engaged in no physical activity, indicating none reported, were assigned to the inactive group. Those who engaged in physical activity which was less than the recommended level but greater than none were assigned to the insufficient group. Finally, persons who

engaged in 23 METs-hour/week of physical activity or more were assigned to the recommended group.

Possible demographic correlates. Possible demographic correlates of participation in the recommended level of physical activity included gender, age, marital status, educational level, household income level, and employment status. Age was classified in years as 20 to 29, 30 to 39, 40 to 49, and 50 or older. Marital status was categorized as currently married or not currently married. Educational level was classified as less than high school graduate, junior college graduate or equivalent, and college graduate or higher. Household income level was classified into 5 categories, ranging from less than 3,000,000 to 15,000,000 yen or more annually. The current study utilized the existing classification of household income level set by the Internet research service organization with reference to the National Survey of Family Income and Expenditure by the Statistics Bureau Ministry of Public Management Home Affaires Japan. Employment status was categorized as employed or unemployed.

Statistical analyses

For the analysis, data were analyzed for 5177 persons who provided complete information for the study variables. All the analyses were stratified by gender. Descriptive statistics were reported by physical activity levels

(recommended, insufficient, and inactive). Chi-square tests were utilized to determine the differences in the proportions of individuals who assigned to either recommended, insufficient, or inactive group within the demographic variables. A multivariate logistic regression analysis was conducted to examine whether potential demographic correlates related to physical activity levels even after controlling for all other demographic variables. The adjusted odd ratios (ORs) and a 95% confidence interval (CI) were calculated for the potential demographic variables. Independent variables included age, marital status, educational status, employment status, and household income level. Statistical significance was considered to be $p < 0.05$. The SPSS for Windows 14.0 was utilized to compute the statistics (SPSS, 2005).

Results

Basic characteristics of respondents

In the present study, 2587 males and 2590 females were classified into three groups according to their physical activity level. Table 1 presents the distribution of age, marital status, educational level, household income level, and employment status for males and females. Overall, 65% of the respondents were married (59% of males and 71% of females). Twenty-four percent of the samples (21% of males and 29% of

females) had less than a high school diploma, while 51% had graduated from a college or graduate school (67% of males and 35% of females). Eighty-three percent of males and 31% of females were employed. Overall, 15% of the respondents had a household income of less than 3,000,000 yen, while 3% earned more than 15,000,000 yen per year. The distributions of age and household income level were similar for males and females. Responders were more likely to be younger and have a higher educational status and household income level compared to the general Japanese population (Statistics Bureau Ministry of Public Management, Home Affairs, Post and Telecommunications, 2001, 2007a, 2007b; Ministry of Health, Labour and Welfare, 2006b). Similar trends were observed in gender, marital status, and employed status (Statistics Bureau Ministry of Public Management, Home Affairs, Post and Telecommunications, 2001, 2007a, 2007b). Table 4 presents the distribution of age, marital status, educational level, employment status, and household income level for the study participants and the general Japanese adults (Statistics Bureau Ministry of Public Management, Home Affairs, Post and Telecommunications, 2001, 2007a, 2007b; Ministry of Health, Labour and Welfare, 2006b).

Prevalence of recommended physical activity recommendation

Table 5 and 6 present the prevalence of physical activity levels by gender. Overall, 26.6% of the respondents were

Table 4

Basic Characteristics for Male and Female Respondents and General Japanese Adults

	Participants						*#General Japanese
	Male		Female		Total		
	n	%	n	%	n	%	%
Total	2587	50.0	2590	50.0	5177	100.0	-
Age							
20-29	643	24.9	651	25.1	1294	25.0	15.9
30-39	646	25.1	646	24.9	1295	25.0	19.0
40-49	651	25.2	651	25.1	1302	25.1	16.3
≥50	644	24.9	642	24.8	1286	24.9	48.8
Marital status							
Married	1529	59.1	1845	71.2	3374	65.2	64.5
Unmarried	1058	40.9	745	28.8	1803	34.8	35.5
Educational status							
≤high school graduate	538	20.8	739	28.5	1277	24.7	67.7
2-years college or equivalent	322	12.4	955	36.9	1277	24.7	12.6
≥college graduate	1727	66.8	896	34.6	2623	50.7	15.5
Employment status							
Employed	2138	82.6	811	31.3	2949	57.0	56.0
Unemployed	449	17.4	1779	68.7	2228	43.0	44.0
Household income level							
<3,000,000 yen	372	14.4	424	16.4	796	15.4	30.6
3,000,000- yen	704	27.2	739	28.5	1443	27.9	23.2
5,000,000- yen	628	24.3	575	22.2	1203	23.2	13.5
7,000,000- yen	516	19.9	531	20.5	1047	20.2	17.2
10,000,000- yen	268	10.4	258	10.0	526	10.2	7.6
15,000,000- yen	99	3.8	63	2.4	162	3.1	3.7

*Reference
Age, Marital Status, & Employed status: 2005 Population Census of Japan
Educational Status: 2000 Population Census of Japan
Household Income levels: 2006 National Livelihood Survey
#All data of those who aged 19 and below were excluded.

Table 5

Prevalence of Physical Activity Status in Males

	Male							
	Recommended		Insufficient		Inactive			
	n	%	N	%	n	%	x^2	(df,n)
Total	785	30.3	1154	44.6	648	25.0		
Age							6.98	6, 2587
20-29	207	32.2	266	41.4	170	26.4		
30-39	192	29.6	287	44.2	170	26.2		
40-49	184	28.3	304	46.7	163	25.0		
≥50	202	31.4	297	46.1	145	22.5		
Marital status							10.45**	2, 2587
Married	453	29.6	720	47.1	356	23.3		
Unmarried	332	31.4	434	41.0	292	27.6		
Educational status							21.78***	4, 2587
≤high school graduate	196	36.4	199	37.0	143	26.6		
2-years college or equivalent	94	29.2	136	42.2	92	28.6		
≥college graduate	495	28.7	819	47.4	413	23.9		
Employment status							9.83**	2, 2587
Employed	621	29.0	971	45.4	546	25.5		
Unemployed	164	36.5	183	40.8	102	22.7		
Household income level							29.52**	10, 2587
<3,000,000 yen	125	33.6	144	38.7	103	27.7		
3,000,000- yen	220	31.3	291	41.3	193	27.4		
5,000,000- yen	166	26.4	286	45.5	176	28.0		
7,000,000- yen	162	31.4	244	47.3	110	21.3		
10,000,000- yen	80	29.9	139	51.9	49	18.3		
15,000,000- yen	32	32.3	50	50.5	17	17.2		

*Reference
Age, Marital Status, & Employed status: 2005 Population Census of Japan
Educational Status: 2000 Population Census of Japan
Household Income levels: 2006 National Livelihood Survey
#All data of those who aged 19 and below were excluded.

Table 6

Prevalence of Physical Activity Status in Females

	Female							
	Recommended		Insufficient		Inactive			
	n	%	n	%	n	%	x^2	(df,n)
Total	593	22.9	1356	52.4	641	24.7		
Age							31.22***	6, 2590
20-29	150	23.0	350	53.8	151	23.2		
30-39	123	19.0	331	51.2	192	29.7		
40-49	140	21.5	333	51.2	178	27.3		
≥50	180	28.0	342	53.3	120	18.7		
Marital status							7.13*	2, 2590
Married	448	24.3	945	51.2	452	24.5		
Unmarried	145	19.5	411	55.2	189	25.4		
Educational status							27.99***	4, 2590
≤high school graduate	163	22.1	357	48.3	219	29.6		
2-years college or equivalent	212	22.2	490	51.3	253	26.5		
≥college graduate	218	24.3	509	56.8	169	18.9		
Employment status							0.68	2, 2590
Employed	182	22.4	420	51.8	209	25.8		
Unemployed	411	23.1	936	52.6	432	24.3		
Household income level							23.41**	10, 2590
<3,000,000 yen	93	21.9	217	51.2	114	26.9		
3,000,000- yen	175	23.7	386	52.2	178	24.1		
5,000,000- yen	113	19.7	295	51.3	167	29.0		
7,000,000- yen	120	22.6	282	53.1	129	24.3		
10,000,000- yen	75	29.1	138	53.5	45	17.4		
15,000,000- yen	17	27.0	38	60.3	8	12.7		

physically active at the recommended level. Males (30.3%) surpassed females (22.9%) in attaining the recommended level. Furthermore, females (52.4%) were more likely to engage in insufficient levels of physical activity than males (44.6%). The prevalence of those who were inactive was similar for both males and females (25.0% of males and 24.7% of females).

For males, the prevalence of meeting the recommended level physical of activity decreased with advancing age until 40-year age group and increased in the 50-year age group. The prevalence of meeting the recommended level of physical activity was the highest in the younger (20–29 years) age group and lowest in the 40-year age group (29.6%). For females, the prevalence of attaining the recommended physical activity decreased in the 30-year age group and then successively increased with advancing age. Meeting the recommended level of physical activity was the highest in the older age group (>50 years: 28.0%) and the lowest in the 30-year age group (19.0%). For both males and females, the proportion of those attaining the recommended level of physical activity was lower in the middle aged (30–49 years) groups than in the other 2 groups. While males surpassed females in meeting the physical activity recommendation in all the age groups, the gender difference in the 50-year age group (3.4%) was less than that in the other age groups (9.2% of the 20-year, 10.6% of the

30-year, & 6.8% of the 40-year age groups).

