An Attempt at the Classification of Adolescents Into Sprint Endurance Types

By

Hiroaki KANEHISA and Mitsumasa MIYASHITA

Laboratory for Exercise Physiology and
Biomechanics, Faculty of Education,
University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan

ABSTRACT

The present study was designed to classify adolescents into sprint or endurance types according to physical performance tests. Five hundred sixty-nine normal Japanese boys and girls, ages 13 to 17 years, served as subjects. Performance tests consisted of 50-meter dash, 5-minute run, peak torque at 35 rpm of knee extensor muscles, and some children were tested for isometric endurance time at 50% of maximal voluntary isometric contration of knee extensor muscles. Based on the T-score of peak torque, 22-29% of the boys and girls were classified into fast or slow twitch types. But almost 30% of the classified subjects did not show the expected results. According to the T-scores of three performance tests, three sprint-type boys and seven endurance-type girls were detected. A significant negative correlation was found between peak torque and endurance time among the ten classified subjects.

Key Words: FT fiber, ST fiber, 50-meter dash, 5-minute run, adolescents

INTRODUCTION

Recent application of histochemical techniques has indentified two distinctly different fiber types, slow twitch (ST) and fast twitch (FT), in human skeletal muscles. Furthermore, several researchers have reported a wide range of fiber populations in human muscles: 14-85% in the deltoid muscle, 13-80% in the lateral portion of the vastus lateralis muscle (Gollnick et al. 1972) and 13-74% in the lateral head of the gastrocnemius (Costill et al. 1976). The metabolic property of ST and FT fibers implies that a man who has a high percentage of a specific fiber in his muscle shows a specific motor ability. In fact, several researchers show a high percentage of FT fibers in leg muscles of weight lifters and sprinters, performing fast contractions with high tension, whereas long distance runners and distance skiers display a high percentage of ST fibers in the corresponding muscles (Costill et al. 1976, Edostrom et al. 1972 and Thorstensson et al. 1977). Although there is a predominant genetic influence on the skeletal muscle fiber composition in man (Komi et al. 1977), a part of the type Ⅱ-B (low oxidative FT) fiber population can be gradually converted into type Ⅱ-A (high oxidative FT) in response to an endurance training program (Andersen et al. 1977).

Since the fundamental aim of physical education in elementary schools is to develop the motor ability and physical fitness of boys and girls, it is appropriate to construct an exercise program based on the fiber composition of them. However, it is impractical to use the biopsy technique to test directly the fiber composition of many persons.

Fortunately, significant relationships between physical performance and fiber composition have been

elucidated in several ways (Hulten et al. 1975 and Thorstensson et al. 1976). The present study was designed to reveal how many boys and girls can be classified into sprint or endurance types based on their physical performances.

PROCEDURE

Five hundred sixty-nine Japanese children were tested including 275 boys and 294 girls.

Performance tests: (1) 50-meter (m) dash was run on a straight course. The amount of time between the starter's signal and the subject crossing the finish line was measured by a split timer. (2) 5-minute (min) run was conducted on a 300-meter round course. The distance covered by the subject in five minutes was measured with a steel tape scale. (3) Peak torque (PT) of knee extensor muscles in isokinetic contraction of 35 rpm was determined by Cybex Ⅱ (Lumex Co.). (4) Isometric endurance time at 50% of maximal voluntary isometric contraction (MVC) of knee extensor muscles was measured. The subject was seated on an arm chair with the force indicator placed in front of him/her and maintained 50% MVC with the knee joint at 90 degrees until exhaustion.

RESULTS AND DISCUSSION

The means and standard deviations (SD) for body height, body weight, peak torque, 50-m. dash and 5-min. run are listed according to sex in Table 1. Body height for boys increased with age from 13 to 17 years, while that for girls remained unchanged throughout 14 to 17 years of age. Only from 13 to 14 years of age were significant gains in girls noted. Similar trends were observed in the other tested parameters.

Table 1 Means and standard deviations of physical characteristics and performance tests.

