Paper

Influence of exercise habits and physical fitness level on subjective fatigue symptoms in adolescents

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This study examines the effects of physical fitness level and exercise habits on subjective fatigue symptoms in adolescents. 746 young male adults (age: 16.5 +/- 1.0 year, 15-20 years) participated in the physical fitness tests (grip strength, sit-up, trunk anteflexion, repeated sideways jump, 20-meter shuttle run, 50-meter dash, standing long jump and handball throw) of the Ministry of Education, Culture, Sports, Science and Technology in Japan, and answered a questionnaire on life habits and subjective fatigue symptoms. The relationship between subjective fatigue symptoms and exercise habits and physical fitness level was examined by application of Quantification Method I. Multiple significant correlation (R = 0.295) was found, as well as partial correlations of the physical fitness level (r_{xy} = 0.10). However, significant partial correlations were also found in the life habits items other than exercise habit (r_{xy} = 0.07-0.12), and their item ranges (4.54-10.55) were higher than that of physical fitness level (5.87). In conclusion, although physical fitness level is one of the factors that affects subjective fatigue symptoms, many life habits other than exercise habits affect subjective fatigue as well. However, in these cases, the magnitude of their whole influence is not very large.

Key words : fatigue symptoms, adolescent, life habit

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1. Introduction

Evaluating fatigue is very important for understanding overall health and for developing healthy life habits (Kadota, 1990). Students who sleep less and go without breakfast, as well as students who experience an unpleasant awakening and who have a lower overall subjective sense of health, have high subjective fatigue symptoms (Kadota, 1990; Kadota, 1978; Takakura, 1993). Consistent life habits may reduce subjective fatigue symptoms in adolescents.

At the same time, many researchers have studied the relationships between life habits, health and physical fitness, and have found that people who actively incorporate exercise habits into their daily lives have higher health and physical fitness levels (Momose and Une, 1998; Naka and Demura, 1994). Immobilization increases the rate of obesity and other related diseases (Momose and Une, 1998). Deteriorating health and a decrease in physical fitness lead to a less active life in middle and old age (Shibata, 1987) and also negatively affect daily life habits (Kimura, 1991). Thus, acquiring good exercise habits improves physical health.

Muraki et al. (1993) examined the relationship between physical fitness and mental health, and reported that maximal oxygen consumption is significantly related to tension, anxiety and fatigue. Maintaining a higher physical fitness level may be required for maintaining mental health, because it relates to the ability to adapt to environmental changes. Moreover, exercise and sports produce a large psychological effect, such as feelings of exhilaration and the elimination of stress, hostile feelings, tension and anxiety, in addition to maintaining a fit physical condition. Annesi (2004) examined the effect of moderately intense exercise intervention for 10 weeks on mental status, and reported that tension, anxiety, vigor and fatigue were improved by regular exercise. Steptoe and Cox (1988) reported that vigor and happiness are improved

even with minimal exercise. Hence, it is suggested that performing exercise and sports is useful for maintaining a healthy mental status, since it causes anxiolysis and antidepressant effects, in addition to dissolving stress and building up resistance to it.

From these studies, it is clear that developing vigorous exercise habits and maintaining or enhancing physical fitness could relieve anxiety and tension caused by environmental changes, in addition to preventing disease. Namely, development of exercise habit and enhancing physical fitness may be useful for reduction of subjective fatigue symptoms. However, Demura et al. (2011) examined the relationship between subjective fatigue symptoms, physical fitness level, and exercise habits, and reported that the fatigue symptoms have a relatively strong relationship with physical fitness level, but not as strong a correlation as with exercise habits. People who incorporate exercise into their daily lives have higher health and physical fitness levels (Momose and Une, 1998; Naka and Demura, 1994). Because physical fitness level is affected by exercise habits (exercise frequency and intensity), their relationship with subjective fatigue symptoms is inferred to be similar. However, the details have not yet been clarified. Although people who perform exercise with higher intensity and frequency have higher physical fitness levels, they may also feel higher subjective fatigue symptoms from intense exercise. Hence, it will be necessary to further examine the relationship between physical fitness level and exercise habits.

