Paper : Fitness and Physical Activities

The Influence of Past Sports Experience on Determining Current Exercise Habit in Japanese Youth

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[Received September 13, 2006 ; Accepted May 30, 2007]

The purpose of this study was to identify the specific influence of past sports experience on establishing the habit of exercise in Japanese high school students. The participants were 2,725 (male: 58.0%) high school students in Japan. Survey items included current exercise habit (frequency, and duration), and past sports experience (number of sports events [NSE], commencing time of sports [CTS], and time spent per week [TS/wk]). An exercise habit was defined the implementation of exercise three or more days/wk and one or more hrs/day. Data were randomly split into sample A and B halves. Forty seven percent of the participants were included in the exercise habit group. From the result of a classification and regression tree (CART) analysis for sample A, the rule of the highest ratio of the exercise habit group (72.9%) was NSE > 2 events, and TS/wk > 6.9 hrs. From the result of a CART analysis for sample B, the rule of the highest ratio of the exercise habit group (76.3%) was NSE > 2 events, and TS/wk > 8.3 hrs. Split sequences indicated the same results between the samples. The results of logistic regression analysis using each sample indicated that NSE and TS/wk were statistically significant in both samples. Therefore, the study, although limited to statistical methods and characteristics of samples, suggested that a requirement for establishing exercise habits in youth was NSE > 2 events, and TS/wk > 6.9-8.3 hrs before entering senior high school.

Keywords: Habitual physical activity, number of sports events, commencing time of sports, Decision tree analysis

[School Health Vol.3, 22-29, 2007]

1. Introduction

The ongoing increase in national health care expenditure has become a serious problem in Japan. In this context, the maintenance of lifelong physical and mental health is significant not only for individuals but also for the nation. Since the revision of the nursing care insurance system, increasing numbers of middle-aged and older individuals have been encouraged to exercise. From a short-term perspective, it is indeed necessary to approach middle aged and older individuals in order to reduce health care expenditure. From a long-term perspective, however, it is equally important to approach minors (individuals under 20 years of age). An increase in lifestyle-related diseases and a decline in physical fitness among minors have become serious problems. Many studies (e.g. U. S. DHHS, 1996) have reported that habitual exercise can contribute to the promotion of health and the improvement of physical fitness. On September 30, 2002, the Central Education Council of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) issued its "Comprehensive Strategies for Improving Physical Fitness of Children," establishing the improvement of children's physical fitness as a national measure. Against this background, efforts have been made on a national scale to improve the physical fitness of children. Kobayashi (2003) has demonstrated that physical education at school contributes to the upgrading of physical fitness. It has also been clarified that sports activities at school or in local communities play an important role in the maintenance of high physical activity intensity (Van Mechelen, et al., 2000) and contribute to the improvement of physical fitness (Kawakami, et al.,

1996; Morimoto, et al., 1992; Tokunaga, 1981). The importance of physical activity through sports club activities at school and in the community has thus been recognized.

Meanwhile, Kemper, et al., (2001) have reported that there is little relationship between physical fitness during adolescence (ages 13-17) and the amount of physical activity in adulthood (age 33). In other words, not all individuals who had excellent physical fitness in childhood engage in vigorous physical activity in adulthood. According to other studies (e.g. Boreham and Riddoch, 2001; Malina, 2001), there exists a certain relationship between the amount of physical activity in childhood and that in adulthood. Considering that physical fitness provides a basis for a fulfilling life and the creation and maintenance of a vibrant society (Central Council for Education, 2002), the improvement of physical fitness in children is desirable not only for the prevention of lifestyle-related diseases and the improvement of motivation and morale, but also for the development of a lifelong habit of exercise in order to maintain a high level of physical fitness and health throughout life. In other words, approaches to physical fitness improvement in children should be designed to contribute to the formation of a lifelong habit of exercise rather than the temporary upgrading physical fitness.

It has been shown that the formation of exercise habit during the period of senior high school (aged 15-18) is related to past exercise experience (Suzuki and Nishijima, 2005). Earlier studies have illustrated that participation in exercise is associated with the self-efficacy and enjoyment of exercise (Stuky-Ropp and DiLorenzo, 1993; Sallies, et al., 1989; Zakarian et al., 1994), and that an increase in self-efficacy can lead to an increase in the amount of physical activity (Sallies et al., 1992; Trost et al., 1997). Based on these study results, it can be speculated that past exercise experience is related to self-efficacy and enjoyment of exercise and leads to the formation of exercise habit. However, the type of exercise experience that is connected to the formation of exercise habit has not been identified.

