

COMPARATIVE STUDIES OF ANTHROPOMETRIC, PHYSICAL AND CARDIORESPIRATORY FITNESS OF PREPUBERTAL, PUBERTAL AND POSTPUBERTAL CHILDREN

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ABSTRACT ■ The sports talent may be identified from the children of prepubertal, pubertal and postpubertal age group (10-16 yrs). In view of the above, a study was undertaken to investigate the anthropometric, physical and cardiorespiratory fitness of prepubertal, pubertal and postpubertal children. A total of 120 male children of 10-16 yrs age volunteered for this study; were divided equally into 3 groups (i) Prepubertal (age-11.0 ± 0.8yrs, n=40); (ii) Pubertal (age 13.5 ± 0.5 yrs, n=40); (iii) Postpubertal (age 15.5 ± 0.5 yrs, n=40). Selected anthropometric, physical and cardiorespiratory fitness variables were measured for each group. ANOVA followed by multiple comparison tests were performed to find out the significant difference among the groups. A significantly ($P < 0.05$) greater height, body mass, BSA, lean body mass (LBM), mid upper arm circumference (MUAC), hip and trunk flexibility, grip strengths, abdominal strength, elastic leg strength, maximum speed, peak power, VO_{2max} , peak expiratory flow rate (PEFR) and blood pressure were observed in Postpubertal children when compared to Prepubertal and Pubertal children. On the other hand, a significantly ($P < 0.05$) lower percent body fat, reaction time, maximal heart rate (HRmax) and recovery heart rates were noted in Postpubertal children when compared to Prepubertal and Pubertal children. The waist- hip ratio (WHR) of pubertal children was noted significantly higher ($P < 0.05$) when compared to prepubertal and postpubertal children. However, no significant change was reported in BMI and resting heart rate among the groups. The study may be beneficial to identify the sports talent among prepubertal, pubertal and postpubertal (10-16 yrs) children.

Key words: body composition, VO_{2max} , power, strength, motor fitness.

INTRODUCTION

Sports talent may be identified from the school children of prepubertal, pubertal and postpubertal age group (10-16 yrs) when they show interest in different sports. Anthropometric, physical and cardiorespiratory fitness profiles contribute to selection procedures in different sports events (1). Besides success in track and field

discipline is based on the synthesis of anthropometric characteristics and motor abilities as well as optimal technique (2). But overall characteristics are also influenced by genetic inheritance, morphology, personal interest and habitual activity. Cardiorespiratory fitness variables such as maximal aerobic capacity, heart rate, blood pressure and pulmonary functions reflects the

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overall capacity of the cardiovascular and respiratory systems and the ability to carry out prolonged exercise (3). Hence, Cardiorespiratory fitness has been considered as a direct measure of the physiological status of the individual (3, 4). To identify athletic potentiality, norms of the anthropometric, physical and cardiorespiratory fitness profiles have an importance because they represent the achievement level of a particular group to which observed score can be compared (5). In view of the above, a study was undertaken to investigate the anthropometric, physical and cardiorespiratory fitness of prepubertal, pubertal and postpubertal (10-16 years) age group children in order to identify potentiality and sports talent in them.

METHODS

Subjects

A total of 120 male children of 10-16 yrs age volunteered for this study. The children were selected after proper medical checkups, from West Midnapore districts of West Bengal, India; and were equally divided into 3 groups (i) Prepubertal (age-11.0 \pm 0.8yrs, n=40); (ii) Pubertal (age 13.5 \pm 0.5 yrs, n=40); (iii) Postpubertal (age 15.5 \pm 0.5 yrs, n=40). The subjects were informed about the possible complications of the study and gave their consent. The institutional review board approval was also obtained for the present study.

Measurements

Height and body mass were measured using standard methodology (6). Body mass index (BMI) and Body surface area (BSA) were derived from the height and body mass using standard equations (6). Measurements of hips and waist of the subject was taken by a steel tape using standard procedure, and the waist- hip ratio

(WHR) was determined by standard equation (6). Mid upper arm circumference (MUAC) of the subject was taken by a steel tape using standard procedure (6). A skin fold calliper (Mitutoyo, Japan) was used to assess the body fat percentage, from biceps, triceps, sub scapular and suprailiac sites. Body density was calculated according to the formulae of Durnin and Womersley (7). Body fat was derived using the standard equation of Siri (8). Subsequently, lean body mass (LBM) was derived by subtracting fat mass from total body mass using the standard equation (6).

