South African Journal for Research in Sport, Physical Education and Recreation, 2010, 32(2): 71-93.
Suid-Afrikaanse Tydskrif vir Navorsing in Sport, Liggaamlike Opvoedkunde en Ontspanning, 2010, 32(2): 71-93.
ISSN: 0379-9069

PHYSICAL AND MOTOR ABILITY, ANTHROPOMETRICAL AND GROWTH CHARACTERISTICS OF BOYS IN THE NORTHWEST PROVINCE OF SOUTH AFRICA: A SPORT TALENT PERSPECTIVE

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ABSTRACT

The objective of the study was to analyse age group differences among and unique to 10 to 15 year old boys of different racial groups living in the North West Province (NWP) of South Africa. Boys (N=604) between 10 and 15 years participated in the study. They were a randomized group and a proportional representation of the four different racial groups living in the NWP. The tests included the Australian Talent Search protocol, consisting of 10 parameters (four anthropometrical, one physical and five motor abilities) and four additional physical fitness parameters (abdominal, grip- and upper body strength and flexibility). The analyses were based on cross sectional data and age group comparisons for anthropometric composition, physical and motor abilities of the boys. Analysis of Variance with an age and group effect revealed growth patterns similar to other studies, although unique growth characteristics were also found in the different racial groups, suggesting population variation. Age group differences and tendencies with regard to body dimensions and physical and motor abilities were indicated. In order to achieve a distinct profile of the current and future sporting potential of a boy in his rapid growing years, it is recommended that comparison to peers from a sport talent perspective will provide a more sensitive assessment when regional or national reference data, but also racial specific growth profiles, are used. The results of this study can serve as a reference base for future comparisons in order to ensure that the most talented children are identified for sport on the basis of their own growth profile.

Key words: Growth; Maturity; Boys; Talent; Physical; Motor.

INTRODUCTION

Every athlete's ultimate goal is to excel in performance of the sport in which he/she has specialized (Reilly, 2001). To achieve this, many years of training and preparation are needed. It is indicated that it can take up to 10 years for an athlete to reach his/her full sporting potential (Woodman, 1985). Sport talent identification (TID) should therefore commence relatively early in an athlete's life for the optimalisation of sporting talent. The fact that South Africa has not been a prominent force since the 1992 return to world sport suggests that much more should be done to identify and develop potentially talented sportsmen and –women.

South African researhers (Du Randt *et al.,* 1993) conducted an extensive literature survey regarding TID, and pointed out that lack of scientifically based TID protocols and programs compromised sport development in the South African context. They also highlighted that the scientific identification and development of young talented athletes require knowledge of the biological growth and maturation processes during adolescence. It is indicated in this regard (Post *et al.,* 1997) that the onset of puberty, peak height velocity (PHV) and sexual maturation radically differ from one individual to another of the same chronological age, and different researchers (Carey, 1989; Fisher & Borms, 1990; Van Rooyen, 1993) suggest that these aspects should receive more attention. Changes in physical, motor and anthropometrical TID determinants are especially influenced by growth and maturation (Pienaar *et al.,* 1998), therefore scientists working in the field of TID should have sufficient knowledge of these processes (Schmidt, 1991). It is also maintained by researchers (Malina *et al.,* 2004) that race, ethnicity or the population group the individual belongs to, influences growth and development. Cameron and Kgampe (1993) also report that if the purpose of a comparison is to monitor the health status of a child compared to his peers, a local or national chart will provide a more sensitive assessment compared to an international norm. The same argument is true from a sport talent perspective. Studies (Du Randt, 2000; Abbot & Collins, 2002) confirmed that the Australian TID norms cannot be applied directly to South African or Scottish children, while differences were also found in a comparison of the talent-search variables of a sample of 12-15 year old Australian, South African and North West Province (NWP) boys (Viljoen *et al.,* 2004). Thus the aim of this study was to determine how boys, from different racial groups, who live in the NWP of South Africa, develop with regard to their anthropometrical characteristics, physical and motor abilities between the ages 10 to 15 years. A further aim was to determine and describe possible unique growth patterns among and unique to their anthropometrical, physical and motor abilities from a TID perspective.

METHODS

Participants

Boys (N=604) between the ages of 10 to 15 years, living in the NWP of South Africa, served as subjects in the study. Ethical approval (no. 00M07) for the study was obtained from the Ethics Committee of the NWU, and each subjects' parents signed a consent form before the child could participate in the study.

A stratified random sample, compiled by a biostatistician from the North-West University (NWU), was used to obtain the data for this cross-sectional study. To determine the sample, a list of all the schools in the NWP was obtained from the Department of Education. All these schools are grouped into 12 school districts with every district representing 4-7 regions, with approximately 20 schools (minimum 14, maximum 47) in each of the regions. Regions and schools were then randomly selected according to population density, after which the subjects were randomly selected from every school. Hence the participants in this study can be considered a proportional representation of the boys of different racial groups living in the NWP of South Africa. The research sample included 44 schools and the group composition from the various primary and high schools is indicated in Table 1.

TABLE 1. **SAMPLE SIZE (N), AGE AND RACIAL DISTRIBUTION OF THE GROUP**

	Mean age		Primary schools			Secondary schools			Sample size
	M	SD	10yr	11yr	12yr	13yr	14yr	15yr	10-15 years
Black	12.41	1.67	58	83	106	55	54	74	430
White	12.55	1.76	16	15	17	16	16	19	99
Coloured	11.76	1.59	8	10	7	4	5	2	36
Indian	12.35	1.46	6	6	6	11	8	2	39
Age group totals (n)	12.38	1.67	88	114	136	86	83	97	604

M= mean; SD= Standard deviation

Black, Coloured (a mixture of white and black groups) and to a lesser extent Indian boys (ancestry mainly from India), came from predominantly disadvantaged communities. Many of the participants included in this study live in remote (rural) areas and no or little knowledge is available concerning their growth and development, physical and motor abilities and their potential for sport. Testing conditions were not always optimal (e.g. uneven and sand surfaces) and could have played a role in the results.

Measuring instruments

The protocol used for the study was based on the Sport Search Program which is used in Australia for the identification of sports talent (Australian Sports Commission, 1995) among children 12 years and older. This protocol includes 10 tests determining four anthropometrical and six physical and motor abilities. The anthropometrical measurements for stature, body mass, relative sitting height and arm span were obtained using standard measuring procedures as described in the Australian manual (Australian Sports Commission, 1995). Sitting height is expressed as a percentage of total height. The physical and motor tests included in this protocol are the bleep, basketball throw, 40 meter sprint, 5 meter agility, vertical jump and a throw and catch for accuracy. The bleep test is a 20 meter multi-stage shuttle run with a progressive increase in pace, expressed as the number of shuttles and levels completed. The basketball throw from the chest is executed from a sitting position against a wall, and the better of two attempts is recorded. The 40 meter sprint test is executed from a standing position and the better of two attempts is recorded in seconds. The vertical jump test is performed against a wall, subtracting jumping height from reaching height. Two attempts are allowed and the best jump is recorded in centimetres. The 5 meter agility test consists of two markers that are placed 5 meter apart. The subject must complete five concecutive runs between the markers. The best time of the two attempts is recorded in seconds. The throw-and-catch task for accuracy consists of 10 underhand throws for each hand. Subjects (13-15

years) had to hit a 30 cm diameter round target against a wall, which is placed 2.5 meters away from the starting line. The Australian protocol was not designed for children younger than 12 years, therefore a pilot study was conducted and also taking the recommendations of another study (Abbot & Collins, 2002) into consideration, the distance from the target was adjusted to 1.5 meters for the 10-12 year old subjects in this study.

