Relationship between Changes over the Years in Physical Ability and Exercise and Sports Activity in Japanese Youth


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The purpose of this study was to analyze the relationship between changes over the years in physical abilities of young people and their exercise and sports activity statistically. Samples were 17-year-olds covered in the National Statistics on Physical Fitness and Motor Ability prepared by MEXT obtained through Sports-test during the 18 years between 1980 and 1997. Changes over the years in averages of total physical fitness test scores was statistically analyzed by gender and groups divided by participation in exercise and sports and by length of time spent in exercise and sports daily. The normal distribution curves of distance running for every 10 years between 1970 and 2000 was also visually compared, together with the effect of changes over the years and that of exercise and sports activities on total physical fitness test scores for 17-year-olds by using structural equation modeling. It was found out that total physical fitness test scores continuously decreased after 1980 for all groups divided by the participation and time spent in exercise and sports daily. It was concluded that exercise and sports activities greatly affected the yearly decrease of physical ability after 1980, especially significantly declining the systemic staying power of the group that did not participate in exercise and sports daily, and that the above was one main cause of the decreasing physical ability in Japanese youth.

Keywords: national statistics, physical fitness test, sports-test, randomization test, structural equation modeling

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1. Introduction


Aoyama (1994) reported reduced flexibility in children over the last decades, and Wakita (1996) reported decreasing tendency in physical and motor abilities. The National Network of Physical and Mental Health in Japanese Children (2002) reported increase physical and mental disorders along with decrease physical fitness and motor abilities in children. Based on data in the National Statistics on Physical Fitness and Motor Ability of MEXT, Nishijima et al (2001) statistically examined changes over the years in physical and motor abilities of youth between 12 and 17 years old, and found that physical and motor abilities in those continued to improve until around 1980, and then steadily declined after 1985. Noi et al. (2002) statistically investigated changes over the 34 years between 1964 and 1997, on coefficients of variation in total physical fitness test scores and those in total motor ability test scores for 11-year-old (elementary school 6th graders), 14-year-old (junior high 3rd graders), and 17-year-old (senior high 3rd graders) based on the national statistics data. They found that coefficients of variation in physical fitness and motor abilities test scores for young Japanese boys and girls had declined until 1980 and started continuously increase after 1985, supporting the findings of Nishijima et al (2001).

No study, to our knowledge, has clarified the possible cause of this trend. Accordingly, the purpose of
Table 1. Physical fitness test items in Sport-test during 1964-1997 in Japan.

<table>
<thead>
<tr>
<th>Test</th>
<th>Domain</th>
<th>Item (unit)</th>
<th>Age</th>
<th>Rating point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical fitness</td>
<td>Total score of 7 items (point)</td>
<td>12-29</td>
<td>7-35</td>
</tr>
<tr>
<td></td>
<td>Agility</td>
<td>Side step test (point)</td>
<td>12-29</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>Power</td>
<td>Vertical jump (cm)</td>
<td>12-29</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>Strength</td>
<td>Back strength (kg)</td>
<td>12-29</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>Strength</td>
<td>Grip strength (kg)</td>
<td>12-29</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
<td>Trunk extension (cm)</td>
<td>12-29</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
<td>Standing trunk flexion (cm)</td>
<td>12-29</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>Endurance</td>
<td>Step test (point)</td>
<td>12-29</td>
<td>1-5</td>
</tr>
</tbody>
</table>

This study was to examine the relationship between recent trends in decreasing physical abilities and youth participation in daily exercise and sports statistically, based on the National Statistics on Physical Fitness and Motor Ability.

2. Methods

2.1. Samples

The number of samples from the National Statistical Survey on Physical Fitness and Motor Ability conducted in 1997 totaled 1,136 with 568 each gender of 17-year-olds (high school 3rd graders). The statistical data of this study were averages of total physical fitness test scores by gender and groups. The groups divided by the frequency of participation in exercise and sports of 17-year-olds between the 31 years between 1967 and 1997, and groups divided by daily hours during which they engaged in exercise and sports during the 18 years between 1980 and 1997.