In addition to past exercise experience, social, cultural and physical factors are reported to be strongly related to the determination of physical activity (Sallies et al., 1997). These factors, however, are difficult to improve on an individual level. According to another study, no relation was observed between the amount of highly intensive physical activity and imminent environment in senior high school children (Zakarian et al., 1997). This indicates that some children, despite being in an environment hospitable to exercise, continue to have a low amount of physical activity by opting not to participate in any of the sports club activities that are offered to them. It is, therefore, important to identify the type of exercise experience that contributes to the formation of exercise habit.

No earlier studies have clarified the conditions of exercise experience that are required for the formation of exercise habit (e.g. the appropriate amount of exercise in childhood). From the viewpoint of exercise habit, it is considered to be desirable to build such a habit as early as possible. In surveys on the past exercise experiences of minor children, however, the younger the subjects are, the shorter their past becomes and, therefore, the more difficult clarification of their past exercise experience becomes. With this point in mind, senior high school children were chosen as the subjects of this study. This study aimed to clarify the conditions of past exercise experience that affect the formation of an exercise habit in minor children that exceeds the level of exercise generally recommended for minors.

2. Methods

2.1. Subjects

The subjects of this study were 2,725 students (1,580 males aged 16.0 ± 0.9; 1,136 females aged 16.1 ± 0.9; and 9 students of unspecified gender aged 16.2 ± 0.4) enrolled in 10 senior high schools located in Hokkaido, Aomori, Gunma, Tokyo, Fukui, Aichi, Kyoto, Ehime, and Saga. With the cooperation of their boards of education, these prefectures were selected as representative of the 8 regions of Japan; namely, Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, and Kyushu.

2.2. Survey items

Regarding the current exercise habit of the subjects, the duration and frequency of daily exercise excluding that performed in physical education classes required by the school curriculum were surveyed. Regarding past sports experience, number of sports events (NSE), commencing time of sport

(CTS) and the average exercise time spent per week (TS/wk) were surveyed. Daily exercise duration was rated on a 4-point scale; that is, less than 30 minutes, 30 minutes or longer but less than 1 hour, 1 hour or longer but less than 2 hours, and 2 hours or longer. Similarly, daily exercise frequency was rated on a 4-point scale; that is, none, 1-3 days per month, 1-2 days per week, and 3 days or more per week. Sports experience was analyzed based on the NSE (ratio scale: maximum 4), CTS (ordinal scale), and TS/wk (ratio scale). Regarding the sports that subjects performed as school-based or community-based club activities during the period from enrollment in kindergarten (nursery school) through junior high school graduation, sports events (up to 4 events), CTS (kindergarten, elementary school, and junior high school), and accumulated weekly exercise time were surveyed.

2.3. Definition of habitual exercise

The amount of physical activity that is regarded as sufficient for children to acquire health benefits varies according to study. Moderate or vigorous exercise performed for 30-60 minutes per session and more than 2 or 3 days per week, however, is regarded as common criterion in some studies (Biddle et al., 1998; Sallis and Patrick, 1994; U.S.DHHS, 1991). Considering all the recommended criteria, individuals who perform exercise for more than one hour per day and more than 3 days per week were defined in this study as the habitual exercise group.

2.4. Statistical analysis

In order to clarify the conditions of past exercise experiences that were required for the formation of exercise habit in senior high school students, a decision tree analysis was performed with the use of habitual exercise as a dependent variable and past exercise experience as an independent variable. It is known that decision tree analysis results are affected by analysis method and split criteria (Shinmura, 2002; SPSS, 2002). Therefore, a cross-validation (for replicability) and a logistic regression analysis were performed to validate the consistency of the decision tree analysis. In order to examine the conditions of past exercise experience that were required for the formation of exercise habit in senior high school students, a decision tree analysis with the use of habitual exercise (binary data; i.e. yes/no) as a dependent variable and past sports experience (NSE, CTS, and TS/wk) as an independent variable and a logistic regression analysis (for 3 items) with the use of the forced entry method were performed. For decision tree analysis, CART (classification and regression trees), a widely-used analysis method (Breiman et al., 1984), was used.