To obtain a more comprehensive profile of the developmental and performance status of the physical abilities of boys, four additional physical ability tests were added to the testing protocol. These tests included the seven-level sit-up test (abdominal strength) (Ellis *et al.,* 1998), hand grip strength test of the right hand (forearm and hand muscle strength) (Kirby, 1991), pull-ups (dynamic upper body strength and endurance) (Kirby, 1991) and the modified sit-and-reach test (flexibility) (Kirby, 1991). The seven level sit up test is performed in seven levels from easy to difficult (different arm positions) and a 2.5 and 5kg weight are added in levels 6 and 7 respectively. The number of levels (0-7) completed are recorded. A sucessfull pull-up was recorded when the subject pulled himself up from a straight arm hanging position to where the chin is above the bar. Grip strength was measured by the Lafayette-hand grip dynamometer held parallel with the leg and squeezed as hard as possible with the right hand, and recorded in kilograms (kg). In the modified sit-and-reach test the subject had to sit upstraight against a wall with both feet against a standard sit-and-reach box with straight arms, hands on top of each other on the measuring box. Without bending forward, the distance to the tip of his fingertips is recorded in centimeters. The subject then had to reach forward as far as possible and hold this position for three seconds without bending the knees. The difference between the two measurements is recorded.

All tests were administered during school hours. Sufficient rest was allowed between tests, and the bleep test was performed at the end of the testing procedure in small groups. Participants were familiarized with the test procedures and encouraged to do their best.

Statistical procedure

The Statistica computer processing package (Statsoft, 2007) was used to analyze the data. For descriptive purposes, increments between means of the different age groups were calculated to determine age group differences. Analyses of variance (ANOVA) and a Tukey post-hoc analysis were used to determine the statistical significance ($p<0.05$) within and between groups (Thomas & Nelson, 1996), whilst effect sizes (ES) were calculated to indicate practical significance of differences between groups (ES>0.8 indicates high practical significance. A two way ANOVA was used to construct graphs with race and age as main effects.

RESULTS

The results are discussed by *age group* and the biological variation among and unique to the four racial groups is highlighted. Analysis of within and between group effects (see Figures 1-3) indicates relatively large variation in the Coloured and Indian groups who represent relatively small numbers of participants, therefore discussion of racial effects will mainly focus on the results of the white and black groups. SD_w indicates the variability of the measurements within each race group within each age level.

Figures 1a-d and Table 2 display the cross-sectional analysis of the data for the anthropometric characteristics of the *group* (age group means for stature, body mass, relative sitting height and arm span) and in each of the racial groups separately. A gradual increase ($p<0.05$, ES>0.8) in *age group means* for stature (135.05 cm – 162.8 cm) are indicated between 10 and 15 years. The largest significant age group increase (6.60 cm) was seen between 12 and 13 years, with a similar increase ($p<0.05$) up until 15 years of age.

TABLE 2. **MEANS AND STANDARD DEVIATIONS (SD) FOR THE GROUP AND SIGNIFICANE OF AGE GROUP DIFFERENCES**

VARIABLES	10yrs		11yrs		12yrs		13yrs		14yrs		15yrs	
	M	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD
Body stature (cm)	135.0	7.5	139.2♦	8.3	144♣	8.1	150.6♠	9.8	156.7 +	10.9	162.8#	9.5
Body mass (kg)	29.3	7.2	31.2	6.2	35.0♣	9.2	39.1♠	9.3	44.5 +	10.9	49.4#	11.5
Rel.sitting height (%)	51.0	2.0	50.4	2.1	50.0	2.1	49.9	1.7	50.0	2.6	50.0	1.8
Arm span (cm)	135.8	7.7	140.6♦	9.1	145.6♣	9.7	151.5♠	8.0	158.6 +	10.7	166.4#	10.9
Abdominal strength (n)	2.6	1.8	2.5	1.7	2.8	1.7	3.5	1.6	4.2	1.5	4.0	1.9
Hand grip strength (kg)	16.7	3.7	18.2	3.3	19.9	3.8	23.3♠	5.6	27.1 +	6.9	32.0#	7.7
Pull- ups (n)	2.2	2.5	2.0	2.0	1.5	1.9	2.1	2.3	3.2	3.2	4.4#	3.4
Flexibility (cm)	25.4	6.0	26.5	5.8	26.4	7.6	27.9	6.1	27.9	7.7	31.5#	7.3
Shuttles (n)	40.8	17.5	45.1	15.4	45.8	19.3	50.3	18.5	55.3	18.3	60.0	15.9
Basketball throw (m)	3.4	0.9	3.4	0.7	3.8	0.9	4.5♠	1.1	5.1 +	1.3	5.8#	1.5
Throw for accuracy (n)	10.5	4.6	11.7	4.9	13.1	4.4	9.0*	4.7	9.6	4.2	10.5	4.1
40m dash (sec)	7.7	0.9	7.8	1.2	7.7	0.7	7.4	0.7	7.2	0.8	7.0	0.8
5m agility (sec)	22.3	2.3	22.8	2.2	22.1	2.1	21.9	2.3	20.9 +	2.0	21.2	2.1
Vertical jump (cm)	23.3	5.8	23.2	7.7	23.8	5.2	26.1	5.5	29.4 +	8.5	31.6*	7.8

Statistical ($p< 0.05$) and practical significant differences (ES>0.8); ♦ = 10-11 yrs: ♣= 11-12 yrs; ♠ = 12-13 yrs; += 13-14 yrs; # = 14-15 yrs; Statistical significance= *($p<0.05$); rel. = relative

