

Somatic and Motor Fitness Characteristics of Rural Primary School Girls in Ellisras, South Africa 南非鄉鎮小學女生體質和運動技能的特徵

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Abstract

The purpose of this study was to measure somatic and motor fitness characteristics in 8 to 11 (N = 232) year-old girls in Ellisras rural area of South Africa. Motor fitness was assessed with the EUROFIT test battery: 10 x 5 m shuttle run, standing broad jump, sit and reach, bent arm hang, sit-ups, flamingo balance and plate tapping. Somatic measurements were taken according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK). Significant increases were observed with age in height, body weight, girth, width, skinfolds and sum of skinfolds in the Ellisras girls ($p < 0.05$). The girls' mean motor fitness performances were not significantly different across the age groups, except that standing broad jump and plate tapping (for ages 10 and 11) significantly increased with age ($p < 0.05$). In 8-year old girls height was significantly negatively correlated with plate tapping ($p < 0.05$). At age 11 the sum of five skinfolds was significantly negatively associated with motor fitness items (sit-and-reach, bent arm hang and sit-ups). The relationships between subcutaneous fatness and motor fitness were inconsistent across age groups (these ranged from -0.02 to -0.32). Similarly, no consistent pattern of differences was found in height, body mass and femur width. The results obtained confirm that body fatness impairs motor fitness in young girls.

摘要

本文旨在探討南非鄉鎮小學女生體質和運動技能的特徵，調查了 232 名 8 至 11 歲的學童，以 EUROFIT 標準量度她們的體適能及身體協調技能。部份結果指出學童的皮下脂肪與身高、體重等身體因素存在不穩定的關係。綜合各資料，身體肥胖阻礙女童的肌動控制適能。

Introduction

Many factors influence motor development at a particular period or age including biological variables such as growth and

maturation. Malina (1980) reported that little information exists about the extent to which various factors actually influence the motor development of children. However, it is important to understand the effect of somatic characteristics in the development of motor

skill during childhood (Malina, 1986; Malina & Bouchard, 1991).

Among children, however, the activity-fitness relationship is less clear with genetic, maturational, and environmental factors being important contributors to fitness in children (Krahenbuhl et al., 1985; Malina, 1994). It has been demonstrated from previous studies that growth and body composition affects physical fitness in children (Malina et al., 1995; Pate et al., 1989; Taylor & Baranowski, 1991). Generally, fatness has a negative influence on health and performance-related physical fitness (Cureton et al., 1991; Malian, 1994), and height is positively related to physical fitness in children.

Information concerning the relationship between somatic characteristics and motor performance in children is not extensive. It seems that environmental factors have positive effects on the acquisition of fundamental motor skills in prepubertal years, but the effect of physical fitness or instruction is quite specific (Malina & Bouchard, 1991). Although Butcher and Eaton (1989) have demonstrated that fundamental motor skills are related to free-play behavior and activity level in preschool children, the associations between biological factors and motor skills in children seems to be relatively low (Silvia et al., 1984). Further systematic analyses of research findings on the relationships between motor skill development and related biological factors during childhood are inclusive (Malina & Bouchard, 1991). Therefore, the aim of this study was to measure somatic characteristics and motor fitness in primary school girls in Ellisras rural area of South Africa. The study was also intended to assess the relationships between the girls' somatic and motor fitness characteristics.

Methods

Subjects

The subjects were part of the Ellisras Longitudinal Study (ELS) (Monyeki, 2000), which is a mixed-longitudinal study aimed at examining the nutritional status and identifying the prepubertal and pubertal growth velocity curves of Ellisras rural community children. The sample comprised of 232 apparently healthy Ellisras rural primary school girls (aged 8-11 years), who were drawn from 22 schools out of a total of 68 schools in Ellisras rural area. The nature and scope of the study was explained to the children and their parents who gave informed consent.

Ellisras rural villages are situated within the northwestern area of the Northern Province of South Africa. These villages, located approximately 70km from the regional town of Ellisras

(23° 40S, 27° 44 E), are adjacent to the Botswana border. The Iscor coal mine and Matimba electricity power station are the major sources of employment for many of the Ellisras rural residents, while the remaining workforce are involved in subsistence farming and cattle rearing. A few of the residents are teachers and civil servants.