This study clarifies the relationship between subjective fatigue symptoms and both exercise habits and physical fitness level in adolescents, and compares their effects to those of other life habits.

2. Methods

2.1. Subjects

746 healthy adolescent students, aged 15 to 20 years, who were enrolled in the National College of Technology (age: 16.5 +/- 1.0 yr, height: 171.0 +/- 5.7 cm, body-mass: 60.7 +/- 9.0 kg) participated in this study. Their physical characteristics were almost the same as the coeval Japanese standard values. Informed consent was obtained from each subject after a full explanation of the experimental project and its procedure. The present experimental protocol was approved by an inquiry committee of studies intended for humans at the Kanazawa University Health & Sports Science Ethics Committee.

2.2. Methods for the physical fitness test and the lifestyle habits and subjective fatigue symptoms questionnaire

Physique and physical fitness were evaluated by height, body-mass, and the physical fitness test of the Ministry of Education, Culture, Sports, Science and Technology in Japan (grip strength, sit-ups, sit & reach, repeated sideways jump, 20-meter shuttle run, 50-meter dash, standing long jump and handball throw). The subjective fatigue symptoms questionnaire proposed by Kobayashi et al. (2000) was used. This questionnaire was developed to evaluate the fatigue of adolescent students, and consists of the following six sub-scales (total 24 items): difficulties with concentrated thinking; languor; loss of vigor; loss of willingness; drowsiness; and, uncomfortable physical feelings. The contents of each fatigue sub-scale are as follows: concentration, thought faculties and patience for “difficulties with concentrated thinking”; languor of the whole or parts of the body for “languor”; perturbation of conversation and loss of vigor for “loss of vigor”; irritation over moving and general distaste for activity for “loss of willingness”; drowsiness and hoping for attitude adjustment for “drowsiness”; and asthenopia and feeling stiff in the shoulders for “uncomfortable physical feelings” (Demura et al., 1997; Kobayashi et al., 1998; Demura et al., 2000; Kobayashi et al., 2000; Kobayashi et al., 2001). Subjects responded to each questionnaire item during the week before the test by using the following five rating scales: no (1 point), not very (2 points), no preference (3 points), somewhat yes (4 points) and yes (5 points). In addition, the scales were considered an interval scale and used for analysis in this study.

Life habits were evaluated by the seven practices (exercise habits, eating habits, sleeping, maintaining adequate body-mass, eating between meals, drinking and smoking) proposed by Belloc and Breslow (1972). The contents of each life habit sub-scale are as follows: for exercise habits, exercise frequency (almost every day [more than 3 days/week], sometimes [1-2 days/week], occasionally [1-2 days/month] and never) and exercise time (less than 30 min, more than 30 min and less than

1 hour, more than 1 and less than 2 hours, and more than 2 hours); for eating habits, breakfast (eating every day, sometimes missing a meal, and never eating), regularity of eating meals (regularly eat 3 times a day, sometimes miss a meal and is irregular), likes and dislikes (nothing, a little, and many), midnight snack (often, sometimes and never), dietary intake per day (eat only a little, eat in moderation, and eat a lot), nutrient balance (not generally, a little, and very), and seasoning (none, a little, and a lot); for sleeping, sleep time (less than 6 hours, more than 6 and less than 8 hours, and more than 8 hours), regularity of waking time (regular and irregular), and regularity of bed time (regular and irregular); for maintenance of proper body-mass, BMI (less than 18.5, more than 18.5 and less than 25, and more than 25), and percent body fat (less than 14%, more than 14 and less than 25%, and more than 25%); and, eating between meals (often, sometimes and never) (Table 1). In addition, items regarding drinking and smoking were excluded because all subjects were not yet of legal age.

