Material:

**Changes over the Years in Physical and Motor Ability in Japanese Youth in 1964-97**

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The purpose of this study was to statistically analyze the changes over the years in the physical and motor ability in Japanese youth. The sample size was 12,832 boys and girls age 12 to 17 in the National Statistical Survey on Physical Fitness and Motor Ability using the Sports-test implemented for 34 years during 1964-1997. The transition trend over the years of the average by gender regarding the total scores of both of the physical fitness and motor ability tests was statistically confirmed. The first principal component score was used as the overall score in 12- to 17-year old boys and girls. The integration of 12 to 17 years old showed a significant increase for 11 years from 1964 to 1974 and a significant decrease for the following 12 years from 1986 to 1997. The both of total physical fitness and motor ability test scores of both boys and girls at the age of 17 indicated the tendency of a continuous decrease since 1985. It was concluded that physical and motor ability of Japanese youth age 12 to 17 increased until 1980 and that it tended to decrease continuously since 1985.

**Keywords:** national statistics, physical fitness test, motor ability test, principal component analysis

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1. Introduction

The new National Statistical Survey on Physical Fitness and Motor Ability by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan has been implemented using the Japan Fitness Test since 1999 following a trial in 1998. The National Statistical Survey on Physical Fitness and Motor Ability, MEXT in Japan using the Sports-test was initiated in 1964, and performed for 34 years until 1997 for men and women at the age of 11 to 29.

A decline tendency over the years in the physical and motor ability in Japanese youth has been pointed out in the national statistics since the 1990s. Aoyama (1994) reported a decline in the flexibility of children, and Wakita (1996, 1997) and Nishijima et al. (2001) also reported the tendency of a decrease in the physical and motor ability of children as well as an increase in the bad condition of their physical and mental health. Kagaya (1997) proposed the role of the physical education at school against a decline in the physical and motor ability of children and youth. In addition, a decline in the physical ability of children and youth has been regarded an educational policy subject in relation to countermeasures against the aged society with fewer children. In September 2002, the Central Educational Council, MEXT announced a report on the comprehensive polices to enhance the physical and motor ability of children and youth.

The purposes of this study were to statistically analyze the transition of the physical and motor ability of Japanese youth for 34 years from 1964 to 1997, and to verify the decline trend over the years in recent years by using the national statistics announced in the physical fitness and motor ability survey report implemented by the MEXT.

2. Method

2.1. Sample

The samples of this study were on boys and girls with a difference in six years at the age of 12 (the first grade students of the junior high school) to 17 (third grade students of the senior high school). The national statistics survey on physical fitness and motor ability in 1997 had a sample number of 12,432 ranging from
12- to 17-year-old boys and girls. The number of secondary school student samples was 2,809, while the number of senior high school student samples was 3,408.

2.2. Items

The Sports-test was built up by the physical fitness and motor ability tests as shown in Table 1. The former test was measured by using seven performance test items: repetitive side step, vertical jump, back strength, grip strength, trunk extension, standing trunk flexion, and step-test. The total physical fitness test score was calculated by using the standardized score table to evaluate the overall physical fitness. The latter test was measured by using five performance test items that included the 50m run, running broad jump, handball throw, pull-ups for boys or oblique pull-ups for girls, and 1500m distance run for boys or 1000m distance run for girls. The total motor ability test score was calculated by using the standardized score table to evaluate the overall motor ability.

The average of 12- to 17-year-old boys and girls by gender and age was used for analysis regarding the total scores of both the physical fitness and motor ability tests for 34 years from 1964 to 1997. The age of 17 was determined to be the arrival point of development in the physical fitness and motor ability during the youth period for analysis with the following reasons.

The age of 17 showed the highest average in almost all years as to both the total physical fitness and motor ability scores between 12- and 29- year-old youth for 34 years with the physical fitness and motor ability survey carried out based on the Sports-test. Almost all cohort data with the age of 29 used as the final year of age showed the highest average of the total physical fitness and motor ability test scores at the age of 17.

The target groups at the age of not less than 18 included adults and led to an increase in intersection. In this study, the height transition over the years at the age of 17 by boy and girl for 34 years from 1964 to 1997 was employed as the comparison criteria.

2.3. Statistical Analysis

The principal component was analyzed by gender to summarize the trend of the changes over the years in the total physical fitness and motor ability test scores in six ages from 12 to 17. The first principal component scores were computed as the overall scores of these six ages. The application software package of SPSS release 11.0J was used for a data analysis.

Thirty-four years from 1964 to 1997 were subdivided into three groups: 1964-74 (11 years), 1975-85 (11 years), and 1986-97 (12 years). The randomization test was used to statistically determine differences in the average between serial groups ($\alpha = 0.05$). It is a nonparametric statistical testing [Edgington (1995)] that has no hypothesis of population. It is not affected by the serial dependence between data [Barlow and Herson (1984)]. The application software package of RANDIBM.EXE [Edgington (1987)] was used for the randomization testing.