With regard to marital status, for males, those who were married were less physically active at the recommended level (29.6% vs. 31.4%), whereas, the married females were more active (24.3% vs. 19.5%) at the recommended level. Meeting the physical activity recommendation was successively lower for males but slightly higher for females with greater educational attainment. As for employment status, the unemployed males (36.5%) were more physically active at the recommended level than the employed males (25.0%). For females, the prevalence of meeting the recommended physical activity was similar for both the employed (22.9%) and the unemployed (23.1%). With regard to income level, for both males and females, those with a household income of 5,000,000 yen to 7,000,000 yen had the lowest prevalence of meeting the recommended level of physical activity.

With respect to the prevalence of meeting physical activity recommendation on the types of physical activity, approximately two thirds of the respondents (66.6%) reported to walk at least 10 minutes or more per week (male: 65.5%; female: 67.7%). However, only 11.1% (male: 12.1%; female: 10.2%) did a recommended amount of walking. On the other hand, overall 40.9% (male: 45.2%; female: 36.6%) of respondents were reported to engage in moderate to vigorous intensity activity

at least 10 minutes or more per week. Of those who engaged in a moderate to vigorous intensity activity, 15.3% (male: 18.5%; female: 12.1%) achieved recommended level of physical activity. The prevalence of walking at insufficient level was 55.4% (male: 53.4%; female: 57.5%), as compared with 25.6% (male: 26.7%; female: 24.5%) of those who engaged in moderate to vigorous intensity activity. Table 7 presents types of activity undertaken by physical activity level.

Demographic correlates of recommended physical activity

The ORs for physical activity levels are presented in Table 8 and 9 by age, marital status, educational level, employment status, and household income level. Gender, employment status for males, and age, marital status, and educational level for females were the demographic correlates that had a statistical significance for meeting the recommended level of physical activity. Females were less likely to attain the recommended level of physical activity than males (OR = 0.71; 95% CI: 0.59–0.86). For males, employment status was inversely correlated with meeting the physical activity recommendation (OR = 0.64; 95% CI: 0.46–0.87). For females, marital status was positively associated with meeting the recommended physical activity level (OR = 1.41; 95% CI: 1.02–1.94). Moreover, those with college degrees or higher were approximately twice as likely to meet the recommended level

Table 7

Type of Activity undertaken by physical Activity Level

	n	Physical Activity Level			As % of Total Sample (%)
		Recommended (%)	Insufficient (%)	Inactive (%)	
Total (n=5177)					
No activity	1289	0	0	100	24.9
Walking	3448	11.1	55.4	33.4	66.6
Moderate to vigorous intensity activity	2116	15.3	25.6	59.1	40.9
Total physical activity	3888	26.6	48.5	24.9	75.1
Male (n=2587)					
No activity	648	0	0	100	25.0
Walking	1695	12.1	53.4	34.5	65.5
Moderate to vigorous intensity activity	1169	18.5	26.7	54.8	45.2
Total physical activity	1939	30.3	44.6	25.0	75.0
Female (n=2590)					
No activity	641	0	0	100	24.7
Walking	1753	10.2	57.5	32.3	67.7
Moderate to vigorous intensity activity	947	12.1	24.5	63.4	36.6
Total physical activity	1949	24.7	52.4	24.7	75.3

Table 8

Adjusted Odds Ratios for Meeting Recommended Levels of Physical Activity Among Males and Females

	Recommended					
	Male			Female		
	OR	(95% CI)		OR	(95% CI)	
Age						
20-29	1	(ref)		1	(ref)	
30-39	1.02	(0.74-1.41)		0.65	(0.46-0.91)	*
40-49	0.92	(0.65-1.29)		0.76	(0.54-1.09)	
≥50	0.97	(0.68-1.39)		1.44	(0.99-2.08)	
Marital status						
Unmarried	1	(ref)		1	(ref)	
Married	1.19	(0.92-1.54)		1.41	(1.02-1.94)	*
Educational status						
≤high school graduate	1	(ref)		1	(ref)	
2-years college or equivalent	0.76	(0.53-1.10)		1.23	(0.93-1.62)	
≥college graduate	0.83	(0.64-1.07)		1.86	(1.37-2.52)	***
Employment status						
Unemployed	1	(ref)		1	(ref)	
Employed	0.64	(0.47-0.88)	**	0.97	(0.74-1.27)	
Household income level						
<3,000,000 yen	1	(ref)		1	(ref)	
3,000,000- yen	1.05	(0.75-1.50)		1.17	(0.82-1.68)	
5,000,000- yen	0.88	(0.61-1.27)		0.77	(0.53-1.14)	
7,000,000- yen	1.41	(0.95-2.08)		0.98	(0.66-1.46)	
10,000,000- yen	1.58	(0.98-2.53)		1.55	(0.95-2.51)	
15,000,000- yen	1.88	(0.97-3.67)		1.82	(0.73-4.50)	

OR= odd ratios; CI=confidence interval; ref= referent group
*** p<.000 ** p<.001 *p<.05

Table 9

Adjusted Odds Ratios for Participating in Insufficient Levels of Physical Activity Among Males and Females

	Insufficient					
	Male			Female		
	OR	(95% CI)		OR	(95% CI)	
Age						
20-29	1	(ref)		1	(ref)	
30-39	1.05	(0.78-1.42)		0.84	(0.64-1.11)	
40-49	1.01	(0.74-1.39)		0.90	(0.67-1.21)	
≥50	1.03	(0.74-1.44)		1.41	(1.02-1.94)	*
Marital status						
Unmarried	1	(ref)		1	(ref)	
Married	1.28	(1.01-1.63)	*	0.93	(0.71-1.21)	
Educational status						
≤high school graduate	1	(ref)		1	(ref)	
2-years college or equivalent	1.07	(0.76-1.51)		1.25	(0.99-1.57)	
≥college graduate	1.32	(1.03-1.70)	*	1.88	(1.46-2.43)	***
Employment status						
Unemployed	1	(ref)		1	(ref)	
Employed	0.79	(0.58-1.07)		0.85	(0.68-1.06)	
Household income level						
<3,000,000 yen	1	(ref)		1	(ref)	
3,000,000- yen	1.10	(0.79-1.53)		1.23	(0.91-1.67)	
5,000,000- yen	1.13	(0.80-1.59)		0.99	(0.72-1.35)	
7,000,000- yen	1.51	(1.04-2.18)	*	1.15	(0.83-1.61)	
10,000,000- yen	1.85	(1.19-2.87)	**	1.44	(0.94-2.20)	
15,000,000- yen	1.97	(1.05-3.69)	*	2.07	(0.92-4.67)	

OR= odd ratios; CI=confidence interval; ref= referent group
*** p<.000 ** p<.001 *p<.05

of physical activity compared to those with less than a high school education (OR = 1.86; 95% CI: 1.37–2.52). However, females in the 30-year age group were less likely to be physically active at the recommended level than the other age groups (OR = 0.65; 95% CI: 0.46–0.91).

As for the associations between insufficient level of physical activity and demographic correlates, marital status was positively related to engagement in an insufficient level of physical activity for males (OR = 1.28; 95% CI: 1.01–1.63). Also, those with a college degree or higher (OR = 1.32; 95% CI: 1.03–1.70) as well as those with a household income of 7,000,000 yen or more (OR = 1.51, 1.85, 1.97; 95% CI: 1.04–2.18, 1.19–2.87, 1.05–3.69) were more likely to participate in an insufficient level of physical activity than the other corresponding groups. Females aged 50 years or older (OR = 0.90; 95% CI: 1.02–1.94) as well as those with a college degree or higher (OR =1.88 CI: 1.46–2.43) were more likely to engage in insufficient physical activity than the corresponding groups.

CAHPTER 4

RELATIVE CONTRIBUTIONS OF PSYCHOLOGICAL SOCIAL, AND ENVIRONMENTAL FACTORS TO MEETING PHYSICAL ACTIVITY RECOMMENDATION AMONG JAPANESE ADULTS

Purpose

The present study was purposed to examine the relative contributions of psychological, social, and environmental factors to meeting physical activity recommendations among the general adult population in Japan.

Methods

Participants

The data sample for the current study consisted of 2,000 male and female respondents to an Internet-based cross-sectional survey, which was conducted through a Japanese Internet research service organization that owns approximately 264,000 voluntarily registered samples all over Japan. The organization had access to samples of detailed sociodemographic attributes and was able to target specific attributes according to the requirements of each survey. The set sample size and attributes in the current study were as follows: approximately 2,000 adults, 20–79 years of age, stratified by an equivalent distribution of Japanese national age, gender, and regional distributions

on the 2005 Population Census of Japan (Statistics Bureau Ministry of Public Management, 2007a). Total of 7501 potential respondents were randomly and blindly selected according to the set sample size and attributes from the registered samples and were subsequently invited via e-mail to participate in the Internet-based survey. The invitation e-mail contained a URL directing the potential respondents to a protected area of the Web site where the questionnaire was located. They could then log on using their own login ID and password. As incentives for participation, the Internet research service organization offered reward points valued at 40 yen. US one dollar was equivalent to approximately 109 yen. All of the respondents voluntarily completed a demographic data information form and signed an online Institutional Review Board-approved letter of informed consent.

