


Gender Differences in Physical Fitness among Cameroonian School Children Aged 10 to 15 Years in Yaounde City

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Abstract

Background: The level of physical fitness indicates children's health status and guides them towards sport branches. This cross-sectional study aimed at determining the physical fitness of Cameroonian school-children aged 10 to 15 years in Yaounde city by comparing the results according to gender and with European normative values. A total of 504 healthy school children (51.58% females and 48.42% males) regularly attending physical education classes were conveniently selected from a secondary school.

Methods: We collected anthropometric and physiological characteristics and the participants completed five physical tests integrated in the EUROFIT battery, namely standing broad jump (SBJ), flexed arm hang (FAH), sit-ups for 30 sec (SU), hand grip strength (HGS), and 10×5-m shuttle run test (10×5-mSRT). Values obtained from the tests were compared according to gender in each age.

Results: Boys had a better performance compared with girls in different tests. No significant difference was found between boys and girls aged 10 to 14 years in 10×5-mSRT and from 10 to 12 years regarding HGS. However, performances were similar at 12 years in SBJ, at 12 and 13 years in FAH, and at 11 years in SU. School children in Yaounde city had better performances in SBJ, FAH, and 10×5-mSRT compared to their European counterparts.

Conclusions: School-children in Yaounde city presented high physical fitness, and males had a better physical fitness than females aged 10-15. A study including the entire EUROFIT test battery with a great number of participants is needed to provide reference values in this population.

Keywords: Child, Exercise, Physical tests, Cameroon

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1. Introduction

Physical fitness is a state of mental, physical, and social wellbeing influenced by health and physical aptitude (1). It is considered as an important health factor (2), and it is strongly correlated with physical activity. Physical activity is a key component of different health aspects, including physical, mental, and emotional health (3-5). Based on evidence, physical activity is able to improve musculoskeletal health, cardiovascular fitness, body composition, and overall physical fitness (2, 5).

A number of researchers have confirmed the important role of physical activity in a healthy lifestyle (6-10). Furthermore, at all levels, physical education plays a vital part in establishing positive lifestyle behaviors, particularly in improving fitness in children and adolescents (11, 12).

It has been emphasized that measuring basic motor skills such as height, weight, Body Mass Index (BMI), standing broad jump, balance, and endurance provide information concerning physical structure and health status (13, 14). Balanced physical activity can reduce the development of cardiovascular diseases by 15-40%, coronary heart disease by 50%, hypertension by 12%, and diabetes by 35% (1, 10). Therefore, developing a regular physical activity behavior is important for enhancing the overall health in childhood, adolescence, and future adulthood.

Over the recent decades, on the other hand, the fitness of children and adolescents has significantly declined (15, 16). Rostan and colleagues (17) revealed that the physical fitness of the youth aged 9-16 years worldwide decreased by approximately 40% in past decades. In fact, in occidental and African countries, children were more engaged in indoor physical activities (media, video

game, and computer) compared with outdoor physical activities (running, football, volleyball, and handball) (18-20). Furthermore, with the economic development and the increase in urbanization and communication technologies, children are increasingly using cars or buses instead of cycling or walking to school (20, 21). This leads to sedentary behaviors and reduced physical activity (22, 23). Therefore, it is necessary to examine the physical fitness level of children in order to adopt the better decision in case of low physical activity as it is associated with high levels of cardio-vascular risk factors in adulthood (24).

Many batteries of tests have been developed in other continents for measuring and evaluating the physical fitness of children and adolescents. For instance, the Council of Europe Committee of Ministers recommended its members to use the European Test of Physical Fitness (EUROFIT). These tests augment the health status of the young population in societies (25). Furthermore, they are used by many developed countries to indicate children's health status, guide children to sports branches, and compare physical and motoric characteristics between countries (26). Many studies have been carried out using the EUROFIT battery tests and physical fitness level of children and adolescents of European, American, and Asian countries, and European normative values (27-31).

In Africa, a few scientific studies assessed the physical fitness level in children and adolescents (32, 33). In Cameroon, Navti and colleagues (34) highlighted the importance of objective assessment of physical activity in students due to the inverse relationships detected between the body mass index and physical activity. Indeed, the alarming prevalence of overweight and obesity in Cameroonian schools is also explained by the sedentary behaviors (consumption of sweet drinks, passive means of travelling to school, and physical inactivity at school) observed in Caucasian environments (34-38). Furthermore, two studies (35, 37) found a positive association between high socioeconomic status and high prevalence of overweight / obesity, thereby testifying to the low level of physical activity among Cameroonian students from wealthy backgrounds. Physical inactivity is currently a major concern for African countries where infectious diseases and non-communicable diseases coexist. A recent study (39) published in Cameroonian children and adolescents revealed the gender differences in cardiorespiratory capacity. Exploring other components of physical fitness such as motor and muscle components would

provide additional information on the overall level of health-related physical fitness.

The purpose of this study was to specify the Cameroonian physical fitness of school children with the age range of 10-15 years in Yaounde city. The results were compared in terms of gender and European normative values. A previous study revealed that independent of age, girls remained less active than boys because of hormonal cycle (40). We hypothesized that the physical fitness of females aged between 10 and 15 years was lower than that of male school children in the same age range.

2. Methods

Participants

The protocol was fully approved by the National Ethics Committee for Scientific Research of the Republic of Cameroon, registered under the number C3/102C/MINEDUB/DREB-C/S-DAG/IMS. Using a non-probability sampling method of convenience, we enrolled 504 school children (51.58% females and 48.42% males) with an age range of 10 to 15 years. For this cross-sectional investigation, participants were selected from a secondary school in Yaounde (capital of Cameroon) following the authorization of the Regional Delegate of the Ministry of Basic Education. The subjects did not have any acute or chronic illnesses and regularly attended physical education classes. We excluded those diagnosed by a medical doctor as having musculoskeletal problems such as leg length discrepancies that could limit their ability to perform physical tests, those with clinical evidence of debilitating diseases, and those engaged in extracurricular competitive sports activities.