BOYS	Age 13	14	15	16	17
	$n=56$	$n=53$	$n=59$	$n=54$	$n=53$
Height (cm)	154.0 ± 6.42	159.6 ± 6.84	163.9 ± 5.87	167.8 ± 5.51	169.7 ± 5.16
Weight (kg)	42.6 ± 6.28	46.5 ± 6.04	49.3 ± 6.32	55.3 ± 7.14	58.0 ± 5.72
Peak Torque					
Leg Extension (Nm)	65.0 ±18.48	85.4 ±19.00	92.9 ±20.43	106.1 ±22.45	114.4 ±20.62
50-m. Dash (m/sec)	5.97± 0.401	6.21± 0.443	6.28± 0.474	6.85± 0.295	7.08± 0.339
5-min. Run (m/sec)	4.03± 0.369	4.20± 0.266	4.43± 0.334	4.55± 0.264	4.55± 0.368
GIRLS	$n=61$	$n=61$	$n=58$	$n=58$	$n=60$
Height (cm)	151.1 ± 5.77	156.0 ± 4.72	157.2 ± 4.60	156.9 ± 4.86	157.0 ± 4.54
Weight (kg)	41.1 ± 7.30	47.0 ± 6.29	49.1 ± 4.08	49.6 ± 6.08	51.1 ± 6.16
Peak Torque					
Leg Extension (Nm)	53.3 ±13.51	68.2 ±13.82	66.0 ±16.20	68.3 ±14.58	71.1 ±16.58
50-m. Dash (m/sec)	5.59± 0.270	5.82± 0.289	5.80± 0.311	5.79± 0.286	5.82± 0.393
5-min. Run (m/sec)	3.66± 0.243	3.79± 0.341	3.66± 0.289	3.74± 0.247	3.66± 0.321

* Values are presented as means±SD.

These results might indicat the size of the body may affect the performance tests in addition to the mechanical and chemical properties of the corresponding muscles. In fact, the following significant correlation between physical performance tests and body height were obtained for both boys and girls:

50-m. dash (Y) vs. body height (X)

Boys: $r=0.719$ ($p<0.001$)

$\hat{Y}=0.050X-1.569$, SD=0.393

Girls: $r=0.212$ ($p<0.01$)

$\hat{Y}=0.013X+3.799$, SD=0.315

5-min. run (Y) vs. body height (X)

Boys: $r=0.539$ ($p<0.001$)

$\hat{Y}=0.025X+0.232$, SD=0.393

Girls: $r=0.022$ (ns)

$\hat{Y}=0.001X+3.483$, SD=0.283

PT (Y) vs. body height (X)

Boys: $r=0.743$ ($p=<0.001$)

$\hat{Y}=2.387X-296.699$, SD=17.675

Girls: $r=0.502$ ($p<0.001$)

$\hat{Y}=1.508X-169.504$, SD=14.051

Though there was no statistically significant correlation between the 5-min. run and body height for girls, the regression equation was calculated. Because the result showed that the regression equation line was almost parallel with the abscissa (body height), the following calculation for T-scores was done for this case as well.

In order to eliminate the influence of body height on the performance tests, individual regression T-score of 50-m. dash, 5-min. run and/or PT/body height was calculated by the following equation:

$$\text{T-score of performance/body height}=\frac{Y-\hat{Y}}{SD}+10+50$$

where Y is the raw value of a performance tert corresponding to a selected X (body height), $\hat{Y}$ is the value determined by the regression equation at a selected X, and SD is the standard deviation from the regression equation.

Positive relationships have been demonstrated between PT produced at the high speed of isokinetic contraction and the percentage as well as relative area of FT fibers in the contracting muscle (Thorstensson et al. 1976). Therefore, the subjects whose T-score of PT/body height is 55 or over are likely to have more than 50% of FT fibers in the leg extensor muscles, and conversely, those whose T-score is 45 or under have more than 50% of ST fibers. (Figure 1)