Reaction time (RT) of the subject was assessed by ruler drop test (RDT) using standard procedure (6). Modified sit and reach test (MSRT) was applied using standard procedure in order to assess subject's hip and trunk flexibility (6). Sit ups test (SUT) was performed using standard procedure to monitor the development of the subject's abdominal strength (6). Standing long jump test (SLJT) was performed to monitor the development of the subject's elastic leg strength (6). A grip strength dynamometer (T.K.K.5001 Grip-A, Japan) was used to record the grip strength of right hand (GSTR) and grip strength of left hand (GSTL) muscles following a standard methodology (6). To monitor the development of the subject's ability to effectively and efficiently build up acceleration from a standing start to maximum speed, 30 meter acceleration test (30MAT) was performed using standard procedure (6). Margaria Kalamen Power Test was used to monitor subject's peak power using the standard procedure (9).

Subject was asked to take rest for 15 min and the resting heart rate (RHR) and resting systolic blood pressure (RSBP) and diastolic blood pressure (RDBP) were recorded.

Maximal heart rate (HR_{max}) and recovery heart rates, [recovery heart rate in 1st min (RecHR1), recovery heart rate in 2nd min (RecHR2), recovery heart rate in 3rd min (RecHR3)] were recorded following a maximal exhaustive exercise. Maximal aerobic capacity (VO_{2max}) was measured indirectly using Queen's College step test following standard procedure (10). Peak expiratory flow rate (PEFR) was recorded using a vitalograph (Montari, India) following standard procedure (11).

Statistical Analysis

All the values of anthropometric, physical and cardiorespiratory fitness variables were expressed as mean and standard deviation (SD). Analysis of Variance (ANOVA) followed by multiple comparison tests was performed to find out the significant difference in selected anthropometric, physical and cardiorespiratory fitness variables among the groups. In each case the significant level was chosen at 0.05 levels. Accordingly, a statistical software package (SPSS) was used.

RESULTS

A significantly ($P < 0.05$) higher height, body mass, body surface area (BSA), lean body mass (LBM) and mid upper arm circumference (MUAC) were observed in Postpubertal children when compared to Prepubertal and Pubertal children. On the other hand, a significantly ($P < 0.05$) lower percent body fat was noted in Postpubertal children when compared to Prepubertal and Pubertal children. The waist- hip ratio (WHR) of pubertal children was noted significantly higher ($P < 0.05$) when compared to prepubertal and postpubertal children. However, no significant change was reported in body mass index (BMI) among the groups.

Table 1: Anthropometric variable of Prepubertal, Pubertal and Postpubertal children

Variables	Prepubertal	Pubertal	Postpubertal
Height (cm)	140.2 ± 4.1	152.5 ± 4.2*	161.7 ± 4.3*#
Body mass (kg)	34.8 ± 5.2	41.9 ± 4.2*	46.5 ± 4.5*#
BMI (kg/m ²)	17.3 ± 1.5	18.0 ± 1.5 ^{NS}	17.8 ± 1.2 ^{NS}
BSA (m ²)	1.2 ± 0.04	1.3 ± 0.05*	1.5 ± 0.04*#
Body fat (%)	18.6 ± 2.4	17.3 ± 2.1*	15.0 ± 2.7*#
LBM (kg)	28.0 ± 4.3	34.6 ± 3.6*	39.4 ± 3.9*#
WHR	0.8 ± 0.02	0.9 ± 0.02*	0.8 ± 0.02#
MUAC (cm)	17.5 ± 2.9	20.8 ± 2.7*	23.2 ± 2.5*#

* $P < 0.05$ when compare to prepubertal age group, # $P < 0.05$, when compare to pubertal age group, NS= not significant.

A significantly ($P < 0.05$) higher hip and trunk flexibility as measured by modified sit and reach test (MSRT) score, abdominal strength as measured by sit ups test (SUT) score, elastic leg strength as measured by standing long jump test (SLJT) score, grip strengths of both hands, maximum speed as measured by lower 30 meter acceleration test (30MAT) score, and peak power output were observed in Postpubertal children when compared to Prepubertal and Pubertal children. On the other hand, a significantly ($P < 0.05$) lower reaction time as measured by ruler drop test (RDT) was noted in Postpubertal children when compared to Prepubertal and Pubertal children.

