



# Influence of Nutritional Status on the Physical Aptitudes and Cardiovascular Profiles of School Children in Rural and Urban Areas of North Cameroon

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## Authors' contributions

This work was carried out in collaboration between all authors. Author MNDD designed the study, wrote the protocol, carried out field work and wrote the first draft of the manuscript. Author HKK designed the study, wrote the protocol, read and critically reviewed the manuscript. Author OSMB wrote the protocol, read and corrected the manuscript. Author PM carried out field work, read and corrected the manuscript. Author SNN performed the statistical analysis, read and corrected the manuscript, authors ENN and MBM participated in the data collection. All authors read and approved the final manuscript.

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## ABSTRACT

**Aim:** This work was aimed at determining the influence of nutritional status on physical aptitudes and cardiovascular profiles of children in rural and urban areas of North Cameroon.

**Experimental Design:** The study was a cross-sectional survey.

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**Place and Duration of Study:** The study was carried out in Cameroon from February to March 2014.

**Methodology:** Overall, 633 children aged 6-17 years were enrolled into the study. Demographic information was recorded. Weight, height, cardiovascular profiles [heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP)] and physical aptitudes [six minutes walk (6MWT), broad jump (BJ), 30 m dash] were evaluated.

**Results:** Prevalence values of malnutrition and hypertension were 3.3% and 0.31% respectively. HR was significantly higher in males ( $P<0.001$ ), children aged 6-10 years ( $P=0.001$ ) and those from urban areas ( $P<0.001$ ) when compared with their respective counterparts. DBP was significantly higher in children aged  $>10$  years ( $P=0.01$ ) and normonourished children ( $P=0.014$ ) than their respective counterparts. SBP was higher in children aged  $>10$  years than those aged 6-10 years and the difference was significant ( $P<0.001$ ). The mean 6MWT and mean BJ were significantly higher ( $P<0.001$ ) in children aged  $>10$  years and those from rural areas ( $P<0.001$ ) than their respective counterparts. The mean time taken to do the 30 m dash was significantly higher ( $P = 0.001$ ) in children from rural areas ( $6.15\pm 0.06$  sec), than those from urban areas ( $5.86\pm 0.22$  sec). There was a negative correlation between the HR and mean BJ ( $P<0.001$ ), HR and mean 6MWT ( $P<0.001$ ), SBP and mean time for 30 m dash ( $P<0.001$ ), DBP and 30 m dash ( $P<0.001$ ) in the normonourished children. There was a positive correlation between HR and 30 m dash ( $P<0.001$ ), SBP and BJ ( $P<0.001$ ) as well as DBP and BJ ( $P<0.001$ ) in normonourished children.

**Conclusion:** A weak correlation was registered between the nutritional status, physical and cardiovascular parameters of the school children.

*Keywords: Nutritional status physical aptitudes; cardiovascular profiles; malnutrition; school children; urbanization.*

## 1. INTRODUCTION

The nutritional status of children is determined by age, gender, household characteristics, dietary intake and health status. Children are usually the most visible victims of malnutrition. Some studies estimate that malnutrition especially under-nutrition generally causes 3.1 million deaths annually [1] in children and approximately two thirds of all wasted children live in Asia and almost one third in Africa [2]. The majority of malnourished children live in rural areas and this is associated with food insecurity and household poverty in such communities [3,4].

It has been reported that there is a link between the nutritional profile, level of growth, physical aptitude, mental development, cardiovascular risk factors and school performance [5]. Physical fitness is a powerful marker of the health condition in childhood and adolescence [6]. Previous research indicates that boys have better muscular fitness in different age groups and achieve better results in the tests for assessment [7,8]. Adolescence is a key period in life for major physical aptitude development and this differs between boys and girls. Increase in anaerobic and aerobic functional capacities is higher in boys than girls and there is a higher amount of skeletal muscle mass in boys [9]. Some studies have equally shown that children

who participated in physical education maintained or improved grades and scores on standardized tests and had better classroom performance [10]. Physical activity in children therefore remains a preventive and therapeutic measure to reduce the risks of future cardiovascular diseases [11]. Children who meet recommended physical activity guidelines have improved aerobic fitness, muscular strength, cardiovascular and metabolic health and are less likely to be overweight or obese [12].

