

Paper

## Criteria of exercise and sports for improvement of physical fitness and motor ability in youth (15-18 year olds)

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The purpose of this study was to examine criteria of exercise and sports for improving physical fitness and motor ability in youth. The samples were 1626 male and 1230 female high school students (15-18 yr). Eight items of the Japan Fitness Test (physical fitness), 61 items concerning fundamental movement-control skills and gymnastic skills (motor ability), participation and time spent in exercise and sports (present exercise habit), number of sports events, and participation in exercise and sports (past sports experiences) were measured. Results of this study were as follows: 1) the proportion of fitness test score A or B and motor ability score in a group of exercise for 3 days or more in a week or 2 hours or more in a day are significantly higher than the scores of the other groups; 2) the proportion of fitness test score D or E in a group of sports experiences of 2 or more events is significantly lower than the scores of the other groups, and motor ability score is higher; 3) motor ability score in a group which began sports since junior high school (13-15 yr) is significantly lower than the score of the other groups, and the proportion of fitness test score A or B in a female group which began sports before the third or fourth grade at elementary school (8-10 yr) is higher than the scores of the other groups. Therefore, It was concluded that requirements for improving physical fitness and motor ability in youth were as follows: 1) an exercise for 3 days or more in a week and 2 hours or more in a day, 2) sports experiences of 2 events or more before entrance to high school (15-18 yr), and 3) commencement of sports before graduation of elementary school (11-12 yr).

**Key words** : high school students, commencing time of sports, number of sports types

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### 1. Introduction

Physical fitness and motor ability are essential for individuals to grow and engage in creative activity, and can be an important element in one's zest for life (IKIRUCHIKARA) (Ministry of Education, Culture, Sports, Science and Technology: MEXT, 2002a). A physical fitness and motor ability survey (MEXT 2002b) has been conducted in Japan annually since 1964. The physical fitness and motor ability of the youth are measured by performance test and evaluated statistically. Nishijima et al. (2001) and Noi and Masaki (2002) showed statistically that the physical fitness and motor ability of Japanese children increased significantly between 1964 and 1975 and decreased between 1985

and the present. These studies also revealed a significant difference between the high and low physical fitness groups, in other words, that the gap in physical fitness has become larger (Nishijima et al., 2003). The MEXT Central Education Council submitted its guidelines entitled *Integrated Measures for Physical Fitness Improvement of Children and Youth* on September 30<sup>th</sup>, 2002 in order to stop and reverse the decline in the physical fitness of children and youth (Central Education Council, 2002). The guidelines set as goals both an increase in the overall average physical fitness and motor ability survey scores (improvement of physical fitness for exercise) and a decrease in the scores of factors leading to lifestyle-related diseases (improvement of physical fitness for healthy living). Based on these guidelines,

improvement in the environment regarding exercise and sports are employed as comprehensive strategies to improve the physical fitness of children and youth. These approaches aim not only for short-term results but for long-term and continuing results that contribute to the improvement of physical fitness in children, the group that the future tasks with the responsibility to maintain and form a vigorous Japanese society. Therefore, educational approaches that lead to the development of a life-long habit of exercising are required.

Studies on the factors regarding physical fitness and motor ability in children and youth have reported a high relevance to the exercise habit (Kawakami et al., 1996; Kim et al., 1993; Morimoto et al., 1991; Naka and Demura, 1994, 1992; Nishijima et al., 2003; Park et al., 1990; Taks et al., 1991), a high relevance to the exercise and sports experience in the past (Morimoto et al., 1993), and the high relevance of the exercise habit to the environment and the past exercise experience related to the current exercise (Naka and Demura, 1992). Furthermore, Suzuki and Nishijima (2005) carried out a validation of the causal association between exercise experience, exercise habit and physical fitness and motor ability utilizing samples of several thousand individuals in consideration of regionality. As a result, it was verified that past exercise and sports experience promote current exercise habit and that current exercise habit contributes to the improvement of physical fitness and motor ability.