In order to validate the replicability of the analysis results, the samples were randomly dual partitioned with the use of the Select cases function of SPSS11.5J, and sample A (1356) and sample B (1369) were analyzed by the above-mentioned method. Decision tree analysis is a method of discrimination, or analysis similar to discriminant and cluster analysis, traditional statistical methods (Shinmura, 2002). When the dependent variable is binary data, decision tree analysis also serves as a method for examining or predicting the degree of the effect of independent variables on dependent variables, similar to logistic regression analysis (Oku et al., 2004). It can also be described as a nonparametric statistical analysis method which responds to discriminant and regression analysis (Ootaki et al., 1998). Being able to show the correlation of independent variables to dependent variables hierarchically, decision tree analysis, unlike traditional statistical analysis methods, is performed based on the concept that the samples (the subjects) are multistage-classified into homogeneous groups through more-than-two-way split by multiple independent variables that affect dependent variables (Ootaki et al., 1998). As a nonparametric statistical method, it requires no assumptions of prior distribution and error. CART (also abbreviated as C&RT) is one of the decision tree algorithms, a binary split method.

Gini diversity index was used as a split criterion (SPSS, 2002). Split stopping criterion consists of the maximum number of split hierarchies and the minimum number of the samples included in the descendant, a new group produced by split, and the ancestor, a node from which the descendant splits. In this study, the split stopping criterion of AnswerTree 3.1J default was used; that is, the maximum number of the split hierarchy: 5; descendant: 50; and ascendant: 100. A decision tree is rated based on misclassification cost. Misclassification cost is the rate of the number of misclassified samples to the total number of samples. The lower the

Table 1 Characteristics of the Subject

Items	Number of the subjects	Sex	Category				
Exercise duration			3 days or more per week	1−2 days per week	1−3 days per month	None	
	1,588	Male	58.8%(59.1%)	20.4%(16.0%)	11.5%(11.5%)	9.3%(13.4%)	
	1,160	Female	42.4%(41.5%)	16.9%(18.1%)	15.4%(19.1%)	25.3%(21.4%)	
Exercise frequency			Less than 30 minutes	More than 30 minutes − less than 1 hour	More than 1 hour − less than 2 hours	More than 2 hours	
	1,580	Male	25.6%(25.5%)	16.7%(13.7%)	19.6%(17.2%)	38.1%(43.7%)	
	1,136	Female	45.2%(50.0%)	11.9%(14.2%)	17.3%(13.2%)	25.7%(22.6%)	
NSE (up to 4 events)			None	1 event	2 events	3 events	4 events
	1,580	Male	6.5%	13.0%	19.8%	24.6%	36.1%
	1,136	Female	10.3%	16.5%	17.5%	21.5%	34.2%
CTS			Kindergarten	Elementary school	Junior high school	Senior high school	
	1,474	Male	15.3%	58.7%	17.7%	1.6%	
	1,016	Female	19.5%	50.6%	18.0%	1.4%	
TS/wk			Mean value±standard deviation				
	1,461	Male	7.0±5.5				
	997	Female	6.5±5.5				

Figures in parentheses represent the corresponding national values (MEXT, 2003)

misclassification cost, the more reliable the results become. There is, however, no criterion of the allowable limits of misclassification cost. In this study, the reliability of the decision tree analysis was validated by cross-validation and from the consistency of the logistic regression analysis results and the decision tree analysis results. The degree of contribution of independent variables to dependent variables is shown as variable importance. Variable importance signifies degree of contribution as split variable and is evaluated relatively, setting the highest valuable as 100.

The significant level of the above-mentioned statistical analysis was set as 1%. SPSS 11.5J and SPSS AnswerTree 3.1J were used for all the analyses.

Earlier studies (e.g. Dishman and Sallis, 1994) have reported that amount of physical activity varies by sex. In this study, a sex-based difference of physical activity amount was also expected. It was also expected that such a difference would affect the conditions of past exercise experience, producing a possibility of revealing conditions that were different according to the sex of the subjects. However, sex-based difference in amount of physical activity does not always affect analysis results. Moreover, Suzuki and Nishijima (2007) have reported that the robustness of split value is low in a decision tree analysis with approx. 1,000 samples. It has also been reported by Ootaki (1998) that more than 2,000 samples are required to obtain any meaningful results in a decision tree analysis. Because neither male nor female samples used in this study exceeded 2,000 in number, sex-based analyses were not performed in this study.