Clinical markers of chronic disease in adulthood like atherosclerosis, obesity and osteoporosis are linked to life-long processes that originate in childhood with physical inactivity and low aerobic fitness [13]. Physical inactivity and poor nutritional status have been reported among cardiovascular risk factors [14,15]. Current reports suggest that school-based physical activity interventions may be useful in the improvement of health parameters and lifestyle behaviours in children and adolescents and this could lead to reduced cardiovascular disease risk in adulthood [16].

In Cameroon malnutrition is widespread especially in the northern part of the country [17,18]. The nutritional problems in children have been reported to be multifactorial [19] and have been linked primarily to lack of access to

age-appropriate foods, poor feeding habits, inadequate health services, unsafe water and poor hygiene practices [2]. It manifests through lateness in growth in children as well as in size. These two factors coupled with a low physical activity could have a negative effect on the development of physical aptitude and cardiovascular profiles of children. Despite the reported high prevalence of malnutrition in the northern part of Cameroon [9,17], no study has linked nutritional status to physical aptitudes and cardiovascular profiles of children in the area. The situation therefore needs to be investigated. Against this background, the aim of this study was to determine the influence of the nutritional status on the physical aptitudes and cardiovascular profiles of school children aged 6 to 17 years in rural and urban areas of the North Region of Cameroon.

## **2. MATERIALS AND METHODS**

### **2.1 Study Sites**

The study was carried out in an urban (Garoua) and rural (Pitoea) areas of the Northern Region of Cameroon. Garoua is the administrative capital of the North Region of the country and is situated at 166 m above sea level (a.s.l.), Latitude 9° 18' 0" N and Longitude 13° 24' 0" E. Pitoea is situated 15 Km away from Garoua at 201 m a.s.l., Latitude 9.38° N and Longitude 13.53° E. A primary school (Government School Poumpoumre) and secondary school (Government High School Garoua) were randomly selected in the urban area. In the rural area - Government Primary School, Government Technical High School and Government Bilingual High School Pitoea were randomly selected.

### **2.2 Study Population**

National school enrolment rate was reported at 80%; in 2012 with 49% in the Far North; 55% in the North; and 60% in the Adamawa regions (all in north Cameroon).

The study included 633 children of both sexes aged 6-17 years. Participants were enrolled into the study only if they had received parental/guardian informed consent (came with signed informed consent forms).

### **2.3 Study Design**

The study was a cross-sectional survey on school children from February to March, 2014. At each study site, a sensitization talk was

organized with the school authorities to explain the purpose and potential benefits of the study (lessons on importance of good eating habits and physical exercises). Informed consent forms were sent to parents/guardians through the children stating the purpose of the study as well as the benefits. Only children who brought back signed informed consent forms were included in the study. However, children who were sick and also those whose ages were less than six or more than seventeen years were not included in the study. Investigative methods included a questionnaire approach as well as measurement of anthropometric, cardiovascular and physical aptitude parameters of the children.

## **2.5 Collection of Data**

### **2.5.1 Administration of questionnaire**

Age and gender of the children were recorded in a structured questionnaire. Interviews were done in French and exceptionally in the best understood language. The age of each child was calculated from date of birth and confirmed from the school registers as entered by parents based on the information in the birth certificate.

### **2.5.2 Cardiovascular parameters**

Before physical exercise, each participant's blood pressure was measured on the right arm by a nurse using an Omron BP 742N 5 series upper arm Blood Pressure Monitor. The systolic and diastolic blood pressures as well as the heart rate were measured twice and the mean value was recorded.

### **2.5.3 Anthropometric parameters**

The children's heights were measured with an Accustat Ross stadiometer (Genentech, Inc South San Francisco, CA). Each participant was instructed to stand erect with the heels, buttocks, shoulders and occiput against the stadiometer, so that the external auditory meatus and lower border of the eye sockets were in the same horizontal plane. The headboard was brought down to touch the head, and the height was read off the stadiometer. The measurements were recorded to the nearest 0.1 cm. Body weight was measured while the child was in light clothing to the nearest 0.1 kg using a Seca 813 Robusta High Capacity Digital floor scale. The body mass index was calculated using the body weight in Kg divided by the square height in m<sup>2</sup>.