The measurements were performed from September to December (2017) under standard school conditions during the regular physical education classes between 7:30 AM and 11:30 AM.

Anthropometric and Physiological Measurements

Body weight and body height were recorded with subjects dressed in light clothing, without shoes. Body weight was measured with a bio-impedance meter scale Tanita BC-532 (Tanita Corp., Tokyo, Japan). Body height was measured using a precision stadiometer (Seca 220, Seca) to the nearest 0.1 cm. Body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared (kg/m^2).

Oxygen saturation (SpO₂) and resting heart rate (HRr) were measured with an electronic pulse oximeter (ChoiceMMed, OxyWatchC20, Beijing, China). Systolic blood pressure (SBP) and diastolic (DBP) were determined using an electronic blood pressure device (Medisana AG, Neuss, Germany).

Evaluation of Physical Fitness

Validated and standardized by the European Council, the test battery comprised five tests integrated in the EUROFIT battery. All tests were performed twice (with the best score retained for analysis) except for the sit-up tests and the 10×5-m shuttle run test which were performed only once. These tests were applied in the following order:

a) Standing broad jump test (SBJ): The subjects made a jump as far as possible, landing on both feet without falling backwards. The maximum horizontal distance attained was measured in centimetres. This test measures the explosive power of legs.

b) Hand grip strength (HGS): By use of a electrical model EH 101 dynamometer (range, 90 kg / 200Lbs), the maximum grip strength was measured for the dominant hand. The dynamometer was held firmly with the right hand at a 30° body angle between the arm and body. This test measures the static strength.

c) Flexed arm hang (FAH): The subjects were assisted into position and the timing started when they were released. Timing stopped when their chin fell below the level of the bar or their head was tilted backwards to enable the chin to stay level with the bar. Time in seconds was recorded and used as the outcome. This test measures upper body relative strength and endurance.

d) Sit-ups for 30 sec (SU): The test was performed with a knee angle of 90° and the feet fixed to the floor. We recorded the number of completed sit-ups (from a complete horizontal position on the floor to the position where the elbows touched the knees) during a 30 s period. This test measures the endurance of the abdominal and hip-flexor muscles.

e) 10×5-m Shuttle Run Test (10×5-mSRT): This test provides an integral evaluation of the movement speed, agility, and coordination. Marker cones were positioned 5 m apart. When instructed by the timer, the subject ran to the opposite marker, turned, and returned to the starting line. This was repeated five times without stopping (covering 50 meters total), and

time in seconds was used as the outcome.

Data Analysis

All statistical analyses were performed using Statview 5.0 software (SAS Institute Inc., Cary, NC, USA). Data were expressed as mean±Standard Deviation. The normality of distribution for continuous measurements was verified with the Kolmogorov-Smirnov test. The *t*-test for independent samples allowed for the comparison of anthropometric, physiological, and performance variables between males and females at different ages. The Pearson's moment correlation coefficient or the Spearman's correlation coefficient was employed to examine the correlations between performance parameters (SBJ, FAH, SU, 10×5-mSRT) with anthropometric and physiological parameters (age, height, weight, BMI, SpO₂, HRr, SBP, DBP), depending on the normality or lack of normality of the distribution. The level of significance was set at P<0.05.

3. Results

Descriptive Statistics

Table 1 shows the baseline anthropometric and physiological characteristics of participants. We recorded 260 female (51.58%) and 244 male (48.42%) school children distributed in different ages. Significant differences existed between males and females concerning height at 10 years (1.40±0.08 vs 1.46±0.08; P=0.02), 11 years (1.45±0.06 vs 1.50±0.08; P=0.01), 12 years (1.50±0.09 vs 1.55±0.09; P=0.01), 14 years (1.63±0.06 vs 1.59±0.08; P=0.004), and 15 years (1.65±0.06 vs 1.59±0.07; P=0.005). Nonetheless, males and females had no significant difference in height at 13 years (P=0.26). We further recorded significant differences in weight between boys and girls at 10 years (36.0±8.1 vs 40.0±7.6; P=0.02), 12 years (43.0±9.4 vs 47.3±8.1; P=0.03), 14 years (56.1±7.3 vs 51.7±6.5; P=0.004), and 15 years (58.5±7.4 vs 54.2±8.1; P=0.02). No significant difference in weight was observed between males and females at 11 years (P=0.44) and 13 years (P=0.60). As far as BMI is concerned, no significant differences were detected between boys and girls at any age.

Regarding the physiological characteristics of participants, no statistically significant difference was observed in SpO₂ between males and females at any age. There were significant differences between males and females in HRr at 13 years (75.9±9.5 vs 79.7±7.6; P=0.04), 14 years (73.5±8.0 vs 79.5±8.1; P=0.0009), and 15 years (70.6±7.2 vs 78.5±9.6; P<0.001). However,

Table 1: Comparison of the baseline anthropometric and physiological characteristics of participants