3. Results

Table 1 shows the characteristics of the subjects. Compared with national average values (MEXT 2003), the rate of the male subjects who were uninvolved in physical activity was low, while the rate of the corresponding female subjects was high. A total of 46.9% of the subjects (male: 52.7%; female: 38.7%) belonged to the habitual exercise group defined in this study.

As a result of decision tree analysis utilizing Sample A, a tree diagram with 3 hierarchies and the terminal node 5 (misclassification cost: 35.1%) was produced (**Figure 1**). The rate of the habitual exercise group was 47.3%. The first condition for an increase in the rate of the habitual exercise group was NSE >2 (3 events or more). Under this condition, the rate of the habitual exercise group was 60.3%. The second condition was TS/wk >6.9 hours. Under the

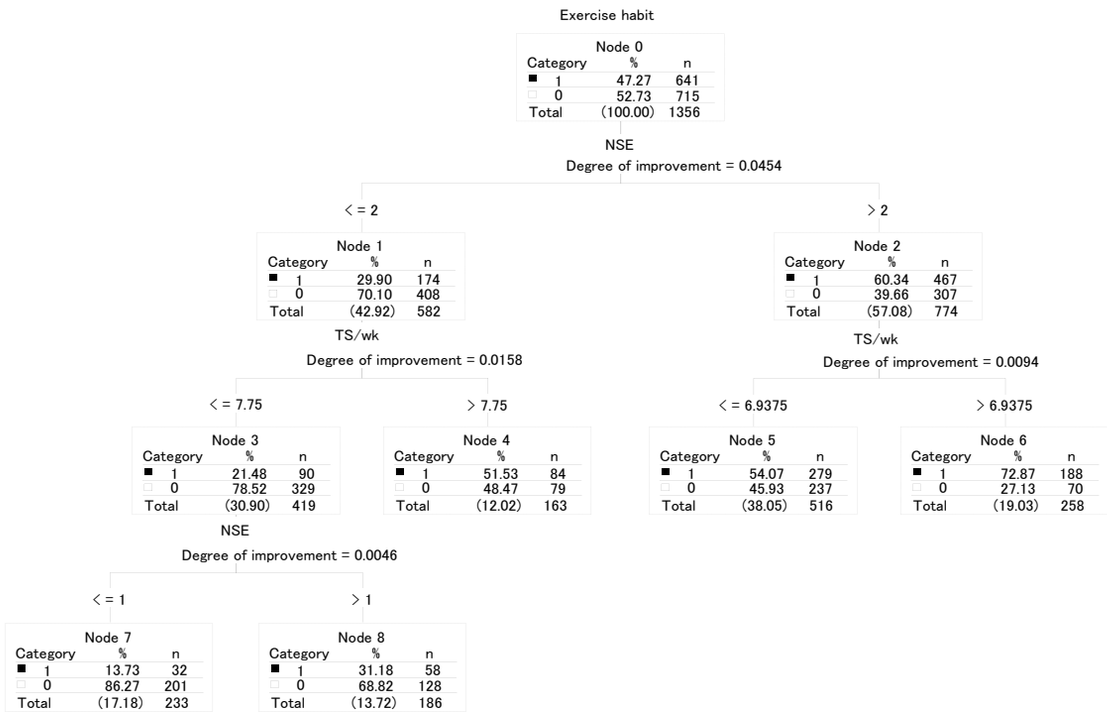

Figure 1 Results of decision tree analysis (CART) utilizing Sample A
Note 1) With exercise habit: 1; without exercise habit: 0
Note 2) Misclassification cost: 35.1%