#### **2.5.4 Determination of nutritional status**

Anthropometric indices were expressed in relationship to the reference population in statistical terms of standard deviations from the median. Using the Z-scores as described by Bundy et al. [20], we were able to describe how far a child's weight was from the median weight of a child at the same height in the reference value and further deduced whether a child was malnourished or normonourished. The nutritional status was assessed by the WHO growth reference for school-aged children and adolescents to monitor the nutritional status of children aged 6 to 17 years [21].

#### **2.5.5 Physical aptitude parameters**

The physical aptitude of the participants was assessed using the following tests: the six minutes walk test (6 MWT) to estimate the aerobic capacity and a 30 meter track to assess the children's speed. The participants were instructed to walk to their pace as far as possible in six minutes without running and at the end of the six minutes, a whistle was blown for them to stop and the distance covered by each child was recorded. The 30 m shuttle test was done on a 30 meter track with cones placed at the beginning and the end of the 30m track. The children were asked to run at maximum speed and time was recorded with a stop watch.

The broad jump (BJ) test was used to quantify the explosive strength of the participants. Here, the child stood behind the starting line, with feet together, and pushed off vigorously and jumped forward as far as possible. The distance was measured from the take-off line to the point where the back of the heel nearest to the take-off line landed on the floor. The test was repeated twice, and the best score was recorded (in cm).

#### **2.6 Statistical Analysis**

Data was entered into spread sheets using the Census and Survey Processing System (CSPRO) 4.0 and analysed with the statistical package for social sciences (SPSS) version 17 (SPSS, Inc., Chicago, IL, USA). Data was summarized into means and standard deviations, and percentages were used in the evaluation of descriptive statistics. Values were expressed as means  $\pm$  standard deviations (SD) for age, weight, height, heart rate and blood pressure. The analysis of variance (ANOVA) was used where appropriate to compare means into two different groups. Pearson's correlation

coefficients were used to examine the relationship between body mass index (BMI) (Z-score value) and variables of cardiovascular parameters; BMI (Z-score value) and variables of physical activity; variables of cardiovascular parameters and variables of physical activity parameters. Differences between two groups were considered significant at  $P < 0.05$ .

### **3. RESULTS**

#### **3.1 Characteristics of the Study Population**

A total of 633 primary and secondary school Cameroonian children (346 males and 287 females) were enrolled in the study. Ages ranged from 6 to 17 years with a mean  $\pm$  SD of  $12.79 \pm 2.81$  years. There were more children in  $>10$  years (485; 76.62%) than the 6 -10 years (148; 23.38%). Overall, 303 (47.9%) children were from the rural area and 330 (52.1%) from the urban area. The mean  $\pm$  SD of weight was  $25.99 \pm 5.36$  kg and that for height was  $1.31 \pm 0.88$  m for the 6 -10 years age group while the mean  $\pm$  SD of weight and height for the  $>10$  years age group were  $43.96 \pm 11.21$  kg and  $1.56 \pm 0.27$  m respectively. The mean  $\pm$  SD of weight and height for children in the rural area were  $42.34 \pm 11.87$  kg and  $1.53 \pm 0.14$  m respectively and those for participants from the urban area were  $37.39 \pm 12.96$  kg and  $1.46 \pm 0.16$  m respectively (Table 1). The mean  $\pm$  SD of SBP, DBP and HR in the population were  $107.36 \pm 18.44$  mmHg,  $60.48 \pm 14.02$  mmHg and  $89.16 \pm 14.95$  beats/min respectively. The prevalence of malnourished children was 3.3% (21). All the malnourished cases were stunting and none of them was overweight or obese.

#### **3.2 Nutritional Status and Cardiovascular Profiles of Participants in Relation to Sex, Age and Level of Urbanization**

A total of 21 (3.3%) out of the 633 school children examined were malnourished. A total of 2 (0.3%) were severely malnourished while 19 (3%) were moderately malnourished. The prevalence of malnutrition was similar ( $P = 0.96$ ) in the age groups  $>10$  years (3.3%, 16) and 6-10 years (3.4%, 5). The prevalence of malnourished cases was higher in children from the urban area (4.2%, 14) than those from the rural area (2.3%, 7), but the difference was not significant ( $P = 0.18$ ). The prevalence of malnourished cases was comparable ( $P = 0.82$ ) in males (3.5%, 13) and females (3.1%, 8).