Age (yrs)	Gender	n	%	Height (m)	Weight (Kg)	BMI (Kg/m ²)	SpO ₂ (%)	HRr (bpm)	DBP (mmHg)	SBP (mmHg)
10	M	40	47.6	1.40±0.08*	36.0±8.1***	18.21±2.51	97.1±0.8	80.9±8.1	69.8±11.1	109.6±12.5
	F	44	52.4	1.46±0.08	40.0±7.6	18.84±2.55	96.6±1.7	85.1±11.2	66.9±8.1	107.7±13.1
11	M	42	50.6	1.45±0.06*	41.5±6.8	20.05±2.75	97.0±0.9	79.9±7.5	76.5±8.4*	114.4±12.5***
	F	41	49.4	1.50±0.08	42.8±8.2	19.21±2.37	96.8±1.5	82.8±8.5	69.8±9.4	108.6±13.3
12	M	41	48.8	1.50±0.09*	43.0±9.4*	19.16±2.71	96.9±1.0	81.8±8.9	71.8±9.6	112.5±11.7
	F	43	51.2	1.55±0.09	47.3±8.1	19.87±2.19	96.6±2.0	80.0±8.4	72.5±11.8	111.1±14.6
13	M	43	48.9	1.57±0.09	50.1±9.7	20.28±2.46	96.6±1.1	75.9±9.5*	74.4±8.5	113.7±10.9
	F	45	51.1	1.55±0.08	49.2±7.2	20.51±2.25	96.7±1.8	79.7±7.6	75.2±10.6	112.8±15.0
14	M	38	44.7	1.63±0.06**	56.1±7.3**	21.32±2.66	96.4±1.3	73.5±8.0***	76.9±7.6	116.8±12.3
	F	47	55.3	1.59±0.08	51.7±6.5	20.63±1.78	96.8±1.4	79.5±8.1	76.0±11.2	116.8±15.1
15	M	40	50.0	1.65±0.06*	58.5±7.4***	21.78±2.32	96.6±1.4	70.6±7.2***	78.0±7.2	118.3±9.3
	F	40	50.0	1.59±0.07	54.2±8.1	21.43±2.41	96.8±1.5	78.5±9.6	74.7±10.4	115.2±14.0

Values are presented as mean±standard deviation. SpO₂, oxygen saturation ; HRr, resting heart rate ; SBP, systolic blood pressure ; DBP, diastolic blood pressure ; BMI, Body mass index ; *Difference between males (M) and females (F). *P<0.05. **P<0.01. ***P<0.001

no statistically significant difference was observed in HRr between males and females at 10 years (P=0.05), 11 years (P=0.10), and 12 years (P=0.34). In terms of blood pressure, we observed significant differences between boys and girls in SBP at 11 years (114.4±12.5 vs 108.6±13.3; P=0.04) and DBP (76.5±8.4 vs 69.8±9.4; P=0.0009).

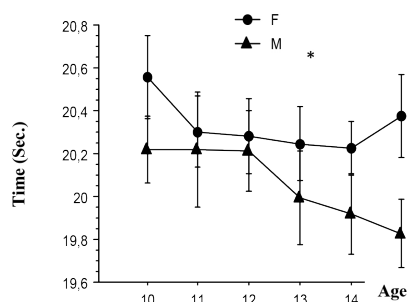
10x5-m Shuttle Run Test

Figure 1 compares the performances of males and females in different physical tests . Based on Figure 1A, males exhibited lower values in the 10x5-m Shuttle

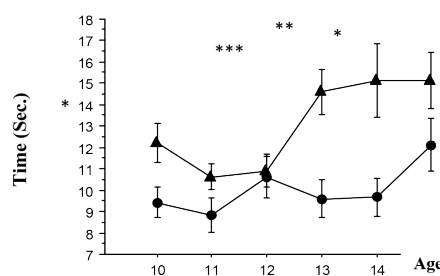
Run Test (10x5-mSRT) compared with females at 15 years (19.83±1.01 vs 20.38±1.24 Sec.; P=0.03). However, no significant difference was found from 10 to 14 years.

Flexed Arm Hang (FAH)

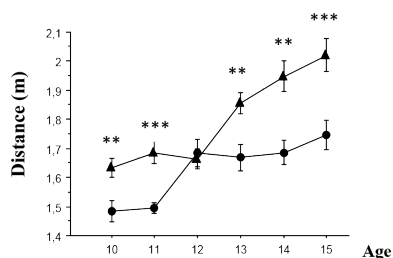
Regarding this variable, Figure 1B showssignificant differences between males and females at 10 years (12.33±5.79 vs 9.43±4.81 Sec.; P=0.02), 13 years (14.61±6.94 vs 9.60±6.06 Sec.; P=0.0005), 14 years (15.13±10.69 vs 9.68±6.11 Sec.; P=0.004), and 15 years (15.14±8.50 vs 12.12±7.72 Sec.; P=0.01). No difference was detected at 12 and 13 years.



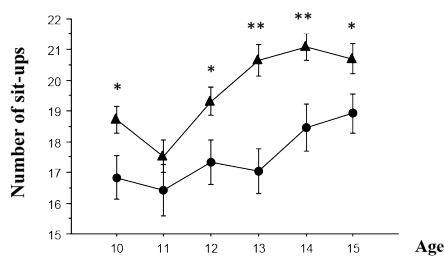
1A : 10x5-m Shuttle Run Test (10x5-mSRT)



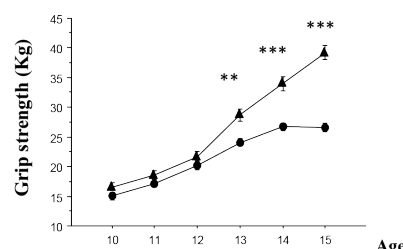
1B : Flexed arm hang (FAH)



1C : Standing Broad Jump (SBJ)



1D : Sit-ups 30 sec. (SU)



1E : Hand Grip Strength

Figure 1: Comparison of performances in different physical tests between males and females. 1A, 10x5 m Shuttle Run Test; 1B, Flexed Arm Hang; 1C, Standing Broad Jump; 1D, Sit-ups 30 sec.; 1E, Hand Grip Strength. *Difference between males and females. *Difference between boys and girls. *P<0.05; **P<0.01; ***P<0.001; M, Males; F, Females.