Measurements

Physical activity. The IPAQ was utilized to estimate the amount of physical activity the participants engaged in. The IPAQ was designed for adults 18–65 years of age for the purpose of identifying the frequency and duration of walking, moderate and vigorous physical activity, and sedentary activity during the past week (Craig et al., 2003). One-week test-retest reliability of the short, self-administered, Japanese version of the IPAQ is good (Spearman r = .72–.93), and the criterion

validity for the Japanese version of the IPAQ against an accelerometer is acceptable (Spearman r = .39; Murase et al., 2002).

The short form data were utilized to estimate the total weekly physical activity, the moderate to vigorous intensity activity, and the walking level (METs-hour/week) by weighting the reported hours per week within each of three activity categories—walking, moderate, and vigorous activity—by MET energy expenditure estimates assigned to each category of activity. METs value to each activity category was obtained from the study of Craig et al. (2003). Current national guidelines for exercise in Japan recommend 23 METs-hour/week of physical activity (Ishikawa-Takata & Tabata, 2007; Ministry of Health, Labour and Welfare, 2006a). Based on each of their estimated total weekly physical activity, moderate to vigorous intensity activity, and walking level, respondents were assigned to one of three (mutually exclusive and exhaustive) groups. Those who engaged in no physical activity, indicating none reported, were assigned to the inactive group. Those who engaged in physical activity which was less than the recommended level but greater than none were assigned to the insufficient group. Finally, persons who engaged in 23 METs-hour/week of physical activity or more were assigned to the recommended group.

Demographic variables. Demographic variables included

gender, age, marital status, educational level, household income, and employment status. Age was classified in years as 20–29, 30–39, 40–49, and 50 or older. Marital status was categorized as currently married or currently unmarried. Educational level was classified as less than high school graduate, junior college graduate or equivalent, and college graduate or higher. Household income was classified into five categories, ranging from less than 3,000,000 yen to 15,000,000 yen or more annually. US one dollar was equivalent to approximately 109 yen. Employment status was categorized as employed or unemployed.

Psychological variables. Self-efficacy for exercise was measured with a four-item scale that assessed the confidence of participants in engaging in a physical activity when they were faced with common barriers (Oka, 2003). The participants were asked to rate their level of confidence using a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) in terms of their ability to be physically active under the following conditions: physical tiredness, poor weather conditions, lack of time, and psychological stress. For this scale, the two-week test-retest reliability ($r = .78$) and internal consistency ($\alpha = .84$) were good (Oka, 2003). In addition, self-efficacy scores from this scale have been reported to be associated with the stage of change for exercise

behavior ($p < .001$; Oka, 2003). All of the items were subsequently summed to form a single self-efficacy variable, which was dichotomized into high and low categories based on a median split.

Avoidance of exercise (cons) and positive perceptions of exercise (pros) were assessed by a decisional balance measure (pros minus cons), including a 10-item pros scale and a 10-item cons scale (Oka, Hirai, & Tsutsumi, 2003). The participants rated the importance of each item on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), and good two-week test-retest reliability (pros: $r = .80$; cons: $r = .77$) and internal consistency (pros and cons scales: $\alpha = .84$) were reported (Oka et al., 2003). Additionally, pros, cons, and the decisional balance measure were observed to be associated with the stage of exercise adoption ($p < .001$; Oka et al., 2003). All of the items were subsequently summed to form a single item for pros and cons and dichotomized into high and low categories using a median split.

Social variables. Social support for exercise from family and friends was measured using a five-item scale (Itakura et al., 2003, 2005; Oka, Togo, & Aoyagi, 2004). This scale assessed functional, emotional, and informational social support for exercise using a 5-point Likert scale that measured participants' agreement or disagreement on a scale of 1

(strongly disagree) to 5 (strongly agree) for the following contents: advice/instruction, understanding/sympathy, encouragement/reinforcement, joint implementation, compliment/appreciation. This scale has been tested and validated and reliable in Japan (Itakura et al., 2003). All of the items were subsequently summed to form a single item for social support and dichotomized into high and low categories using a median split.

By referring to previous research (Glasgow et al., 2001), a question with regarding to health professional advice/support was asked "Within the last year, have you been advised by a physician and/or health professional to exercise more?" The participants responded by answering yes or no.

Environmental variables. The perceived neighborhood environments for physical activity, which may act as facilitators or barriers to physical activity, were assessed by five items obtained from the previous investigation (Oka et al., 2004). These items are as follows: (1) I have home fitness equipments (shoes, pedometer, dumbbell, etc.), (2) I have access to facilities that promote physical activity, (3) I ensure neighborhood safety (adequate lighting and sidewalks, light traffic volume, etc.) for physical activity, (4) I have access to enjoyable scenery when engaging in physical activity, and (5) I frequently observe other people exercising. Each item

was assessed on a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree) and dichotomized into yes and no categories. Furthermore, the participants were asked to state whether their residential area was urban, suburban, or rural.

Statistical Analyses

The data were analyzed for 1,932 adults who provided complete information for the study variables. All the analyses were stratified by gender. Descriptive statistics were reported by physical activity levels (recommended, insufficient, and inactive). Chi-square analyses were utilized to determine a bivariate association between physical activity group and all demographic, psychological, social, and environmental variables. A force entry multinomial logistic regression analysis was conducted to examine whether or not potential demographic, psychological, social, and environmental correlates were related to physical activity levels even after controlling for all other demographic variables. The adjusted ORs and a 95% CI were calculated for the potential demographic variables. The independent variables included gender, age, marital status, educational status, employment status, household income, self-efficacy, pros, cons, social support, advice from a health professional, home fitness equipment, access to facilities, neighborhood safety, enjoyable scenery,

frequently observing others exercising, and urban location. The statistical significance was considered to be $p < .05$. The SPSS for Windows 14.0 was utilized to compute the statistics (SPSS, 2005).

Results

Basic characteristics of respondents

In the present study, 962 males and 970 females were classified into three groups according to their self-reported physical activity level. Table 10 presents the demographic characteristics of the respondents and comparative data from the 2005 and 2000 Population Census of Japan and 2006 National Livelihood Survey (Ministry of Health, Labour and Welfare, 2006b; Statistics Bureau Ministry of Public Management, Home Affairs, Post and Telecommunications, 2001, 2007a, 2007b). The frequencies for gender, age, marital status, and employment status in the respondents were relatively similar to those in the Census data. However, the respondents had a higher educational status and household income as compared to the general Japanese population.

Prevalence of meeting physical activity recommendations

Table 11 and 12 present the comparisons of demographic characteristics by gender among three physical activity levels. Overall, 28.3% of the respondents attained the recommended

Table 10

Demographic Characteristics of Male and Female Respondents

	Participants						*#General Japanese
	Male		Female		Total		
	n	%	N	%	n	%	%
Total	962	49.8	970	50.2	1932	100.0	-
Age							
20–29	192	20.0	195	20.1	387	20.0	15.9
30–39	196	20.4	191	19.7	387	20.0	19.0
40–49	197	20.5	196	20.2	393	20.3	16.3
≥50	377	39.2	388	40.0	765	39.6	48.8
Marital status							
Married	606	63.0	703	72.5	1309	67.8	64.5
Unmarried	356	37.0	267	27.5	623	32.2	35.5
Educational status							
≤high school graduate	237	24.6	292	30.1	529	27.4	67.7
2-years college or equivalent	125	13.0	358	36.9	483	25.0	12.6
≥college graduate	600	62.4	320	33.0	920	47.6	15.5
Employment status							
Employed	801	83.3	496	51.1	1297	67.1	56.0
Unemployed	161	16.7	474	48.9	635	32.9	44.0
Household income							
<3,000,000 yen	150	15.6	160	16.5	310	16.0	30.6
3,000,000– yen	283	29.4	265	27.3	548	28.4	23.2
5,000,000– yen	201	20.9	195	20.1	396	20.5	13.5
7,000,000– yen	202	21.0	214	22.1	416	21.5	17.2
10,000,000– yen	101	10.5	98	10.1	199	10.3	7.6
15,000,000– yen	25	2.6	38	3.9	63	3.3	3.7

Table 11

Comparisons of Demographic Characteristics Among Three Physical Activity Levels in Japanese Male Adults

	Male (n = 962)			
	Recommended	Insufficient	Inactive	
	%			x^2
Total	31.6	48.3	20.1	
Age				5.96
20–29	30.7	44.3	25.0	
30–39	30.6	48.5	20.9	
40–49	30.5	48.7	20.8	
≥50	33.2	50.1	16.7	
Marital status				3.15
Married	32.5	49.2	18.3	
Unmarried	30.1	46.9	23.0	
Educational status				10.76*
≤high school graduate	34.2	45.1	20.7	
2-years college or equivalent	40.8	37.6	21.6	
≥college graduate	28.7	51.8	19.5	
Employment status				2.77
Employed	30.6	49.4	20.0	
Unemployed	36.6	42.9	20.5	
Household income				10.34
<3,000,000 yen	33.3	41.3	25.3	
3,000,000– yen	29.7	49.1	21.2	
5,000,000– yen	30.3	48.8	20.9	
7,000,000– yen	34.2	49.5	16.3	
10,000,000– yen	29.7	55.4	15.8	
15,000,000– yen	44.0	40.0	16.0	