The overall prevalence of hypertensive cases in the study population was 0.3% (2). Hypertensive cases in females (0.4%, 1) and males (0.3%, 1) were comparable ( $P = 0.37$ ). The prevalence of hypertensive cases in participants in the 6 -10 years age group (0.7%, 1) was similar ( $P = 0.27$ ) to that in the participants aged >10 years (0.2%, 1). With respect to the zone of residence, children from rural areas had a similar ( $P = 0.26$ ) prevalence of hypertensive cases (0.3%, 1) when compared with children from urban areas (0.3%, 1).

With respect to sex, the mean SBP ( $107.36 \pm 18.44$  mmHg) was similar in females ( $P = 0.46$ ) and males ( $106.26 \pm 18.87$  mmHg). The mean DBP ( $61.38 \pm 13.99$  mmHg) was also similar in females ( $P = 0.42$ ) and males ( $60.48 \pm 14.02$  mmHg). Conversely, males had a higher mean HR ( $97.38 \pm 13.66$  beats/min) when compared with the females ( $89.16 \pm 14.95$  beats/min) and the difference was highly significant ( $P < 0.001$ ).

In relation to age a higher mean SBP ( $109.60 \pm 18.88$  mmHg) was recorded in children aged >10 years when compared with children aged 6 -10 years old ( $97.91 \pm 14.54$  mmHg) and the difference was highly significant ( $P < 0.001$ ). Mean DBP was also significantly higher ( $P = 0.01$ ) in participants aged >10 years ( $61.88 \pm 14.11$  mmHg) than those aged 6 -10 years ( $57.61 \pm 13.20$  mmHg). A significantly lower ( $P < 0.001$ ) mean HR was recorded in children aged >10 years ( $90.87 \pm 14.11$  beats/min) when compared with those aged 6 -10 years ( $98.95 \pm 15.75$  beats/min).

With respect to the level of urbanization, the mean SBP was similar ( $P = 0.96$ ) in children from urban areas ( $106.83 \pm 18.88$  mmHg) and those from rural areas ( $106.90 \pm 18.38$  mmHg). Children from rural areas had a similar value ( $60.98 \pm 12.932$  mmHg) of DBP with those from urban areas ( $60.80 \pm 14.94$  mmHg) ( $P = 0.09$ ). However, HR was higher in children from urban areas ( $94.36 \pm 14.62$  beats/min) than in those from rural areas ( $91 \pm 15.02$  beats/min) and the difference was highly significant ( $P < 0.001$ ).

Mean SBP was similar ( $P = 0.12$ ) in malnourished children ( $100.76 \pm 18.81$  mmHg) and nourished children ( $107.07 \pm 18.6$  mmHg). There was a significant difference ( $P = 0.014$ ) between mean DBP ( $56.52 \pm 11.52$  mmHg) in

malnourished children and that of normal children ( $61.10 \pm 14.06$  mmHg). Malnourished children had similar ( $P = 0.50$ ) mean HR ( $94.90 \pm 13.0$  beats/min) with normally nourished children ( $92.68 \pm 14.96$  beats/min) as shown in Table 2.

### 3.3 Nutritional Status and Physical Aptitude in Relation to Sex, Age and Level of Urbanization

The mean  $\pm$  SD 6MWT was higher in males ( $852.83 \pm 146.46$  m) than females ( $773.83 \pm 119.66$  m) and the difference was highly significant ( $P < 0.001$ ). Males also had a significantly higher mean BJ ( $1.69 \pm 0.31$  m) when compared with their female counterparts ( $1.46 \pm 0.24$  m). Table 3 indicates that males also had a significantly higher ( $P < 0.003$ ) mean  $\pm$  SD time for the 30m dash ( $6.22 \pm 0.24$  sec) when compared with the female counterparts ( $5.79 \pm 0.06$  sec).

