

Anthropometric and Hemodynamic Profiles of Athletes and Their Relevance to Performance in the Mount Cameroon Race of Hope

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Abstract

Purpose: Many factors influence athletes' performance including anthropometric, physiological and environmental parameters. High altitude is characterized by adverse environmental conditions that are not found at sea level. We investigated the influence of some anthropometric and physiological factors on performance in the context of the Mount Cameroon Race of Hope.

Methods: Age, height, weight, blood pressure, heart rate and breathing rate of 83 finisher athletes of both genders were collected during medical checkup, and race time was recorded at the arrival line. Measured and calculated data association with performance was assessed.

Results: The race time was significantly influenced by the area of training ($p=0.0022$), and gender ($p=0.0036$) of athletes; BMI showed significant association with race time in the overall athletes' population; this was confirmed in male ($r=0.565$; $p=0.034$) but not in female athletes ($r=0.749$; $p=0.058$). Weight class showed significant association to performance, the lighter athletes performing better than the heavier ($p<0.00001$). None of the investigated physiological parameters showed association to the race time.

Conclusions: We hypothesized that high altitude training and body size are significantly influential on athletes' performance in the Mount Cameroon race of hope and similar mountain races.

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INTRODUCTION

A multitude of factors affect physical performance. Beside biological factors such as age, sex, height, weight and body composition, a variety of external influences contribute to observed performance, including nutrition, psychological and training status, fatigue, drugs, and environmental factors [1,2]. Like anthropometric parameters, several physiological factors show an association with endurance performance. Some of these, such as lactate threshold, oxygen uptake, running economy, hemoglobin concentration, energetic metabolism and fiber types proportion in muscle have been shown to impact athletes' performances in endurance and extra-endurance competitions [3,4,5].

The effects of altitude on physical performance are extensively discussed and divisive for specialists of environmental considerations in sport [6]. Increase in altitude, results in more intense solar radiation and reduction of barometric pressure, ambient temperature, relative humidity, air density and partial pressure of all gases including oxygen. Athletes in this context have to face many adverse environmental conditions, the most important being hypoxia with its incidence on physical performance. To counter these problems, the body generates immediate and complex compensations in respiration, metabolism, and hemodynamic regulations for the redistribution of blood flow to vital organs and maintenance of systemic oxygenation which is critical for survival [7,8].

The effects of both physiological and anthropometric factors vary, depending on the intensity, duration, mode and some other peculiarities of physical exercises. Data available on the impact of these factors on athletes have mostly been obtained at sea level. Few studies have been carried out for high endurance in the context of high mountain racing and they mostly aimed at assessing physiological response. As the mount Cameroon Race of Hope is concerned, only one study was found in literature and aimed to assess the effects of sickle cell traits on athletes' performance [9].

The Race of Hope is a grueling footrace that gives a good opportunity for assessing the impact of some anthropological and physiological parameters on athletes' performance in the context of high altitude competition. However, no scientific data is presented in international literature.

METHODS AND SUBJECTS

The present work is a transversal study based on data collected from athletes who participated in the 2011 Race of Hope. The study was approved by the local Institutional Review Board. Oral informed consent was received from all participants after verbal explanation of the experimental design.

Subjects:

In February 2011, 124 athletes (110 males and 14 females) finished the race to the summit and back in the official time. Data from 73 male and 12 female

volunteer finisher athletes collected during medical fitness control were used for the purpose of this study, as athletes who had incomplete data, who were disqualified at the medical checkup or in the course of the race were excluded. The athletes were from seven regions of Cameroon, situated at varied altitudes (Table 1).

The area and the race:

Mount Cameroon is a live volcano situated at Longitude 9° 170' East and Latitude 4° 203' North, part of the 1600 km long chain of Cenozoic volcanic and sub-volcanic complexes that extends from the Gulf of Guinea to the interior of the African continent, known as the Cameroon Volcanic Line [10].