Although the results of previous studies have clarified the importance of exercise, sports experience and exercise habit for the improvement of physical fitness and motor ability, they have not explained sufficiently the degree to which these three factors are required. In order to promote the development of physical fitness and motor ability from the long-term viewpoint of physical fitness improvement in children and youth, it is necessary to have a concrete activity policy that aims at the development of a life-long habit of exercising. It is particularly necessary to ascertain the most effective methods for the improvement of physical fitness and motor ability, including *when* and *how much* exercise is required. With the exception of the investigation undertaken by Naka and Demura (1994) in which they attempted to indicate the number of days (per week) of exercise by showing a statistically significant difference in the measurement values of physical fitness and motor ability from the difference of

exercise frequency, previous studies that examine the relationship among exercise habit, physical fitness and motor ability have described the exercise habit only in terms of the existence or nonexistence of participation in club activities. Exercise and sports experiences were also measured in terms of the existence or nonexistence of participation in club activities at junior high schools and high schools, and the number of years of such experience; therefore, such studies do not show when and what kind of exercise and sports experience were required.

The purpose of this study was to examine the concrete exercise and sports activity performance standards required for the physical fitness and motor ability improvement during the period of youth of Japanese high school students (15-18 years old).

## 2. Method

### 2.1 Subjects

Subjects of this study were 2,856 high school students (16.0±0.9 years of age) 1,626 male high school students (16.0±0.9 years of age) and 1,230 female high school students (16.0±0.9 years of age), from 10 high schools in Hokkaido, Aomori, Gunma, Tokyo, Fukui, Aichi, Kyoto, Okayama, Ehime and Saga Prefectures that agreed to participate in the survey. A request for cooperation with the survey was made to the boards of education of the targeted prefectures in the hopes of obtaining samples from one or two prefectures from each of the Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku and Kyushu regions in order that the survey population would be representative of students nationwide (Table 1). Before the measurement and survey, we explained the purpose of

Table 1. Subjects

Prefecture	Male	Femal	Total
Hokkaido	81	81	162
Aomori	81	81	162
Gunma	81	81	162
Tokyo	885	471	1,356
Fukui	89	88	177
Aichi	81	81	162
Kyoto	81	81	162
Okayama	86	103	189
Ehime	81	81	162
Saga	80	82	162
<b>Total</b>	<b>1,626</b>	<b>1,230</b>	<b>2,856</b>

this study and obtained informed consent from students and their parents through their respective boards of education and school principals.

## 2.2 Items for measurement and investigation

- (1) Physical Fitness: Grip strength, sit-up, sit & reach, side step, endurance run (1,500 m for males, 1,000 m for females), 20 m shuttle run, 50 m dash, standing long jump and handball throw were performed in conformity to the Japanese MEXT Fitness Test (for children 12-19 years of age) (MEXT, 2001). Measured values were converted to a 10-point scale for comprehensive evaluation. After calculating all scores, performances were classified into 5 levels, from A to E, in accordance with the Comprehensive Evaluation Standards Chart (MEXT, 2001). In cases where the measured values of both endurance run and 20 m shuttle run were obtained, the better converted value was adopted as the measurement for endurance.
- (2) Motor Ability: We used 37 individual exercises, including 4 short-rope jumping exercises, 3 vehicle exercises, 10 floor exercises, 5 horizontal bar exercises, 7 vaulting exercises, and 8 swimming exercises; and 24 ball sport exercises, including 7 basketball exercises, 10 soccer exercises and 7 baseball exercises, totaling 61 motor task items listed in the educational guidelines for elementary and junior high schools in Japan. We asked the students to evaluate their own performance on these items in a questionnaire using a 3-point scale including "I can do it well," "I can do it" and "I cannot do it." In order to ascertain student motor task achievement level, we calculated individual exercise achievement levels and ball exercise achievement levels from the score totals of the 37 individual exercises and 24 ball exercises and combined them (see Kokudo et al., 2003) for details regarding these concrete items and the characteristics of the items.
- (3) Exercise and sport experience: In a previous study regarding exercise and sport experience (Morimoto et al., 1993; 1991), existence and nonexistence of participation in club activities were often used; however, in this study, we used the number of sport types and when they began the sports they had experienced in the past. For the number of sport types, we targeted the sports that they experienced through

participation in organizations including club activities at schools, youth sports clubs and other sports clubs prior to entering high school. For when individuals began participation in the sports they had experienced, we targeted students who experienced more than 1 sport in the past and checked when they began participation in the sport(s) from pre-school to high school entrance (3-18 years old).