Children aged >10 years had a higher mean 6MWT ( $839.27 \pm 144.58$  m) as compared with those aged 6 -10 years old ( $744.04 \pm 95.09$  m) and the difference was highly significant ( $P < 0.001$ ). Similarly for BJ, those aged >10 years had a significantly higher ( $P < 0.001$ ) mean ( $1.63 \pm 0.32$  m) than those aged 6 -10 years ( $1.43 \pm 0.20$  m).

Children from rural areas had a significantly higher ( $P < 0.001$ ) mean 6MWT ( $879.80 \pm 159.40$  m) than those from urban areas ( $759.31 \pm 87.21$  m). Participants from rural areas also had a higher mean BJ ( $1.63 \pm 0.34$  m) when compared with those from urban areas ( $1.54 \pm 0.26$  m) and the difference was highly significant ( $P < 0.001$ ). Children from rural areas took significantly ( $P = 0.001$ ) more time ( $6.15 \pm 0.06$  sec) to cover the 30 m dash when compared with those from urban areas ( $5.86 \pm 0.22$  sec).

Normally nourished children had a comparable value ( $P = 0.07$ ) for mean 6MWT ( $818.88 \pm 141.71$  m) when compared with malnourished children ( $762.14 \pm 83.18$  m). Normonourished children also had a similar mean BJ value ( $1.59 \pm 0.30$  m) with the malnourished children ( $1.52 \pm 0.25$  m). The time taken by normonourished children for the 30 m dash ( $5.87 \pm 0.88$  Sec) did not vary significantly ( $P = 0.09$ ) from that of malnourished children ( $6.20 \pm 1.17$  Sec) as shown in Table 3.

**Table 1. Characteristics and anthropometric parameters of the study population (N = 633)**

Factor	Category	Enrolment	%	Anthropometric parameters (Total)							
				Weight (kg)		Level of significance		height (m)		Level of significance	
				F	P	F	P	Value	F	P	
Sex	Male	346	54.7	40.26±12.96	1.198	0.27	1.51±0.17	6.44	0.01		
	Female	287	45.3	39.15 ±12.34			1.48±0.14				
Age (years)	6 -10	148	23.3	25.99 ±5.36	355.2	<0.001	1.31±0.88	495.8	<0.001		
	> 10	485	76.6	43.96± 11.21			1.56±0.27				
Zone	Rural	303	47.9	42.34±11.87	24.9	<0.001	1.53±0.14	30.54	<0.001		
	Urban	330	52.1	37.39±12.96			1.46±0.16				

**Table 2. Nutritional status and cardiovascular parameters in relation to sex, age and zone of residence (N = 633)**

Factor	Category	Cardiovascular parameters								
		SBP (mmHg)			DBP (mmHg)			HR (beats/min)		
		Value	F	P	Value	F	P	Value	F	P
Nutritional Status	Malnourished	100.76 ±18.81	2.33	0.12	56.52±11.52	2.11	0.014	94.90±13.0	0.45	0.50
	Normonourished	107.07±18.6			61.10±14.06			92.68±14.96		
Sex	Male	106.26±18.87	0.55	0.46	60.48±14.02	0.64	0.42	97.38±13.66	47.59	<0.001
	Female	107.36±18.44			61.38±13.99			89.16±14.95		
Age (years)	6 -10	97.91±14.54	47.98	<0.001	57.61±13.20	10.70	<0.001	98.95±15.75	35.10	<0.001
	> 10	109.60±18.88			61.88±14.11			90.87±14.11		
Level of urbanization	Rural	106.90±18.38	0.002	0.96	60.98±12.932	0.03	0.09	91±15.02	8.04	<0.001
	Urban	106.83±18.88			60.80±14.94			94.36±14.62		

**Table 3. Nutritional status and physical aptitudes in relation to sex, age and level of urbanization**

Factor	Category	Physical parameters								
		6MWT (m)			BJ (m)			30 m dash (Sec)		
		Value	F	P	Value	F	P	Value	F	P
Nutritional Status	Malnourished	762.14±83.18	3.32	0.07	1.52±0.25	0.93	0.33	6.20±1.17	2.85	0.09
	Norm nourished	818.88±141.71			1.59±0.30			5.87±0.88		
Sex	Male	852.83±146.46	53.76	<0.001	1.69±0.31	101	<0.001	6.22±0.24	60.11	0.003
	Female	773.89±119.66			1.46±0.24			5.79±0.06		
Age	6 – 10	744.04±95.09	56.68	<0.001	1.43±0.20	54,03	<0.001	5.93±0.24	0.08	0.14
	>10	8839.27±144.58			1.63±0.32			6.06±0.06		
Level of urbanization	Rural	879.84±159.40	142.2	<0.001	1.63±0.34	157	<0.001	6.15±0.06	16.22	0.001
	Urban	759.31±87.29			1.54±0.26			5.86±0.22		