A significantly ($P < 0.05$) higher VO_{2max}, peak expiratory flow rate (PEFR), resting systolic and diastolic blood pressure were observed in Postpubertal children when compared to Prepubertal and Pubertal children. On the other hand, a significantly ($P < 0.05$) lower maximal heart rate (HR_{max}) and recovery

heart rates were noted in Postpubertal children when compared to Prepubertal and Pubertal children. However, no significant change was reported in resting heart rate among the groups.

Table 2: Physical fitness variable of Prepubertal, Pubertal and Postpubertal children

Variables	Prepubertal	Pubertal	Postpubertal
RDT (cm)	19.7 ± 2.3	16.8 ± 2.8*	15.3 ± 2.8 [#]
MSRT (cm)	10.9 ± 1.8	14.0 ± 1.3*	16.0 ± 1.6 [#]
SUT (in 30 sec)	15.5 ± 1.5	17.2 ± 1.2*	18.9 ± 1.3 [#]
SLJT (m)	1.5 ± 0.2	1.7 ± 0.3*	1.9 ± 0.3 [#]
GSTR (kg)	18.0 ± 3.6	24.7 ± 3.5*	31.5 ± 3.4 [#]
GSTL (kg)	17.0 ± 2.7	24.0 ± 3.3*	29.9 ± 3.1 [#]
30MAT (sec)	6.6 ± 0.3	5.7 ± 0.4*	5.1 ± 0.5 [#]
Peak power (watt)	496.9 ± 22.1	716.3 ± 20.6*	821.4 ± 21.3 [#]

*P<0.05 when compare to prepubertal age group, #P<0.05, when compare to pubertal age group.

Discussion

Childhood and adolescence are crucial periods of life, since dramatic physiological and psychological changes take place at these ages. During childhood and adolescence, body size and composition markedly change. These changes are strongly associated with the development of various physical performance characteristics. Body size (height, body mass, BMI and BSA) play important role during selection of players (12, 13). In the present study, a significantly (P<0.05) higher height, body mass and BSA were observed in Postpubertal children when compared to Prepubertal and Pubertal children. However,

Table 3: Cardiorespiratory variable of Prepubertal, Pubertal and Postpubertal children

Variables	Prepubertal	Pubertal	Postpubertal
RHR	64.3 ± 3.3	65.2 ± 3.6 ^{NS}	64.0 ± 2.9 ^{NS}
HRmax	195.3 ± 6.0	190.8 ± 5.7*	186.7 ± 6.4 [#]
RecHR1	158.6 ± 5.5	148.3 ± 6.1*	142.3 ± 4.7 [#]
RecHR2	134.6 ± 4.1	128.3 ± 3.5*	121.4 ± 4.4 [#]
RecHR3	115.1 ± 4.8	108.2 ± 2.5*	102.2 ± 2.7 [#]
RSBP	95.5 ± 5.0	99.8 ± 5.3*	102.9 ± 6.2 [#]
RDBP	60.2 ± 4.7	62.4 ± 4.9*	66.4 ± 4.1 [#]
VO2max (ml/kg/min)	37.8 ± 2.3	43.2 ± 3.1*	45.5 ± 3.7 [#]
PEFR (l)	224.0 ± 10.7	289.3 ± 12.4*	346.5 ± 12.1 [#]

*P<0.05 when compare to prepubertal age group, #P<0.05, when compare to pubertal age group, NS= not significant.

no significant change was reported in BMI among the groups. The possible reason for the increase in height Prepubertal to Pubertal and Postpubertal children might be the osteotropic response to exercise. The osteotropic effect of exercise is dependent on load dynamics, the volume, intensity and duration of training, administered on the individual and the period in life when exposure occurs (14). The waist to hip ratio (WHR) has been shown to be related to the risk of coronary heart disease (15). Mid-upper arm circumference (MUAC) is a measure of nutritional status (16). The WHR of pubertal children was noted significantly higher (P<0.05) when compared to prepubertal and postpubertal children. Moreover, a significantly (P<0.05) higher MUAC was observed in Postpubertal children when compared to Prepubertal and Pubertal children. The changes might be because of level of maturation factors and/or motivation, and exposure to long term and higher intensity of training among the Postpubertal children when compared with Prepubertal and Pubertal children. The percentage of body fat plays an important role for the assessment of

physical fitness of the players (17, 18). A significantly lower ($P < 0.05$) percent body fat was observed in Postpubertal children when compared to Prepubertal and Pubertal children. The lower body fat values in the postpubertal children might be because of exposure to long term and higher intensity of aerobic endurance training compared with Prepubertal and Pubertal children. However, significant ($P < 0.05$) increase in LBM was noted in Postpubertal children when compared to Prepubertal and Pubertal children. This might be again due to long term effect of exercise among the Postpubertal children than Prepubertal and Pubertal children which reduces the body fat and which shows higher LBM among the Postpubertal children. The observations of our study are supported by several studies, where decrease in body fat was noted with the advancement of age of the players (13, 19).