Anthropometric Measurements

The subjects underwent the following anthropometric measurements according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK) (Norton and Olds, 1996): height, body weight, 5 skinfolds (triceps, biceps, subscapular, abdominal, and medial calf), 4 girths (arm, chest, thigh, and calf) and 2 widths (humerus and femur). A Martin anthropometer was used to measure height to the last complete 0.1 cm and a Schoenle electronic scale to measure weight to the last complete 0.1 kg. A steel tape was used to assess body girth measurements to the last 0.1 cm, a spreading caliper for width measurements to the last 0.1cm and Harpenden (John Bull) skinfold caliper with inter-jaw pressure of 10g/mm² was used to measure skinfolds to the last 0.2 mm.

Motor Fitness Assessments

The subjects' motor fitness was assessed according to the EUROFIT (1988) protocol. The test items and attributes measured included 10 x 5 m shuttle run (seconds) (running speed), standing broad jump (cm) (explosive strength), sit and reach (cm) (lower back/upper thigh flexibility, sit-ups (number in 30 sec.) (functional strength), bent arm hang (functional strength) (seconds) flamingo balance (number of faults per sec.) (static balance) and plate tapping (25 counts in sec.) (speed of arm movement).

Pilot Test

Before the survey was conducted all research assistants participated in an intensive two weeks training conducted by one of the authors (KDM, an ISAK accredited level 3 Criterion Kinanthropometrist). Reliability of the fitness tests was measured in a group of 8-11 year-old children (n = 46). Test-retest correlations obtained ranging from $r = 0.57$ to 0.79 were judged as satisfactory for group comparisons. The absolute and relative values of intra-tester technical error of measurement (%TEM) for height ranged from 0.04cm to 0.16cm (0.2% to 5.01%), weight from 0.01-0.02kg (0 to 0.3%), girth from 0.23 to 0.26cm (0.26 to 1.02%) and skinfolds from 0.49 to 1.21mm (3.71% to 5.4%). A wheel tape measurer was used to measure the distance ran.

Procedures

The measurements took place at two different venues arranged as follows: Anthropometric measurements were the first to be assessed inside the classroom. Motor fitness tests were divided into 5 measurement stations as follows: (1) Flamingo balance (FLB), plate tapping (PLT), (2) Sit and reach (SAR), Standing broad jump (SBJ), (3) Bent arm hang (BAH), (4) Sit-ups (SUP) and (5) 10 x 5 Shuttle run (SHR).

Children were allowed specific number of trials as recommended in the EUROFIT test battery. An interval of 5-7 minutes was allowed between the tests. The anthropometric measurements and motor tests were performed by the main author with the aid of well-trained research assistants.

Data Analysis

Descriptive statistics used included means and standard deviations. One-way analysis of variance (ANOVA) was used to test for significant differences between the age groups. Pearson product moment correlation coefficients were calculated to examine the relationships between the somatic and physical fitness variables. Statistical significance was set at $p < 0.05$.

Results

Means and standard deviations of somatic characteristics of Ellisras rural primary school girls in four age groups (ages 8-11) are given in Table 1. The results indicated significant height increases of 4.2cm; 5.2cm and 5.7cm, respectively in the age groups (see Table 4). Regarding body weight significant increase of 3.7kg occurred in ages 10 and 11 (see Table 4). No consistent trend was found in girth, width, skinfolds and sum of skinfolds in the results of Ellisras girls (see Table 4).

Table 2 presents the means and standard deviations of motor fitness data of Ellisras rural primary school girls in four age groups. There was no significant difference in the 10 x 5m shuttle run, sit and reach, Flamingo balance, bent arm hang and sit-ups in all age groups (see Table 5). In the 10-11 year-olds, standing broad jump and plate tapping however, significantly increased with age ($p < 0.05$).

Partial correlations between anthropometric characteristics and performances on the fitness tests are given in Table 3. In 8-year old girls height was significantly negatively related to plate tapping ($p < 0.05$). The correlations between subcutaneous fatness and fitness performance items were inconsistent across age groups and ranged from -0.02 to -0.32 , except age 11. Similarly, no consistent pattern was found in the relationships among height, body weight and femur width.

Table 4 and 5 present the somatic characteristics of Ellisras rural girls. Significant differences occurred in height and weight in all age groups. Also, significant differences were observed in girth: arm (ages 10 and 11) and both chest and calf (ages 8 and 11), except thigh girth. Regarding bone width significant differences were found in humerus (ages 9 and 10) and femur (ages 9,10 and 11).

Table 1. Descriptive Data of Somatic Characteristics of Ellistras Rural Primary School Girls in Four Age Groups.