Standing Broad Jump (SBJ)

During the standing broad jump test (SBJ) (Figure 1C), except at 12 years of age where the scores were similar, male school children had a better explosive strength in lower limb at 10 years (1.63 ± 0.21 vs 1.48 ± 0.23 m; $P=0.003$), 11 years (1.69 ± 0.25 vs 1.50 ± 0.12 m; $P<0.001$), 13 years (1.86 ± 0.25 vs 1.67 ± 0.31 m; $P=0.003$), 14 years (1.95 ± 0.32 vs 1.69 ± 0.29 m; $P=0.0001$), and 15 years (2.02 ± 0.35 vs 1.75 ± 0.32 m; $P=0.0005$).

Sit-ups for 30 Seconds (SU)

As shown in Figure 1D, significant differences existed between males and females at 10 years (18.73 ± 2.71 vs 16.84 ± 4.71 ; $P=0.03$), 12 years (19.32 ± 2.99 vs 17.33 ± 4.80 ; $P=0.03$), 13 years (20.65 ± 3.35 vs 17.04 ± 4.90 ; $P=0.0001$), 14 years (21.08 ± 2.66 vs 18.47 ± 5.21 ; $P=0.006$), and 15 years (20.7 ± 3.10 vs 18.93 ± 4.05 ; $P=0.03$). Regarding the age of 11, no significant difference was observed between males and females.

Hand Grip Strength (HGS)

No difference was observed at 10 years ($P=0.08$), 11 years ($P=0.19$), and 12 years ($P=0.16$) between males and females (Figure 1E). Significant differences, on the other hand, were detected between males and females at 13 years (28.76 ± 6.58 vs 24.10 ± 4.64 Kg; $P=0.002$), 14 years (34.01 ± 7.30 vs 26.70 ± 4.74 Kg; $P<0.001$), and 15 years (39.22 ± 7.54 vs 26.66 ± 4.47 Kg; $P<0.001$).

We studied the correlations of anthropometric and physiological characteristics with the overall performances in different physical tests in the population (Table 2). We noted that 10×5-mSRT was significantly correlated with age ($P=0.02$; $r=-0.11$), height ($P<0.001$; $r=-0.18$), SpO_2 ($P=0.02$; $r=0.10$), and HRr ($P<0.001$; $r=0.18$). FAH test was also significantly associated with age ($P=0.01$; $r=0.11$), height ($P=0.04$;

$r=0.09$), and HRr ($P<0.01$; $r=0.12$). SBJ test and SU test performances had a significant correlation with age, height, weight, HRr, and SBP. Strong and significant correlations were registered between the HGS test scores and age ($P<0.001$; $r=0.73$), height ($P<0.001$; $r=0.58$), and weight ($P<0.001$; $r=0.55$). Moderate and significant correlations existed between the HGS test scores and BMI ($P<0.001$; $r=0.35$), HRr ($P<0.001$; $r=-0.34$), DBP ($P<0.001$; $r=0.30$), and SBP ($P<0.001$; $r=0.25$).

4. Discussion

We evaluated physical fitness with five tests integrated in the EUROFIT battery, validated and standardized by the European Council. The results revealed that the performances of boys and girls in this study were similar at 10, 11, and 12 years of age. At 13, 14, and 15 years of age, on the other hand, the physical fitness of boys was higher than that of girls, except for the 10×5-m Shuttle Run Test, where the differences were only observed at 15 years with better performances in males.

Results of anthropometric parameters (Table 1) showed that girls were taller and heavier than boys until the age of 12. However, from 13 years on, boys tended to be taller. This result is in accordance with the findings of Berisha and Cilli (14) who reported that boys became significantly bigger and heavier than girls with the increase in age.

Concerning the physiological parameters (Table 1), we observed no significant difference in SpO_2 between boys and girls. In fact, all the participants had a normal SpO_2 value, which could justify the absence of difference regarding this parameter. Except at 11 years, where there was a significant difference, males and females did not show any difference in SBP and DBP. Xi and colleagues (41) reported no difference in blood pressure values between boys and girls prior to the age of 13.

Table 2: Correlations between anthropometric and physiological characteristics with performances in different physical tests

	10×5-mSRT	FAH	SBJ	SU	HGS
Age (Years)	-0.11*	0.11*	0.36***	0.23***	0.73***
Height (m)	-0.18***	0.09*	0.38***	0.27***	0.57***
Weight (Kg)	-0.08	-0.10	0.28***	0.18***	0.55***
BMI (Kg/m ²)	0.05	-0.11	0.08	0.01	0.35***
SpO_2 (%)	0.10*	0.03	0.07	0.07	-0.02
HRr (bpm)	0.18***	-0.12**	-0.29**	-0.19**	-0.34***
DBP (mmHg)	-0.03	0.01	0.11*	-0.01	0.30***
SBP (mmHg)	0.08	-0.02	0.10*	-0.15**	0.25***

SpO_2 , oxygen saturation ; HRr, resting heart rate ; SBP, systolic blood pressure ; DBP, diastolic blood pressure ; 10×5-mSRT, 10×5-m Shuttle Run Test ; FAH, Flexed arm hang ; SBJ, Standing broad jump ; SU, Sit-ups ; HGS, hand grip strength. *Significant correlation. ^{*} $P<0.05$; ^{**} $P<0.01$; ^{***} $P<0.001$

The higher the time spent to achieve the 10×5-mSRT test, the lower the performance would be. The lack of difference between boys and girls in 10×5-m Shuttle Run Test, except at 15 years where boys had better performances ($P=0.03$) (Figure 1A), suggested that it was only after 15 years that boys had a better movement speed, agility, and coordination. This can be attributed to the fact that at 15 years, males developed more muscle strength, which could also explain why they were faster than females (14). These findings are consistent with Schipman and colleagues. (42) who demonstrated that the mean speed in the shuttle run tests was higher in boys compared to girls.