The averages in total physical fitness test scores of 17-year-olds in the national statistics were analyzed by gender statistically. This particular age seemed to be the peak of physical ability development because 17-year-olds showed the highest average in most yearly surveys; most cohort data that ended with 29-year-olds showed the highest average of total physical fitness test score at 17 year; 18-year-olds and those older included working individuals, which complicated factors.

2.2. Items

As shown in Table 1, physical fitness in 7 performance test items, including side step test, vertical jump, back strength, grip strength, trunk extension, standing trunk flexion, and step test, were measured, and total scores for calculated using a standardized score table to comprehensively evaluate physical ability.

Averages of total physical fitness test scores for groups divided by participation in exercise and sports during the 31 years between 1967 and 1997 were used to examine the relationship between recent declining physical ability in Japanese youth and their participation in exercise and sports statistically. Data was successive after 1977, or for 21 years. Respondents had 4 options to choose from on the participation:

1. Almost daily (more than 3-4 days a week)
2. Sometimes (once or twice a week)
3. Occasionally (Once or twice a month)
4. Almost never

Averages of total physical fitness test scores for groups divided by daily hours engaged in exercises and sports during the 18 years between 1980 and 1997 were used to examine the relationship between recent declining physical ability in Japanese youth and time they spent in exercise and sports statistically. Respondents had 4 options to choose from on time spent:

1. Less than 30 minutes
2. More than 30 minutes and less than 1 hour
3. More than 1 hour and less than 2 hours
4. More than 2 hours

2.3. Statistical Analysis

The 34 years between 1964 and 1979 were divided into 3 periods of 1964-74 (11 years), 1975-85 (11 years), and 1986-97 (12 years). A randomization test was used to statistically determine differences in the average between serial groups (α = 0.05). This statistical testing method was nonparametric statistical testing [Edgington (1995)] that has no hypothesis of population and no affecting by serial dependence between data [Barlow and Herson (1984)]. The application software package of RANDIBM.EXE [Edgington (1987)] was used for randomization testing.

Physical fitness Physical fitness Total score of 7 items (point) 12-29 7-35

The effect of frequency of exercise and sports and the time spent on physical activities daily in yearly
declining total physical fitness test scores after 1978 was analyzed with structural equation modeling (SEM) [Bollen (1996); Maruyama (1998)]. Arrows in path diagrams (charts) show the direction of cause and effect, and figures on paths are path coefficients that are standardized partial regression coefficients in the path diagrams of standardized solution of SEM. Arrows pointing both ways between error variables (ε#) are correlation coefficients between variables. The path coefficients of the variable secular change show the effects of changes over the years, and those of the variables exercise and sports participation and exercise and sports time a day show the effects of the daily participation in exercise and sports activities.

The normal distribution was assumed to analyze statistical features of the yearly declining trend in distance running performances over the years and daily participation in exercise and sports. Normal distribution curves in four specific years between 1970 and 2000 every 10 years were prepared using average and standard deviations of distance running of 17-year-olds divided into two groups: one that participated almost daily and one that did not participate in exercise and sports.

3. Results

3.1. Changes over the Years in Physical Ability by Exercise and Sports Participation Levels

Figure 1 shows changes in the physical fitness test scores of 17-year-old boys divided into groups based on the participation in exercise and sports over the 31 years between 1967 and 1997. Data was consecutive for 21 years after 1977. The average of total physical fitness test score was the highest for the group with mostly daily participation, leading other groups by a wide margin. The average dropped with participation dropped. For the groups with mostly daily participation and with no participation, the average after 1986 was significantly lower than before 1985. Total physical fitness test scores for the 4 groups after around 1980 decreased.

Figure 2 shows changes in the percentage of the groups of 17-year-old boys divided by participation in exercise and sports during the 18 years between 1980 and 1997. The largest group was that with mostly daily participation, or about 40%. The second largest was with 1-2 days-a-week participation, or about 40%, and the other two followed at 15%. The percentages of the four groups over the 18 years after 1980 were mostly stable statistically.