The normal distribution was assumed to analyze the statistical features of the declining trend over the years in the total physical fitness and motor ability test scores for the observing the transition over the years in the distribution shape. The normal distribution curve was drawn from the average and standard deviation of the distance run performance in the 17-year-old boys and girls at the four points of 1980, 1990, and 2000 every 10 years starting with 1970.

<table>
<thead>
<tr>
<th>Test</th>
<th>Domain</th>
<th>Items (unit)</th>
<th>Age</th>
<th>Rating point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical fitness</td>
<td>Total score of 7 items (point)</td>
<td>12-29</td>
<td>7-35</td>
<td></td>
</tr>
<tr>
<td>Agility</td>
<td>Side step test (point)</td>
<td>12-29</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>Vertical jump (cm)</td>
<td>12-29</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>Physical fitness</td>
<td>Back strength (kg)</td>
<td>12-29</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td>Grip strength (kg)</td>
<td>12-29</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>Trunk extension (cm)</td>
<td>12-29</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>Standing trunk flexion (cm)</td>
<td>12-29</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>Endurance</td>
<td>Step test (point)</td>
<td>12-29</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>Motor ability</td>
<td>Total score of 5 items (point)</td>
<td>12-29</td>
<td>5-100</td>
<td></td>
</tr>
<tr>
<td>Sprint</td>
<td>50 m run (second)</td>
<td>12-29</td>
<td>1-20</td>
<td></td>
</tr>
<tr>
<td>Jump</td>
<td>Running broad jump (cm)</td>
<td>12-29</td>
<td>1-20</td>
<td></td>
</tr>
<tr>
<td>Ball throw</td>
<td>Handball throw (m)</td>
<td>12-29</td>
<td>1-20</td>
<td></td>
</tr>
<tr>
<td>Pull-up</td>
<td>Pull-ups for boy (times)</td>
<td>12-29</td>
<td>1-20</td>
<td></td>
</tr>
<tr>
<td>Distance run</td>
<td>Oblique pull-ups for girls (time)</td>
<td>12-29</td>
<td>1-20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1500 m distance run for boy (second)</td>
<td>12-29</td>
<td>1-20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1000 m distance run for girl (second)</td>
<td>12-29</td>
<td>1-20</td>
<td></td>
</tr>
</tbody>
</table>
2.4. Sport-test

Statistical information is indispensable to the confirmation of a physical ability decline over the years in children and youth. The national statistics on physical fitness and motor ability of the nations in Japan are the National Statistical Survey on Physical Fitness and Motor Ability (MEXT, 2002; MESSC, 2000) that is implemented every year by the Ministry Education, Culture, Sports, Science and Technology (MEXT) as the approved statistics. This national statistical survey was started in 1964 based on the Sports-test (1963) submitted by the Health and Physical Education Council according to the Sports Promotion Law established in 1961.

The aim of the Sports-test was to make proper promotion of sports and enhance the physical fitness development of people and oriented to the 12-year-old secondary school or more pupils and the general working youths who were up to 29 years old. As shown in Table 1, the Sports-test was composed of the physical fitness tests to measure the basic factors building up the physical fitness, and the motor ability tests to measure the basic motor ability. The physical fitness test consisted of seven performance test items to measure five physical fitness domains of power, strength, agility, flexibility, and endurance. The motor ability test consisted of the performance tests of five items to measure five basic motor skills of sprint, jump, ball throw, pull-up, and distance run (other alternatives for endurance include fast walking for adults, swimming, skating or skating for boys and girls).

In 1965, the Sports-test was slightly modified and the elementary school Sports-test was added for fifth and sixth grade pupils (at the age of 10 and 11). In 1967, the adult physical fitness test was added for adults at the age of 30 to 59. The purpose of this test was for adults to know their physical fitness level that was the base of their daily life and help them choose those exercises suitable for them. The test was built up by the performance tests of five items to measure five physical fitness domains of strength, power, agility, skillfulness, and endurance. It was characterized by using the standardized score table for evaluation with one item of 20 scores as a perfect score, calculating the total score of five items and determining the physical fitness age by sex.

In 1983, the motor ability test for elementary schoolchildren in the lower and middle grades was added to measure their basic motor ability, which was oriented to the first to the fourth grades of the elementary school (at the age of 6 to 9).

The results of the physical fitness and motor ability survey that was obtained from those tests as stated above were announced on the National Spots Day of the next year and widely used as basic statistical data for policies related to the promotion of sports and improvements in the physical fitness. This is a very precious system and material because no other nation keeps survey statistics in such a way that the physical fitness and motor ability has been statistically collected for 34 years from 1964 to 1997 targeting at the six year-old schoolchildren in the first grade of the elementary school and up to 59-year-old adults [Nishijima (2000)].