2.3. Measure and survey methods

Prior to the physical fitness test and subjective fatigue symptoms questionnaire, subjects were given a substantial explanation of their contents. The tests and questionnaires were conducted in accordance with the standards of the Ministry of Education, Culture, Sports, Science and Technology in Japan, and the survey method by Kobayashi et al. (2000), respectively. They were conducted once a week using a curricular class by health and physical education faculty with expert knowledge and experience. A subjective fatigue symptoms questionnaire was conducted 5 times in each curricular class, considering variation during the physical fitness test period.

2.4. Parameters

Measured values from the physical fitness test were transformed into scores based on the point table shown below in its standard form. Moreover, total scores of each subject were calculated, and subjects were ranked from A to E based on the total point table. The number of students classified into ranks A through D were 112, 264, 245 and 125 subjects, respectively, and not applicable in rank E. Each score from the items of the subjective fatigue symptoms questionnaire, conducted 5 times per class, was averaged, and the total scores in each sub-scale were calculated.

2.5. Statistical analysis

Mean and standard deviation of total subjective fatigue symptoms score, and frequencies in respondent category of life habits items in adolescent were calculated. Using subjective fatigue symptoms scores as a dependent variable, and exercise habit and physical fitness level as independent variables, their relationships were examined by Quantification Method I. In addition, before Quantification Method I application, multicollinearity was confirmed by calculating the correlations among life habits items and physical fitness level (Cramer's V (φ

Table 1. Frequencies and fundamental statistics of each responded category

Item ＼ Category				1		2		3		4		Mean	SD
Basic characteristics	X1	Age	1: 15 yr, 2: 16 yr, 3: 17 yr, 4: 18 yr	112	(15.0%)	264	(35.4%)	245	(32.8%)	125	(16.8%)		
Exercise habit and	X2	Exercise frequency	1: every day, 2: sometime, 3: occasionally, 4: never	298	(39.9%)	193	(25.9%)	148	(19.8%)	107	(14.3%)		
Physical fitness level	X3	Exercise time	1: less than 30 min, 2: more than 30min and less than 1 hour, 3: more than 1 hour and less than 2 hours, 4: more than 2 hours	214	(28.7%)	116	(15.5%)	199	(26.7%)	217	(29.1%)		
	X4	Physical fitness	1: rank A, 2: rank B, 3: rank C, 4: rank D	58	(7.8%)	301	(40.3%)	295	(39.5%)	92	(12.3%)		
Dietary habits	X5	Breakfast	1: eating every day, 2: somtimes missing a meal, 3: never eating	591	(79.2%)	131	(17.6%)	24	(3.2%)				
	X6	Regularity of eating meals	1: regularly eat 3 times, 2: somtimes missing, 3: irregular	559	(74.9%)	158	(21.2%)	29	(3.9%)				
	X7	Likes and dislikes	1: nothing, 2: a little, 3: many	166	(22.3%)	478	(64.1%)	102	(13.7%)				
	X8	Midnight snack	1: often, 2: sometimes, 3: never	86	(11.5%)	333	(44.6%)	327	(43.8%)				
	X9	Dietary intake per every day	1: eat only a little, 2: eat in moderation, 3: eat a lot	40	(5.4%)	436	(58.4%)	270	(36.2%)				
	X10	Nutrient balance	1: not generally, 2: a little, 3: very	288	(38.6%)	420	(56.3%)	38	(5.1%)				
	X11	Seasoning	1: none, 2: a little, 3: a lot	101	(13.5%)	536	(71.8%)	109	(14.6%)				
Sleeping	X12	Sleep time	1: less than 6 hours, 2: more than 6 and less than 8 hours, 3: more than 8 hours	154	(20.6%)	575	(77.1%)	17	(2.3%)				
	X13	Regularity of waking time	1: regular, 2: irregular	704	(94.4%)	42	(5.6%)						
	X14	Regularity of bed time	1: regular, 2: irregular	476	(63.8%)	270	(36.2%)						
Maintaining proper body-mass	X15	Body mass index	1: less than 18.5, 2: more than 18.5 and less than 25, 3: more than 25	142	(19.0%)	565	(75.7%)	39	(5.2%)				
	X16	% body fat	1: less than 14%, 2: more than 14 and less than 25%, 3: more than 25%	450	(60.3%)	252	(33.8%)	44	(5.9%)				
Eating between meals	X17		1: often, 2: sometimes, 3: not generally	233	(31.2%)	407	(54.6%)	106	(14.2%)				
Subjective fatigue symptoms	Y											56.7	19.7