*** p < .000, ** p < .001, *p < .05

Table 12

Comparisons of Demographic Characteristics Among Three Physical Activity Levels in Japanese Female Adults

	Female (n = 970)			
	Recommended	Insufficient	Inactive	
	%			x^2
Total	24.9	52.4	22.7	
Age				20.79*
20–29	22.1	51.3	26.7	
30–39	18.9	55.5	25.7	
40–49	25.5	45.9	28.6	
≥50	29.1	54.6	16.2	
Marital status				10.62*
Married	27.0	52.6	20.3	
Unmarried	19.5	51.7	28.8	
Educational status				8.89
≤high school graduate	21.6	51.7	26.7	
2 years of college	28.5	49.2	22.3	
≥college graduate	24.1	48.3	19.5	
Employment status				10.62
Employed	23.6	48.3	25.6	
Unemployed	26.4	54.0	19.6	
Household income				22.80*
<3,000,000 yen	21.9	48.8	29.4	
3,000,000– yen	21.1	54.0	24.9	
5,000,000– yen	28.2	49.7	22.1	
7,000,000– yen	23.4	58.4	18.2	
10,000,000– yen	28.6	53.1	18.4	
15,000,000– yen	47.4	34.2	18.4	

*** p < .000, ** p < .001, *p < .05

level of physical activity; however, males (31.6%) surpassed females (24.9%) in this regard. For males, the prevalence of attaining the recommended level of physical activity was similar in all age groups; for females, the prevalence of attaining the recommended physical activity level decreased in the 30-years age group (18.8%) and then successively increased with advancing age. Regarding marital status, the prevalence of meeting the recommended level physical of activity was similar in both married and unmarried males, whereas married females were more likely to be physically active at the recommended level (27.0% vs.19.5%). Males with the highest educational level attainment were less likely to attain the recommended physical activity level, whereas the prevalence for females was similar regardless of educational level. As for employment status, the unemployed males and females had a great tendency to be more physically active at the recommended level than the employed males and females. With respect to household income, for males, the prevalence of attaining the recommended level of physical activity was relatively similar in all age groups, except in the case of those in the highest income group. For females, the two lowest income groups were less likely to attain the recommended level of physical activity than the other three groups.

With respect to the prevalence of meeting physical activity

recommendation on the types of physical activity, the proportion of the respondents who walked at least 10 minutes or more per week was high (total: 69.0%; male: 70.7%; female: 67.3%). However, only 12.1% (male: 12.7%; female: 11.4%) did a recommended amount of walking. On the other hand, overall 41.8% (male: 44.0%; female: 39.6%) of respondents were reported to engage in moderate to vigorous intensity activity at least 10 min or more per week. Of those who engaged in a moderate to vigorous intensity activity, 16.2% (male: 19.0%; female: 13.4%) achieved recommended level of physical activity. The majority (56.9%) of respondents reported to walk at insufficient level, whereas 58.2% of respondents reported no engagement in moderate to vigorous intensity activity. Table 13 presents types of activity undertaken by physical activity level.

Bivariate association among recommended physical activity and psychological, social, and environmental variables

Table 14 and 15 present the bivariate relationship between physical activity level and psychological, social, and environmental factors by gender. Most of the psychological, social, and environmental factors were significantly associated with attaining the recommended level of physical activity. For both males and females, those who reported a high level of self-efficacy, greater pros and fewer cons, a high level of social support, possessing home fitness equipment,

Table 13

Type of Activity Undertaken by Physical Activity Level

	n	Physical Activity Level			As % of Total Sample (%)
		Recommended (%)	Insufficient (%)	Inactive (%)	
Total (n=1932)					
No activity	413	0	0	100	21.4
Walking	1333	12.1	56.9	31.0	69.0
Moderate to vigorous intensity activity	807	16.2	25.6	58.2	41.8
Total physical activity	1519	28.3	50.4	21.4	78.6
Male (n=962)					
No activity	193	0	0	100	20.1
Walking	680	12.7	58.0	29.3	70.7
Moderate to vigorous intensity activity	423	19.0	24.9	56.0	44.0
Total physical activity	769	31.6	48.3	20.1	79.9
Female (n=970)					
No activity	220	0	0	100	22.7
Walking	653	11.4	55.9	32.7	67.3
Moderate to vigorous intensity activity	384	13.4	26.2	60.4	39.6
Total physical activity	750	24.9	52.4	22.7	77.3

Table 14

Bivariate Relationship Between Physical Activity Level and Psychological, Social, and Environmental Factors Among Japanese Males

	Male (n = 962)			
	Recommended	Insufficient	Inactive	
	%			x^2
Self-efficacy				66.17***
Low	20.1	51.2	28.7	
High	41.4	45.9	12.7	
Pros				43.85***
Low	24.4	46.8	28.8	
High	37.6	49.6	12.8	
Cons				20.76***
Low	38.3	46.3	15.4	
High	26.0	50.0	24.0	
Social support				26.17***
Low	23.7	52.6	23.7	
High	38.7	44.5	16.8	
Health professional advice				2.87
No	32.5	46.5	21.0	
Yes	29.6	52.3	18.1	
Home equipment				30.59***
No	25.3	50.2	24.5	
Yes	40.2	45.8	14.0	
Access to facilities				30.63***
Low	26.0	46.0	28.0	
High	35.8	50.1	14.1	
Neighborhood safety				18.75***
Low	26.1	48.5	25.4	
High	36.1	48.2	15.7	
Enjoyable scenery				32.98***
No	27.6	45.1	27.2	
Yes	35.7	51.7	12.6	
Frequently observing others exercising				20.25***
No	26.9	47.4	25.6	
Yes	35.9	49.2	14.9	
Residential area				11.45*
Urban	31.3	52.9	15.9	
Suburban	32.9	44.4	22.6	
Rural	25.6	47.4	26.9	

*** p < .000, ** p < .001, *p < .05

Table 15

Bivariate Relationship Between Physical Activity Level and Psychological, Social, and Environmental Factors Among Japanese Females

	Female (n = 970)			
	Recommended	Insufficient	Inactive	
	%			x^2
Self-efficacy				91.75***
Low	11.7	49.8	38.4	
High	31.9	53.7	14.4	
Pros				41.54***
Low	18.7	50.4	30.9	
High	30.8	54.2	15.1	
Cons				64.56***
Low	35.3	50.4	14.3	
High	15.8	54.1	30.2	
Social support				39.58***
Low	19.0	50.4	30.5	
High	30.7	54.3	15.0	
Health professional advice				0.55
No	25.3	51.9	22.8	
Yes	22.9	54.9	22.2	
Home equipment				39.19***
No	18.7	52.1	29.2	
Yes	32.3	52.7	15.0	
Access to facilities				43.39***
Low	18.0	49.2	32.7	
High	29.6	54.5	16.0	
Neighborhood safety				23.35***
Low	20.7	50.5	28.8	
High	29.2	54.2	16.6	
Enjoyable scenery				27.14***
No	19.0	52.6	28.4	
Yes	30.8	52.2	17.0	
Frequently observing others exercising				11.78*
No	20.4	52.8	26.9	
Yes	28.4	52.1	19.5	
Residential area				17.35*
Urban	25.1	56.3	18.6	
Suburban	26.6	50.3	23.1	
Rural	15.4	47.3	37.4	

*** p < .000, ** p < .001, *p < .05

having access to facilities, neighborhood safety, access to enjoyable scenery, and frequently observing others exercising were more likely to attain the recommended level of physical activity and less likely to be categorized as physically inactive. The respondents living in urban and suburban areas were more likely to be physically active at the recommended level than those living in a rural area. The proportion of those who were physically inactive successively increased for both genders from urban to rural environments. The advice from a health professional was not significantly associated with attaining the recommended level of physical activity.

Relative association among recommended physical activity and psychological, social, and environmental variables

Table 16 and 17 present the results of the logistic regression analysis. Gender, educational level, self-efficacy, pros, cons, home fitness equipment, enjoyable scenery, and residential area were significantly associated with attaining the recommended level of physical activity ($p<0.05$). Females were less likely to attain the recommended level of physical activity than males (OR = 0.41; 95% CI: 0.33–0.65). For males, self-efficacy (OR = 3.27; 95% CI: 2.12-5.03) was the strongest positive association of attaining the recommended level of physical activity followed by more pros (OR = 2.11; 95% CI: 1.37-3.24), home fitness equipment (OR = 1.67; 95% CI:

Table 16

Adjusted Odds Ratios for Meeting Recommended Levels of Physical Activity Among Japanese Male and Female Adults

