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Nutritional status, socio-economic status, heart rate, and blood pressure in African school children and adolescents

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Abstract

Objectives: To determine the impact of gender, nutritional anomalies, puberty and socio-economic status on the levels of blood pressure, fat distribution and heat rate in African school children and adolescents. This study also identified the risk factors of arterial hypertension in African adolescents.
Design: A cross-sectional study carried out between April and July 1996.
Setting: Randomly selected schools of the semi-urban area of Kinshasa Province, capital of the Democratic Republic of Congo.
Subjects: 1535 school children and adolescents.
Outcome measure: Height, weight, waist circumference, hip circumferences, blood pressure and heart rate were measured. Body mass index, and waist–hip ratio, and *Z*-scores of NCHS/WHO for different levels of malnutrition were calculated for gender and age.
Results: High rates of malnutrition forms and overweight/obesity coexisted. Boys with chronic malnutrition had significant higher blood pressure levels. Children with pooled types of malnutrition had higher waist circumference, waist–hip ratio and heart rate values. Children from the low socio-economic status had higher blood pressure and heart rate levels than those from high socio-economic status. Overweight/obesity was more ($p<0.05$) prevalent among female adolescents (68.5%) than male adolescents (24%). Obese male adolescents had higher blood pressure and heart rate levels than their non-obese male counterparts. 39% of variations of systolic blood pressure of male adolescents were explained only by body mass index, whereas 56% of variations of diastolic blood pressure of male adolescents were explained only by age. Only low socio-economic status was identified as a significant risk factor of arterial hypertension among these African adolescents (OR = 1.2; 95% CI 1.1 to 1.3; $p<0.01$).
Conclusion: Intervention strategies to combat poverty and high cardiometabolic risk may need to be developed for these African school children and adolescents.

Keywords: Malnutrition; Socio-economic status; Obesity; Heart rate; Fat distribution; Hypertension; Africa

1. Introduction

Malnutrition with different levels of severity, is one of the leading causes of infantile morbidity and mortality world-wide [1] and particularly in pre-school African children [2,3].

There is evidence that under nutrition in early life and subsequent intrauterine growth retardation as well as rural–urban migration lead to the development of arterial hypertension [4–6], stress, and obesity. Elevated heart rate, a feature of stress and hyper-adrenergic sympathicotony in obesity, is well established as a cardiovascular risk factor [7]. Furthermore, the prevalence of childhood obesity has more than doubled in the last 15 years in many regions of the world [8,9]. Abdominal obesity is emerging as an important driving force behind the deterioration of cardiometabolic risk [10].

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However, there is no data on the role of the early interaction of non-modifiable (environment, cardiovascular) diseases in Africa. Indeed, the lack of information on the relationship between nutritional status, socio-economic status and cardiovascular risk (high blood pressure and heart rate) hampers the development and implementation of specific cardiovascular disease prevention programmes among African children in course of epidemiological and nutrition transitions. Those transitions are characterized by the coexistence (double burden) of denutrition in action of obesity, and arterial hypertension.

The present study therefore aimed to examine the impact of gender, nutritional anomalies, puberty and socio-economic status on the levels of blood pressure, fat distribution and heart rate in African school children and adolescents. This study also identified the risk factors of arterial hypertension in African adolescents.

2. Subjects and methods

2.1. Subjects

The sample for this study was a representative group of various schools from the semi-urban area of Kinshasa, capital of the Democratic Republic of Congo, with valid anthropometric parameters. Thus, a total of 1535 randomly selected subjects agreed to participate and provided informed consent according to Helsinki II Declaration. The design of this cross-sectional study was described in details elsewhere [6]. Permission was obtained from the supervising Ministry of Education. In each school, the school administration gave its consent, and the Tutor of every selected class explained the nature of the study to school children.

The Research and Ethics Committee of the Congolese Ministry of Health gave approval to conduct the study. Informed written consent was obtained from the parent or guardian of each pupil before they were allowed to participate in the study and pupils gave verbal assent.

2.2. Procedure

Data was collected between April and July 1996 and during working hours (09:00–13:00 h). The average of two anthropometic measurements provided summary of nutritional status. Body weight rounded to the nearest 100 g and height to the nearest 1 cm, were reached with the children and adolescents in loose clothing without shoes, using a standard medical balance scale and height bar.

The scale was calibrated to zero at the beginning of the day measurements. Body mass index (BMI) was calculated as weight (kg)/height (m^2) [12]. Waist circumference was measured in duplicate to the nearest 1 mm midway between the lowest rib margin and iliac crest, and hip circumference at the widest trochanters. Waist-to-hip (WHR) ratio was computed. However, nutritional intake was not assessed in this study.

After 20 min of quiet sitting, the Blood pressure (BP) and heart rate (HR) were measured five times using an electronic blood pressure monitor (Omron HEM-705 CP device, Tokyo, Japan). In the pilot study, good agreement was found between the readings from the automatic device and measurements taken with a conventional sphygmomanometer.

2.3. Definitions

The lowest socio-economic status was defined by the underdeveloped environment according to the Congolese Ministry of Interior: slum area, lack of blocks, green spaces, electricity and tap water. The highest socio-economic status was characterized by affluent blocks with electricity, tap water, greener areas and sport (football) places.

Children were aged 5–11 years versus adolescents with age $\geq$ 12 years and secondary sexual signs or periodic (hormones: puberty).

Using anthropometric indicators [13] of pre-pubertal children such as weight for age (WFA), weight for height (WFH), and height for age (HFA) according to *Z*-scores lesser than the median of the population reference NCHS/WHO [14], various levels to grade protein-energy malnutrition were defined as follows: severe malnutrition $<$ *Z*-scores; moderate malnutrition between -3 *Z*-scores and <-2 *Z*-scores; normal nutrition status >-2 *Z*-scores; global malnutrition as a decrease in WFA; acute and current malnutrition as a decrease in WFH, and chronic malnutrition as a decrease in HFA or growth rate failure.

Arterial hypertension (high blood pressure) and overweight/obesity were defined as BP and BMI greater than mean + 1.96 SD of the gender group among adolescents was defined as $<$BMI-1.96 SD. The status of rural–urban migration in parents was obtained by a standard questionnaire.

2.4. Statistical analysis

The data of pre-pubertal and post-pubertal children were imported into EPI-INFO version 6.04 and SPSS version 10 for windows spreadsheets and analyzed.

The data were expressed as means ± SD or proportions (percentages). One analysis of variance (ANOVA) with Schéffé test for multiple comparisons and Chi-square test were used to compare group means for continuous variables and percentages for categorical variables respectively.

Multiple linear regressions were used to identify determinants of systolic blood pressure (DBP) in each gender group of adolescents. Adjusted odds ratios of arterial hypertension were calculated in adolescents using the logistic regression model considering undernutrition, migration of parents, gender, and potential risk factors for arterial hypertension.

The p value <0.05 was considered statistically significant.