- (4) Exercise habit: The items measured for exercise habit were the amount of time devoted to exercises per day and the frequency of exercise per day. Respondents self-reported the amount of time devoted to exercise per day (except P.E. classes at schools) on a 4-point scale: "less than 30 minutes," "between 30 minutes and 1 hour," "between 1 hour and 2 hours," and "more than 2 hours." Frequency of exercise per day (except P.E. classes at schools) was also self-reported on a 4-point scale: "more than 3 days per week," "1 or 2 days per week," "between 1 and 3 days per month," and "none."
- (5) Measurement and survey method  
All measurements and surveys were conducted during P.E. classes and classroom activities from April, 2001 to October, 2001.

## 2.3 Definition of physical fitness and motor ability

In this study, ability as measured by Japanese MEXT Fitness Test was defined as physical fitness, and ability measured by the achievement levels of the 61 motor task items listed in the educational guidelines was defined as motor ability. Among the items of the Japanese Fitness Test, the 50 m dash, handball throw and endurance run were classified into the motor ability test of the Ministry of Education sports test that had been conducted until 1999, and they were not items that could not be proven conclusively to be unrelated to motor ability. As is shown in the evaluation method for the handball throw, however, regardless of the great contribution of motor ability to achievement in handball throw performance, it is usually evaluated by the distance of the long throw and energy contribution to the results of the handball throw is large. On the other hand, motor task achievement levels were evaluated in terms of whether or not the individual "can do" or "cannot do" a given exercise, which can be considered the measure of a concept different from the Japanese Fitness Test items that energy contributes to.

In this study, using the physical fitness classification established by Ikegami (1990), physical fitness was defined operationally as abilities that contribute significantly to the ability to move and maintain movement measured by the Japanese Fitness Test; and motor ability was defined operationally as abilities that contribute significantly to the ability to control actions measured by motor task achievement levels.

## 2.4 Statistical analysis

Composition ratio differences for the evaluation for each item were examined by chi-square for each sex, and a residual analysis was conducted for items indicating significant differences. Differences in the motor task achievement levels for each item were examined by two-way ANOVA taking sex as a factor. Scheffe's multiple-comparison test was conducted for items that were revealed as a main effect. Statistical significance was set at 5% in all statistical analyses.

## 3. Results

Tables 2 and 3 show the characteristics of the subjects in this study. A comprehensive evaluation of the physical fitness test showed that male students accounted statistically more for B group and less for C, D and E groups; and female students accounted more for A and B groups and less for D and E groups compared with the values nationwide. For frequency of exercise, male students exhibited a significantly lower rate of non-exercise. Female students showed a higher rate.

Table 4 shows the composition ratio for each item of the physical fitness evaluation, exercise and sports experience and exercise habit for each sex. In order to conduct chi-square, as a precondition, cells with an expected frequency of less than 5 should be less than 20% of all cells in the cross table (Tanaka, 1996). Therefore, physical fitness evaluation, number of sport types being experienced and when participation in a sport began that did not satisfy this precondition were analyzed after combining categories, as show in the table, in order to

Table 2. Subject Characteristics (Ordinal Scale)

Items	Sex	Subject	Category				
Physical Fitness Test comprehensive evaluation			A	B	C	D	E
Male: $\chi^2(4)=43.55, p < .05$	Male	1,496	16.5%(15.7)	43.6%(35.1)*	30.9%(34.8)*	8.2%(11.8)*	0.7%(2.6)*
Female: $\chi^2(4)=38.53, p < .05$	Female	1,065	12.4%(9.5)*	28.4%(22.2)*	37.2%(36.4)	19.5%(25.5)*	2.5%(6.4)*
Frequency of exercise			More than 3 days per week	1-2 days per week	1-3 days per month	No exercises	
Male: $\chi^2(3)=20.65, p < .05$	Male	1,588	58.8%(59.1)	20.5%(16.0)*	11.5%(11.5)	9.3%(13.4)*	
Female: $\chi^2(3)=11.05, p < .05$	Female	1,160	42.0%(41.5)	16.7%(18.1)	15.3%(19.1)*	26.0%(21.4)*	
Amount of time devoted to exercise			Less than 30 minutes	More than 30 minutes - less than 1 hour	More than 1 hour - less than 2 hours	More than 2 hours	
Male: $\chi^2(3)=14.134, p < .05$	Male	1,590	25.5%(25.5)	16.7%(13.7)*	19.8%(17.2)	38.0%(43.7)*	
Female: $\chi^2(3)=12.971, p < .05$	Female	1,141	45.4%(50.0)*	11.8%(14.2)	17.2%(13.2)*	25.6%(22.6)	
When participation in a sport began			Lower grades of elementary school and earlier (1)	Middle grades of elementary school	Higher grades of elementary school	After entrance to junior high school	
	Male	1,483	38.3%	29.6%	11.1%	21.0%	
	Female	1,046	33.1%	27.1%	16.8%	23.0%	