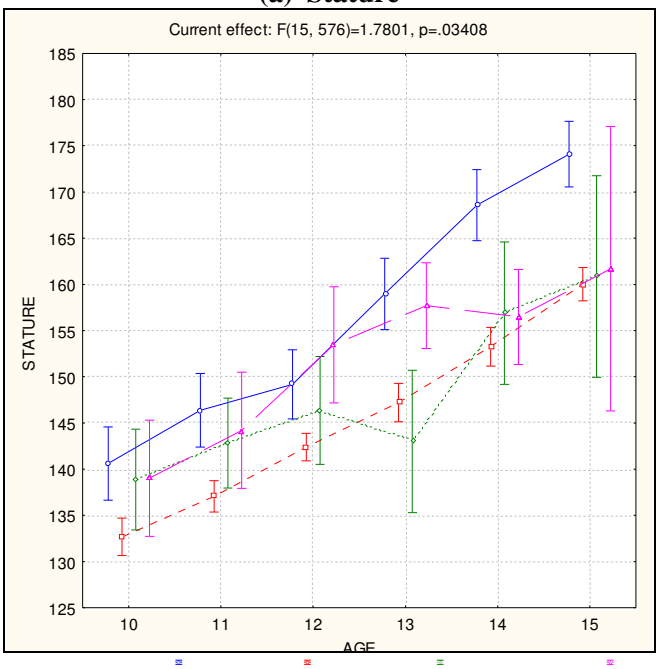
TABLE 3. **SIGNIFICANCE OF AGE GROUP MEAN DIFFERENCES BETWEEN WHITE AND BLACK BOYS**

VARIABLES		10yrs		11yrs		12yrs		13yrs		14yrs		15yrs	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Body stature (cm)	W	140.6*	4.9	146.4*	6.4	149.2*	8.2	158.9*	9.5	168.6*	8.8	174.1*	7.0
	B	132.7	6.3	137.1	7.6	142.4	7.4	147.2	7.9	153.3	9.7	160.0	8.1
Body mass (kg)	W	35.2*	10.5	38.0*	10.2	42.8*	9.9	49.4*	11.2	55.5*	12.4	60.4*	9.1
	B	27.9	5.6	29.8	4.3	32.9	6.4	35.9	6.9	41.9	9.3	46.6	10.6
Rel. sitting height (%)	W	51.9*	2.1	50.9	2.1	51.4*	2.5	50.7*	1.6	50.4	1.5	50.9*	1.88
	B	50.8	1.8	50.3	2.1	49.7	1.9	49.7	1.8	49.7	3.0	49.8	1.7
Arm span (cm)	W	137.9	7.2	145.8*	5.6	150.3*	8.1	156.6*	10.8	168.5*	7.5	175.9*	7.9
	B	133.8	6.5	138.2	8.4	143.6	8.7	149.2	9.2	156.2	10.6	164.5	10.7
Abdominal strength (n)	W	3.8*	1.7	4.0*	1.4	4.2*	1.9	4.3*	1.5	5.6*	0.8	5.2*	1.9
	B	1.9	1.6	2.2	1.6	2.7	1.6	3.2	1.6	3.9	1.4	3.7	1.7
Grip strength (kg)	W	20.0*	3.0	20.9*	2.9	22.1*	3.5	28.3*	6.3	34.3*	6.7	41.0*	4.4
	B	15.9	3.8	17.6	2.8	19.4	3.6	21.9	4.5	24.9	5.2	30.0	6.6
Pull- ups (n)	W	3.8*	2.9	3.5*	1.7	2.3	1.9	3.6*	3.6	5.9*	3.2	7.8*	3.5
	B	1.9	2.4	1.8	1.9	1.4	1.6	1.8	1.9	2.0	2.4	3.6	2.8
Flexibility (cm)	W	25.3	6.9	23.5*	5.4	24.1	6.2	25.8*	6.5	25.2*	9.5	27.4*	7.4
	B	26.2	5.9	27.6	5.8	27.3	7.6	29.6	5.6	29.6	7.1	32.8	6.7
Shuttles (n)	W	42.1	18.7	53.5*	21.9	51.6	15.8	44.8	22.5	55.1	12.1	55.6	16.1
	B	39.2	15.6	42.9	15.3	45.1	19.0	46.7	17.5	48.2	17.1	55.1	19.5
Basketball throw (m)	W	4.7*	1.3	4.5*	0.9	5.5*	0.6	5.7*	1.2	6.8*	1.1*	7.8*	1.3*
	B	3.2	0.6	3.3	0.6	3.7	0.8	4.1	0.8	4.6	0.9	5.2	1.0
Throw for accuracy (n)	W	14.5*	3.8	13.3	4.7	15.3	3.6	9.8	5.0	12.6*	2.6	12.7*	3.7
	B	9.9	4.4	11.5	4.9	12.9	4.4	9.2	4.9	8.6	4.2	9.9	4.2
40m dash (sec)	W	6.5*	0.8	6.8*	0.3	6.9*	0.5	6.6*	0.7	6.5*	0.7*	6.3*	0.5
	B	7.8	0.8	7.9	1.3	7.7	0.7	7.5	0.7	7.4	0.7	7.2	0.7
5m agility (sec)	W	20.3*	1.8	21.5	0.9	20.4*	1.9	21.1	2.4	19.3*	1.8	20.2*	2.0
	B	22.3	2.2	22.9	2.2	22.3	2.1	22.2	2.4	21.3	1.8	21.4	2.0
Vertical jump (cm)	W	30.8*	6.2	25.3	4.5	29.1*	2.1	27.9	6.8	37.9*	8.7	38.7*	5.5
	B	22.2	4.9	23.0	7.9	23.3	5.1	25.3	5.2	26.2	5.8	29.6	7.2

*Significant difference between white (W) and black boys (B), $p<0.05$

Height at 15 years was 174.1 cm (white), 160.0 cm (black), 160.8 cm (Coloured) and 161.7 cm (Indian) (Table 3 and Fig. 1a). A 33.48 cm gain in stature where found among the white boys over the period from 10 to 15 years, compared to 27.36 cm (black), 21.97 (Coloured) and 22.69 cm (Indian). White boys displayed the largest age group means for stature (158.9, 168.6, 174.1), body mass (49.4, 55.5, 60.4) and arm span (156.6, 168.5, 175.9) from the age of 13 years (Table 3) and a largest significant maximal growth difference in stature (9.78 cm) was evident between the 12 and 13 year old groups with another big difference between the 13 and 14 year olds (9.61 cm). With the exception of the 13 year old Coloured boys, the black children were the shortest in all the age groups, and the largest significant maximal growth difference in stature (6.76 cm) was found between the 14 year and 15 old groups. They also displayed significantly lower stature values compared to the white boys in all age groups (Table 3). Age group increases were observed between 13 and 15 years (143.0, 156.87, 160.85) of age in the Coloured group (Fig. 1a), although none of these differences were significant. A lower age group mean for stature among 13 year old Coloured boys (143 cm), compared to 12 year olds (146 cm) is seen, although this could be a result of the cohort effect. Among the Indian group, the biggest age group difference was found between the 11 (144.21) and 12 year (153.46) old boys.