More than 30 years have passed since the start of the Sports-test in 1964 and a variety of matters have been pointed out that should be reviewed in the entire Sports-test. They include the progress of scientific recognition related to the physical fitness and motor ability, the new needs for the development of the physical fitness test of the aged with rapid aging, and the reconsideration of the measuring methods for each test items and the validity of the evaluation criteria. In July 1996, the director of Physical Education in MEXT gave a ruling that considered how the physical fitness and motor ability survey should be. The physical fitness and motor ability survey based on the Sports-test was reviewed and how a new test for physical fitness and motor ability survey should be discussed corresponding to changes in the physique of people, the progress of the sports medicine and science, and the aged society. After the trial in 1998, the new physical fitness and motor ability survey was started from 1999 by using the new physical performance tests named Japan Fitness Test.

3. Results

3.1. Changes over the Years in Physical Fitness and Motor Ability

Figure 1 illustrates the changes over the years in the total physical fitness test scores in 17-year-old boys and girls for 34 years from 1964 to 1997. The significance probability (p) values of the randomization test for three periods are shown in the figure. The upper p values on the curves are for boys, while the lower p values are for girls.

Both boys and girls acquired 22 points in 1964 and showed a subsequent increase in their scores. Girls reached the highest of 26 points in 1978, while boys reached it in 1980. Subsequently, the scores decreased and girls acquired 23 points in 1997, while boys acquired 24 points in 1980. There was a significant difference in the average of the adjacent two periods for both boys and girls.

Figure 2 indicates the changes over the years in the
total motor ability test scores in 17-year-old boys and girls. Girls acquired 35 points in 1964 and showed a subsequent increase. They reached the peak of 48 points in 1978. They showed a subsequent decrease and resulted in the lowest score of 32 points in 1995. A significant difference was recognized in the average of adjacent two periods. Boys acquired 41 points and showed a subsequent increase. Like girls, they reached the peak of 49 points in 1978. They showed a subsequent decrease and resulted in the lowest score of 40 points in 1995. A significant difference was recognized in the average of the adjacent two periods.

Table 2 lists the results of a principal component analysis of the total physical fitness and motor ability test scores in six ages of 12 to 17 by gender.

For boys, the total physical ability test score showed that the first principal component had a total variance description rate of 89% with high principal component loading’s range of 0.92 or more. For girls, it had a rate of 90% with a high range of 0.92 or more.

Similarly, for boys, the total motor ability test score showed that the first principal component had a total variance description rate of 78% with a high principal component loading’s range of 0.74 or more for boys at the age of 12. For girls, it had a rate of 87% with a high range of 0.92 or more.

Figure 3 illustrates the changes over the years in the principal component scores of the total physical fitness test scores between 12- and 17-year-old boys and girls for 34 years from 1964 to 1997. The significance probability (p value) of the randomization test for three periods is shown in the figure. The p values in the upper portion of the curve are for boys and the values in the lower portion of the curve for girls.

Both boys and girls acquired approximately -2.5 points in 1964 and showed a subsequent increase. They reached a maximum value of about 1.0 in 1980 and showed a subsequent decrease. They acquired a score of -1.0 points in 1997. A significant difference was recognized in the average of adjacent two periods for both boys and girls.

Table 2. The first principal component loading of total scores of physical fitness and motor ability tests in 12-17 year boys and girls.

<table>
<thead>
<tr>
<th>Age</th>
<th>Physical fitness</th>
<th>Motor ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.919</td>
<td>0.742</td>
</tr>
<tr>
<td>13</td>
<td>0.922</td>
<td>0.931</td>
</tr>
<tr>
<td>14</td>
<td>0.964</td>
<td>0.970</td>
</tr>
<tr>
<td>15</td>
<td>0.953</td>
<td>0.945</td>
</tr>
<tr>
<td>16</td>
<td>0.955</td>
<td>0.962</td>
</tr>
<tr>
<td>17</td>
<td>0.936</td>
<td>0.964</td>
</tr>
</tbody>
</table>

Eigenvalue 5.3 5.4 4.7 5.2

% of variance 89.0 90.2 78.3 87.3
Figure 4 illustrates the changes over the years in the principal component scores of the total motor ability test scores between 12- and 17-year-old boys and girls. Both boys and girls acquired approximately -2 points in 1964 and showed a subsequent increase. They reached a maximum value of about 1.5 points in 1980 and showed a subsequent decrease. They acquired a score of -1.5 points in 1997. A significant difference was recognized in the average of adjacent two periods for both boys and girls.