Note 1: Japanese average values in the same generation (are indicated in 15-18 years of age) are shown in parentheses (MEXT, 2002b)

Note 2: \* indicates a significant difference in the comparison with Japanese average values.

(1): "Lower grades of elementary school (less than 7 years of age)" includes sports that started before entrance to elementary school.

Table 3. Subject Characteristics (Interval Scale or Ratio Scale)

Field	Item	Subject	Male (Average value±Standard deviation)	Subject	Female (Average value±Standard deviation)
Physical fitness Each item: 10 point-scale	Grip strength	1,567	6.3±1.5	1,124	6.1±1.8
	Sit-up	1,597	7.7±1.8	1,170	7.1±1.9
	Sit & reach	1,602	6.5±2.0	1,178	6.2±2.0
	Side step	1,591	7.5±1.8	1,168	6.8±2.1
	Endurance run <sup>1</sup>	1,591	6.7±1.9	1,180	6.1±2.1
	50m dash	1,577	6.6±1.8	1,158	6.2±1.9
	Standing long jump	1,601	6.3±1.7	1,172	5.9±2.0
	Handball throw	1,585	6.1±1.9	1,163	6.1±2.1
Motor Ability	Individual exercise achievement levels (74 maximum points)	1,626	29.3±12.3	1,230	27.6±11.0
	Ball exercise achievement levels (48 maximum points)	1,626	19.6±10.3	1,230	10.3±7.6
	Motor task achievement levels (122 maximum points)	1,626	48.9±20.2	1,230	37.9±16.4
Exercise & sport experience	Number of sport types (Maximum 4 types)	1,626	1.2±0.6	1,230	1.1±0.6
	Average number of days of exercise/per week	1,626	4.4±3.2	1,230	4.0±3.0

1: 20m shuttle run or endurance run (1500m for males, 1000m for females)

maintain the intention of the classification.

Both male and female students showed significant differences between predicted and observed degrees for the number of sport types they experienced. Both male and female students in the no-experience group showed a significantly low rate of inclusion in the A and B groups, and a significantly high rate of inclusion in the C, D and E groups. They also showed a significantly low rate of inclusion in the A and B groups of students who experienced more than 2 sports (Fig.1). Only female students showed significant differences in when participation in a sport began. In the group of female students who started sports before the middle grades at elementary schools, significantly high values were seen in the A and B groups, and significantly low values were seen in the D and E groups (Fig.2). Both male and female students showed significant differences in frequency of exercise. Both male and female students showed

significantly low values in the D and E groups of those who were exercising more than 1 or 2 days per week, and significantly high values in the A and B groups of those who were exercising more than 3 days per week (Fig.3). Both male and female students showed significant differences in the amount of time devoted to exercising. Male students showed significantly low values in the D and E groups of those who were exercising more than 1 hour; however, female students showed low values in the D and E groups of those who were exercising more than 30 minutes (Fig.4).

Table 5 shows the results of ANOVAs for each item of motor ability, exercise and sports experience, and exercise habit. There were no significant differences by sex found in any item; however, the main effect of each item was found for all items. Multiple comparisons revealed the tendency for common results for all items, and the group of those without experience showed significantly low

Table 4. Cross table of physical fitness evaluation, exercise and sports experience, and exercise habit (number of students)