When comparing to European normative values (43), we realized that the mean performance value of males at 10 years (20.22 sec) in our study was between the 80th (20.38 sec) and the 90th (19.44 sec) percentiles. At 15 years, the mean performance value (19.83 sec) was between the 50th (20.05 sec) and the 60th (19.60 sec) percentiles. This result suggested that the performance of the males in our study regarding 10×5-mSRT was above the average of European population at the same age.

In females, the mean performance value at 10 years (20.56 sec) was between the 80th (21.30 sec) and the 90th (20.43 sec) percentiles of the European population of children and adolescents. The mean performance value at 15 years (20.38 sec) was also between the 80th (20.48 sec) and the 90th (19.79 sec) percentiles. This means that the performance of the girls in our study concerning 10×5-mSRT was similar to 20% of the most optimal performance in European children and adolescents.

The results of the present study showed significant differences between males and females in terms of flexed arm hang (FAH) (Figure 1B) at 10 years ($P=0.02$), 13 years ($P<0.001$), 14 years ($P<0.01$), and 15 years ($P=0.01$). There were no differences at 12 and 13 years. Thus, at 10, 11, 14, and 15 years, boys had a better relative upper body strength and endurance compared with girls. In fact, after the pubertal period, we detected a body muscle development in boys and increased body fat in girls, which can justify the differences observed between males and females in physical strength and endurance from 13 to 15 years (41, 44, 45).

When comparing with the normative values published by Tomkinson and colleagues. (43), we observed that the lower mean value in the FAH test at 11 years varied between the 60th and 70th percentiles in boys (10.62 sec), and from 70th to 80th percentiles in girls (8.84 sec). A higher mean value existed between

the 40th and 50th percentiles in boys (15.13 sec) at 14 and 15 years and between the 70th and 80th percentiles in girls (12.12 sec) at 15 years.

Results of standing broad jump (SBJ) showed that except at 12 years where the scores were similar, boys had a significantly higher explosive strength ($P<0.01$) in lower limb compared with girls (Figure 1C). This finding is consistent with that of Ramirez-Velez and colleagues. (44). Furthermore, Tremblay and colleagues. (46) and Tremblay and colleagues. (47) reported male adolescents to have better scores in general strength tests compared to their female counterparts.

Compared to the European normative values (43), we noted that the mean score of explosive strength (1.63 m) in the lower limb of male children and adolescents in our study ranged between 80th and 90th percentiles at 10 years and between 60th and 70th percentiles at 15 years (2.02 m). Furthermore, the mean score of explosive strength (1.48 m) in girls ranged from 70th to 80th percentiles at 10 years and between 80th and 90th percentiles at 15 years (1.75 m). For these reasons, the participants in our study had globally better scores in the SBJ test compared to their European counterparts.

The present research also revealed significant differences between males and females regarding sit-ups 30 sec (SU) performance (Figure 1D) except at 11 years of age. This suggested that globally, males had greater abdominal muscle endurance than females. These findings are consistent with previous studies that reported better general muscle strength in boys than in girls (46, 48-50).

The performance of European children and adolescents in the sit-ups 30 sec test (43) indicated that the children and adolescents in our study had below average mean performances. Performances varied from 17.5 to 21.1 sit-ups per 30 sec in boys, corresponding to the 20th to 40th percentiles, and from 16.4 to 18.9 sit-ups per 30 sec in girls, which corresponds to the 10th to 40th percentiles.

Regarding the hand grip strength, the results of our research showed that male and female school children differed from 13 to 15 years ($P<0.001$). For the same reasons, following the pubertal period, the body muscle development in males and the increased body fat in females can justify the differences between males and females in physical strength and endurance from 13 to 15 years of age (41, 44, 45). Although our results revealed significant differences in gender from 13 to

15 years, previous studies demonstrated significant differences at all ages (13, 51-54).

The mean values of grip strength in the present study ranged from 9.6 to 53.4 Kg in males and from 9.0 to 35.7 Kg in females. These values varied from the 5th and 95th percentiles of the European normative values for both males and females. The school children of our sample presented grip strength values similar to European values and the normative values published by Tomkinson and colleagues. (43).

In general, our findings indicated that boys had a better physical fitness than girls of the same age, and the differences were more significant from 13 years. A plausible justification for these results could be the increased fat mass related to growth and puberty in girls, which reduces their physical fitness (55, 56).

In the present study, we found that age, height, and weight had a significant correlation with SBJ and SU performances (Table 2). In fact, the lower limb explosive strength and the endurance of the abdominal muscles improved with the increase in age, height, and weight (2, 29). The positive correlation ($r=0.2$) between the resting heart rate and the 10x5-m shuttle run test performance is in conflict with the finding of a previous study (57).

Concerning the HGS, we observed strong or moderate significant correlations between HGS test scores and demographic, anthropometric, and physiological measurements in the current study, except for SpO₂ ($P=0.70$; $r=-0.02$). Fredriksen and colleagues. (51) revealed a positive association between grip strength and age, which is in line with our findings.

5. Conclusions

School children in our study presented higher physical fitness compared with European children, and boys had a better overall physical fitness compared with girls from 10 to 15 years. Multicentric studies involving representative samples of school children, carried out on the entire EUROFIT test battery, are required to determine the real physical fitness data of children in Cameroon.