X: independent variables, Y: dependent variablrs, n = 746

coefficient was calculated among two items from sleeping, regularity of waking time (regular and irregular), and regularity of bed time (regular and irregular)). Namely, two items, which indicate correlations more than 0.3 was to be higher relationship, and either item was excluded. A probability level of 0.05 was used as indicative of statistical significance, and SPSS 16.0 for Windows and its GUI Quantification Method analysis program was used in all analysis.

3. Results

Table 1 shows frequencies in each answered category from all life habits items, and means and standard deviations of subjective fatigue symptoms. Table 2 shows correlations among basic characteristics and life habits items. Significant correlations were observed within 50 items/136 items, moderate and over correlations were observed between the following items: V = 0.52 between exercise frequency (almost every day [more than 3 days/week], sometimes [1-2 days/week], occasionally [1-2 days/month] and never) and exercise time (less than 30 min, more than 30 and less than 60 min, more than 60 and less than 120 min, and more than 120 min), V = 0.51 between breakfast (eating every day, sometimes missing a meal, and never eating) and mealtimes (regularly eat 3 times a day, sometimes miss a meal and is irregular), V = 0.47 between BMI (less than 18.5, more than 18.5 and less than 25, and more than 25) and percent body fat (less than 14%, more than 14 and less than 25%, and more than 25%), and V = 0.35 between midnight snacks (often, sometimes and never) and eating between meals (often, sometimes and never). Either one of the items that indicate moderate and over correlations was selected, considering the item contents and the relationships with the other item, and applied to Quantification Method I. Four items regarding exercise frequency, dietary habit, midnight snacking and BMI were excluded and the others were applied to Quantification Method I.

Table 3 shows the results of Quantification Method 1 by using subjective fatigue symptoms scores as the dependent variable, and basic characteristics (age), exercise habit and physical fitness level as independent variables. Significant partial correlations (0.07-0.12) were found in physical fitness level, eating habits (breakfast, likes and dislikes, nutrient balance and seasoning), sleeping (sleeping time and regularity of awakening) and eating between meals. The multiple correlation coefficient was also significant and moderate (0.295). However, the contribution ratio was low (8.7%).

4. Discussion

A relatively strong relationship between subjective fatigue symptoms and physical fitness level was found, but the relationship with exercise habit was lower (Demura et al., 2011). Although people who exercise with higher intensity and frequency have higher physical fitness levels, it is inferred from these findings that subjective fatigue symptoms perceived during hard exercise also become higher. However, previous studies have not examined the relationship between exercise intensity