Item	Category	Physical Fitness Evaluation					
		Male			Female		
		AB	C	DE	AB	C	DE
Number of experienced sport types Male: $\chi^2(6) = 44.12, p < .05$ Female: $\chi^2(6) = 72.34, p < .05$	None	32(33.7)	42(44.2)	21(22.1)	20(46.0)	47(42.0)	46(24.9)
		-25.15*	12.60*	12.55*	-26.05*	4.98*	21.07*
	1type	646(60.4)	329(30.8)	94(8.8)	300(39.7)	280(37.0)	176(23.3)
		2.89*	-1.85	-1.04	-8.08*	-1.10	9.18*
	2types	187(65.9)	81(28.5)	16(12.0)	104(60.1)	58(33.5)	11(6.4)
		16.14*	-6.90*	-9.25*	33.50*	-6.33*	-27.17*
	More than 3 types	35(72.9)	11(22.9)	2(4.2)	10(43.5)	11(47.8)	2(8.7)
		6.12*	-3.86*	-2.27*	0.63	2.45*	-3.08*
When participation in a sport began Male: $\chi^2(6) = 9.22, p > .05$ Female: $\chi^2(6) = 20.53, p < .05$	Lower grades of elementary school	327(62.4)	160(30.5)	37(7.1)	141(49.3)	103(36.0)	42(14.7)
					16.11*	-1.23	-14.88*
	Middle grades of elementary school	267(65.9)	111(27.4)	27(6.7)	115(46.2)	92(37.0)	42(16.9)
					6.27*	1.25	-7.52*
	Higher grades of elementary school	95(61.3)	49(31.6)	11(7.1)	67(42.7)	52(33.1)	38(24.2)
					-1.56	-5.22*	6.77*
	After entrance to junior high school	162(56.6)	92(32.2)	32(11.2)	70(33.7)	81(38.9)	57(27.4)
					-20.8*	5.20*	15.63*
Frequency of exercise Male: $\chi^2(6) = 173.30, p < .05$ Female: $\chi^2(6) = 202.04, p < .05$	None	48(35.8)	54(40.3)	32(23.9)	48(18.1)	114(42.9)	104(39.1)
		-32.58*	12.71*	19.88*	-60.55*	15.18*	45.37*
	1-3 days per month	59(33.5)	80(45.5)	37(21.0)	35(22.0)	69(43.4)	55(34.6)
		-46.84*	25.76*	21.08*	-29.89*	9.93*	19.96*
	1-2 days per week	155(52.7)	115(39.1)	24(8.2)	64(36.6)	82(46.9)	29(16.6)
		-21.80*	24.40*	-2.60*	-7.41*	16.99*	-9.57*
	More than 3 days per week	622(71.8)	204(23.6)	40(4.6)	277(63.1)	121(27.6)	41(9.3)
		101.22*	-62.87*	-38.35*	97.85*	-42.09*	-55.76*
Amount of time devoted to exercise Male: $\chi^2(6) = 126.81, p < .05$ Female: $\chi^2(6) = 178.13, p < .05$	Less than 30 minutes	146(38.8)	166(44.2)	64(17.0)	102(22.1)	200(39.3)	160(34.6)
		-80.27*	49.80*	30.47*	-88.88*	29.98*	58.90*
	More than 30 minutes - less than 1 hour	138(56.6)	84(34.4)	22(9.0)	52(42.6)	48(39.3)	22(18.0)
		-8.83*	8.59*	0.24	1.60	3.10*	-4.70*
	More than 1 hour - less than 2 hours	188(64.6)	84(28.9)	19(6.5)	92(50.6)	69(37.9)	21(11.5)
		12.89*	-5.93*	-6.95*	16.81*	2.02*	-18.83*
	More than 2 hours	412(73.8)	120(21.5)	26(4.7)	175(69.2)	58(22.9)	20(7.9)
		76.21*	-52.45*	-23.76*	70.47*	-35.11*	-35.37*

Note: Values in parenthesis are applied to the cases for which % and  $\chi^2$  tests in the group are significant. Results of residual analysis are shown in the bottom column of each category.

\*: |Residual Analysis| > 1.96,  $p < .05$



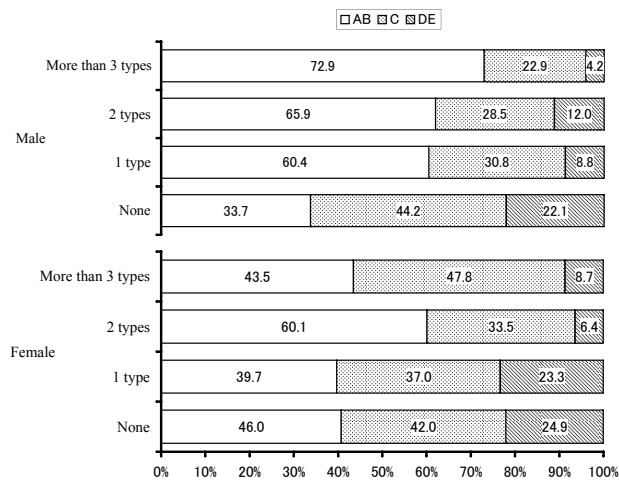


Figure 1. Relationship between number of experienced sport types and evaluated physical fitness values