	Recommended					
	Male (n = 304)			Female (n = 242)		
	OR	(95% CI)		OR	(95% CI)	
Age						
20–29	1	(ref)		1	(ref)	
30–39	1.04	(0.55–1.99)		0.62	(0.32–1.28)	
40–49	1.01	(0.50–2.04)		0.72	(0.36–1.44)	
≥50	1.02	(0.52–2.00)		1.41	(0.72–2.74)	
Marital status						
Married	1	(ref)		1	(ref)	
Unmarried	0.94	(0.56–1.56)		0.83	(0.47–1.48)	
Educational status						
≤high school graduate	1	(ref)		1	(ref)	
2 years of college	1.12	(0.59–2.14)		1.91	(1.15–3.19)	*
≥college graduate	0.72	(0.44–1.17)		1.82	(1.05–3.16)	*
Employment status						
Employed	1	(ref)		1	(ref)	
Unemployed	0.94	(0.53–1.67)		1.18	(0.75–1.84)	
Household income level						
<3,000,000 yen	1	(ref)		1	(ref)	
3,000,000– yen	0.86	(0.47–1.58)		0.99	(0.51–1.89)	
5,000,000– yen	0.88	(0.86–1.69)		0.53	(0.62–2.52)	
7,000,000– yen	0.95	(0.46–1.97)		0.79	(0.38–1.61)	
10,000,000– yen	0.79	(0.33–1.88)		1.04	(0.44–2.47)	
15,000,000– yen	1.24	(0.33–4.68)		1.17	(0.38–3.58)	
Self-efficacy						
Low	1	(ref)		1	(ref)	
High	3.27	(2.12–5.03)	***	5.22	(3.23–8.42)	***
Pros						
Low	1	(ref)		1	(ref)	
High	2.11	(1.37–3.24)	**	1.34	(0.84–2.13)	
Cons						
Low	1	(ref)		1	(ref)	
High	0.83	(0.54–1.27)		0.41	(0.26–0.66)	***
Social support						
Low	1	(ref)		1	(ref)	
High	1.13	(0.74–1.73)		1.51	(0.97–2.35)	
Health professional advice						
No	1	(ref)		1	(ref)	
Yes	1.10	(0.69–1.74)		0.57	(0.31–1.03)	
Home fitness equipment						
No	1	(ref)		1	(ref)	
Yes	1.67	(1.08–2.59)	*	1.75	(1.12–2.76)	*
Access to facilities						
No	1	(ref)		1	(ref)	
Yes	1.54	(0.98–2.43)		1.58	(0.97–2.56)	

(continued)

Table 16 (continued)

	Recommended					
	Male (n=304)			Female (n=242)		
	OR	(95% CI)		OR	(95% CI)	
Neighborhood safety						
No	1	(ref)		1	(ref)	
Yes	0.91	(0.56-1.49)		0.98	(0.59-1.65)	
Enjoyable scenery						
No	1	(ref)		1	(ref)	
Yes	1.82	(1.14-2.91)	*	1.95	(1.17-3.25)	*
Frequently observing others exercising						
No	1	(ref)		1	(ref)	
Yes	1.12	(0.76-1.90)		1.02	(0.63-1.64)	
Residential area						
Urban	1	(ref)		1	(ref)	
Suburban	0.63	(0.41-0.96)	*	0.80	(0.51-1.26)	
Rural	0.41	(0.19-0.87)	*	0.25	(0.11-0.56)	*

OR = odd ratios; CI = confidence interval; ref = referent group
Reference = inactive group (male: n = 127; female: n = 128)
*** p<.000, ** p<.001, *p<.05

Table 17

Adjusted Odds Ratios for Participating in Insufficient Levels of Physical Activity among Japanese Male and Female Adults

	Insufficient					
	Male (n = 465)			Female (n = 508)		
	OR	(95% CI)		OR	(95% CI)	
Age						
20–29	1	(ref)		1	(ref)	
30–39	1.08	(0.60–1.90)		0.90	(0.53–1.55)	
40–49	1.11	(0.60–2.08)		0.66	(0.38–1.14)	
≥50	1.15	(0.63–2.09)		1.50	(0.87–2.57)	
Marital status						
Married	1	(ref)		1	(ref)	
Unmarried	0.99	(0.63–1.56)		1.01	(0.64–1.59)	
Educational status						
≤high school graduate	1	(ref)		1	(ref)	
2 years of college	0.82	(0.44–1.51)		1.31	(0.87–2.00)	
≥college graduate	1.09	(0.70–1.70)		1.72	(1.10–2.69)	*
Employment status						
Employed	1	(ref)		1	(ref)	
Unemployed	0.80	(0.47–1.36)		1.33	(0.92–1.93)	
Household income level						
<3,000,000 yen	1	(ref)		1	(ref)	
3,000,000– yen	1.11	(0.65–1.99)		1.20	(0.72–2.02)	
5,000,000– yen	1.11	(0.60–2.03)		1.14	(0.65–2.02)	
7,000,000– yen	1.09	(0.56–2.11)		1.22	(0.68–2.18)	
10,000,000– yen	1.24	(0.56–2.74)		1.21	(0.58–2.50)	
15,000,000– yen	1.04	(0.28–3.89)		0.46	(0.16–1.34)	
Self-efficacy						
Low	1	(ref)		1	(ref)	
High	1.79	(1.21–2.64)	*	2.41	(1.69–3.44)	***
Pros						
Low	1	(ref)		1	(ref)	
High	2.00	(1.35–2.95)	**	1.44	(0.98–2.12)	
Cons						
Low	1	(ref)		1	(ref)	
High	1.00	(0.68–1.48)		0.86	(0.58–1.27)	
Social support						
Low	1	(ref)		1	(ref)	
High	0.74	(0.50–1.08)		1.44	(1.00–2.09)	
Health professional advice						
No	1	(ref)		1	(ref)	
Yes	1.32	(0.87–1.99)		0.84	(0.52–1.36)	
Home fitness equipment						
No	1	(ref)		1	(ref)	
Yes	1.13	(0.75–1.69)		1.34	(0.91–1.97)	
Access to facilities						
No	1	(ref)		1	(ref)	
Yes	1.55	(1.03–2.35)	*	1.45	(0.98–2.14)	

(continued)

Table 17 (continued)

	Insufficient					
	Male (n = 465)			Female (n = 508)		
	OR	(95% CI)		OR	(95% CI)	
Neighborhood safety						
No	1	(ref)		1	(ref)	
Yes	0.91	(0.56-1.49)		0.80	(0.52-1.24)	
Enjoyable scenery						
No	1	(ref)		1	(ref)	
Yes	1.82	(1.14-2.91)	*	2.10	(1.36-3.23)	**
Frequently observing others exercising						
No	1	(ref)		1	(ref)	
Yes	1.12	(0.76-1.90)		1.10	(0.72-1.67)	
Residential area						
Urban	1	(ref)		1	(ref)	
Suburban	0.63	(0.41-0.96)	*	0.52	(0.35-0.76)	**
Rural	0.41	(0.19-0.87)	*	0.51	(0.27-0.99)	*

OR = odd ratios; CI = confidence interval; ref = referent group
Reference = inactive group (male: n = 127; female: n = 128)
*** p<.000, ** p<.001, *p<.05

1.08-2.59), and access to enjoyable scenery upon engaging in physical activity (OR = 1.82; 95% CI: 1.14-2.91). For females, the strongest positive association of attaining the recommended level of physical activity was also self-efficacy (OR =5.12; 95% CI: 3.23-8.42). Being a junior college graduate or higher (OR =1.91; 95% CI: 1.15-3.19, OR =1.82; 95% CI: 1.05-3.17), fewer cons (OR = 0.41; 95% CI: 0.26-0.66), home fitness equipment (OR = 1.75; 95% CI: 1.12-2.76), and enjoyable scenery (OR = 1.95; 95% CI: 1.17-3.25) were also positively associated with attaining the recommended level of physical activity. Regarding residential area, males residing in a suburban area (OR = 0.63; 95% CI: 0.41-0.96) and a rural area (OR = 0.41; 95% CI: 0.19-0.87) were approximately twice less likely to attain the recommended level of physical activity than those living in an urban area. Females living in a rural area were four times less likely than those living in an urban area to attain the recommended level of physical activity (OR = 0.25; 95% CI: 0.11-0.56).

As for the associations between attaining an insufficient level of physical activity and psychological, social, and environmental factors, self-efficacy (males: OR =1.79; 95% CI: 1.21-2.64, females: OR = 2.41; 95% CI: 1.69-3.44) was significantly associated with engaging in an insufficient level of physical activity in both genders. In males, more pros (OR

= 2.00; 95% CI: 1.35-2.95), access to facilities (OR =1.55; 95% CI: 1.03-2.35) and enjoyable scenery upon engaging in physical activity (OR = 2.10; 95% CI: 1.36-3.23) were also determined to be correlates of engaging in an insufficient amount of physical activity. Additionally, males living in a suburban area (OR = 0.52; 95% CI: 0.35-0.76) and a rural area (OR = 0.51; 95% CI: 0.27-0.99) were approximately two times less likely than those living in an urban area to engage in physical activity at the insufficient level. Females who were college graduates or higher were more likely to participate in an insufficient level of physical activity than the other corresponding groups (OR = 1.72; 95% CI: 1.10-2.69). Females residing in a rural area were also less likely than those living in an urban area to engage in physical activity at the insufficient level (OR = 0.40; 95% CI: 0.22-0.73).

CHAPTER 5

COMPREHENDIVE DISCUSSION

The current study was conducted following three studies; (1) recommended level of physical activity and health-related quality of life among Japanese adults; (2) prevalence and demographic correlates of meeting physical activity recommendation among Japanese adults; and (3) relative contributions of psychological, social, and environmental factors to meeting physical activity recommendations among Japanese adults in order to explore the effective population-based approaches to promote physical activity at recommended level.