Ages Variables	Age groups							
	8 (n = 49)		9 (n = 61)		10 (n = 55)		11 (n = 67)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height (cm)	128.0	7.3	132.2	5.9	137.4	5.3	143.1	5.6
Weight (kg)	22.7	3.2	22.5	3.7	26.7	3.8	30.4	5.2
Girths (cm):								
Arm	16.4	1.1	16.7	1.7	17.3	1.7	18.4	1.9
Chest	57.2	2.9	59.2	3.2	60.6	3.2	63.5	4.3
Thigh	35.6	2.4	36.9	3.5	37.9	3.3	40.4	3.7
Calf	23.6	1.8	24.5	2.5	25.0	2.2	26.3	4.1
Width (cm)								
Humerus	4.9	0.3	5.1	0.3	5.4	0.4	5.5	0.3
Femur	7.2	0.4	7.4	0.5	7.6	0.5	7.9	0.5
Skinfolds (mm)								
Triceps	7.4	1.8	7.9	2.6	8.1	2.1	9.3	3.2
Biceps	5.2	1.5	5.3	1.8	5.7	1.6	6.1	2.6
Subscapular	6.1	1.4	6.2	1.4	6.2	1.4	7.2	2.5
Abdominal	5.7	1.4	6.2	2.1	6.5	1.7	7.8	3.4
Calf	8.9	2.2	9.5	2.8	10.7	3.2	11.1	2.9
Sum of skinfolds	33.4	7.3	35.8	9.6	37.2	8.7	41.5	13.4

Furthermore, substantial differences were noted in skinfolds: triceps (ages 9 and 10), biceps (ages 8 and 9), sum of skinfolds (ages 8, 9 and 11), calf (ages 10 and 11) subscapular and abdominal (age 10 and 11)

skinfolds. In motor fitness tests, substantial differences were found in both standing broad jump and plate tapping in 10 and 11 year-old children, respectively.

Table 2. Descriptive Data of Motor Fitness Characteristics of Ellisras Rural Primary School Girls in Four Age Groups.

Age in years	Age groups							
	8 (n = 49)		9 (n = 61)		10 (n = 55)		11 (n = 67)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
10x5 run	22.8	2.1	22.5	1.8	22.0	1.6	21.8	2.0
Sit & reach	41.0	4.1	41.2	4.6	41.7	5.4	42.5	5.4
Flamingo balance	10.3	5.3	10.0	4.6	8.6	5.3	9.2	5.2
Standing broad jump	122.4	16.4	129.7	16.2	134.0	17.0	141.0	17.6
Bang arm hang	6.4	6.4	5.9	6.4	0.9	6.5	7.4	6.8
Sit-ups	13.9	8.4	14.7	9.6	12.7	8.2	14.7	9.3
Plate tapping	20.1	3.4	19.4	3.0	18.2	3.8	16.7	2.4

Table 3. Correlations between Anthropometric Characteristics and Motor Fitness of Ellisras Rural Primary School Girls.

Age (yrs)	Age groups															
	8 (n = 49)				9 (n = 61)				10 (n = 55)				11 (n = 67)			
Variables	Height	Weight	Femur	SSF	Height	Weight	Femur	SSF	Height	Weight	Femur	SSF	Height	Weight	Femur	SSF
Balance	-.08	.09	-.13	-.11	.12	.10	-.04	.02	.07	.08	.02	.01	-.09	.00	.04	.02
Sit and Reach	.11	.26	.24	-.03	-.08	-.08	.01	-.02	.02	-.09	.01	.11	-.09	-.20	.00	-.31**
Standing Broad jump	.24	.18	.28*	-.09	.19	.05	-.06	-.17	.04	.17	.29*	-.09	-.01	-.11	-.14	-.20
10x5 m run	-.19	-.09	-.21	-.02	-.13	-.10	-.07	.15	.05	.13	.01	.12	.18	.28*	.24	.26*
Bent arm hang	-.18	-.20	-.39*	-.23	.03	-.03	.09	-.09	-.13	-.29*	-.15	-.26	-.14	-.22	-.14	-.32*
Plate tapping	-.35*	-.33*	-.26	-.05	-.13	-.08	-.11	-.13	-.12	-.01	-.14	.16	-.00	.08	.02	.27*
Sit ups	.04	.12	-.06	-.17	-.15	-.15	-.06	-.31	.01	.09	.18	-.07	-.00	-.08	-.14	-.27*

*P < 0.05; **P < 0.01; SSF- Sum of skinfolds

Table 4. Age Differences in Somatic Characteristics of Ellisras Rural Girls.