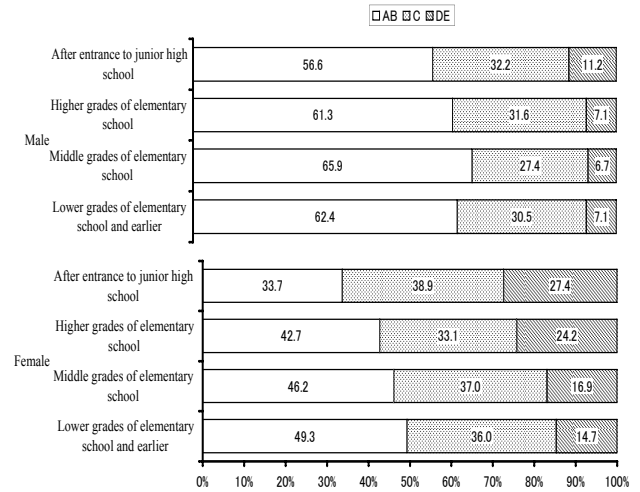


Figure 2. Relationship between when participation in sport began and physical fitness evaluated values

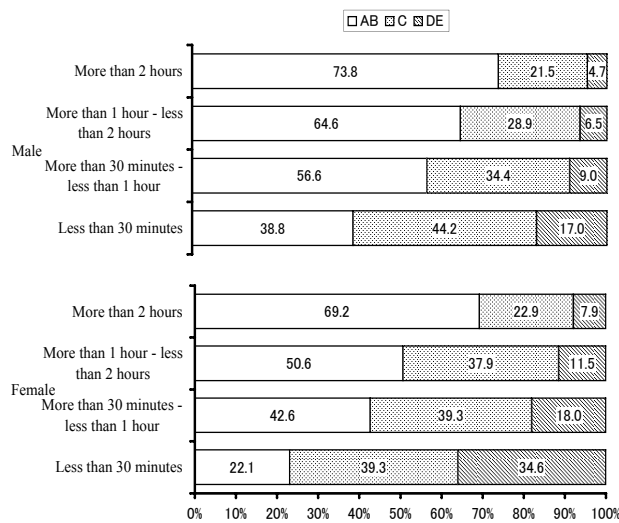


Figure 3. Relationship between frequency of exercise and evaluated physical fitness values

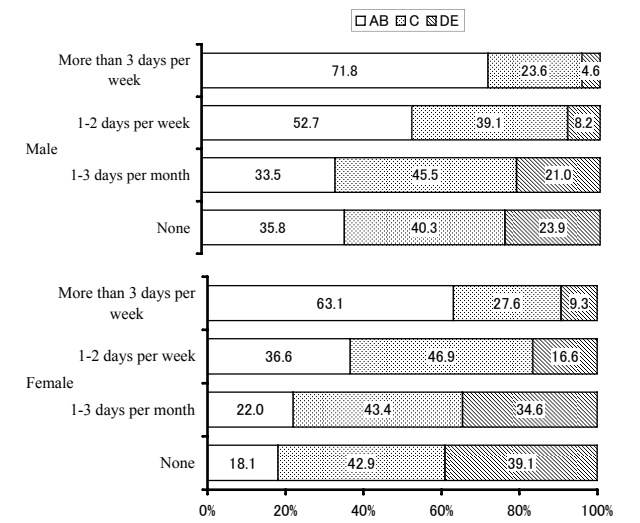


Figure 4. Relationship between amount of time devoted to exercise and evaluated physical fitness values

Table 5. Relationship among motor ability (Motor task achievement levels), exercise and sport experience, and exercise habit