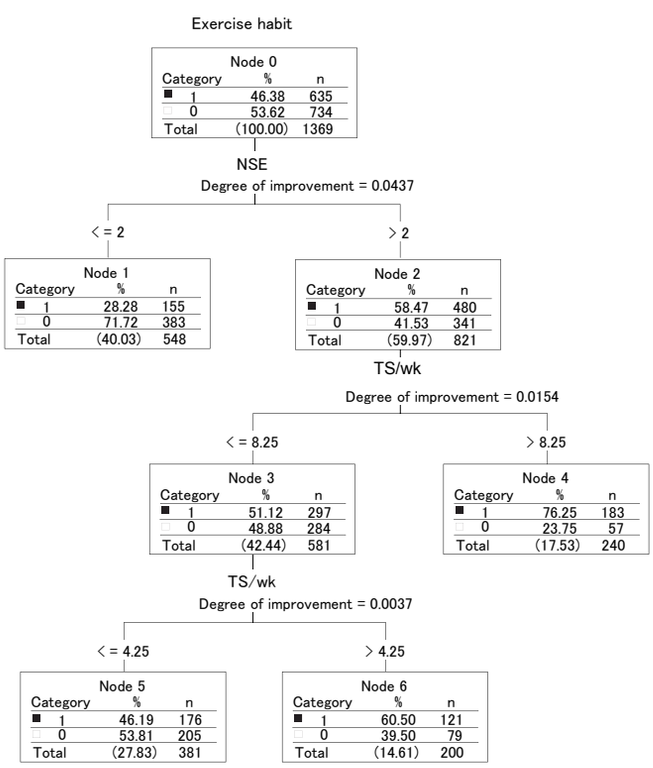

Figure 2 Results of decision tree analysis (CART) utilizing Sample B
Note 1) With exercise habit: 1; without exercise habit: 0
Note 2) Misclassification cost: 34.1%

conditions of NSE >2 (3 events or more) and TS/wk >6.9 hours, the rate of the habitual exercise group was 72.9%. When the variable importance of the NSE was set as 100, the corresponding rate of TS/wk was 50.4.

The first condition for a decrease in the rate of the habitual exercise group was NSE <=2. Under this condition, the rate of the habitual exercise group was 29.9%. The second condition was TS/wk <=7.8 hours. Under the conditions of NSE <=2 and TS/wk <=7.8 hours, the rate of the habitual exercise group was 21.5%. The third condition was NSE <=1. Under the conditions of NSE <=1 and TS/wk <=7.8 hours, the rate of the habitual exercise group was 13.7%.

As a result of the analysis utilizing Sample B, a tree diagram with 3 hierarchies and the terminal node 4 (misclassification cost: 34.1%) was produced (**Figure 2**). The rate of the habitual exercise group was 46.4%. The first condition for an increase in the rate of the habitual exercise group was NSE >2 (3 events or more). Under this condition, the rate of the habitual exercise group was 58.5%. The second condition for an increase in the rate of the habitual exercise group was TS/wk >8.3 hours. Under the conditions of NSE >2 (3 events or more) and TS/wk

Table 2 Results of logistic regression analysis utilizing Sample A (Number of samples: 1,356)

Variable	Estimated value of model coefficient (β)	Standard error	Wald Chi-Square	Significance	Odds ratio	Odds ratio (95% CI)
Constant term	−1.848	0.205	81.334	$P < 0.01$	0.158	
CTS	0.001	0.080	0.000	*N.S*	1.001	0.856−1.171
NSE	0.503	0.049	106.472	$P < 0.01$	1.653	1.503−1.819
TS/wk	0.063	0.011	30.021	$P < 0.01$	1.065	1.041−1.089

Table 3 Results of logistic regression analysis utilizing Sample B (Number of samples: 1,369)

Variable	Estimated value of model coefficient (β)	Standard error	Wald Chi-Square	Significance	Odds ratio	Odds ratio (95% CI)
Constant term	−2.499	0.244	104.830	$P < 0.01$	0.082	
CTS	0.107	0.085	1.574	*N.S*	1.113	0.942−1.314
NSE	0.574	0.052	120.074	$P < 0.01$	1.776	1.603−1.968
TS/wk	0.091	0.012	54.686	$P < 0.01$	1.095	1.069−1.122

>8.3 hours, the rate of the habitual exercise group was 76.3%. When the variable importance of the NSE was set as 100, the corresponding rate of TS/wk was 43.7.

As a result of the logistic regression analysis utilizing Sample A, only 2 variables, that is, NSE and TS/wk, show significant values ($P < 0.01$). The odds ratio of NSE was 1.65 (95%CI: 1.50-1.81) and the odds ratio of TS/wk was 1.07 (95%CI: 1.04-1.09) (**Table 2**). The result of the Hosmer-Lemeshow (HL) test was $\chi 2(8)=20.07$ (*N.S*). In the logistic regression analysis utilizing Sample B, only 2 variables, that is, NSE and TS/wk, show significant values ($P < 0.01$). The odds ratio of NSE was 1.78 (95%CI: 1.60-1.97) and the odds ratio of the TS/wk was 1.10 (95%CI: 1.07-1.12) (**Table 3**). The result of the Hosmer-Lemeshow (HL) test was $\chi 2(8)=11.09$ (*N.S*).