3.2. Changes over the Years in Normal Distribution of Distance Running Performance

Figure 5 shows the changes over the years in the normal distribution curves computed from the means and standard deviations of the distance running performance in 17-year-old boys and girls every 10 years from 1970 to 2000.

In 1970, both boys and girls indicated a sharp upward distribution. In 1980, the distribution spread out slightly toward a higher performance and tended to an increased average and a larger standard deviation. In 1990, a high performance was maintained and the distribution tended largely toward a lower performance. As a result, there was a tendency that the average went down with a larger standard deviation. In 2000, this tendency was sustained and the average tended to slightly go down.

3.3. Changes over the Years in Body Height

Figure 6 shows the changes over the years in the body height in 17-year-old boys and girls for 34 years from 1964 to 1997. The average of body height was 166.4 cm in 1964 and subsequently increased their height. In 1982, they reached 170 cm. They tended to drop an increased growth rate a year of body height in subsequent years with 1983 as an inflection point, resulting in 170.9 cm high in 1997.

Girls had changes over the years
similar to boys. The average of body height was 154.7 cm in 1964 and subsequently increased their body height. In 1982, they reached 157 cm. They tended to drop an increased growth rate a year of body height in subsequent years with 1984 as an inflection point, resulting in 158.0 cm high in 1997.

4. Discussion

The trend of the changes over the years in the physical and motor ability in the Japanese youth was statistically analyzed using the national statistics announced in the National Survey Report on Physical Fitness and Motor Ability, MEXT in Japan using the Sports-test. It was confirmed that in 1964 and after, the physical and motor ability continued to improve on a secular basis, but it began to tend to drop with the year of 1980 as a peak and that in 1985 and after, a drop in this ability tended to continue. This changes over the years in the physical and motor ability in the Japanese youth was the same as in the Annual Report of the National Network of Physical and Mental Health in Japanese Children (2002).

It was also confirmed that the changes over the years in the physical and motor ability in 17-year-old boys and girls tended to continue to improve from 1964 in which the Sports-test was started, but it tended to continuously drop in subsequent years with 1978 as a peak and that this trend was the same as for those boys and girls at six ages of 12 to 17.

The changes over the years in body height in both 17-year-old boys and girls for 34 years from 1964 to 1997 tended to decrease a growth rate a year with 1984 as an inflection point. There was a tendency that a growth rate a year dropped during a period of 1964 to 1984 and that it was small and maintained in this condition from 1985 and after. It was inferred that improvements in the physique had an effect on the development of physical fitness and motor ability from 1964 to 1984 because this ability was affected by the physique. It was also inferred that a declining tendency over the years in the physical fitness and motor ability in 1985 and after was hardly affected by the trend to the maintenance of the physique. A variety of causes can be considered for a secular declining tendency of the physical fitness and motor ability in the Japanese youth in 1985 and after. In particular, it is necessary to statistically verify the effect of the social life factors such as the implementation of a physical activity, exercise and sports situation.

The 10-year changes over the years in the normal distribution curve in the distance running performance had the same trend for both boys and girls. The distance running performance from 1970 to 1980 tended to improve and the standard deviation was maintained with a tendency of the enhanced average. From 1980 to 1990 there was a tendency that the average dropped to a great extent with a larger standard deviation. From 1990 to 2000 it was visually confirmed that the trend of a decrease in the average was maintained with an extended standard deviation. Populations of higher distance running performance were maintained from 1970 to 2000, while those of lower distance running performance increased in 1980 and after, which appar-

![Fig. 6. Changes over the years in body height in 17 year boys and girls during 1964-1997.](image)
ently caused a declining tendency over the years in the average.

The Annual Report of the National Network of Physical and Mental Health in Japanese Children (2000) describes the changes over the years in physical and motor measuring items, and the coefficient of variation of total physical fitness and motor ability scores. This coefficient dropped until 1980 in which the physical fitness and motor ability improved and it tended to increase in 1985 and after. In other words, the coefficient of variation dropped because the average improved against the standard deviation for an improvement period of the physical fitness and motor ability from 1964 in which the Sports-test was started to 1980, while it improved because the standard deviation became large against the average for a declining Changes over the Years in Physical and Motor Ability in Japanese Youth in 1964-97 period of the physical fitness and motor ability in 1985 and after.

A drop tendency over the years in the physical and motor ability of the youth was caused not only by a decrease in the amount of daily physical activity, exercise and sports due to changes in the living environment, but also diverse factors including transition of physical education (PE) program in school, changes in the sports club guidance system and also in working on the measurement of the physical and motor ability, and less eagerness to be involved in the performance test requiring every possible effort. For these reasons, it seems to be necessary to promote scientific evidence based comprehensive strategies for improvements in the physical and motor ability of youth on a nationwide basis in Japan.

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