### 3.4 Correlation between Nutritional Status, Cardiovascular Parameters and Physical Aptitudes of the Study Population

Table 4 shows that there was a negative correlation between the HR and BJ in the normonourished children ( $R = -0.29$ ;  $P < 0.001$ ) and the total population ( $R = -0.28$ ;  $P < 0.001$ ), but the correlation was not significant in the malnourished children ( $R = -0.099$ ;  $P = 0.67$ ). There was a negative correlation between the HR and mean 6MWT in the normonourished children ( $R = -0.27$ ;  $P < 0.001$ ) and the total population ( $R = -0.27$ ;  $P < 0.001$ ). The correlation was however not significant in the malnourished children ( $R = -0.07$ ;  $P = 0.75$ ). There was a positive correlation between the HR and 30m dash in the normonourished ( $R = 0.26$ ;  $P < 0.001$ ) and the total population ( $R = 0.26$ ;  $P < 0.001$ ). But this correlation was not significant in the malnourished ( $R = 0.34$ ;  $P = 0.13$ ).

There was a negative correlation between the SBP and 30 m dash in the normonourished ( $R = -0.23$ ;  $P < 0.001$ ) and the total population ( $R = 0.22$ ;  $P < 0.001$ ), but this correlation was not significant in the malnourished ( $R = 0.38$ ;  $P = 0.87$ ) as shown in (Table 4). There was a positive correlation between the SBP and mean BJ in the normonourished ( $R = 0.17$ ;  $P < 0.001$ ) and the total population ( $R = 0.18$ ;  $P < 0.001$ ). However, this correlation was not significant in the malnourished ( $R = 0.34$ ;  $P = 0.12$ ).

Table 4 indicates that there was a negative correlation between the DBP and 30 m dash in the normonourished children ( $R = -0.17$ ;  $P < 0.001$ ) and the total population ( $R = -0.17$ ;  $P < 0.001$ ). This correlation was not significant in the malnourished children ( $R = -0.01$ ;  $P = 0.98$ ). In the normonourished children, there was a positive correlation between the DBP and BJ ( $R = 0.13$ ;  $P < 0.001$ ) and the total population ( $R = 0.13$ ;  $P < 0.001$ ). But this correlation was not significant in the malnourished ( $R = 0.02$ ;  $P = 0.91$ ).

## 4. DISCUSSION

The purpose of this study was to determine the prevalence of malnutrition in school children in northern Cameroon and investigate the association between their nutritional statuses

with cardiovascular profiles and physical aptitudes. Chronic malnutrition (stunting) has been reported to be wide spread in Cameroon, (35.8%) especially in the North Region [1]. Contrary to previous reports, this study revealed that the prevalence of malnutrition was relatively very low (3.3%) in the North Region of Cameroon. Only 0.3% of children were severely malnourished while 3.0% were moderately malnourished cases. This drop in the prevalence of malnutrition in recent years could be attributed to a nutrition transition which involves a shift in diets of populations towards increasing consumption of energy dense food and high calorie liquids, as well as an increasing and more stable access to low priced foods [20]. It could equally be attributed to behavioural changes including the promotion of a feeding scheme in government schools, physical activity and dietary interventions that have received keen attention in recent years in the northern part of Cameroon. Although school feeding programmes cannot reverse the consequences of earlier cases of malnutrition, literature demonstrates that providing free and nutritionally balanced meals in school can have a significant impact on the nutritional status and educational outcomes in children. It has also been reported that children who are well nourished are generally more attentive and active during classes when compared with their malnourished counterparts [20,21].