Table 2. Correlations among items

Item ＼ Category			X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
Basic characteristics	X1	Age																
Exercise habit and	X2	Exercise frequency	0.10 *															
Physical fitness level	X3	Exercise time	0.08	0.53 *†														
	X4	Physical fitness	0.10 *	0.24 *	0.24 *													
Dietary habits	X5	Break fast	0.11 *	0.12 *	0.11 *	0.06												
	X6	Regularity of eating meals	0.10 *	0.14 *	0.11 *	0.07	0.51 *†											
	X7	Likes and dislikes	0.05	0.09	0.07	0.03	0.05	0.08 *										
	X8	Midnight snack	0.04	0.06	0.08	0.07	0.09 *	0.08 *	0.07									
	X9	Dietary intake per every day	0.04	0.09	0.09	0.05	0.05	0.04	0.11 *	0.08 *								
	X10	Nutrient balance	0.05	0.11 *	0.07	0.08	0.05	0.10 *	0.11 *	0.09 *	0.05							
	X11	Seasoning	0.04	0.06	0.07	0.08	0.03	0.05	0.06	0.13 *	0.12 *	0.07						
Sleeping	X12	Sleep time	0.07	0.14 *	0.09 *	0.08	0.03	0.07	0.07	0.11 *	0.07	0.08	0.04					
	X13	Regularity of waking time	0.07	0.02	0.06	0.04	0.12 *	0.12 *	0.05	0.06	0.06	0.06	0.13 *	0.01				
	X14	Regularity of bed time	0.10	0.04	0.08	0.02	0.11 *	0.11 *	0.07	0.12 *	0.09	0.14 *	0.05	0.19 *	0.23 *			
Maintaining proper body-mass	X15	Body mass index	0.10 *	0.17 *	0.12 *	0.18 *	0.06	0.04	0.12 *	0.04	0.08	0.07	0.05	0.06	0.06	0.01		
	X16	% body fat	0.07	0.14 *	0.13 *	0.20 *	0.02	0.04	0.07	0.04	0.06	0.06	0.05	0.05	0.05	0.06	0.47 *†	
Eating between meals	X17		0.05	0.06	0.08	0.05	0.04	0.04	0.10 *	0.35 *†	0.10 *	0.14 *	0.14 *	0.10 *	0.01	0.08	0.08	0.07

Cramer V was calculated among items except for X13 and X14 (φ coefficient)

* $p < 0.05$, † $V > 0.30$

and frequency in detail. Although significant partial correlations were observed in exercise habit (exercise time) and physical fitness level, they were low (physical fitness level: 0.10 and exercise time: 0.04). However, Muraki et al. (1993) examined the relationship between maximal oxygen uptake during incremental graded cycle ergometer exercise and mood (tension, blues, anger, vigor, tiredness and confusion) and anxiety (state and attribute anxiety) measured by the Profile of Mood States (POMS) and State-Trait Anxiety Inventory (STAI), in order to clarify the relationship between physical fitness and mental health in adolescents. The results showed that the maximal oxygen uptake related significantly and moderately to tension, blues, tiredness, and anxiety state and attribute anxieties (r = -0.59 to -0.76). Namely, psychological characteristics are suggested to be affected by physical fitness level. However, the relationship between psychological characteristics and physical fitness level was lower in the present results as compared with Muraki et al. It is inferred that the difference between the present results and Muraki et al.'s results was observed due to the difference in physical fitness measurement method and psychological characteristics (total physical fitness and endurance; subjective fatigue symptoms, and mood and anxiety). Meanwhile, it is judged that the relationship to physical fitness level is similar to other life habits, because significant relationships of the other life habits to subjective fatigue symptoms were strongest in sleeping time (0.12), followed by eating between meals (0.10), and minimum in nutrient balance (0.07). From the above, it is suggested that although physical fitness level relates significantly to subjective fatigue symptoms, it is low and not much different from the other life habits.

Meanwhile, category scores of each answered category were maximum when sleeping time is more than 8 hours (9.329), followed by never eating breakfast (8.545), irregular awakening (6.931), and a D rank in physical fitness level (4.702) (Figure 1). Category scores in exercise frequency (exercise time) were all low: less than 30 min scored -0.118, more than 30 min and less than 1

Table 3. Item range, partial and multiple correlation coefficients of life habits and physical fitness level