Figure 3 shows changes in total physical fitness test scores for 17-year-old boys divided into groups based on time spent in exercise and sports in a day during
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Fig. 3. Changes over the years in physical ability test scores of 17 year-boys in each level of daily time spent in exercise and sports during 1980-97; probability values above are for 120min and over level, and lower ones for under 30min level.

Fig. 4. Changes over the years in percentages of each level of daily time spent in exercise and sports in 17 year-boys during 1980-97.

the 18 years between 1980 and 1997. The average of total physical fitness test score was highest in the group engaging in exercise and sports more than two hours daily. The average dropped with time spent in exercise and sports, with the group of more than 1 hour and less than 2 hours ranking second, that of more than 30 minutes and less than 1 hour third, and that of less than 30 minutes last. For the group engaging in exercise and sports less than 30 minutes daily, the average after 1986 was significantly lower than before 1985. In general, total physical fitness test scores dropped continuously after 1980 for all 4 groups.

Figure 4 shows changes in the percentage of groups of 17-year-old boys by daily time spent in exercise and sports during the 18 years between 1980 and 1997. The group that exercised less than 30 minutes daily was the largest, or about 40%, with that of more than 30 minutes and less than 1 hour about 30%, that of more than 1 hour and less than 2 hours about 10%, and that of more than 2 hours about 20%. Percentages of the four groups during the 18 years after 1980 were mostly stable with a minor increase in the percentage of the group of more than 2 hours. Around 1980, percentages were 35%, 30%, 15%, and 20% in order of increasing time spent in exercise and sports. After 1992, the group engaging in exercise and sports for more than 2 hours daily increased slightly, and in 1997, groups engaging in exercise and sports for more than 2 hours, for more than half and less than 1 hour, and for less than half hour neared 30%.

Figure 5 shows changes in the total physical fitness test scores of 17-year-old girls divided into groups based on participation in exercise and sports. After 1992, the group engaged in exercise and sports for more than 2 hours daily increased slightly, and in 1997, groups engaging in exercise and sports for more than 2 hours, for more than half and less than 1 hour, and for less than half hour neared 30%. For the group with mostly daily participation and that with no participation, the average after 1986 was significantly lower than before 1985. The total physical fitness test scores for the four groups after around 1980 decreased.

Figure 6 shows changes in the percentage of groups of 17-year-old girls divided by participation in exercise and sports during the 18 years between 1980 and 1997. Throughout this period, their participation mostly decreased. Around 1980, the group that sometimes participated in exercise and sports was the largest, or about 40%, while that with mostly daily participation accounted for about 25%, that with occasional partici-
pation about 20%, and that with no participation about 15%. The percentage of girls in the group with no participation increased, while that with occasional participation decreased. Around 1997, no participation and 1-2-days-a-week groups were about 30%, mostly daily participation about 25%, and occasional participation about 15%.

Figure 7 shows changes in total physical fitness test scores for 17-year-old girls divided into groups based on daily time spent in exercise and sports during the 18 years between 1980 and 1997. The overall trend was mostly the same for boys. The average of total physical fitness test score was the highest in the group engaging in exercise and sports more than two hours daily. Followed by dropping with daily time spent in exercise and sports with the group of more than 1 hour and less than 2 hours ranking second, that of more than 30 minutes and less than 1 hour third, and that of less than 30 minutes last. For the group that engaged in exercise and sports less than 30 minutes daily, the average after 1985 was significantly lower than before 1985. In general, total physical fitness test scores continuously decreased after 1980 in all four groups, and difference in the average of the group of more than 1-hour exercise and that of less than 1 hour exercise increased somewhat.