Item	Sex	Category				Analysis of variance	
		None	1 type	2 types	More than 3 types	Main effects (F value) of factors in items	Multiple comparison
Number of experienced sport types	Male	34.3±18.1	48.9±20.2	53.0±18.8	55.5±19.1	61.186*	No experience<1 type, 2 types, 3 types; 1 type<2 types
	Female	25.9±13.1	37.6±15.6	45.0±16.6	47.3±18.6		No experience<1 type<2 types, 3 types
When participation in a sport began	Male	Lower grades of elementary school	Middle grades of elementary school	Higher grades of elementary school	After entrance to junior high school	13.276*	After entrance to junior high schools<Lower grades of elementary school, Middle grades elementary school
	Female	50.7±19.9	51.9±21.3	48.7±17.4	45.6±18.4		After entrance to junior high schools<Lower grades of elementary school, Middle grades elementary school, Higher grades of elementary school
Frequency of exercise	Male	None	1-3 days per month	1-2 days per week	More than 3 days per week	51.660*	None, 1-3 days per month, 1-2 days per week<More than 3 days per week
	Female	43.8±21.8	42.7±18.9	43.4±17.7	52.9±20.3		None<1-3 days per month, 1-2 days per week<More than 3 days per week
Amount of time devoted to exercises	Male	Less than 30 minutes	More than 30 - less than 1 hour	More than 1 hour - less than 2 hours	More than 2 hours	56.802*	Less than 30 minutes, More than 30 minutes - less than 1 hour, More than 1 hour - less than 2 hours<More than 2 hours
	Female	33.2±15.4	39.7±14.7	40.9±15.8	43.9±17.2		Less than 30 minutes, More than 30 minutes - less than 1 hour, More than 1 hour - less than 2 hours<More than 2 hours

Note 1: Unit of Average=Standard deviation and Measured values is points.

Note 2: Interaction of sex×items in two-way ANOVA were insignificant in all items.

\*:p < .05

values compared with other groups for the number of sport types experienced. The group of individuals that began participation in sports after junior high school entrance showed significantly low values compared with other groups for the period of time for starting sports. The group of individuals who exercise more than 3 days per week showed significantly high values compared with other groups for frequency of exercises. The group of individuals who exercise more than 2 hours showed significantly high values compared with other groups for the amount of time devoted to exercise.

#### 4. Discussion

Previous studies regarding the relationship between frequency of exercise and physical fitness during youth have reported that the group of individuals who exercise more than 3 days per week showed higher physical fitness and significant improvements in physical fitness compared with other groups (Naka and Demura, 1994; 1992). This study also showed that the group of individuals who exercise more than 3 days per week had a significantly high rate of A or B physical fitness evaluation values. For the amount of time devoted to exercise, the group of individuals who exercise more than 1 hour per day had a significantly high rate of A or B physical fitness evaluation values. The group of individuals who exercise more than 3 days per week and more than 2 hours per day showed a significantly higher motor ability compared with other groups. In consideration of the above, it is estimated that the standard for inclusion in the A and B physical fitness evaluation values is exercise more than 3 days per week and 1 hour per day, and that improvement of motor ability requires that the individual exercise more than 3 days per week and 2 hours per day.

Meanwhile, a significant decrease in the physical fitness of Japanese children was revealed in the groups of individuals who were below average (Nishijima et al., 2003); therefore, it is necessary to focus on improvement in the group of individuals with low physical fitness from the viewpoint of reducing the risk factors for lifestyle-related diseases. In terms of physical fitness evaluation values, this means a significant reduction in the D and E group populations. This study showed a significantly low rate of inclusion in the D and E groups for groups of individuals who exercise more than 1 day

per week. The group of male students who exercise more than 1 hour per day and female students who exercise more than 30 minutes per day showed a significantly low rate of inclusion in the D and E groups. Female students reported a shorter amount of time devoted to exercise, revealing significant differences compared with male students. It is speculated that the reason for this is that female students generally have low physical fitness compared with male students; therefore, female students can improve physical fitness at a low level with even less time devoted to exercise compared with male students. However, it is still necessary to exercise some caution regarding these results because the subjects in this study showed a lower rate of inclusion in the D and E groups compared with nationwide values, especially male students included in E group at only 0.7% (10 students). Therefore, it is required to assure an adequate sample size for a focus on the group with less than average physical fitness.