Discussions and Implications

Recommended physical activity and quality of life

The first investigation was designed to examine whether or not the recommended level of physical activity would be associated with HRQOL in the general middle-aged Japanese population. Meeting the recommended level of physical activity was associated with better scores on GH, VT, and PCS in males, and only on GH and VT in females, even after the adjustment of age and socioeconomic status. Additionally, engaging in

physical activity, even at insufficient levels, had a positive effect on the perception of PF in both genders. The current study suggests that engaging in the recommended level of physical activity appears to be positively related to some dimensions in both the physical and mental aspects of HRQOL.

The current study is, perhaps, the first to examine the association between the recommended levels of physical activity and HRQOL in Japan. Previously, foreign researchers also found that the recommended levels of physical activity were positively associated with one or more dimensions of HRQOL. Vuillemin et al. (2005) found that those who attained the recommended physical activity level scored significantly higher in almost all dimensions of SF-36 than those who did not attain the recommended level. In particular, the PF, GH, VT, SF, and MH were critically affected by the recommended level of physical activity. Brown et al.(2003) also investigated the cross-sectional effects of recommended levels of physical activity on HRQOL. In this study, HRQOL was evaluated by asking questions about the number of physically and mentally unhealthy days experienced. The number of adults who met the recommended level of physical activity and reported 14 or more unhealthy days during the past 30 days was found to be significantly lower than the number of those who did not meet the recommended level of physical activity.

In prior cross-sectional studies similar to the current study, Laforge et al. (1999) investigated using the association between the stage of readiness to exercise and HRQOL assessed with the SF-36. The stage was found to be significantly related to all dimensions of HRQOL; notably, a stronger association was observed in PF, GH, and VT dimensions. Wendel-Vos et al. (2004) and Morimoto et al. (2006) examined the relationship between the amount of physical activity and HRQOL. Wendel-Vos et al. (2004) found a positive association between PF, GH, and VT of the SF-36 and time spent for leisurely physical activity (h/week). Morimoto et al. (2006) also found that a greater amount of physical activity (kcal/week) was positively correlated with higher scores for all domains of the SF-36.

In the current study, the physical aspects of HRQOL, such as PF and GH, seemed to be more closely associated with the amount of physical activity than with mental aspects. This finding is consistent with several previous studies (Laforge et al., 1999; Wendel-Vos et al., 2004). Although the perception of vitality–measuring the degree of energy, pep, or tiredness experienced–is classified as a mental health component in the SF-8 and the SF-36, it has a complex construction and is moderately correlated with both mental and physical health functioning (Ware & Sherbourne, 1992). Brown et al. (2003) found that the number of physically unhealthy days was more strongly

correlated with physical activity as compared with that of mentally unhealthy days in the general US population. The objective benefits on physical activity, such as a decreased risk of morbidity, may be directly reflected in the perception of physical health among respondents.

The findings of the current study differed from the previous studies with regard to the mental aspect of HRQOL (Laforge et al., 1999; Morimoto et al., 2006; Nakamura et al., 2006; Vuillemin et al., 2005; Wendel-Vos et al., 2004). The present study did not observe the association between all dimensions in the mental aspects of SF-8 and the recommended level of physical activity, with the exception of VT. Although the results reported in previous literature on the association between physical activity and mental aspects on the HRQOL are still somewhat controversial, numerous studies have been conducted on the effects of physical activity and exercise on the reduction of the symptoms of depression and anxiety (Rejeski, Brawley, & Shumaker, 1996; US Department of Health and Human Services, 1996). Vuilleimn et al. (2005) reported on the association between the perception of psychological well-being, such as VT, SF, and MH on the SF-36, and the recommended level of physical activity. Moreover, Morimoto et al. (2006) have found that the mental aspects of HRQOL increased in proportion to the amount of physical activity, suggesting that the level

of the current Japanese recommendation of physical activity on health promotion may be lower than the threshold of physical activity required to demonstrate a measureable impact on the mental aspects of HRQOL. Additionally, Laforge et al. (1999) found that the longer the period for those who engaged in exercise at or above the recommended level, the more positive are the associations with higher mental dimensions of SF-36 in a period-dependent manner. This indicates that not only the amount but also the period of physical activity engaged in, which was not examined in the current study, may be one of the key factors influencing the mental aspect of HRQOL.

Prevalence and demographic correlates

The second investigation was designed to examine the prevalence of meeting the Japanese physical activity recommendation and primarily to identify the demographic correlates of engagement in physical activity at the recommended level among the Japanese adults. Although the participants responded to the present survey were more likely to be younger and have a higher educational status and household income level compared with the corresponding demographic parameters reported by population-based surveys of Japanese adults, overall, 26.6% of the surveyed Japanese adults met the recommendation for physical activity (Statistics Bureau Ministry of Public Management, Home Affairs, Post and

Telecommunications, 2001, 2007a, 2007b; Ministry of Health, Labour and Welfare, 2006b). Moreover, approximately one-third of the males and one-fourth of the females engaged in physical activity at the recommended level. While walking was far more popular type of physical activity engaged in than moderate to vigorous intensity activity, few responders did the recommended level of both walking and moderate to vigorous intensity activity to gain health benefits in the present study.

The current study is, perhaps, the first to examine the prevalence of meeting the Japanese recommendation for physical activity. A similar tendency to that found in the current study was acquired in the objectives of a national interim report of Healthy Japan 21 (Ministry of Health, Labour and Welfare, 2007). The prevalence of engaging in habitual leisure-time physical activity was found in 30.9% of males and 25.8% of females in Japan. However, in the present study, the percentages were much lower than those of the previous studies in other countries even though those studies utilized the physical activity level specified by the CDC/American College of Sports Medicine (ACSM) guidelines as the recommended level (Pate et al., 1995). According to the 2003 Behavioral Risk Factor Surveillance System (BRFSS), overall, 45.9% of American adults engaged in physical activity at the recommended level (CDC, 2005). In Australia, a similar prevalence was reported in the study by

Cerin et al. (2005), using data from the 2000 National Physical Activity Survey (NPAS). In addition, in the Supplementation en Vitamines et Mineraux Antioxydants (SUVIMAX) study (Bertrais et al., 2004), Bertrains et al. (2004) estimated that approximately 61.7% of the males and 51.7% of the females in France achieved the recommended level of physical activity. This lower prevalence found in the present study may be due to a higher amount of recommended physical activity than those in other international public health guidelines on physical activity, 150 minutes per week.

The present study found that physical activity participation at the recommended level was higher in males than in females. As for gender-specific correlates, for males, being employed and for females, being aged between 30 and 39 years emerged as negative correlates with regard to meeting the physical activity recommendation. On the other hand, being married and having higher education were found to be positive correlates for attaining the recommended level of physical activity only for females. No association was found with household income level for either gender.

Previously, numerous studies have examined the demographic correlates of participation in physical activity (Bauman et al., 2002; Trost et al., 2002). All variables listed in the current study, excluding marital and employment status, were

well-documented as the consistent correlates of physical activity behavior (Bauman et al., 2002; Trost et al., 2002). Nevertheless, few studies have examined the association between the physical activity recommendation and demographic variables, especially in a large population with wide range of age group (Bertrais et al., 2004; Cerin et al., 2005; Macera et al., 2005; Martin et al., 2000). Therefore, the relationship of these correlates with the physical activity recommendation is still less clear. The results of the current study clearly replicate and strengthen the findings of the previous research with respect to gender (Bauman et al., 2002; Bertrais et al., 2004; Cerin et al., 2005; Macera et al., 2005; Martin et al., 2000; Trost et al., 2002). Additionally, educational level in the present study emerged as having a positive association with meeting the physical activity recommendation only for females, which was a similar result to the SUVIMAX study (Bertrais et al., 2004). Moreover, former population-based cross-sectional investigations, using data of the 2001 BRFSS and 2000 NPAS, found that a higher level of education was a positive correlate for both genders. This finding suggests that individuals with higher education may be more aware of the benefits of regular physical activity at the recommended level with regard to disease prevention and health promotion (Cerin et al., 2005; Macera et al., 2005).

With regard to age, a strong inverse association between age and meeting the physical activity recommendation was found in the 2001 BRFSS, the 2000 NPAS, and the cross-sectional study (which included both age diversity and gender) in the US (Macera et al., 2005; Martin et al., 2000; Cerin et al., 2005). The current study, however, failed to reveal an association of age with attaining the physical activity recommendation, with the exception of a specific age bracket-30 to 39 years-for females. This might imply that females in this age group are unable to engage in physical activity at a sufficient level because of the overlapping roles as a mother and as an employee. The social situation for Japanese females which is characterized by higher employment rate and the trend to marry at a later stage in life might influence this finding (Ministry of Health, Labour and Welfare, 2005).

The notable finding of the current study is the relatively strong association of employment status with attaining the physical activity recommendation in males. Even though some previous studies investigated occupational situation (Macera, 2005; Trost et al., 2002), few of them examined whether employment status (employed versus unemployed) was correlated with physical activity participation. Thus, this finding highlights the significance of identifying the association between employment status and physical activity recommendation

in a large Japanese population. Additional studies are clearly required to examine such a relationship. A second noteworthy point was the examination of the association between marital status and meeting the physical activity recommendation, which has not been studied before. Previous studies examined the demographic correlates of participating in physical activity, the results were controversial (Brown, Young, & Byles, 1999; Brownson et al., 2000; King et al., 2000; Salmon et al., 2000; Sternfeld, Ainsworth, & Quesenberry, 1999). Some studies reported a positive association (Brown et al., 1999; Sternfeld et al., 1999), whereas others reported negative (Salmon et al., 2000) and no association (Brownson et al., 2000; King et al., 2000). However, most of these studies examined only females, minorities, or samples with narrow age ranges (Brown et al., 1999; Brownson et al., 2000; King et al., 2000; Sternfeld et al., 1999).