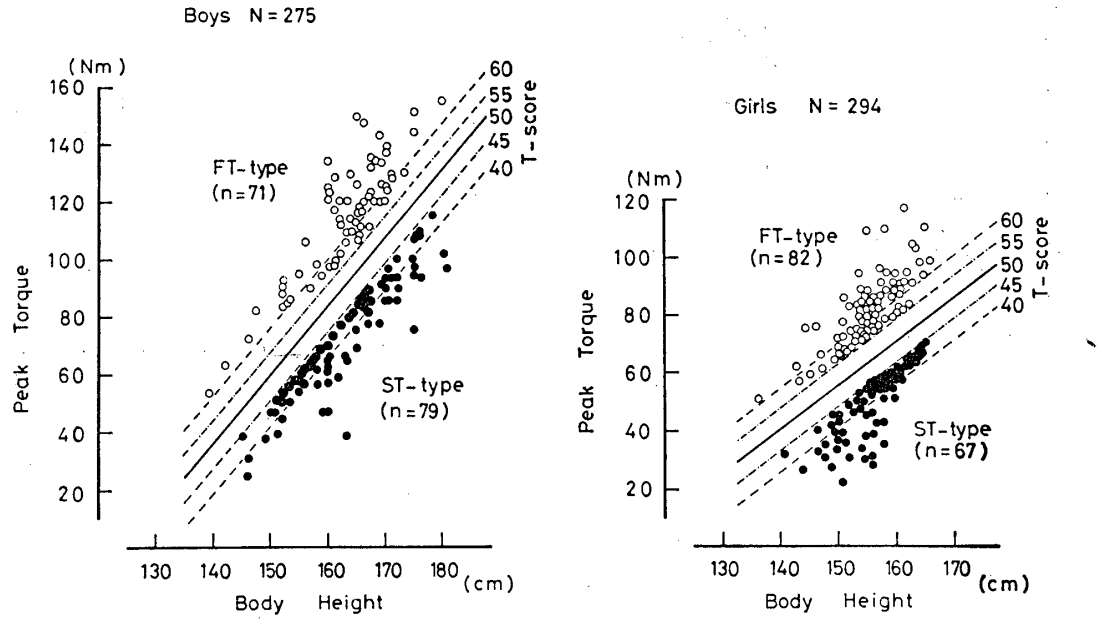

Figure 1 Relationships between peak torque and body height.
(○)=T-score of PT/body height≧55.
(●)=T-score of PT/body height≦45.

The present results classified 25.8% boys and 27.9% girls into the FT type and 28.7% boys and 22.7% girls into the ST type.

Several studies have reported a predominance of ST fibers in athletes in endurance events and that of FT fibers in sprinters (Gollnick et al. 1972). Hence, the T-score of 50-m. dash and 5-min. run were plotted for the classified boys (Figure 2) and girls (Figure 3). These figures show that ST type boys and girls tend to have higher T-scores on the 5-min. run than on the 50-m dash, whereas FT types scored higher on the 50-m. dash than on the 5-min. run.

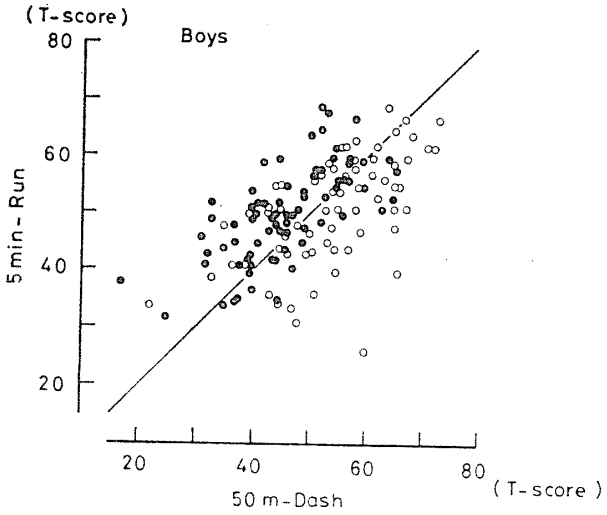

Figure 2 Comparison of the T-scores of 50-m. dash and 5-min. run/body height for the classified boys.
(○)=T-score of PT/body height≧55.
(●)=T-score of PT/body height≦45.