The town of Buea in the South-West region of Cameroon hosts the Race of Hope, an annual sport event that takes place each month of February in the course of the main dry season. The main race covers a marathon distance of 42,000 m, ascending mount Cameroon, to its 4,090 m summit and back to the Molyko stadium over a 6,096 m vertical feet round-trip [11]. The race takes athletes from different origins through various climactic zones such as rainforest, savannah, up to the freezing summit. They have to face very difficult conditions such as temperature fluctuation, mountain malaise and injuries due to loose volcanic stones, exposing them to harder conditions than those admitted by international norms and thus, to adverse reactions such as injuries and Acute High Altitude Diseases [12,13]. The 2011 race took place on the 26/02/2011 and saw the participation of athletes from different origins within the country and from abroad. The race was launched at 7.30 am and the last official finisher was recorded at 4.30 pm.

Table 1: Performances of athletes from various training altitudes

Training regions	Mean altitudes of regions (m)	Number of athletes	Race time (s)	
			Mean (SD)	Range
Littoral	22	8	25251 (2440)	19816 - 27734
Adamaoua	271	1	23512 (0)	---
East	717	2	27048 (970)	26362 - 27734
Center	855	7	21493 (3505)	17842 - 26734
South-West	1000	20	21872 (3060)	16967 - 26874
West	1390	9	21678 (3183)	17072 - 24659
North-West	1615	37	21455 (3280)	16149 - 28933

SD: Standard Deviation

All athletes had their anthropological and physiological measurements recorded during the medical fitness control visit by the appointed health crew based in the Regional Hospital annex in Buea, on the 14th and 15th Feb 2011. Information was also recorded on the region of training of athletes.

Measurements and calculations:

Anthropometric characteristics (height and weight) were measured using a SECA[®] 755 dial column mechanical scale with included SECA[®] 220 height rod; BMI was calculated and athletes were classified as underweight (BMI<18), normal (18≤BMI<25) and overweight (BMI≥25) according to the WHO classification [14].

The resting Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were measured on the right arm of each participant using cuffs of appropriate size and calibrated Spengler[®] VAQUEZ-LAUBRY, integrated aneroid sphygmomanometer and a stethoscope. Optimal blood pressure was defined as a SBP<120mmHg and DBP<80mmHg. Pre-hypertension was defined at a SBP of 120 to 139mmHg and/or DBP of 80 to 89mmHg, and hypertension was diagnosed at a SBP≥140mmHg and/DBP≥90mmHg, according to international guidelines [15]. Mean arterial pressure (MAP) was calculated as (SBP + 2 x DBP)/3 and the average BP (ABP) as SBP – DBP. Pulse and breathing rate were assessed, counting the beats of the radial artery and the movements of the chest respectively, for

1 minute using a chronograph. The measurements were taken after subjects were in resting position in a calm, quiet environment for at least 10 minutes.

Statistical analysis:

The data are expressed as means ± standard deviation. Anthropometric and physiological parameters were correlated with race times. Statistical analysis was performed with the Statistica™ 7.0 package. They were used in linear regression analysis to identify the performance relevant anthropometric and physiological parameters. Directly measured anthropometric and physiological data (body mass, height, resting Systolic BP, resting Diastolic BP and resting Heart Rate) and calculated data (BMI, Differential Blood Pressure, Mean Blood Pressure), were compared using the one tail ANOVA model with the F-test. The significance level was established at *P*-value <0.05.

RESULTS

Anthropometric and physiological characteristics of male and female athletes are presented in Table 2. Underweight athletes were 3.6%, athletes in the normal range 83.1% and overweight athletes 13.2% of the overall athletes' population. Anthropometric parameters showed statistically significant difference