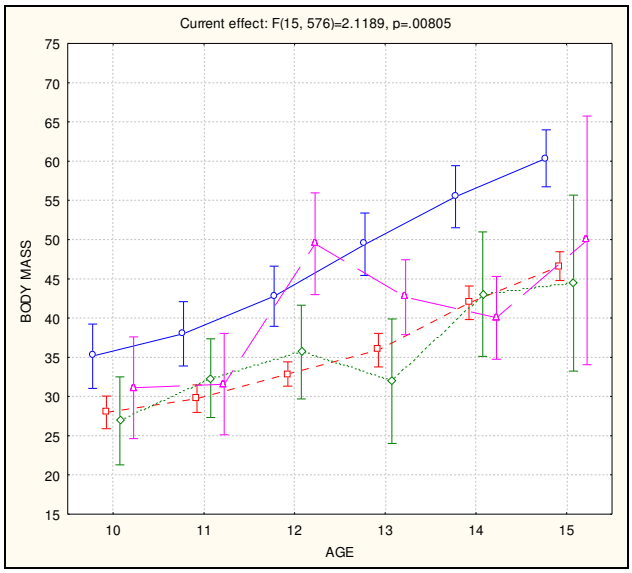
(a) Stature



a. $SD_w = 7.87$ White; Black; Coloured; Indian

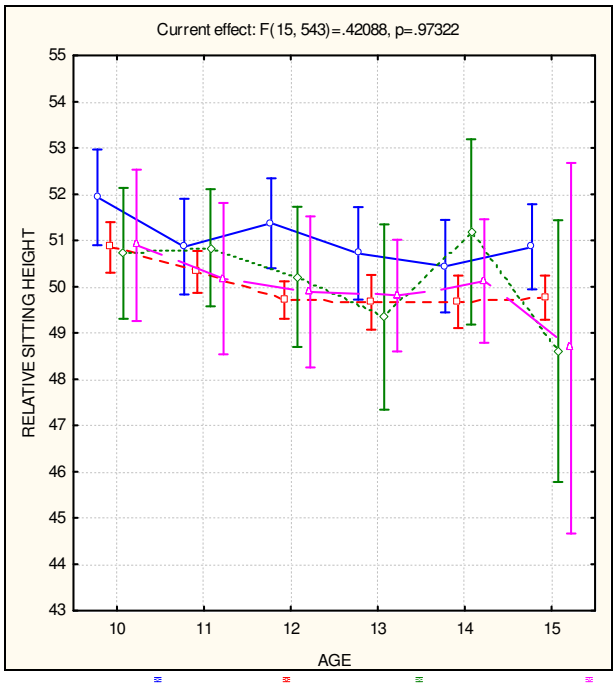
FIGURE 1a-d. **THE RACE BY AGE INTERACTION OF THE ANTHROPOMETRICAL CHARACTERISTICS; SD_w ROOT MEAN SQUARE FROM ANOVA**

(b) Body mass



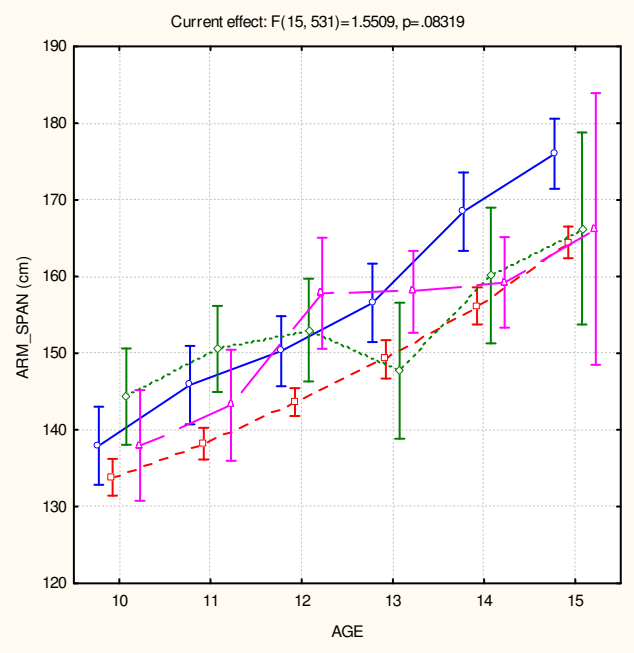
b. SD_w = 8.09 White; Black; Coloured; Indian

(c) Relative sitting height



c. SD_w = 2.05 White; Black; Coloured; Indian

(d) Arm span



d. SD_w = 9.0 White; Black; Coloured; Indian

Regarding body mass (Figure 1b), age group differences contributed to increases from 29-49 kg in the *group* up until 15 years of age, with the increases from 11 to 15 years (31.2, 35.0, 39.1, 44.5, 49.4) being significant ($p<0.05$, ES>0.8; Table 2). The largest age group difference (5.37 kg, $p<0.05$) was found between 13 and 14 years, and occurred after a largest increase in age group means for stature. Figure 1b shows that the body mass of the white boys was higher compared to the other racial groups, and significantly higher than the black group in all the age groups (Table 3). Figure 1b further indicates that the body mass increase in the white, black and Coloured boys between ages 14 and 15 years were less than earlier.

Sitting height (Figure 1c) made up 51.0% of the total stature at 10 years of age; a percentage gradually decreasing up until 12 years (50.0%), and thereafter showing a levelling off tendency to 15 years (50.0%). No significant age *group* differences were found with regard to a change in the relative sitting height percentage with increasing age. White boys displayed the highest relative sitting height of all the race groups with significantly higher values compared to black boys at the ages of 10, 12 13 and 15 years.

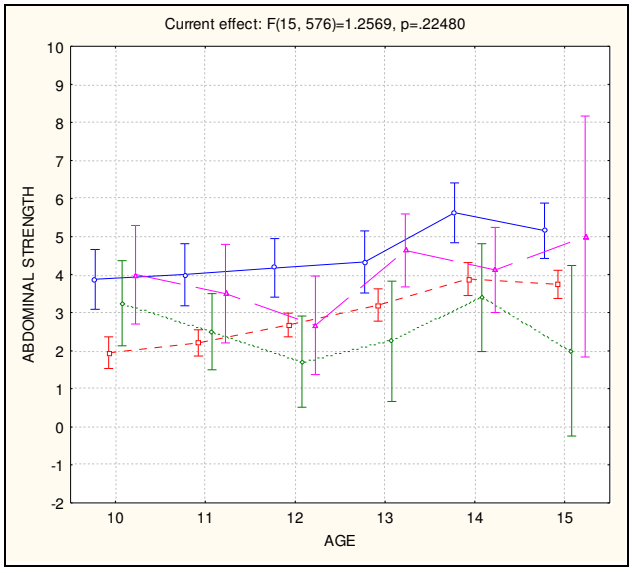
Arm span showed considerable, significant increases ($p<0.05$, ES>0.8) from 10 to 15 years in the *group* (Table 2, Figure 1d). These increases became larger from 13 to 14 years, with the largest difference (7.82 cm, $p<0.05$) seen between 14 and 15 years; approximately a year later than the largest increase in age group means for stature. In the different racial groups, the largest age group differences in arm span were seen for both white (11.89 cm) and Coloured boys (12.4 cm) between ages 13 and 14 years. This difference of 11.88 cm among the 13 and

14 year old white boys was statistically significant ($p<0.05$). Among the black boys, the largest differences in arm span (8.28 cm, $p<0.05$) was seen between 14-15 years, and among the Indian boys (14.58 cm, $p>0.05$) between the 11-12 year old groups. The maximal increase in arm span of the white boys occurred approximately a year later than an observed maximal increase in stature (12-13 years, 9.77 cm), while the maximal stature and arm span increases occurred in the same year for the other racial groups. Compared to the white boys and to a lesser extent the Indian boys, the black and Coloured boys had relatively longer arms in relation to their body stature. The arm span means of the black boys in all the age groups indicated longer lengths compared to their average height, while such a tendency was only seen among the 15 year old white boys (table 3).