Research by Suzuki and Nishijima (2005) showed that exercise and sports experience have a less direct impact on physical fitness and motor ability, and that the impact itself was via the intervention of exercise habit. Therefore, it is predicted that improvement of physical fitness and motor ability can be achieved if based on standards that reflect current exercise habit. However, when taking the development of a life-long habit of exercise into consideration, guidelines for improving physical fitness and motor ability should be examined from the viewpoint of exercise and sports experience that influences exercise habit. In previous studies, the existence and nonexistence of participation in sports club activities have been used to examine the relationship between the past exercise and sports experiences and physical fitness and motor ability (Tatano, 1981); however, an examination of diversity and optimal timing of types of sports including the number of sport types and when participation in sports was begun dealt with in this study has not been conducted.

The results of this study regarding the relationship between the number of sport types experienced and physical fitness showed that both the groups of male and female students without experience had a significantly low rate of inclusion in the A and B groups, and a significantly high rate of inclusion in the C, D and E groups. The group of both male and female students who have experienced more than 2 sports showed a significantly low rate of

inclusion in the D and E groups. Results regarding relationships with motor ability indicated that both male and female students in the group with experience in 1 sport had significantly high values compared with the group without experience, and the groups with experience in 2 sports had significantly high values compared with the group with experience in 1 sport. Therefore, it was estimated that experience in more than 2 sports was necessary for an improvement of physical fitness and motor ability.

According to study results regarding the relationship between when participation in sports began and motor ability, both male and female students in the group that began participation in sports after junior high school entrance showed significantly low values compared with other groups. Results for the relationship between when participation in sports began and physical fitness revealed that female students in the group that began participation in sports before the middle grades at elementary school showed a high rate of inclusion in the A and B groups, and a low rate of inclusion in the D and E groups. The physical fitness of male students was not influenced by differences in when participation in sports began. The reason that only male students showed no significant differences was thought to be the differences in physical growth and development between the sexes. The subjects of this study were high school students. The rate of physical growth, including standing height, in females decreases from approximately 14 years of age and largely ceases within the period of adolescence. The physical growth of males is thought to cease at 18-19 years of age (Matsuura, 1982). In other words, although there are individual differences, the growth in height of males does not cease in adolescence. The same holds true for the period of physical fitness growth, and physical fitness improvement caused by physical growth and development is found during the period of adolescence (Matsuura, 1982). Considering the above, physical growth status exerts a potentially stronger influence on current physical fitness than when participation in sports began. Therefore, while the influence of when participation in sports began on the current physical fitness of females, among whom the cessation of physical growth and development is greater, seems to be large, when participation in sports began seems unrelated to the current physical fitness in males because there are more male students who are

within the period when physical fitness is developing along with physical growth. This must be the reason that no significant differences were revealed in males only.

It is estimated that requires that the improvement of motor ability in both male and female students requires that participation in sports begin before entrance to junior high school; and for female students in particular, improvement in physical fitness requires that participation in sports begin before the middle grades at elementary school.

Miyashita (1980) reported the existence of an optimal time within which training is the most effective. He concluded that this optimal timing differs depending on the system involved. According to the development curve of physical function, it is less than 11 years of age for nerves and muscles (to become proficient), 12-14 years of age for muscles and the cardiorespiratory system (to develop endurance), 15-18 years of age for muscles and skeletal structure (to develop strength). The results of this study support Miyashita's theory and revealed that exercise at the optimal timing exerted influence on the future development of physical fitness and motor ability.

There are limitations to the generalization of the above-stated findings. The first of these is the limitation of items for survey regarding exercise and sports experience. We only used the number of sport types and when participation in sports began for sports experience in this study. The content of the sports, the experience of physical play and the intensity of these exercises are not examined in this study. In consideration of practical application, it is necessary to provide guidelines for the type and intensity of sports, and there is a need to promote continued research continually in the future as well. Another limitation is that of the retrospective survey. As the period of time to be traced increases, the general reliability of the survey is reduced because the answers are based on the memory of participants. It is necessary to increase the reliability of the findings obtained in this study by conducting a long-term follow-up investigation.

## 5. Conclusion

In this study, using 2856 Japanese male and female high school students as samples, we examined the degree of exercise and sports experience and exercise habit required for the improvement of physical fitness and motor ability,



and reached the following conclusions within the range of samples, measurement and investigation items utilized in this study.

Improving of the physical fitness and motor ability of Japanese high school students (15-18 years of age) requires either an exercise habit of more than 3 days per week and 2 hours per day, experience in more than 2 sports before high school entrance (15-16 years of age), or participation in sports that begins before elementary school graduation (11-12 years of age).

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