The results of the present study found different associations for males and females with regard to meeting the physical activity recommendation. In addition, more demographic correlates were explained for females than for males. This suggests that other significant correlates associated with meeting the physical activity recommendation for males, which were not obtained in the present study, may exist. Previous reviews of physical activity correlates in

adults mentioned that physical activity was a multifactorial behavior influenced by demographic, biological, psychological, behavioral, social and/or cultural, and physical environmental factors (Bauman et al., 2002; Trost et al., 2002). Additionally, the findings on gender-specific associations with meeting the physical activity recommendation imply that subgroups based on elements such as gender, age, and location of residence may be likely to differ in the factors that influence their physical activity behaviors. The current investigation has implications for developing interventions to promote physical activity among a large population of Japanese adults. The difference in correlates between males and females may indicate that gender-specific interventions or approaches may be needed. Furthermore, a unique contribution in the current study was that it examined the demographic correlates of engaging in physical activity at an insufficient level, something that has not been extensively studied before. These correlates should also be taken into account when targeting specific program participants.

Psychological, social, and environmental correlates

The third investigation examined the relative associations of psychological, social, and environmental factors with engagement in the recommended physical activity level among a random sample of Japanese adults and determined that

significant correlates emerged psychological and environmental domains. In both genders, a high level of self-efficacy for physical activity was the strongest correlate of being physically active at the recommended level. Further, some perceived environmental factors--owning home fitness equipment and having enjoyable scenery upon engaging in physical activity--emerged as positive correlates, whereas living in a rural area was a negative correlate for both genders with regard to attaining the recommended level of physical activity. As for gender-specific correlates in the psychological domain, identifying more pros for males and fewer cons for females yielded positive correlates for attaining the recommended level of physical activity. Additionally, living in a suburban area was only found to be negatively associated with attaining the recommended level of physical activity in males. Although all of the psychological, social, and environmental factors except health professional advice were significantly related to attaining the recommend level of physical activity in the bivariate analyses, many of these factors lost significant associations in the multivariate analysis.

The current study was a first attempt to incorporate demographic, psychological, social, and environmental factors in examining the correlates of engaging in a sufficient level

of physical activity for health benefits among a large sample of the Japanese population with a wide range of age groups, which enabled comparing the relative contribution of multifactorial correlates on physical activity. Regarding psychological factors, the results of the current study clearly replicated and strengthened the findings of previous research in terms of self-efficacy, which was well-documented as a strong and consistent indicator of physical activity behavior (Booth et al., 2000; Duncan & Mummery, 2005; Granner et al., 2007; Wilcox et al., 2003).

The interesting findings in the psychological domain are that the perception of the pros and cons of engaging in the recommended level of physical activity were differently associated for males and females. Previous Japanese research studies, which were similar to the current study, examined the association between the stage of readiness to exercise and the perception of benefits and barriers for physical activity among male and female Japanese employees. They determined more number of category in perceived benefits for male whereas in barriers for females changed across the stages (Nishida, Suzuki, Wang, & Kira, 2003, 2004). Also, De Bourdeaudhuij and Sallis (2002) examined the relative contribution of psychosocial variables among males and females in middle age and older groups. In their study, the perceived benefits contributed to engagement in

moderate to vigorous physical activity only in middle-aged males, whereas the perceived barriers emerged as a negative correlate only in older females, concluding that the contribution of perceived benefits and barriers might depend on age and gender (De Bourdeaudhuij & Sallis, 2002). These findings imply that devising strategies to encourage awareness of the pros in males and resolve the cons in females may enhance the effectiveness of future interventions that are aimed at promoting engagement in the recommended level of physical activity. On the other hand, Oka et al.(2003) observed that the pattern of change in pros and cons across stages of readiness on Transtheoretical Model of physical activity behavior change was similar in both genders. Thus, additional studies will clearly be required in the future.

With regard to social support, a positive association with attaining the recommended level of physical activity was found in many previous multivariate studies (Booth et al., 2000; Burton et al., 2005; Duncan & Mummery, 2005). However, the current study failed to reveal an association between social support and attaining the recommended level of physical activity. Different influences of social support on engagement in physical activity could explain this. McAuley et al. (2003) examined the predicted factors of maintaining long-term physical activity levels in older adults. In their study, social

support was more indirectly than directly influenced by long-term exercise behavior. In addition, McNeill et al. (2006) investigated the direct and indirect effects of individual, social, and physical environmental factors on adult physical activity using structural equation analysis and found that social support in the form of intrinsic and extrinsic motivation indirectly influenced engagement in physical activity. Further detailed examinations like the study of McNeill et al. (2006) may be required to clarify the function of social support on meeting the recommended level of physical activity.

Among the rapidly increasing number of foreign research studies that investigate the role of the physical environment on physical activity, it appears as though no studies have examined the correlates of attaining the recommended physical activity level among Japanese adults. A previous study reviewed the literature regarding the correlates of physical activity between 1992 and 2000 and mentioned that access to facilities, satisfaction with those facilities, neighborhood safety, home fitness equipment, and frequently observing others exercising might be important correlates of engagement in physical activity (Trost et al., 2002). The positive associations of home fitness equipment and enjoyable scenery that were determined in the current study were consistent with the results in previous US and Australian studies (Brownson et al., 2001; King

et al., 2000; Trost et al., 2002; Wilcox et al., 2000). Accordingly, these findings imply that the presence of equipment in the home as well as green space or beautiful landscapes in daily life may universally motivate adults to be physically active at the recommended level despite differences in national background. Moreover, rural residents were the least likely to attain the recommended level of physical activity, which also coincided with other previous studies (Brownson et al., 2000; Parks, Housemann, & Brownson, 2003). Wilcox et al. (2000) found that rural females in the U.S. experienced more frequent perceived barriers to leisure-time physical activity than urban females. More detailed evaluations of physical activity correlates on a rural area are warranted to decrease the number of physically inactive individuals in the future.

However, several associations contradicted both our expectations and previous literature. Few relative associations of access to facilities to be physically active, neighborhood safety, and frequently observing others exercising, which are recognized as relatively consistent correlates of engagement in physical activity, were observed in the present study (Trost et al., 2002). Some possible explanations for these unexpected findings are as follows. All of the environmental factors were significantly associated with

engaging in the recommended level of physical activity in the bivariate analysis. However, their explanatory abilities were weakened or lost in the multivariate analysis, which suggests that the influence of these environmental factors may not be as strong as the psychological variables to significantly impact the explanation of the variance in physical activity behavior among Japanese adults. Previous literature also found a much weaker contribution of physical environmental variables than psychological and social variables (Burton et al., 2005; Giles-Corti & Donovan, 2002; Granner et al., 2007).

The use of a total physical activity level in respondents as an outcome measure in the study of environmental correlates could be another factor to explain these unexpected findings. Rather than a single action, physical activity can be categorized into a number of behavioral types with various characteristics, demands, and contexts in which the behavior occurs, such as vigorous or moderate-intensity physical activity, facility-based or outdoor physical activity, and walking for transportation or for recreation (Giles-Corti et al., 2005). Previous studies found that the utilization of general or non-context-specific measures, such as overall physical activity or walking, to identify environmental correlates might underestimate the association between environmental and behavioral variables (Burton et al., 2005;

Humpel et al., 2004). In order to enhance the ability to estimate the environmental influence, it is likely necessary to define the setting or context in which physical activity occurs and select environmental factors that are specific to targeting a physical activity behavioral outcome (Giles-Corti et al., 2005). Ultimately, the unexpected results in the environmental domain suggest that perceived environmental influences on physical activity behavior may be more complex than anticipated (King et al., 2000). Different perceptions of certain objective environmental characteristics may possibly impact this complexity. However, the study of relative environmental effects on physical activity is in its early stages; additional studies in various physical activity settings and population groups are clearly required to further explore the association between environmental correlates and physical activity.

Finally, a unique contribution of the current study is that it examined the psychological, social, and environmental correlates of engaging in physical activity at an insufficient level--something that has not been extensively studied before. These correlates should also be taken into consideration when targeting specific program participants and developing interventions to motivate sedentary individuals to engage in any physical activity, even at an insufficient level.

Proposal of Promoting Recommended Physical Activity

Enhancing feasibility and reality

The prevalence of achieving the recommended level of physical activity on EPAE2006 that may be optimal for preventing chronic diseases are low among Japanese adults population in the present study. Some of the biological mechanisms proposed to underline the relationship between physical activity and several chronic diseases such as cardiovascular disease, stroke, hypertension, diabetes mellitus, and obesity predict that more amount of physical activity would have greater protective roles (Oja, 2001). Thus, these low rates of participation in physical activity at recommended level are a potential chronic disease prevention concern.