Age group differences were found in abdominal muscle strength, indicating gradual improvement until the age of 14 years (Figure 2a and Table 2) — a trend which was also apparent in both the white and black groups. At the age of 15, the *group*, as well as the whites, blacks and Coloureds, showed poorer age group means compared to the 14 year old group. The grip strength of the right hand showed gradual increases with significant increases from 12 year onwards (Figure 2b and Table 2).

The mean number of pull-ups increased from 1.54 to 2.2 ($p<0.05$) in 10 to13 year olds, to 3.20 and 4.42 in the 14 to 15 year old *groups* ($p<0.05$, Figure 2c). This increase in dynamic upper body strength among 14 and 15 year olds also coincides with the period of immense weight gain in this group (Figure 1b). The highest age group means for pull-ups was found in the group of white boys (M = 3.81 at 10 years; M = 7.79 at 15 years), whilst these values varied between the other racial groups, namely from 0.69 (10 year old Indian boys) to 4.40 (14 year old Coloured boys). Significant differences were found between white and black boys (white boys superior) in abdominal strength, grip strength and upper body strength (pull ups) in all the age groups except for pull ups among the 12 year old group (see Table 3).

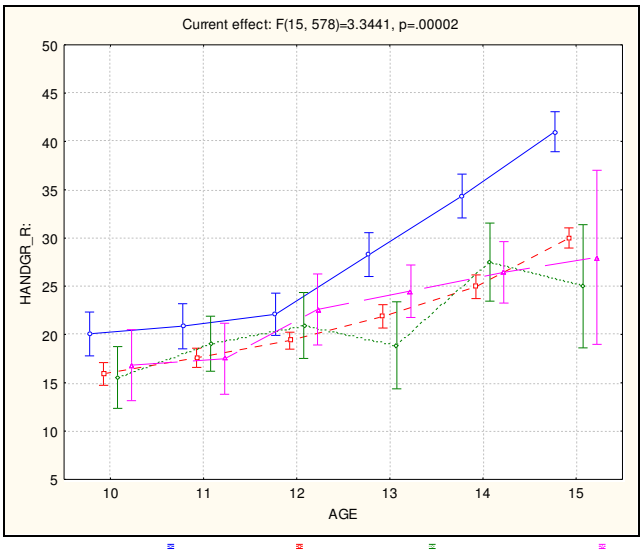
(a) Abdominal strength



a. SD_w= 1.60 White; Black; Coloured; Indian

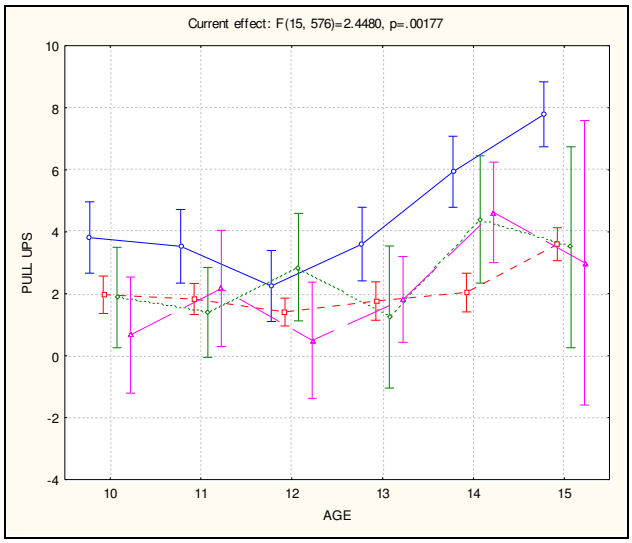
FIGURE 2a-e. **THE RACE BY AGE INTERACTION OF THE MOTOR ABILITIES; SD_w ROOT MEAN SQUARE ERROR FROM ANOVA**

(b) Grip strength R



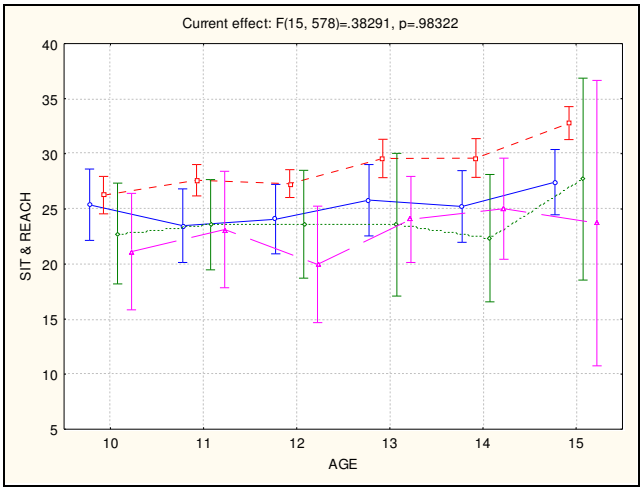
b. SD_w = 4.59 White; Black; Coloured; Indian

(c) Pull ups



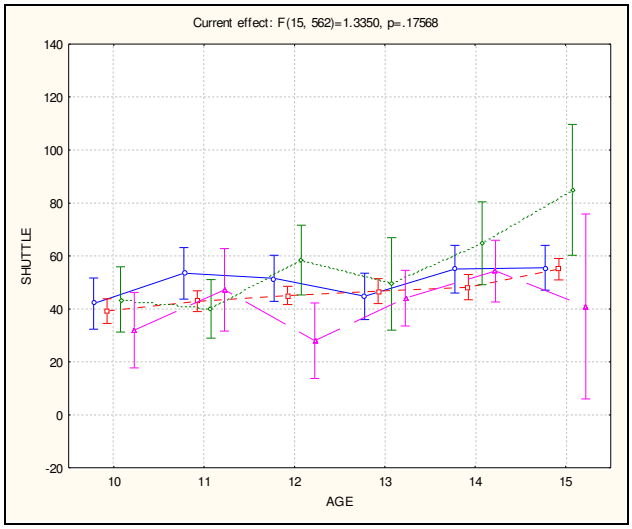
c SD_w = 2.33 White; Black; Coloured; Indian