Age (yrs)	8	9	10	11
Height	128.0	132.2	137.4	143.1
Weight	<u>22.7</u>	<u>24.7</u>	26.7	30.4
Girth:				
Arm	<u>16.4</u>	<u>16.7</u>	17.3	18.4
Chest	57.2	59.2	60.6	63.5
Thigh	35.6	36.9	37.9	40.4
Calf	23.6	24.5	25.0	26.3
Width:				
Humerus	4.9	5.1	5.4	5.5
Femur	<u>7.2</u>	<u>7.4</u>	7.6	7.9
Skinfolds:				
Triceps	7.4	7.9	8.1	9.3
Biceps	5.2	5.3	5.7	6.1
Subscapular	6.1	6.2	6.2	7.2
Abdominal	5.7	6.2	6.5	7.8
Calf	<u>8.9</u>	<u>9.5</u>	10.7	11.1
Sum of Skinfolds	<u>33.4</u>	<u>35.8</u>	<u>37.2</u>	41.5

^a values underlined are homogeneous, but are significantly different ($p < 0.05$) from those not underlined

Table 5. Age Differences in Motor Fitness of Ellisras Rural Girls.

Age (yrs.)	8	9	10	11
10x 5 m run (s)	<u>22.8</u>	<u>22.5</u>	<u>22.0</u>	<u>21.8</u>
Sit and reach (cm)	<u>41.0</u>	<u>41.2</u>	<u>41.7</u>	<u>42.5</u>
Flamingo balance (number of errors)	<u>10.3</u>	<u>10.0</u>	<u>8.6</u>	<u>9.2</u>
Standing broad jump (cm)	<u>122.4</u>	<u>129.7</u>	<u>134.0</u>	<u>141.0</u>
Bent arm hang (s)	<u>6.4</u>	<u>5.9</u>	<u>0.9</u>	<u>7.4</u>
Sit ups (number of counts/sec.)	<u>13.9</u>	<u>14.7</u>	<u>12.7</u>	<u>14.7</u>
Plate tapping (s)	<u>20.1</u>	<u>19.4</u>	<u>18.2</u>	<u>16.7</u>

^a values underlined are homogeneous, but are significantly different ($p < 0.05$) from those not underlined

Discussion

This study examined associations between anthropometric variables and motor performances in Ellisras rural primary school girls. Subcutaneous fatness had a significant inverse relationship with the girls' motor fitness. However, this finding was inconsistent across the age groups.

The results of this study provide some insight into relationships between biological factors and motor skill development of in prepubertal girls. Although considerable cross-sectional and longitudinal information is available on motor development in children, studies on somatic and activity determinants have been shown to correlate more frequently in adolescents (Beunen et al., 1988) and to a lesser extent in prepubertal children. It is important from theoretical as well as practical perspectives however, to understand the interaction between biological factors and development of motor skills during childhood (Branta et al., 1984, Malina & Bouchard, 1991).

The relationship between skinfold thickness and fitness performances are consistent with results of previous studies (Pate et al., 1989; Taylor & Baranowski, 1991; Raudsepp & Jurimae, 1997), but these studies did not report age-specific correlations between fatness and fitness characteristics. Considering the variability of age-specific correlations between PWC_{170} and body fatness in 8-13 years ($r = -0.05$ to -0.45) Belgian girls, it is important to calculate correlations for children grouped across several age groups, since subcutaneous fatness increases with age in girls (Malina et al., 1995).

Correlations between subcutaneous fatness and fitness items were inconsistent across age groups with the exception of 10 x 5 m shuttle run and plate tapping the in 11 year-old girls. This probably reflects the independent negative influence of fatness on fitness performance in which the body is projected or moved through space. Malina et al. (1995) reported partial correlations between fatness and motor fitness for a large sample of girls (aged 7-17 years) ranging from -0.14 to -0.42 . However,

it is important to consider some other factors not taken into consideration in the study (such as genetics, maturation, and socioeconomic factors) that might affect the development of children and youth, and which may result in a cycle that involves the interactions of fatness and fitness (Malina et al., 1995).

Information concerning the relationships between motor skill development and biological factors in the pubertal years is not extensive. Most of the motor development studies have focused on describing intra-skill sequences for fundamental movement patterns and did not consider factors affecting the development of skilled movement in childhood (Branta et al., 1984). However, a previous study by Malina (1986) reported that developmental level of several fundamental motor skills is related to somatic characteristics of children. In the present study fat mass had a negative relationship with motor development in girls mainly at age 11.

The negative effects of fatness on motor fitness in pubertal girls may indicate lack of participation in physical activities in school or in community settings. Previous research has indicated that girls participated less in organized or informal activities as compared to boys of the same age (Halverson et al., 1982). An increased participation in physical activities in both physical education and leisure is needed to remedy this situation. This should be an objective of physical educators, coaches and parents in the Ellsiras rural community.

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