Table 2: Anthropometric and physiological parameters of athletes

Parameter	General (n=83)		Males (n=71)		Females (n=12)		P value
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	
Age (Years)	28.6 (6.08)	18-44	28.9 (5.95)	18-44	26.83 (6.81)	19-38	0.3
Height (cm)	168.57 (6.60)	150-191	169.85 (5.97)	159-191	161 (4.99)	150-167	<0.001
Weight (Kg)	64.19 (7.43)	46-85	64.79 (7.41)	46-85	60.63 (6.79)	51-72	0.07
Systolic Blood Pressure (mmHg)	130.41 (12.63)	102-167	132.49 (11.91)	102-167	118.08 (9.63)	103-130	<0.001
Diastolic Blood Pressure (mmHg)	72.18 (9.63)	50-105	72.65 (10.01)	50-105	69.42 (6.65)	56-80	0.3
Average Blood Pressure (mmHg)	58.23 (13.33)	27-97	59.85 (13.16)	27-97	48.67 (10.27)	32-64	0.006
Mean Arterial Pressure (mmHg)	91.59 (8.69)	71.67-115.67	92.6 (8.69)	71.67-115.67	85.64 (6.08)	76.67-94.33	0.009
Heart rate (Pls/min)	66.61 (10.69)	42-93	65.81 (10.33)	42-88	71.25 (12.02)	50-93	0.1
Breathing rate (Mvt/min)	16.77 (2.43)	11-23	16.41 (2.26)	11-20	19.09 (2.26)	15-23	0.01
Body Mass Index (Kg.m ⁻²)	22.60 (2.40)	15.02-28.67	22.46 (2.29)	15.02-28.07	23.45 (2.97)	18.73-28.67	0.2
Race time (In seconds)	22032 (3279)	11585-28933	21610 (3208)	11585-16149	24531 (2588)	20034-28933	0.003

SD: Standard Deviation

between male and female athletes for the body height, but not for the BMI and body weight. Significant differences were observed between male and female athletes for Systolic BP, MAP and ABP. However, no significant gender difference in physiological parameters was found for heart rate and DBP.

The prevalence of optimal blood pressure, pre-hypertension and hypertension in athletes was 13.25%, 67.47% and 19.28% respectively, with the systolic blood pressure and 73.49%, 21.69% and 04.82% respectively with diastolic blood pressure. Hypertension with both parameters was only found in male athletes.

Concerning athletes' performances, the race time was significantly influenced by the gender of athletes ($F_{1, 81}=8.938, P=0.004$), their region of training ($F_{4, 81}=4.577, P=0.002$), and in males only, the height ($r=-0.512; P=0.02$) and BMI ($r=0.565; P=0.003$) (Fig. 1, 2). A significant race time difference was found between underweight, normal and overweight athletes (race time 18594 s, 21802 s and 24415 s respectively; $F_{2, 80}=62.657, P<0.001$).

No influence of height or BMI on performance was observed in female athletes ($r=0.079, P=0.06; r=0.749, P=0.06$) and no physiological parameter either measured or calculated showed significant influence on athletes' performance.

DISCUSSION

The present study shows a significant effect of BMI on the performance of male athletes. As is the case with long distance runners, BMI influenced the performance of Mount Cameroon athletes, yielding a positive correlation with the race time, the speed being higher in athletes from the underweight to the overweight. This finding is in accordance with the general pattern in runners [16]. In fact, chronic exposure to reduced partial pressure of oxygen as it is the case at high altitude, decreases arterial oxygen saturation, provoking shifts in substrate metabolism [17]. This increases the difficulty for the body to use oxidative phosphorylation to produce the energy needed for endurance exercise; the glycolytic pathway is therefore favored rather than other catabolic pathways, including fat catabolism for energy production, because it has the lowest oxygen cost. A greater ability in fats use for energy production by females may explain the difference observed with males concerning the influence of BMI on performance. The sex specificity of this shift has already been reported [5, 18]. However, the reduced sample size does not allow for any objective conclusion.

Nevertheless, our finding contrast with that of triathletes in whom no influence of BMI was found on