Figure 8 shows changes in percentages of groups of 17-year-old girls by time spent in exercise and sports during the 18 years between 1980 and 1997. The group that exercised less than 30 minutes daily was the largest, or about 50%, with that of more than 30 minutes and less than 1 hour about 30%, that of more than 1 hour and less than 2 hours and more than 2 hours about 10%. The percentages of the four groups were mostly stable with a minor increase in that of more than 2 hours statistically. Around 1980, percentages were 50%, 30%, 10%, and 10% in order of increasing time spent in exercise and sports. After 1992, the group engaging in exercise and sports more than 2 hours daily slightly increased and in 1997, the group of more than 2 hours increased to 15% and that of more than half and less than 1 hour decreased to 25%.

3.2 Changes over the Years in Normal Distribution Curves of 1500 m Distance Running

Figure 9 compares the group engaging in exercise
and sports more than 3 days a week and not participating in any for changes over the years in normal distribution curves of 1500 m distance running performance of 17-year-old boys for every 10 years between 1970 and 2000. It revealed mostly the same trend for gender by comparing with Figure 10, with boys keeping the average and girls declining over the years, which increased in standard deviation. For boys who did not participate, the average over the years dropped the performance with the standard deviation increasing high, keeping better performance, while the worse performance further worsened.

Figure 10 shows changes over the years in normal distribution curve in the 1000 m distance running performance of 17-year-old girls, surveyed every 10 years between 1970 and 2000 to compare the group engaging in exercise and sports more than 3 days a week and that not participating. As mentioned above, it also revealed mostly the similar trend for boys by comparing with Figure 9.

3.3. Effects of Participation in Exercise and Sports

Figure 11 is to show the relative effect of exercise and sports participation and the effect of changes over the years on total physical fitness test scores for 17-year-olds surveyed between 1977 and 1997. All path coefficients on the path diagrams were statistically significant (p<.05). The path coefficient of the effect of changes over the years on total physical fitness test scores for boys was moderately low at -0.48. The negative coefficient means a decreasing effect of year-related changes. In contrast, the path coefficient of the effect of exercise and sports participation on total physical fitness test scores was high at high 0.76. The trend was the same for girls with a moderately low negative path coefficient of -0.61 on changes over the years, indicating the decreasing effect of year-related changes. The effect of exercise and sports participation on total physical fitness test scores showed a moderately high coefficient of 0.62.

Figure 12 shows the relative effect of daily time spent in exercise and sports and the effect of changes over the years on total physical fitness test scores for 17-year-olds surveyed between 1980 and 1997. All path coefficients in the path diagrams were statistically significant (p<.05). The effect of changes over the years on total physical fitness test scores for boys showed a moderately low path coefficient of -0.43, showing the decreasing effect of year-related changes. In contrast, the effect of daily time spent in exercise and sports on total physical fitness test scores showed a high path coefficient of 0.82. The trend was the same for girls with a moderately low negative path coefficient of -0.52 on changes over the years, indicating the decreasing effect of year-related...
Fig. 9. Changes over the years in normal distribution curves of 1500m distance running of 17 year-boys for every 10 years between 1970 and 2000 in compare with exercise and sports participation levels.

Fig. 10. Changes over the years in normal distribution curves of 1500m distance running of 17 year-girls for every 10 years between 1970 and 2000 in compare with exercise and sports participation levels.

Fig. 11. Effect of participation in exercise and sports and changes over the years to total physical fitness test scores during 1980-97 in 17 year-boys and -girls: path coefficients are significant at p<.05.

The effect of daily time spent in exercise and sports on total physical fitness test scores showed a high path coefficient of 0.75.

4. Discussion

The statistical study of changes over the years in total physical fitness test scores for 17-year-olds divided into groups by participation in exercise and sports during the 21 years between 1977 and 1997 revealed that the total physical fitness test scores for all 4 groups have been decreasing since 1980. The total physical fitness test score of the group that participate, in exercise and sports mostly daily was higher than that of all other groups by a large margin. The total physical fitness test score dropped with the participation levels.