4. Discussion

The results of the decision tree analyses utilizing Samples A and B were the same with regard to the magnitude relationship of split items, split order, and variable importance, validating the replicability statistically.

Conditions of past exercise experience required for the formation of exercise habit were extracted by the decision tree analyses. These conditions were the experience of 3 or more sports events prior to senior high school age and TS/wk ≥7-8 hours. Because decision tree analysis results are known to be instable, the stability of the decision tree analyses results in this study was examined by validating the replicability of the decision analysis results (cross-validation) and by validating the consistency of the results of logistic regression analysis, a regression analysis method whose dependent variable is binary data. As a result, the replicability of the decision tree analysis and the consistency of the logistic regression analysis results were validated, verifying that stability of the results of the decision tree analysis in this study was high.

In the logistic regression analysis results, replicability was statistically validated from the consistency of the results of Sample A and Sample B in terms of the magnitude relation of the odds ratio. The variable importance that was gained by decision tree analysis and the odds ratio that was gained by the logistic regression analysis showed the same magnitude relation; that is, NSE > TS/wk. CTS, a variable of exercise habit formation, was not adopted as a split variable of the decision tree analyses, producing no significant value in the Wald test in the logistic regression analysis. It was, therefore, speculated that CTS does not affect the formation of exercise habit. In this study, however, CTS was represented as 3 groups; namely, kindergarten, elementary school, and junior high school. If

analyzed based on school grade, CTS might have been observed as affecting the formation of exercise habit. Thus, the results obtained from the analyses in this study were subject to analytical limitations. Further examination is required.

While there are multiple factors in the determination of the formation of exercise habit (Sallis, et al., 1992), children's physical activity is structured largely by two behavioral settings; that is, physical education classes at school and physical activity programs supported by local communities (Sallis and Owen, 1999). If it is assumed that the subjects of this study were also in the above-mentioned physical activity environment, the formation of exercise habit was supposed to depend to a great extent on personal factors. Considering the longitudinal studies that show improvement of exercise self-efficacy to be related to increase in physical activity (Reynolds, et al., 1990; Trost, et al., 1997), the results of this study, namely, the variable, NSE, affects the formation of exercise habit more strongly than other variables do, may indicate that the experience of multiple sports events contributes to the formation of exercise habit more than lengthy experience of a single sports event does, and that experience of multiple sports events is associated with the formation of exercise habit via the improvement of exercise self-efficacy.

CTS produced no significant values in the logistic regression analysis and was not accepted as a split variable. This indicates that early CTS does not contribute to future exercise habit formation. This result, when viewed in the light of the study reporting that early CTS contributes to the improvement of physical fitness and motor ability (Suzuki and Nishijima, 2006), seems to indicate that early CTS may lead to the gaining of high physical fitness and motor ability but not to the formation of exercise habit. This indication seems to support the study by Kemper, et al., (2001) that reported little relationship between physical fitness in adolescence and physical activity in adulthood. In this study, however, because neither exercise self-efficacy, past physical fitness, nor past motor ability was measured, the criteria for the formation of exercise habit which were yielded by the analyses cannot be verified based on logical background. Logical background of the criteria for the formation of exercise habit, whose stability was validated in this study according to statistical criteria, should be examined in further studies. The results of retrospective studies such as the present study should also be validated by further prospective studies.

5. Conclusion

In this study of 2,725 Japanese senior high school students, conditions of the past exercise experience that affects the formation of exercise habit whose level exceeds the recommended level have been analyzed through decision tree analysis. Within the range of the statistical methods and samples that were used in this study, the results of this study have led to the following conclusion:

1) The conditions required for the formation of exercise habit in senior high school are the experience of more than 3 sports events and a weekly average of greater than 6.9-8.3 hour-long exercise prior to senior high school entrance.

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- Japanese Association of School Health
- The Behaviormetric Society of Japan
- Japanese Society of Science and Football
- The Japan Association for Research on Testing