Factor		Items	Item range	Partial correlation coefficients	*p*	
Age	X1		2.82	0.05	*0.076*	
Exercise habit and	X2	Exercise frequency	—	—	—	
Physical fitness	X3	Exercise time	2.36	0.04	*0.142*	
	X4	Physical fitness	5.87	0.10	*0.003*	*
Dietary habit	X5	Break fast	8.89	0.08	*0.013*	*
	X6	Regularity of eating meals	—	—	—	
	X7	Likes and dislikes	4.05	0.07	*0.027*	*
	X8	Midnight snack	—	—	—	
	X9	Dietary intake per every day	4.37	0.05	*0.083*	
	X10	Nutrient balance	6.71	0.07	*0.021*	*
	X11	Seasoning	4.54	0.09	*0.009*	*
Sleeping	X12	Sleep time	10.55	0.12	*0.000*	*
	X13	Regularity of waking time	7.34	0.09	*0.009*	*
	X14	Regularity of bed time	1.34	0.03	*0.186*	
Maintaining proper	X15	Body mass index	—	—	—	
body-mass	X16	% body fat	4.35	0.06	*0.056*	
Eating between meals	X17		5.42	0.10	*0.005*	*
Multiple correlation coefficient				0.295	*0.000*	*
Contribution ratio				8.7%		

n = 746

hour scored -1.430, more than 1 hour and less than 2 hours scored -0.050, and more than 2 hours scored 0.926. From the above, although subjective fatigue symptoms may be greater in subjects with lower physical fitness level, their influence is judged to be smaller when considering that the influence of the other life habits (eating habit and sleeping) is greater, and the contribution of life habits to subjective fatigue symptoms is low. However, the category scores of exercise time and physical fitness level did not follow a similar trend. Namely, the category "more than 30 min and less than 1 hour" scored the minimum (-1.430) in exercise time, and the score increased as exercise time increased, with the maximum being "more than 2 hours" (0.926). Meanwhile, the D-ranked group showed the maximum category score (4.702) in "physical fitness level", followed by the A- (2.042) and C- (-1.169) rank. These results indicate that longer exercise time and greater physical fitness level are not always useful for decreasing subjective fatigue symptoms. Adequate exercise habits are useful for maintaining and enhancing health and physical fitness levels (Momose and Une, 1998). Moreover, because psychological effects such as attitude adjustments, sense of fulfillment in daily living and stress reduction are expected with exercise and sports (Annesi, 2004; Steptoe and Cox, 1988), students with vigorous exercise habits were assumed to have low subjective fatigue symptoms. However, the present results did not always support the conclusions of these previous studies. Blanchard et al. (2001) examined the effect of temporal exercise with 50% and 80% of maximal heart rate reserved (HRR) on perceived mood state, and reported that, although no significant mood change was found in the 50% group,