The study of changes over the years in the percentage of the groups of 17-year-olds divided into groups by participation in exercise and sports during the 18 years between 1980 and 1997 revealed that percentages of the four groups were mostly stable statistically. The largest male group was that engaging in exercise and sports almost daily, or about 40% of all boys, with the group that sometimes did occupying about 30%, which means that about 70% of boys engaged in exercise and sports more than once a week. The other two groups made up about 15% of boys. For girls, the group engaging in exercise and sports almost daily made up about 25%, with that sometimes did occupying about 40%, which means that about 65% of girls
engaged in exercise and sports more than once a week. The group that occasionally engaged in exercise and sports made up about 20%, and the other group accounted for about 15%, or the same percentage as that of male counterparts.

The statistical study of changes in total physical fitness test scores for 17-year-olds divided into groups based on time spent in exercise and sports daily during the 18 years between 1980 and 1997 revealed that, in general, total physical fitness test scores continuously decreased after 1980 for all 4 groups. The average of total physical fitness test score was the highest for the group engaging in exercise and sports more than two hours daily, leading the other groups by a large margin. The average score dropped with time for exercise and sports, with the group of more than 1 hour and less than 2 hours ranking second, that of more than 30 minutes and less than 1 hour third, and that of less than 30 minutes last.

The statistical study of changes in the percentage of groups of 17-year-olds by time spent in exercise and sports over the 18 years between 1980 and 1997 revealed that percentages of the four groups were mostly stable statistically. For boys, the group that exercised less than 30 minutes daily was about 40%, with that of more than 30 minutes and less than 1 hour about 30%. Thus, about 70% of boys engaged in exercise and sports less than 1 hour daily. The group of more than 1 hour and less than 2 hours was about 10%, and that of more than 2 hours about 20%, or collectively about 30% of all boys. For girls, the group that exercised less than 30 minutes daily was the largest, or about 50%, with that of more than 30 minutes and less than 1 hour about 30%. Thus, about 80% of girls engaged in exercise and sports less than 1 hour daily. The group of more than 1 hour and less than 2 hours occupied about 10%, and that of more than 2 hours about 10%, or collectively about 20% of all girls.

It is thus made clear that although percentages of groups of 17-year-olds have been mostly stable statistically since 1980, total scores for physical fitness test of all 4 groups continuously decreased. Comparing changes over the years in the normal distribution curves of 1500 m distance running performance between the group that participated in exercise and sports almost daily and that did not participate, the latter significantly dropping in distance running performance after 1980. Individual differences in distance running performance in the group that participated in exercise and sports almost daily increased, but the average of the entire group was mostly maintained over the years. The normal distribution curves of 1500 m distance running performance showed different degrees of participation in exercise and sports. The group that participated in exercise and sports almost daily maintained its performance over the years. The distance running performance of the group that did not participate decreased with the average dropping accordingly and increasing the standard deviation. Thus, the significant dropping in staying power of those who did not engage in exercise and sports was a major cause of decreasing tendency of physical ability in Japanese youth over the years.

The relative effects of changes over the years and daily physical activities on physical ability of 17-year-olds during the 21 years between 1977 and 1997 were examined using SEM. The path coefficient of the effect of changes over the years on total physical fitness test scores was moderately low and negative, confirming the declining total physical fitness test score over the years. The coefficient of the effects of participation in exercise and sports and of daily time spent in exercise and sports on the total physical fitness test score was positive and high. This results indicated that total physical fitness test scores were dropping and daily exercise and sports activities affect physical abilities considerably.

The relationships between the recent trend of decreasing physical ability of Japanese youth and their participation in exercise and sports and time spent in exercise and sports in their daily life were statistically analyzed based on data in the National Statistics on Physical Fitness and Motor Ability of MEXT using Sports-test. It was revealed that participation in exercise and sports and time spent in exercise and sports in daily life significantly affect on decreasing physical ability over the years after 1980. The decrease in staying power was especially notable in the group that did not engage in exercise and sports, which indicate that the lack of such participation is a major cause of the decrease over the years in the physical ability of Japanese youth. The effect of exercise and physical activities on the decrease over the years on motor abilities is an issue that requires further examination.

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