The prevalence of malnutrition was similar in males and females. However, previous studies had suggested that the daily energy and micro-nutrient intakes of children should be different with respect to gender [22]. Children aged >10 years had a similar prevalence of malnutrition when compared with those aged 6 -10 years. This may be due to the fact that children in both age groups have similar sources and quality of food. However, adolescents are generally known to experience a less follow-up in the kind of food that they eat and generally have more freedom of making food choices for themselves when compared with younger children. The prevalence of malnutrition in children from urban and rural areas was comparable. This may also be linked to the recently introduced school feeding programme in northern Cameroon which is free-of-charge in both rural and urban areas irrespective of the social status of the children.

**Table 4. Correlation between physical aptitudes parameters, nutritional status and cardiovascular parameters**

Cardiovascular parameter	Nutritional status	Correlation indices			
		6MWT(m)	BJ (m)	30 m dash (sec)	BMI (z-score)
SBP mmHg)	Total population	0.05 (0.20)	0.18 (<0.001)	- 0.22 (<0.001)	0.25 (<0.001)
	Malnourished	0.06 (0.077)	0.34 (0.12)	0.04 (0.87)	-0.12 (0.59)
	Normonourished	0.05 (0.25)	0.175 (<0.001)	-0.23 (<0.001)	0.25 (<0.001)
DBP (mmHg)	Total population	0.01 (0.84)	0.138 (<0.001)	-0.17 (<0.001)	0.14(<0.001)
	Malnourished	-0.09 (0.70)	0.02 (0.91)	-0.01 (0.98)	-0.14 (0.54)
	Normonourished	0.01 (0.84)	0.138 (<0.001)	-0.17 (<0.001)	0.14(<0.001)
HR (pulse/min)	Total	-0.27 (<0.001)	- 0.28 (<0.001)	0.26 (<0.001)	0.01 (0.82)
	Malnourished	-0.07 (0.75)	-0.09 (0.67)	0.34 (0.13)	0.38 (0.09)
	Normonourished	- 0.27 (<0.001)	- 0.29 (<0.001)	0.26 (<0.001)	0.01 (0.71)
BMI ( z-score)	Total	-0.2 (0.67)	- 0.01 (0.07)	- 0.03(0.41)	1
	Malnourished	-0.25 (0.28)	-0.29 (0.19)	0.23 (0.31)	1
	Normonourished	-0.04 (0.26)	- 0.09 (0.02)	- 0.032(0.41)	1

Values in brackets represent the p-values while the others represent the correlation coefficients R.

The overall prevalence of hypertension (HT) was 0.31%. Previous studies revealed that the prevalence of hypertension was much lower in children than adults [23]. The low body mass index recorded in the children was probably due to improved diet habits as stated above as well as regular exercises as Physical Education has also been made a compulsory subject in all the schools in Cameroon and it is assessed in various official examinations with a high coefficient. These measures are likely to have lowered systolic and diastolic blood pressures, improved the strength of the heart and reduced blood cholesterol. These are important steps in preventing heart diseases at adulthood.

The prevalence of hypertension was similar in males and females. This is in line with the reports of Shubi [24] who opined that there are no appreciable differences in levels of blood pressure of children between the sexes. Children aged >10 years had higher mean DBP and SBP than those aged 6 -10 years. The increase in DBP and SBP values with an increase in age may be attributable in part to an increase in body mass. Generally, blood pressure is low at infancy and rises slowly with the age of children and children >10 years were found to be significantly heavier and taller than those aged 6 -10 years.

The mean 6MWT and BJ were significantly higher in males than females. This may be due to the greater muscle mass in males and their ability to achieve higher performance in physical activity [7,8]. These findings also accord well with a study which reported that age, sex and health status had more influence on the 6MWT than height and weight [25]. An increase in anaerobic

and aerobic functional capacities are higher in boys than girls and this is necessary to achieve the oxygen demand for the higher amount of skeletal muscle mass in boys [12]. This observation could also be due to the fact that females have shorter stride lengths and consequently have a lower performance in the 6MWT and BJ when compared with the males. The same thing goes for those who are less motivated or have impaired cognition.