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Ethical Approval

This study was performed in accordance with the principles of Helsinki Declaration as revised in 1989, and the protocol was fully approved by the National Ethics Committee for Scientific Research of the Republic of Cameroon, registered under the number C3/102C/MINEDUB/DREB-C/S-DAG/IMS. All the school children who participated in the sample had obtained consent from their parents

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References

1. World Health Organization, Global recommendations on physical activity for health. Geneva: WHO; 2010.
2. Ortega FB, Ruiz JR, Castillo MJ, Moreno LA, González-Gross M, Wärnberg J, et al. Physical fitness in childhood and adolescence: A powerful maker of Health. *Int J Obes.* 2008;**32**:1-11. doi:10.1038/sj.ijo.0803774.
3. Paoli A, Bianco A. Not all exercises are created equal. *Am J Cardiol.* 2012;**109**:305. doi: 10.1016/j.amjcard.2011.10.011. [PubMed: 22244130].
4. Eime RM, Young JA, Harvey JT, Charity MJ, Payne WR. A systematic review of the psychological and social benefits of participation in sport for children and adolescents: Informing development of a conceptual model of health through sport. *Int J Behav Nutr Phys Act.* 2013;**10**,98. doi: 10.1186/1479-5868-10-98. [PubMed: 23945179]; [PubMed Central: PMC3751802].
5. Ewan T, Antonio P. Physical fitness evaluation of school children in southern Italy : a cross sectional evaluation. *J Funct Morphol Kinesiol.* 2018;**3**,14. doi : 10.3390/jfmk3010014.
6. Blair S, Cheng Y, Holder J. Is physical activity or physical fitness more important in defining health benefits? *Med Sci Sports Exerc.* 2001;**33**(6):379-399. doi:10.1097/00005768-200106001-00007. [PubMed: 11427763].
7. Bergier J, Kapka-Skrzypczak L, Biliński P, Paprzycki P, Wojtyła A. Physical activity of Polish adolescents and young adults according to IPAQ: a population based study. *Ann Agric Environ Med.* 2012;**19**(1):109-115. [PubMed: 22462455].

8. Harmon J, Brusseau TA, Collier D, Lenz E. Habitual physical activity patterns of inner-city children. *Hum Mov.* 2013;**14**(4):305-309. doi: 10.2478/humo-2013-0036.
9. Cocca A, Liukkonen J, Mayorga-Vega D, Viciano-Ramirez J. Health-related physical activity levels in Spanish youth and young adults. *Percept Mot Skills.* 2014;**118**(1):247-260; doi: 10.2466/10.06.PMS.118k16w1. [PubMed: 24724525].
10. Bergier J, Niznikowska E, Bergier B, Acs P, Salonna F, Junger J. Differences in physical activity, nutritional behaviors, and body silhouette concern among boys and girls from selected European countries. *Hum Mov.* 2017;**18**(1):19-28; doi: 10.1515/humo-2017-0009.
11. Sandor D, George AK, Norma C, Julia OB, Gregory DB, Carolyn EA. The Effects of Manual Resistance Training on Fitness in Adolescents. *J Strength Cond Research.* 2010;**23**(8):2287-2294. doi : 10.1519/JSC.0b013e3181b8d42a. [PubMed: 19826296]; [PubMed Central: PMC2907740].
12. Hao W, Yi H, Liu Z, Gao Y, Eshita Y, Guo W, et al. Gender comparisons of physical fitness indexes in inner Mongolia Medical school-children in China. *Global J Health Sci.* 2015;**7**(1):220-227. doi: 10.5539/gjhs.v7n1p220. [PubMed: 25560355]; [PubMed Central: PMC4796522].
13. Berisha M, Cilli M. Comparison of EUROFIT test results of 11-17-years-old male and female school-children in Kosovo. *Eur Sci J.* 2017;**13**(31):138-158. doi:10.19044/esj.2017.v13n31p138.
14. Berisha M, Cilli M. Normative values for physical fitness in children aged 11 – 17 years in Kosovo. *Pedagogics, psychol, med-biol problems phys training sports.* 2018;**22**(1):17-27. doi:10.15561/18189172.2018.0103.
15. Jürimäe T, Vollbekiene V, Jürimäe J, Tomkinson GR. Changes in Eurofit Test Performance of Estonian and Lithuanian Children and Adolescents (1992–2002). In: Tomkinson GR, Olds TS, eds. *Pediatric fitness: secular trends and geographic variability.* Basel: Karger. 2007 ;**50** :129-42. doi:10.1159/000101356.
16. Cepero M, López R, Suárez-Llorca C, Andreucabrera E, Rojas F. Fitness test profiles in children aged 8-12 years old in Granada (Spain). *J Hum Sport Exerc.* 2011;**6**(1):135-146. doi:10.4100/jhse.2011.61.15.
17. Rostan F, Simon C, Ulmer, Z. Promouvoir l'activité physique des jeunes. Elaborer et développer un projet de type Icaps. *Dossier santé en action.* 2011. Paris: INPES. 188p. French.
18. Blair SN, Kohl HW III, Paffenbarger RS Jr, Clark DG, Cooper KH, Gibbons LW. Physical fitness and all-cause mortality. A prospective study of healthy men and women. *JAMA.* 1989;**262**:2395-401. doi: 10.1001/jama.262.17.2395. [PubMed: 2795824].
19. Hoos MB, Gerver WJM, Kester AD, Westerterp KR. Physical activity levels in children and adolescents. *Int J Obes.* 2003;**27** (5):605-9. doi: 10.1038/sj.ijo.0802246. [PubMed:12704404].
20. Fjørtoft I, Pedersen A, Sigmundsson H, Vereijken B. Measuring physical fitness in children who are 5 to 12 years old with a test battery that is functional and easy to administer. *Phys Ther.* 2011;**91**(7):1087-1095. doi: 10.2522/ptj.20090350. [PubMed: 21616933].
21. Rice MH, Howell CC. Measurement of physical activity, exercise, and physical fitness in children: issues and concerns. *J Pediatr Nurs.* 2000;**3**:148-156. doi: 10.1053/jn.2000.6019. [PubMed: 10897552].
22. Gayman AM, Fraser-Thomas J, Spinney JEL, Stone RC, Baker J. Leisure-time physical activity and sedentary behaviour in older people: the influence of sport involvement on behaviour patterns in later life. *AIMS Public Health.* 2017;**4**(2):171–88. doi: 10.3934/publichealth.2017.2.171.[PubMed: 29546211];[PubMed Central: PMC5689803].
23. Verhoeven H, Simons D, Van Dyck D, Van Cauwenberg J, Clarys P, De Bourdeaud'hui JI, et al. Psychosocial and environmental correlates of walking, cycling, public transport and passive transport to various destinations in Flemish older adolescents. *PLoS One.* 2016;**11**(1): e0147128. doi:10.1371/journal.pone.0147128.
24. Hussey J, Bell C, Bennet K, O'Dwyer J, Gormley J. Relationship between the intensity of physical activity, inactivity, cardiorespiratory fitness and body composition in 7–10-year-old Dublin children. *Br J Sports Med.* 2007;**41**:3116. doi: 10.1136/bjism.2006.032045. [PubMed: 17395610]; [PubMed Central: PMC2659066].
25. Kohler, M. Tests de condition physique pour les structures. « Sport-Art étude » du secondaire de la république et de Canton de Jura, Eurofit, 2001. 4 p. French.
26. Asmussen E, Klissouras V, Tuxworth B, Lofi A, Leger L. Sport testing physical Eurofit In: Karaesk F, editor. *Testing physical fitness Eurofit Experimental Battery.* Strasbourg Council of Europe; 1983. p. 1-83.
27. Gontarev S, Kalac R, Velickovska LA, Zivkovic V. Physical fitness reference standards in Macedonian children and adolescents: the MAKFIT study. *Nutr Hosp.* 2018;**35**(6):1275-1286. doi: 10.20960/nh.1881. [PubMed: 30525840].
28. Gulías-González R, Martínez-Vizcaíno V, García-Prieto JC, Díez-Fernández A, Olivás-Bravo A, Sánchez-López M. Excess of weight, but not underweight, is associated with poor physical fitness in children and adolescents from Castilla-La Mancha, Spain. *Eur J Pediatr.* 2014;**173**(6):727-35. doi: 10.1007/s00431-013-2233-y. [PubMed: 24326383].
29. Erikoğlu Ö, Güzel NA, Pense M, Örer GE. Comparison