How feasible and realistic is it to recommended levels of physical activity currently achieved by only a small portion of the population? One-third to one-fourth of surveyed Japanese adults was completely inactive in their daily life. Also, the majority of adults in industrialized countries are reported to be sedentary in their leisure time (US Department of Health and Human Services, 1996). Under such a situation, recommending 60 minutes or more of physical activity a day on EPAR2006 may be unrealistically ambitious and have low feasibility compared with the international public health recommendations to be active for 30 minutes on most days. Both Japanese and

international public health recommendations appear to be provided based on relatively similar scientific evidences on the association between physical activity and several chronic diseases (Haskell et al., 2007: Pate et al., 1995; Ministry of Health, Labour and Welfare, 2006a: US Department of Health and Human Services, 1996). Why is Japanese recommendation on EPAR2006 almost three fold as higher quantity than those of other international public health guidelines? To increase the likelihood of engaging inactive adults in physical activity that may be sufficient for chronic disease prevention and health promotion, the recommended levels of physical activity must be more focused on activating the sedentary, and thus not optimal but sufficient, realistic, and appraised as feasible.

Increasing awareness and knowledge

Alternatively, attempts should be made to shift the entire distribution of participation in physical activity in the population by promoting the idea that, where feasible, all adults should be more physically active toward recommended level for preventing chronic diseases and promoting health. Hence, promotional activities or interventions are required to create more opportunities for being aware of "physical activity recommendations". According to Higo and Nakamura (2008), only 1.4% of 1726 surveyed Japanese adults knew the contents of EPAR2006. Montano and Kaspryzk (2002) mentioned that social

norms and attitudes to a behavior were important determinants of behavior self-efficacy and intention, which were antecedents to physical activity behavior. Thus, raising awareness and knowledge of physical activity recommendation, influencing social norms about the role of physical activity recommendation against several chronic diseases and influencing beliefs about physical activity level of others, may be considered essential first steps in promoting recommended physical activity (Cavill & Bauman, 2004).

As one of effective interventions to increase community awareness and understandings on topic such as physical activity, mass media campaigns and social marketing techniques are documented (Cavill & Bauman, 2004). These mass media campaigns include paid advertisements and donated promotions. Messages are transmitted by using specific channels such as newspapers, radio, and television singly or in combination toward relatively undifferentiated audiences (Cavill & Bauman, 2004; US Department of Health and Human Services, 2001). The benefit of these is to be able to reach large numbers of people at relatively low cost. Campaigns of this sort have changed the social norm around tobacco use and smoking behavior (Hopkins et al., 2001). Some previous studies observed that physical activity-related mass media campaigns were likely to result in high levels of awareness and recall of the campaign name and

main message, which may lead to a greater probability of achieving the end-point physical activity behavior change (Bauman, Bellew, Owen, & Vita, 2001; Booth et al., 1992; Owen et al., 1995). However, the effectiveness of such mass media campaigns in increasing physical activity behavior is still inconsistent in the literatures (Kahn et al., 2002; US Department of Health and Human Services, 2001). Communitywide physical activity campaigns, which combine mass media campaigns with other approach such as support and self-help groups, counseling, screening, and education, community events and environmental changes, are observed strong evidences for its effectiveness and thus, highly recommended by the Guide to Community Preventive Services (Kahn et al., 2002; US Department of Health and Human Services, 2001). Developing such campaigns are fundamental to give a more direct and immediate impact on increasing physical activity behavior.

Changing physical activity behavior

Individually-adapted health behavioral and social approaches, which teach behavioral management skills to help participants incorporate physical activity into their daily routines and create social environments and network to provide supportive relationships for behavior change, are also essential and effective to increase recommended physical activity among population (Kahn et al., 2002; US Department of

Health and Human Services, 2001). More effective intervention programs for physical activity promotion should match the needs, interests, and preferences of the target population. From the findings of current study, walking was a common and easily accessible form of physical activity. Thus, encouraging more walking for transport on various scenes of everyday life and for recreation and exercise may be more realistic than moderate to vigorous intensity physical activities and sports. Additionally, the prevalence among Japanese adults of participating in physical activity at the recommended level was especially low among the employed for males and the 30 to 39 years of age for females, indicating that those would be most in need of intervention for promoting physical activity. Developing programs at worksites for males and 30 to 39 year aged working females as well as local community-based programs targeting 30 to 39 year aged mothers and full-time house-workers may enhance effectiveness and efficiency of interventions.

The findings of the current study underscore the importance of intervening on multiple levels to have an impact on increasing the proportion of achieving recommended physical activity among Japanese adults. Enhancing confidence for engaging in physical activity for both genders, emphasizing the benefits of physical activity for males, resolving the barriers around engaging in physical activity for females, and raising

the awareness of home fitness equipments such as shoes and pedometer for both genders may be effective strategies for future individually-adapted health behavioral programs aimed at increasing physical activity levels to those recommended for Japanese adults. The previous systematic review was also found that the use of pedometer was associated with significant increase in physical activity (Bravata et al., 2007). Environmental and policy approaches to change the structure of environment to provide safe, attractive, and convenient places for physical activity are reported to be one of the highly effective interventions, along with the individually-adapted health behavioral and social approaches (Kahn et al., 2002; US Department of Health and Human Services, 2001). Even though intervening on environment is likely more complicated, locating and addressing green spaces or beautiful landscapes in a neighborhood may also be appealing to Japanese adults for increasing physical activity levels.

Limitation

The current investigation had a number of limitations. First of all, the analysis was cross-sectional, thereby making determinations of cause and effect impossible. Next, the level of physical activity was administered using only the self-reported questionnaire. Ishikawa-Takata et al. (2007)

found that only 36% of 150 healthy free-living Japanese adults were classified into the same level of physical activity groups (insufficiently active, sufficiently active, and highly active) by both the total METs assessed by IPAQ and physical activity level measured by the doubly labeled water method. Thus, inaccurate estimation of physical activity level and recall bias are unavoidable. In addition, the detail listed examples of physical activities, especially lifestyle physical activity, were limited in the IPAQ. However, additional examples of yard work, house work, and occupation with moderate-intensity are included in the EPAR2006 (Ishikawa-Takata & Tabata, 2007), which may lead to a lower estimation of physical activity level among the participants.

Moreover, the current study was conducted in an internet setting. Eysenbach et al. (2002) indicated that issues of generalizability, mainly due to selection bias, were important considerations due to the non-representative nature of the internet population and the self-selection of participants to survey. Rhodes et al. (2003) mentioned that younger, more educated, and higher income individuals have greater access to the internet. Additionally, people are more likely to respond to a survey if they are interested in its contents or are attracted by the incentives offered for participation (Eysenbach & Wyatt, 2002; Rhodes & Bowie, 2003; Yasunaga, Ide,

Imamura, & Ohe, 2006). Therefore, the basic characteristics of the respondents may possibly be biased, implying that the findings under such a setting may not be sufficiently applicable to the general population. In particular, a comparison of sample profiles with census data indicated that there was an overrepresentation of university-educated individuals and those with higher socioeconomic status, which suggests that the results might be less applicable to those who have received less education. Also, the Internet-based Japanese version of IPAQ and the SF-8 were not previously validated for the Internet use. Thus, the results of the physical activity level and HRQOL administered via the Internet may be less accurate than those obtained by other validated methods such as the telephone interview and the self-administered survey.

Additionally, chronic diseases or chronic conditions were not included as covariates in the current study, which may have been one of the factors leading to differential significant domains in the current study from those in prior studies. Those conditions are considered to be negatively correlated with HRQOL and physical activity level (Alonso et al., 2004; Paluska & Schwenk, 2000). Therefore, those factors should have been controlled.

Conclusions

In summary, individuals who attained the recommended level of physical activity had better results on some dimensions of HRQOL than those who did not, suggesting that the current Japanese recommendation for physical activity may be applicable not only to physiological objective outcomes but also to HRQOL. If the perception of physical functioning and psychological well-being are improved through an increase in the physical activity level, it is sufficiently important to plan public health interventions designed to prevent a sedentary lifestyle and to promote physical activity.

Additionally, characteristics of people who met Japanese physical activity recommendation were males, married, high educated females. On the other hand, employed males and 30 to 39 year aged females were identified as negative demographic factor to achieve recommended physical activity among Japanese adults. As the contributing psychological, social, and environmental factors to recommended physical activity, self-efficacy, pros and cons in psychological domain and awareness of home fitness equipment and enjoyable scenery and residential area in environmental domains were observed. Psychological factors including self-efficacy and pros and cons made stronger contributions to engagement in the recommended level of physical activity than social and environmental

factors. The findings of the current study provide useful information for future research designed for intervention to increase the number of Japanese adults who satisfy the physical activity recommendations.

Future Suggestions

First, further investigations on Japanese populations are immediately required in order to accumulate additional evidences for promoting physical activity at recommended level. Moreover, such investigation is necessary to determine the extended associations of meeting the physical activity recommendation with other possible variables or among subgroups, especially in the potentially inactive population such as rural residents in the current study. Additionally, the current study highlights the need for future researchers to examine the relative association of multivariate factors with specific physical activity behavior such as walking for transportation and recreation or facility-based physical activity. Accordingly, deliberation of behavior-specific psychological, social, environmental variables is concomitantly needed to maximize the prediction ability of these factors on physical activity. Next, it is important to develop interventions for promoting physical activity at recommended level on the knowledge derived from the current study and systematically

examine its effectiveness. Finally, identifying the effective recruitment strategies for the target population into the intervention programs are urgently needed to increase the proportion of Japanese adults who achieve recommended level of physical activity on the efficient manner.

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