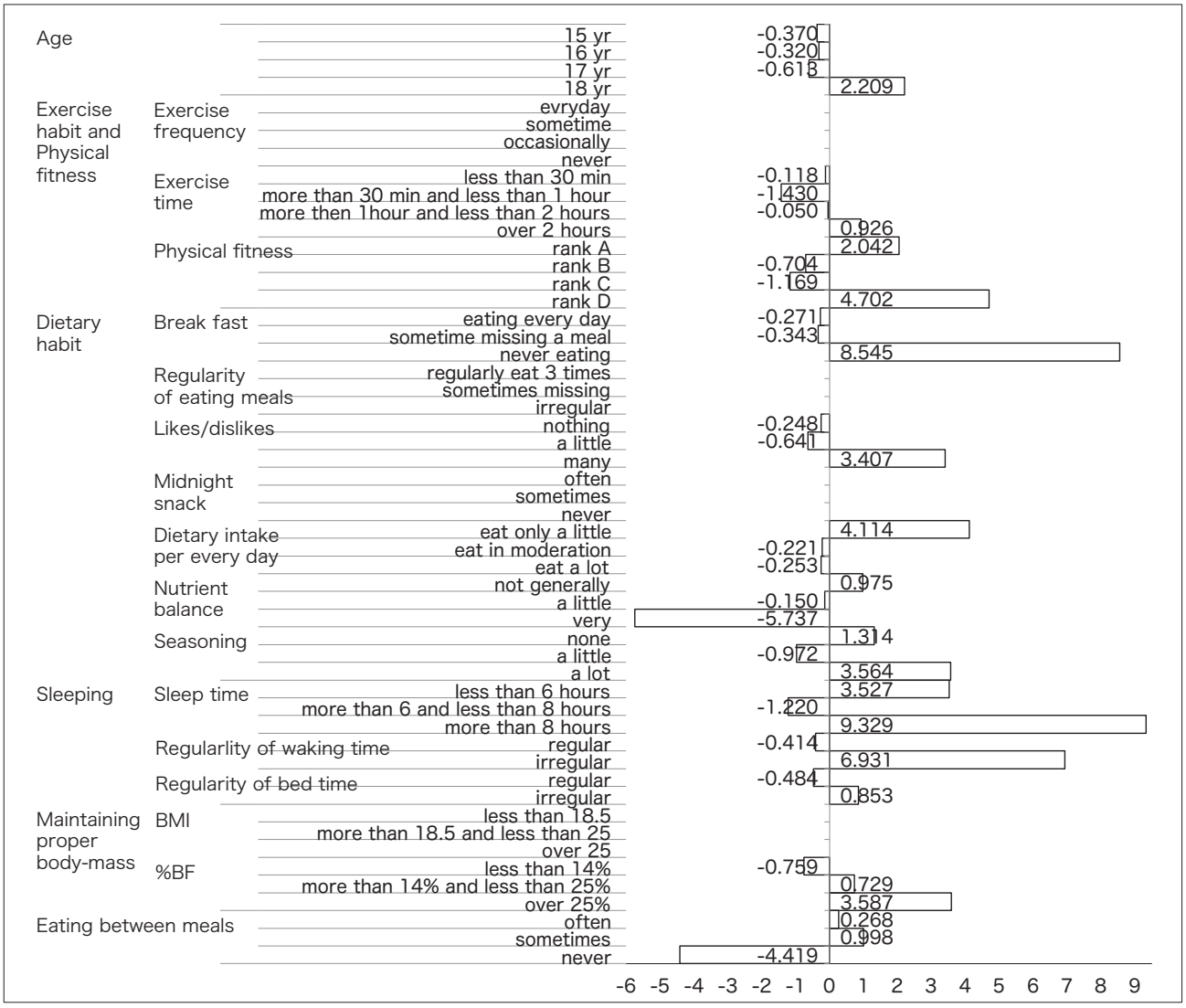

Figure 1. Category scores of each respond category in life habits

soreness increased in the 80% group. Meanwhile, Daley and Huffen (2003) examined the effect of low and moderate intensity exercise on perceived psychological changes and reported that, although contentment and tiredness increased significantly in the moderate intensity group, no change was found in the low intensity group. From these results, as stated in the introduction and the beginning of discussion, it is concluded that people who engaged in exercise with higher frequency and intensity have higher physical fitness levels, but also have higher subjective fatigue symptoms.

From the above, when exercising for the purpose of maintaining/enhancing mental health, exercise frequency and intensity should be noted. Pertruzzello et al. (1991) reported that 21 minutes of exercise is useful to decrease anxiety and is an adequate exercise time to improve elements of psychological health status, such as subjective fatigue symptoms. Some researchers insisted on the necessity of exercise for 20 minutes based on these findings (Berger., 1983; Leith., 1994). However, Petruzzello and Landers (1994) compared the psychological state after 15 and 30 minutes of running with moderate exercise intensity (75% maximal oxygen uptake), and reported that a significant difference was not found between both conditions. In another similar research project, it was reported that an increase of exhilarated feelings and a decrease of anxiety were found via five minutes of exercise (Hashimoto et al., 1996). At any rate, these results suggest that relatively longer exercise time (more than 1 hour) is not useful for the decrease of subjective fatigue symptoms from the present category score in exercise time. However, this may not always be considered comparable to category scores of the other life habits.

5. Conclusion

Although physical fitness level is one of the factors that affect subjective fatigue symptoms, many other life habits have a higher affect than physical fitness level. However, in any case, the magnitude of their whole influence is not large.

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