Physical fitness of the athletes can be assessed by measuring motor skills and activities such as reaction time, hip and trunk flexibility, abdominal strength, elastic leg strength, grip strengths, maximum speed and peak power output (3, 19). A significantly ($P < 0.05$) higher hip and trunk flexibility as measured by modified sit and reach test (MSRT) score, abdominal strength as measured by sit ups test (SUT) score, elastic leg strength as measured by standing long jump test (SLJT) score, grip strengths of both hands, maximum speed as measured by lower value of 30 meter acceleration test (30MAT) score, and peak power output were observed in Postpubertal children when compared to Prepubertal and Pubertal children. On the other hand, a significantly ($P < 0.05$) lower reaction time as measured by ruler drop test (RDT) was noted in Postpubertal children when compared to

Prepubertal and Pubertal children. This might be because of level of maturation factors and / or motivation of the Postpubertal children when compared with Prepubertal and Pubertal children. Moreover, the lower reaction time; and higher level of flexibility, abdominal strength, elastic leg strength and grip strength, speed and power of the postpubertal children might be because of exposure to long term and higher intensity of training when compared with Prepubertal and Pubertal children. Similar findings were also noted by other research groups (20, 21).

Cardiorespiratory fitness of the athletes is assessed by measuring heart rate, blood pressure, VO_{2max} , and lung functions (3, 19). A significantly ($P < 0.05$) lower maximal heart rate (HR_{max}) and recovery heart rates were noted in Postpubertal children when compared to Prepubertal and Pubertal children. However, no significant change was reported in resting heart rate among the groups. On the other hand, a significantly ($P < 0.05$) higher resting systolic and diastolic blood pressure were observed in Postpubertal children when compared to Prepubertal and Pubertal children. Exercise cardio acceleration results from release of parasympathetic inhibition at low exercise intensities and from both parasympathetic inhibition and sympathetic activation at moderate intensities (3, 19). Nevertheless, parasympathetic activation is considered to be the main mechanism underlying exponential cardio deceleration after exercise (3, 19). The results of the present study suggest that the strain on the circulatory system during sports activities is relatively high. Exercising at this intensity should provide a good training stimulus. The maximal oxygen uptake (VO_{2max}) is the best

overall measure of aerobic power (19, 22). Aerobic capacity certainly plays an important role in athletics activities and has a major influence on technical performance and tactical choices (3, 19). A significantly ($P < 0.05$) higher VO_{2max} was observed in Postpubertal children when compared to Prepubertal and Pubertal children. The higher level of VO_{2max} value in the postpubertal children might be because of exposure to long term and higher intensity of aerobic endurance training compared with Prepubertal and Pubertal children. The increase in VO_{2max} might be due to an increase in the systemic a-v O_2 difference and stroke volume, (3, 19). Moreover, these changes might be the result of increased volume of endurance training (3, 19). Peak expiratory flow rate (PEFR) is used as an indicator of asthma or similar lung disease (3). In the present study, a significantly ($P < 0.05$) higher peak expiratory flow rate (PEFR) was observed in Postpubertal children when compared to Prepubertal and Pubertal children. This might be because of level of maturation factors and / or motivation of the Postpubertal children when compared with Prepubertal and Pubertal children. Moreover, the higher peak expiratory flow rate (PEFR) of the postpubertal children might be because of exposure to long term and higher intensity of aerobic endurance training when compared with Prepubertal and Pubertal children. Similar findings were also noted by other research groups (13, 19, 20, 21).

CONCLUSION

Identification of children at early stage of their growth and development may produce elite athletes in future. Talent identification also can be used as a counseling technique that helps to discover and explore areas of talent

for particular athletes. In order to reach the goal, young children should be subjected to a series of tests reflecting anthropometric, physical and cardiorespiratory fitness which indicate the overall strengths and weaknesses of the athletes. Improvement in these parameters depends on level of maturation factors and / or motivation; and exposure to long term and high intensity of training.

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