(d) Sit and reach



d SD_w = 6.59 White; Black; Coloured; Indian

(e) Bleep



e. SD_w = 17.77 White; Black; Coloured; Indian

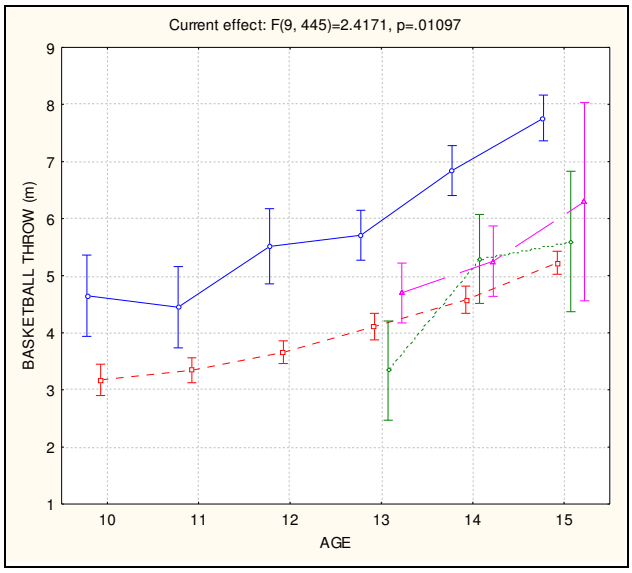
Age group differences in flexibility values between 10 and 15 years indicate an increasing trend in the flexibility of the pelvic girdle and thigh muscle (Figure 2d), with a significant difference among the 14-15 year old age *groups* (Table 2). The results (Figure 1c) regarding relative sitting height indicated considerable leg length increases until the age of 12 years, after which it stabilised. This could have influenced relative sitting height and possibly have contributed to the notably better flexibility of the older age groups. Black boys displayed higher flexibility values compared to white boys in all the age groups which were significant in the 11 year and 13 to 15 year old groups (Table 3).

Constant, although non-significant, increases in aerobic endurance are observed for the *group* (Figure 2e), with a significant increase among the 13-15 year old groups (Table 2 and Figure 2e). Parallel to this a maximal stature increase occurred between the ages of 12 and 14 years in the group (Figure 1a). Maximal stature increases were slightly different in each racial group, although the increases in VO_2-max relative to stature increases were similar. Although the white boys had higher mean age group values than the black boys, no significant differences were indicated between the two groups, except for in the 11 year old group (Table 3).

Figure 3a-e represents the age *group* differences in the motor abilities of the boys. Figure 3a and Table 2 show that the age group means for explosive arm strength of the group, as measured by the basketball throw, constantly, but non-significantly, improved between 10 and 12 years of age. From 13 to 15 years of age the improvement is significant and runs parallel to maximal stature increase, body mass acceleration and an increase in arm span. When all the age groups' means are compared, results indicate that white boys have the best explosive arm strength which was also significantly higher than that of the black boys.

The throw and catch for accuracy of the *group* (Figure 3b) increased gradually between 10 and 12 years. The mean for the 13 year old age group was significantly poorer compared to the 12 year old mean ($p<0.05$), although slight, but non-significant, increases ($p>0.05$) were evident from 13 to 15 years. The test for accuracy was adjusted for the 10–12 year olds by allowing them to stand slightly closer (1.5 m) to the target than the 13–15 year olds (2.5 m) which could possibly explain the lower age group means at 13 years. However, the throwing skills for distance improved at a constant rate from 13 years onwards.

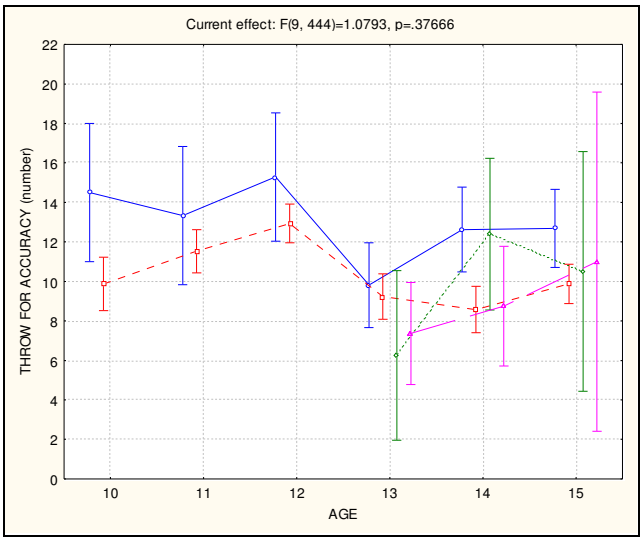
(a) Basketball throw



a. $SD_w = 0.88$ White; Black; Coloured; Indian

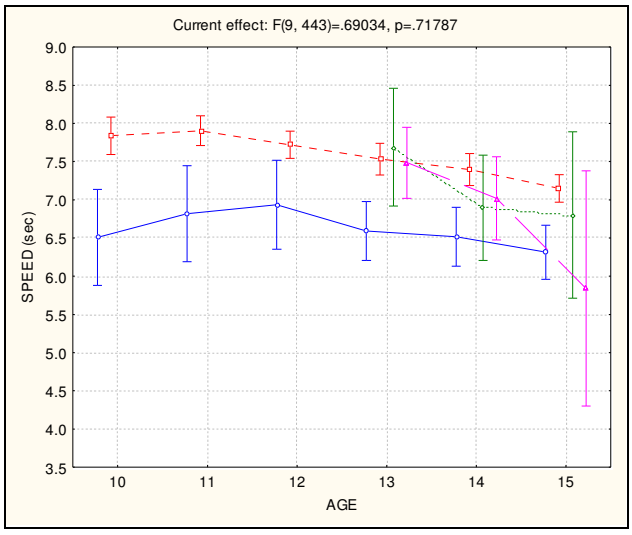
FIGURE 3a-e. **THE RACE BY AGE INTERACTION OF THE PHYSICAL ABILITIES; SD_w ROOT MEAN SQUARE ERROR FROM ANOVA**

(b) Throw and catch



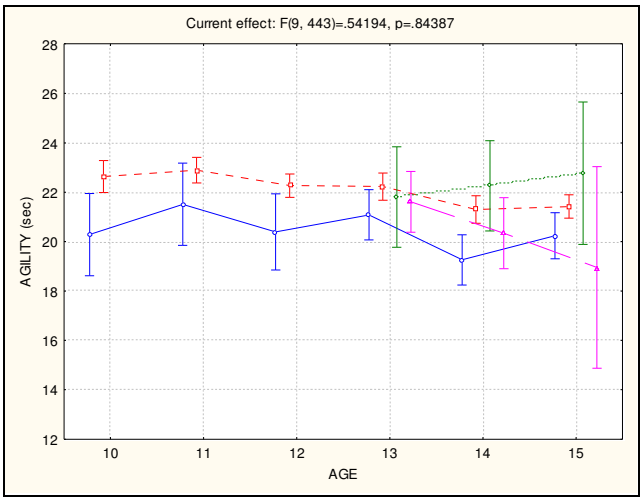
b. SD_w =4.36 White; Black; Coloured; Indian