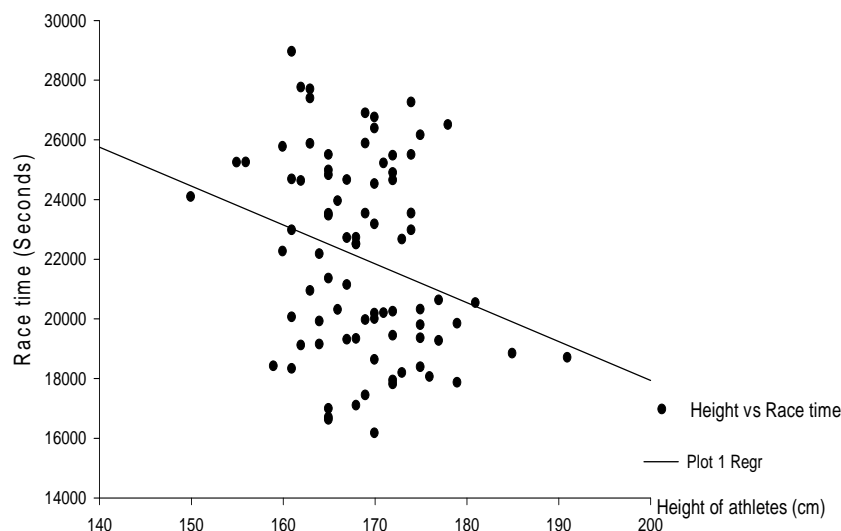


Fig.1- Scatered plot presenting the linear regression between the height and race time of athletes ($r=-0.512; P=0.02$)

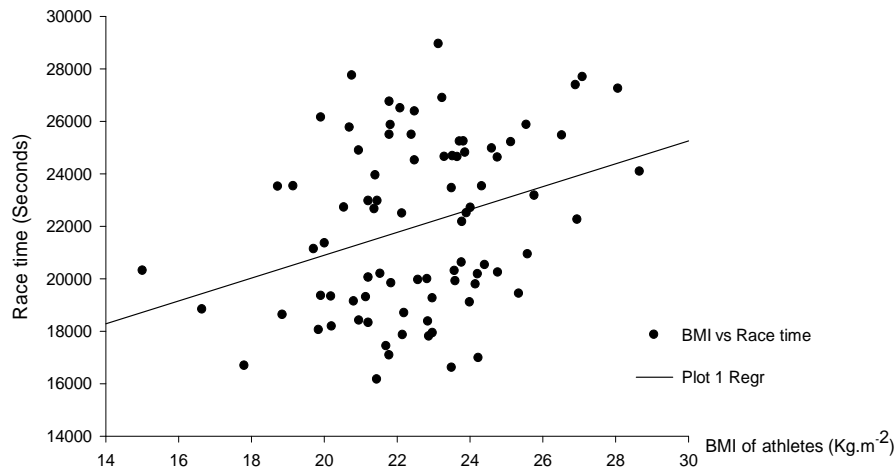


Fig.2- Scatered plot presenting the linear regression between the BMI and race time of athletes
($r=0.565$; $P= 0.003$)

the performance [19]; this might be due to the varied set of exercises (swimming and cycling, added to running), the longer duration of the race with recovery periods and differences in environmental conditions.

Training area was highly influential on the performance of athletes. The results showed better performance for athletes from low to high altitude training sites. This is in accordance with previous investigations which showed that natives of high altitude areas or those athletes training at high altitude perform better both in low and high altitude. This has lead athletes to implement the “live high, train high” preparation system, and can be explained by the favorable genetic background in natives and adaptation to the high altitude environment; these enhance exercise capacity and tolerance both at sea level and high altitude [2, 20, 21].

Men had better s than women; this owes to their higher muscle mass and their higher maximal oxygen consumption (VO_2Max) that make them more powerful in efforts [22].

None of the assessed physiological parameters had a significant influence on athletes' performance. This could be explained by the fact that aptitude to race is mostly tributary to the compliance of the body system so that acute physiological adjustments to maintain body homeostasis are produced, which are not directly related to resting body functions parameters.

The results of this investigation could be bias as no data was collected concerning the training status of participants. However, this information database is of great interest, and to the best of our knowledge, it is the first time that data are collected for scientific investigations in the course of the Mount Cameroon Race of Hope which has the peculiarity of acutely taking the athletes up an down the mountain, in the shortest length of time. Furthermore, data on high altitude mountain competition are not commonly found in literature.

CONCLUSION

The essential findings in this study are that altitude of training, height and BMI were significantly influential on athlete's performance in high mountain competition whereas other anthropometric parameters as weight, age, and physiological data as resting blood pressure, heart rate and breathing rate do not influence performance. These results could be useful for athletes' preparation for the competition as success might depend on the acclimatization to high altitude environment, body size and thus, on diet.

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Conflict of interests: None

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