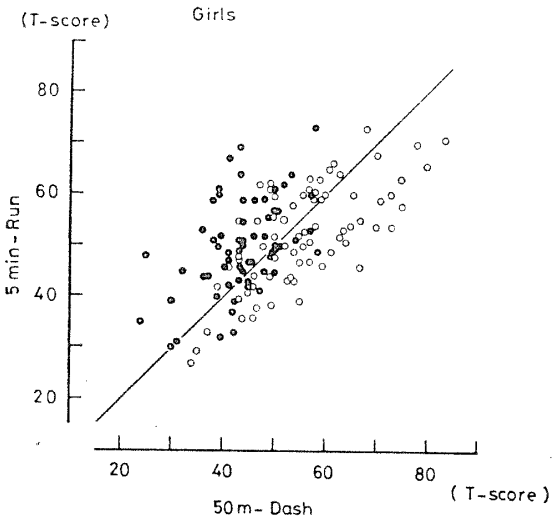

Figure 3 Comparison of the T-scores of 50-m. dash and 5-min. run/body height for the classified girls.
(○)=T-score of PT/body height≧55.
(●)=T-score of PT/body height≦45.

However, almost 30% of the adolescents showed the reverse tendency. This might be due to the fact that running style (body angle, arm swing, foot placement, rear leg lift, etc.) affects performance in addition to the body size and mechanical and chemicl properties of the corresponding muscles.

In order to classify the subjects more specifically, several procedures were adopted. Namely, the subjects whose T-scores of PT and 50-m. dash were 45 or under and whose T-scores on the 5-min. run were 55 or over were classified as endurance-type; and conversely, the subjects whose T-scores of PT and 50-m. dash were 55 or over and whose T-scores on the 5-min. run were 45 or under were classified as sprint-type.

The results indicate that there were three sprint-type boys (1.1% of total subjects) and seven endurance-type girls (3.4% of total subjects). Though Costill et al. (1976) reported that female middle-distance runners had a higher percentage of ST fibers than male middle-distance runners, it can not be explained why the sex difference appears in this classification.

Endurance time at 50% of MVC was found to be negatively correlated to percentage of FT fibers (Hulten et al. 1975). In the case of the ten classified subjects, a negative correlation ($r=-0.733$, $p<0.02$) was found between T-score of PT/body height and endurance time at 50% of MVC in the knee extensor muscles (Figure 4).

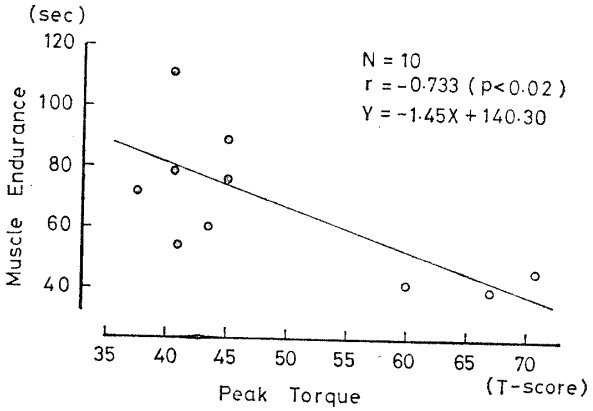

Figure 4 Relationship between T-scores of PT/body height and endurance time at 50% maximal isometric force in the knee extensor muscles.
(○)=sprint-type boys
(●)=endurance-type girls

Burke and Edgerton (1975) stated that one striking feature of human skeletal muscles was the wide variation among individuals in the proportions of FT and ST fibers within a given muscle. As there is a distinct difference in physiological profile between FT and ST fibers, ST type boys and girls who have a relatively large proportion of ST fibers in their leg muscles would be capable of the endurance type of training which results in enhancement

of the oxydative enzyme capacity of muscles. Conversely, FT type boys and girls who have a relatively large proportion of FT fibers would not be capable of the endurance type of training due to more rapid muscle fatigue. As a result, they can not enhance the oxydative enzyme capacity of muscles at all, although there is an apparent shift in FT glycolytic muscle unit histochemistry toward the profile characteristic of the FT oxydative glycolytic fibers. Furthermore, it appears possible that ST type children do not like sprint-type exercise, since they need almost a maximum effort to move faster because of the size principle of motor unit recruitment (Burke and Edgerton, 1975). Thus, they can not develop their ability.

The ideal purpose of physical education is to develop each individual to his or her maximal level. For this purpose it is essential for the schoolteacher to know the physiological profile of each individual in his class and to give him or her a proper exercise program. In the present study, the authors tried to classify the adolescents into sprint or endurance types according to their performance tests and presented the percentage of them that could be classified. Though it needs further investigation to make a definite conclusion, the classification system attempted in this study would aid the teachers in assessing the performance capabilities of adolescents.

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