(c) Speed



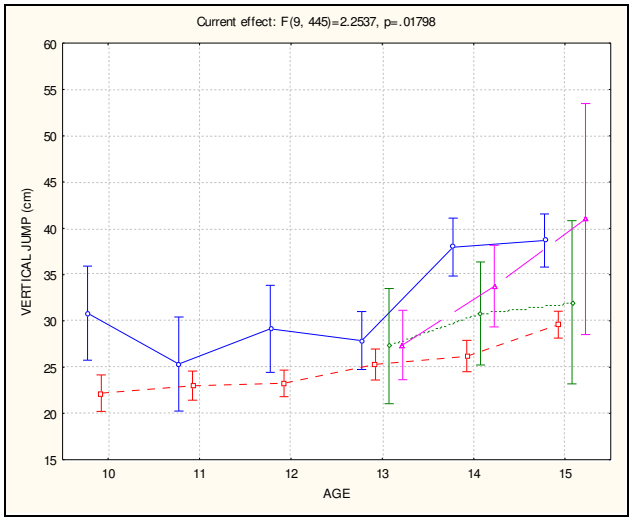
c. SD_w = 0.78 White; Black; Coloured; Indian

(d) Agility



d. SD_w =20.7 White; Black; Coloured; Indian

(e) Explosive strength



e. SD_w = 6.35 White; Black; Coloured; Indian

Age *group* means for speed (Figure 3c) showed a gradual increase ($p>0.05$, Table 2) from 11 to 15 years of age. Slightly lower speed values were recorded for the 11 year olds, compared to the 10 year olds (7.67 sec to 7.81 sec). In general, the white boys tested best for speed and the black boy's worst with a significant difference between them in all the age groups. The Indian boys showed the best times over 40 meters at the age of 15 years, which is in agreement with their results in the vertical jump where they also achieved the highest age

group mean. Similar to speed, agility (Figure 3d) showed a decline between 10 and 11 years of age, after which a gradual (non-significant) improvement in mean scores up until 14 years was observed. Between ages 10 and 14 years, the white boys performed best, and the Indian boys at 15 years. The black boys, as with speed, had the weakest results, and they displayed significantly lower values than the white boys in three age groups.

The explosive leg strength of the *group*, tested by means of the vertical jump, hardly showed any changes between 10 and 12 years, with a gradual increase occurring between 12 and 15 years (Figure 3d). The white boys predominantly performed best, with the Indian boys performing best at 15 years. Differences favouring the white boys compared to the black boys were significant in 3 age groups, especially in the older groups (Table 3).

DISCUSSION

Researchers (Malina *et al.,* 1988) compared different studies and reported that age at Peak Height Velocity (PHV) occurs at approximately 14.2 years (13.7-14.3) in boys. Although speculative in nature as PHV cannot be determined from cross sectional data, it seems approximately two years later than what can be considered as a PHV in the NWP group (12-13 years). Furthermore, researchers (Malina *et al.,* 1988; Malina *et al.,* 2004) estimate PHV in stature to be around 9 cm/year for boys (8.2-10.3), although evidence of such a magnitude (6.60 cm) was well below in the NWP sample. This result can possibly be explained by the fact that each racial group achieved their largest increase in stature at different ages, a trend which was observed in Figure 1a. In confirmation to this, delayed adolescence in rural and urban black children as well as a reduced magnitude in peak velocity among them are reported (Cameron & Kgampe, 1993). A possible cohort effect should however, also be kept in mind when interpreting this result.

A study on predominantly white boys in the Durbanville area (Visagie, 1981) showed clear age group differences in stature between 10 and 11 years (7.9 cm), and the largest differences (11.2 cm) between 13 and 14 years. This researcher also indicates that the difference in stature between 14 and 15 year olds decreased to only 2.9 cm, which is in agreement with similar tendencies (5.53 cm) found in this study among the white boys. Compared to a study done on Belgian boys (Beunen *et al.,* 1988) the white boys in the NWP showed a much earlier accelerated growth in stature than that of the Belgian boys, whose accelerated growth phase was between ages 14 and 15 years (7.8 cm). The average stature of the 15 year old Belgian boys is also 8.9 cm shorter (Beunen *et al.,* 1988) than that of the 15 year old white boys. Also, rapid growth in stature of white boys in the NWP was earlier than what was reported twenty years earlier in another region of South Africa (Visagie, 1981).

The black children were the shortest in all the age groups. A comparison with the results obtained on black children living in South Africa (Hennenberg & Louw, 1998) revealed that the measurements of urban Coloured group greatly exceed that of the black group, with similar or slightly higher measurements than those of the rural black children. The results are also in agreement with findings indicating that black children from rural areas are shorter than those living in urban areas (Monyeki, 2000).

Non significant age group increases in stature were observed between 13 and 15 years of age among Coloured boys. A lower age group mean among 13 year olds (143 cm), compared to 12 year olds (146 cm) was seen, which could be a result of a cohort effect. However, a cross-sectional analysis of mixed longitudinal data (Hennenberg & Louw, 1998) also indicated longer heights among 18 year old compared to 19 year old Coloured boys. The heights reported by them for Cape Coloured boys between 10 and 15 years indicated maximum increases between 11 and 14 years and an overall increase of 136.4 to 163.8 (27.1 cm) in the group with higher socio-economic status (SES). In the lower SES group, the increase was only 24.9 cm (127.5 to 152.4 cm) and maximum increases were observed between 13 and 15 years.

The body mass increases of the boys in the NWP tend to be similar to findings by other researchers (Beunen *et al.,* 1988; Van Rooyen, 1993). However, the size of the increase was smaller for the NWP boys. This smaller increase might be explained by findings where the body weight of rural Coloured children was 20%-25% lower than that of their urban peers during pre-puberty and puberty (Hennenberg & Louw, 1998). The largest increase in body mass occurred after a largest increase in stature which is similar to other research findings (Siedentop *et al.,* 1984; Beunen & Malina, 1996).

The long arm span relative to total height of the black children corresponds to findings indicating that black people have long extremities, and that longer forearms contribute to this tendency (Malina, 1996). The results obtained for relative sitting height agreed with that of researchers (Malina *et al.,* 2004) who found that accelerated growth of the lower limbs is a characteristic of the early adolescent acceleration growth phase. Hence the growth rate may be slower in early adolescence for sitting height relative to that of the lower limbs. A similar tendency [(51.38% (10 yrs), 51% (11 yrs), 50.58% (12 yrs), 50.99% (13 yrs), 50.74% (14 yrs) and 50.53% (15 yrs)] was reported in another study (Visagie, 1981).