- of Physical Fitness Parameters with EUROFIT Test Battery of Male Adolescent Soccer Players and Sedentary Counterparts. *Int J Sci Cult Sport*. 2015;3(13):43-52. doi: 10.14486/IntJSCS434.
30. Popović R, Aleksić A, Stojanović D, Stefanović M, Božić S, Popović M. Evaluation of the Physical Fitness Level in Physical Education Female School-children Using "EurofitTest". *Int J Sports Sci Phys Educ*. 2017;2(1):1-15.
 31. Venckunas T, Emeljanovas A, Mieziene B, Volbekiene V. Secular trends in physical fitness and body size in Lithuanian children and adolescents between 1992 and 2012. *J Epidemiol Community Health*. 2017;71(2):181-187. doi: 10.1136/jech-2016-207307. [PubMed: 27485051].
 32. Armstrong N, Tomkinson GR, Ekelund U. Aerobic fitness and its relationship to sport, exercise training and habitual physical activity during youth. *Br J Sports Med*. 2011;45:849-58. doi: 10.1136/bjsports-2011-090200. [PubMed: 21836169].
 33. Müller I, Yap P, Steinmann P, Damons BP, Schindler C, Seelig H, et al. Intestinal parasites, growth and physical fitness of schoolchildren in poor neighborhoods of Port Elizabeth, South Africa: a cross-sectional survey. *Parasit Vectors*. 2016;9:488. doi : 10.1186/s13071-016-1761-5. [PubMed: 27595566]; [PubMed Central: PMC5011914].
 34. Navti LK, Atanga MB, Niba LL. Associations of out of school physical activity, sedentary lifestyle and socioeconomic status with weight status and adiposity of Cameroon children. *BMC Obes*. 2017;4(35). doi: 10.1186/s40608-017-0171-3. [PubMed: 29152311]; [PubMed Central: PMC5678598].
 35. Choukem SP, Kamdeu-Chedeu J, Leary SD, Mboue-Djieka Y, Nebongo DN, Akazong C, et al. Overweight and obesity in children aged 3–13 years in urban Cameroon: a cross-sectional study of prevalence and association with socio-economic status. *BMC Obes*. 2017;4:7. doi: 10.1186/s40608-017-0146-4. [PubMed: 28163924]; [PubMed Central: PMC5286775].
 36. Navti LK, Ferrari U, Tange E, Parhofer KG, Bechtold-Dalla-Pozza S. Height-obesity relationship in school children in Sub-Saharan Africa: results of a cross-sectional study in Cameroon. *BMC Res Notes*. 2015;8:98. doi: 10.1186/s13104-015-1073-4. [PubMed: 25889151]; [PubMed Central: PMC4377213].
 37. Navti LK, Ferrari U, Tange E, Parhofer KG, Bechtold-Dalla-Pozza S, Parhofer KG. Contribution of socioeconomic status, stature and birth weight to obesity in Sub-Saharan Africa: cross-sectional data from primary school-age children in Cameroon. *BMC Public Health*. 2014;14:320. doi: 10.1186/1471-2458-14-320. [PubMed: 24708806]; [PubMed Central: PMC3983851].
 38. Wamba PC, Enyong-Oben J, Cianflone K. Prevalence of overweight, obesity, and thinness in Cameroon urban children and adolescents. *J Obes*. 2013;2013. doi: 10.1155/2013/737592. [PubMed: 23862056]; [PubMed Central: PMC3703727].
 39. Assomo Ndemba PB, Temfemo A, Mekoulou Ndong, Mbo-Voula CJ, Guessogo WR, Mandengue SH, et al. Physical and cardiorespiratory profiles of urban schoolchildren aged 10-14 years in Douala, Cameroon. *J Hum Sport and Exerc*. 2020; in press. doi : 10.14198/jhse.2021.161.07.
 40. Bucher H. Développement et examen psychomoteur de l'enfant. Issy-les-Moulineaux : Masson; 2004. 224 p. French.
 41. Xi B, Zong X, Kelishadi R, Hong YM, Khadilkar A, Steffen LM, et al. Establishing International Blood Pressure References Among Non-overweight Children and Adolescents Aged 6 to 17 Years. *Circulation*. 2016;133(4): 398-408. doi: 10.1161/CIRCULATIONAHA.115.017936. [PubMed: 26671979]; [PubMed Central: PMC4729639].
 42. Schipman J, Saulière G, Sedeaud A, Deschamps T, Ovigneur H, Maillet H, et al. Indice de masse corporelle et condition physique chez 49 600 collégiens et lycéens de six régions françaises, 2007-2014. *Bull Epidemiol Hebd. - BEH, Saint-Maurice (Val de Marne): Institut de veille sanitaire*, 2015, pp.552-561. hal-01775088. French.
 43. Tomkinson GR, Carver KD, Atkinson F, Daniell ND, Lewis LK, Fitzgerald JS, et al. European normative values for physical fitness in children and adolescents aged 9–17 years: results from 2 779 165 Eurofit performances representing 30 countries. *Br J Sports Med*. 52(22):1445-14563. doi: 10.1136/bjsports-2017-098253. [PubMed: 29191931].
 44. Ramírez-Vélez R, Martínez M, Correa-Bautista JE, Lobelo F, Izquierdo M, Rodríguez-Rodríguez F, et al. Normative Reference of Standing Long Jump for Colombian Schoolchildren Aged 9-17.9 Years: The FUPRECOL Study. *J Strength Cond Res*. 2017;31(8):2083-2090. doi: 10.1519/JSC.0000000000001633. [PubMed: 27642854].
 45. Laurson KR, Saint-Maurice PF, Welk GJ, Eisenmann JC. Reference Curves for Field Tests of Musculoskeletal Fitness in U.S. Children and Adolescents: The 2012 NHANES National Youth Fitness Survey. *J strength Cond Res*. 2017;31(8):2075-2082. doi: 10.1519/JSC.0000000000001678. [PubMed: 27741055].
 46. Tremblay MS, Shields M, Laviolette M, Craig CL, Janssen I, Connor Gorber S. Fitness of Canadian children and youth: results from the 2007-2009 Canadian Health Measures Survey. *Health Rep*. 2010;21(1):7-20. [PubMed: 21510586].
 47. Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson

- V, Latimer Cheung AE, et al. Sedentary Behavior Research Network (SBRN)-Terminology Consensus Project process and outcome. *Int J Behav Nutr Phys Act.* 2017;**14**(1):75. doi: 10.1186/s12966-017-0525-8. [PubMed: 28599680]; [PubMed Central: PMC5466781].
48. Malina RM, Bouchard C, Bar-Or O. Growth, Maturation and Physical Activity, *Human Kinetics 2ndEds, Champaign;* 2004. IL. 695 p. doi: 10.1002/ajhb.1310040415.
49. Sauka M, Priedite IS, Artjuhova L, Larins V, Selga G, Dahlström O, et al. Physical fitness in northern European youth: reference values from the Latvian physical health in youth study. *Scand J Public Health.* 2011;**39**(1):35-43. doi: 10.1177/1403494810380298. [PubMed: 20699349].
50. Dobosz J, Mayorga-Vega D, Viciano J. Percentile Values of Physical Fitness Levels among Polish Children Aged 7 to 19 Years--a Population-Based Study. *Cent Eur J Public Health.* 2015;**23**(4):340-51. doi: 10.21101/cejph.a4153. [PubMed: 26841149].
51. Fredriksen PM, Mamen A, Hjelle OP, Lindberg M. Handgrip strength in 6–12-year-old children: The Health Oriented Pedagogical Project (HOPP). *Scand J Public Health.* 2018;**46**(21):54-60. doi: 10.1177/1403494818769851. [PubMed: 29754575].
52. Alexander J, Sepúlveda R, Vélez RR, Bautista JEC, Izquierdo M, Hermoso AG. Physical fitness and anthropometric normative values among Colombian-Indian schoolchildren. *MBP Public Health.* 2016;**16**(962):2-15. doi: 10.1186/s12889-016-3652-2. [PubMed: 27619491]; [PubMed Central: PMC5020445].
53. Montalcini T, Ferro Y, Salvati MA, Romeo S, Miniero R, Pujia A. Gender difference in handgrip strength of Italian children aged 9 to 10 years. *Italian J Pediatr.* 2016;**42**:16 doi: 10.1186/s13052-016-0226-y.
54. Nhantumbo L, Saranga S, Prista A, Basso L, Maia J. Allometric study of functional fitness of children and adolescents in a rural area of Mozambique. *Brazi J Kinanth.* 2012;**14**(5): 508-516. doi : 10.5007/1980-0037.2012v14n5p507.
55. Beunen G, Baxter-Jones A, Mirwald RL, Thomis M, Lefevre J, Malina RM, et al. Intra individual allometric development of aerobic power in 8 to 16 year old boys. *Med Sci Sports Exerc.* 2002; **34**(3):503-10. doi: 10.1097/00005768-200203000-00018.. [PubMed: 11880816].
56. Armstrong N, Welsman JR. The physical activity patterns of European youth with reference to methods of assessment. *Sport Med.* 2006;**36**:1067-1086. doi: 10.2165/00007256-200636120-00005. [PubMed: 17123328].
57. Cordon C, Houelbecq M, Rioufol MO, Baudry F, Berte C. Etat Clinique d'une personne. *Elsevier Masson;* 2009. 148p. French.