The study also revealed that children from rural areas experienced a higher mean performance in 6MWT, BJ and the 30 m dash, when compared with those from the urban area. This may be due to the relative sedentary lifestyle of children from urban areas. Such children are more likely to go to and from school by car. They are more likely to spend most of their time engaged in indoor activities such as watching television. The reverse is the case with children from rural areas who mostly walk on foot for several kilometres to and from school. They usually accompany their parents to farms and such activities keep them physically fit as far as their aerobic capacity is concerned. It is worth emphasizing here that sports centres which are usually organized only during the holidays, need to be done throughout the year in Cameroon. Parents need to encourage their children to regularly exercise at home and/or register in school sport clubs, since the allocated time of two hours per week in schools for physical education might not be enough for their optimal performance.

Children aged >10 years significantly performed better than those aged 6 -10 years in the 30m dash. This finding could be related to the fact that



age positively affects sprint speed, especially after childhood. This ability is significantly affected by the efficient energy transfer from the hip to the ankle joint and by other factors such as the optimization of the stride length and frequency, muscle morphology and architecture, neuromuscular coordination, training, and age [26]. Other factors that could explain the gradual improvement of sprint speed with age during childhood and adolescence are the maturation of the neuronal system, the improved coordination between agonist and antagonist muscles, the increase in efficiency (running economy) and the potential transformation from slow- to fast-type motor units [27].

The mean physical aptitude parameters of malnourished children in the 6MWT and BJ were comparable ( $P>0.05$ ) with those of the normonourished children. This is contrary to some of the findings reported in children in other countries, which have shown a significantly lower 6MWT in children who are overweight compared to their normal counterparts. The increased or decreased body mass in children who are stunted demands more energy that can limit the distance covered and consequently reduce their physical performance [28].

There was a positive correlation between HR and the 30 m dash ( $P<0.001$ ); SBP and BJ ( $P<0.001$ ) as well as between DBP and BJ ( $P<0.001$ ) in the normonourished children ( $P < 0.001$ ), but not in the malnourished children ( $P > 0.05$ ). An increase in heart rate could contribute to the increase of the cardiac output, which is the product of the heart rate and the stroke volume; leading to a better supply of oxygen to muscles [29,30]. As long as the heart rate remains normal and more especially as these children were not highly trained athletes, this might justify the increase in heart rate associated with better performance in the 30 m dash. Since the recordings of heart rate were done prior to the test, the children with higher heart rates were better predisposed to develop a greater cardiac output. One would have expected a similar relationship between HR and 6MWT, but the correlation was found to be negative. It is understandable that in such a test, other factors such as the power of leg muscles, motivation and attitude towards the test might be more influential [31]. The explanation of the correlation between SBP and BJ or between DBP and BJ is also uncertain. However, BJ is an explosive exercise (by single jump), the power of the muscles could have been better used here to attempt for an explanation. These findings are in

line with some studies which suggested that malnourished children suffer several alterations in body composition, with loss of heart and skeletal muscle mass, complicated by electrolyte abnormalities and mineral or vitamin deficiencies that could produce cardiac abnormalities. These include hypotension, cardiac arrhythmias, cardiomyopathy, cardiac failure and even sudden death [30]. This electrolyte imbalance affects systolic blood pressure and heart rate such that any bit of effort by these malnourished children increases these factors at an exponential rate.

The absence of correlation between cardiovascular parameters and performance parameters in malnourished children can be understood since only 3.3% of the children were malnourished. It is worth noting from these results that physical activity is beneficial to health as it reduces the risk of cardiovascular diseases and improves body composition. Previous studies reported that measures like providing free high energy protein meals during break in schools and educating the children on the necessity of living on cheap quality food, are able to reduce cardiovascular risk factors and obesity in children [30].

## 5. CONCLUSION

The findings from the current study suggest a weak relationship between the nutritional status, cardiovascular and physical aptitudes parameters of the school children living in rural and urban areas. However, there were some positive correlations between cardiovascular parameters and physical aptitudes in the normonourished in the rural and urban areas. The very low prevalence of malnutrition could be due to the introduction of a government school feeding scheme prone with high protein-energy food.

## INFORMED CONSENT

Assent from selected participants and written informed consents from their parents or legal guardians were obtained, prior to data collection and experiments.

## ETHICAL CONSIDERATION

An ethical clearance for the study was obtained from the Institutional Review Board of the North Regional Delegation of Public Health. Administrative clearance and permission were

obtained from the North Regional Delegations of Secondary and Basic Educations.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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