Increased abdominal strength was seen up until 14 years, while poorer age group means were found in the group, as well as among the whites, blacks and Coloureds at age 15, compared to at age 14. This tendency can possibly be ascribed to well-documented decreases in activity levels at this age among children (Malina *et al.,* 2004). It is however stated (Hennenberg *et al.,* 2001) that factors which can be attributed to socio-economic conditions, such as a lack of energy levels and mineral content (calcium and potassium) of the muscles, can have an influence on muscle strength. Gradual increases were found in the grip strength of the right hand from 10 to 15 years of age ($p<0.05$) which is in agreement with the findings of this researchers (Hennenberg *et al.,* 2001). These increases can also possibly ascribed to the fact that boys of this age rapidly become taller and heavier, especially if one considers that there is a relation between muscle mass and body mass during the different growth phases (Rowland, 1996). Upper body strength also increased gradually from 10 years onwards. Researchers (Beunen *et al.,* 1988; Malina *et al.,* 2004) indicate that increases in strength, especially in the upper limbs, run parallel to an increase in body mass for boys. Furthermore, it is indicated that strength increases linearly with age, while peak strength is attained 0.5–12 months later than peak height velocity (Beunen *et al.,* 1988). The same trend of a gradually increasing flexibility was also seen in the group, with a significant increase among the older boys. In line with this finding, researchers (Malina *et al.,* 2004) report that when flexibility is measured by means of the sit and reach test, it linearly increases from a low point at 12 to 13

years up until 18 years of age. Furthermore, this low point coincides with the adolescent growth phase of the lower extremities. From this it can be concluded that when the skeletal and muscle systems become more stable, the flexibility of the child will improve as a result of the muscles that grow in proportion to the bone. The results regarding relative sitting height (Figure 1c) indicated considerable leg length increases until the age of 12 years, after which it stabilised, which could have influenced relative sitting height and possibly have contributed to the notably better flexibility of the older age groups.

Constant increases in aerobic endurance were observed which was significant among the 13-15 year old groups. It is confirmed by researchers (Malina *et al.,* 2004), that aerobic endurance shows a linear increase until 16 years of age, after which it drastically increases. These researchers also state that boys clearly show a peak in VO_2-max values in the same period during which peak stature and body mass acceleration occur. A maximal stature increase occurred between the ages of 12 and 14 years in the group (Figure 1a) and a similar tendency of increased aerobic endurance among the 13-15 year old groups is visible (Table 2 and Figure 2e). Maximal stature increases were slightly different in each racial group, although the increases in VO_2-max relative to stature increases were similar. From a TID perspective, it seems better to determine aerobic capacity for boys after the spurt in stature.

The throwing skills for accuracy improved at a constant rate from 13 years onwards. Ball handling skills of boys were studied by researchers (Brodie, 1985) and a similar tendency of improvement until puberty with a levelling off thereafter was found. Researchers (Arnot & Gaines, 1986) are also of the opinion that the environment in which a child grows up plays a significant role in motor abilities such as coordination. The white boys, who showed the best hand-eye co-ordination between ages 10 and 15 years, participate in sports such as rugby and cricket, and this exposure, might have contributed to the development of these skills. However, this is not the case with the other subjects in this study, as the majority of the children came from remote rural areas. Street soccer is played, but will probably contribute less to hand-eye coordination when compared with a sport such as cricket. Adjustment of the test for the 10–12 year olds by allowing them to stand slightly closer (1.5 m) to the target could possibly explain the lower age group means at the age of 13 years.

No spurt in speed improvement was found which is substantiated by other research findings (Malina *et al.,* 2004) indicating that running speed increases linearly in boys from five to seventeen years, without any indication of accelerated growth having an influence on running speed from a stationary position. Slightly lower speed values were recorded for the 11 year olds, compared to the 10 year olds. Physical awkwardness at this age (Malina *et al.,* 2004) or a possible cohort effect could have contributed to this result. Agility showed similar tendencies to what was found in speed. This result agrees with a statement that agility is influenced by dynamic strength, explosive power and the speed of the muscle fibre contractions (Badenhorst & Pienaar, 2000). Gradual improvement in explosive strength was seen from 12 year onwards. Researchers indicate that it is associated with an improvement in speed from 12 years of age (Arnot & Gaines, 1986).

The composition of the South African nation and those living in the NWP are unique because they represent four different racial groups. As a group, the growth rates appear to be in agreement with other studies. However, when growth was studied in each racial group,

unique differences appeared. These research findings can therefore be used as a reference base for future comparisons in order to ensure that the most talented children are identified for sport on the basis of a unique growth profile. Indian and white boys, for example, reached their accelerated growth phase early, compared to the black and Coloured boys who reached it much later. Therefore, where stature and body mass are important performance indicators at a later age, the interpretation of this race specific growth information for adult stature prediction must be taken into consideration.

South Africa also has an age based school competition system where chronological age and not maturational age are taken into consideration for selection purposes. The information obtained by this study can therefore be valuable for selectors. It is indicated in this regard that skeletal maturity is significantly related to several motor components at 13-16 years therefore performance advantages due to earlier skeletal maturity might be advantagous to the racial groups with earlier maturity. Early maturation can confound talent selection; therefore such problems can be addressed in a way with data of this nature.

Furthermore, other race specific characteristics were also seen which can be valuable in the TID and development process. A lower sitting height in relation to total body stature was found among the black boys and, similar to Coloured boys, they had a long arm span in relation to their body stature, characteristics which make them more suited for specific sports where a long arm span is an advantage. The white boys showed good strength, speed and agility characteristics, while black boys displayed a high degree of flexibility, and especially endurance characteristics which might be promising from a talent development perspective. Indian boys posessed good explosive and agility characteristics, while Coloured boys had reasonably good endurance and explosive power in their arms.

CONCLUSION

The results of this study were gathered by means of a cross-sectional method, therefore certain limitations are evident. It thus should be taken into consideration that the results do not reflect age related changes, but rather age group differences and tendencies with regard to growth of body dimensions and physical and motor abilities of boys. Possible cohort effects were also seen among certain racial groups which could have been caused by socio-economic circumstances, and which could have clouded the results. The different racial groups were also proportionally represented in the sample, contributing to small numbers of certain groups in certain age groups. However, this study contains valuable information regarding the growth, maturity and performance status of 10-15 year old boys who live in the NWP of South Africa. This study also confirmed that uniqueness within a nation consisting of diverse population groups may occur. It must, however, be kept in mind that the performance of especially the black and Coloured children in this study could have been hampered by poor nutrition and other factors resulting from the rural environments in which most of them live. In addition, testing conditions were not always optimal (e.g. uneven and sand surfaces) and could also have played a role in the results. It is therefore suggested that the norms for each racial group should be interpreted separately in some cases, but also in conjunction with the group norm in order to make a more transparent decision concerning the performance potential of a boy living in the NWP. Further similar studies in other provinces of South Africa and especially studies of a longitudinal nature are recommended in this area. In

conclusion, this study provides data regarding the growth of 10-15 year old boys in South Africa which might be helpful in selection decisions.

ACKNOWLEDGEMENTS

The following are gratefully acknowledged for the financial contribution to the study: The South African Sugar Association, the National Research Foundation and the Department of Trade and Industry through the THRIP System of the NWU. Prof Salome Kruger and Prof Hans de Ridder are acknowledged for their effort in managing the research project.

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