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Effect of mid-day meal on nutritional status and haematological profile in school children of Cocody, Abidjan: a case control study

Abstract

We complete a research concerning nutritional status and hemtological profile to determine the impact of school feeding program (canteen) on pupil's health and growth. The protocol involved 139(50%) boys and 139 (50%) girls asymptomatic subjects aged from 5- 12 years old with an average of 9.10±1.9 year old living normal life attending 3 government primary school in Cocody (Abidjan, Côte d'Ivoire). Inclusive criteria were based on those children being healthy. Exclusive criteria were based on students with health complications were not included in that study. All data concerning anthropometric and hemtological parameters were analyzed statistically by using Graph Pad prism version 7 with student t test and Ratio G test. In this present student, total of 278 pupils were included, about 145 (52.16%) were from SMDM and 133 (47.84%) from Non SMDM. The prevalence of underweight, Stunting and overweight/obesity were observed in both group. Underweight was respectively 5.26% in Non SMDM group, 6.26% in SMDM group at J0 and 0.76% J 100 in SMDM group. Stunting was 6.77% in Non SMDM group, against 0.68 % and 0.76% respectively at J0 and J100 in SMDM group. Overweight/obesity was 15.04 in Non SMDM group, 15.15% and 15.37% respectively at J0 and J 100 in SMDM group. Concerning the prevalence of anaemia, 37.59 % in Non-SMDM and 21.37% at J0 and 11.53% at J 100 in SMDM group.

There was significantly higher prevalence of malnutrition and altered hemtological parameters in non SMDM group as compared to SMDM group. School midday meal improves child nutritional status and hemtological profile. So school canteen has a good effect on children health and nutritional status.

Keywords: malnutrition, school midday meal, hemtological parameters, anthropometry, cocody (Abidjan)

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Abbreviations: SMDM, school midday meal; HAZ, height for age z scores; WAZ, weight for age z scores; BMI, body mass index; BAZ, body mass index for age z scores; WHO, world health organization; RBC, red blood cells; MCV, mean corpuscular volume; WBC, white blood cell; MHC, mean haemoglobin concentration; MCHC, mean corpuscular hemoglobin concentration; fl, fentolitre; pg, pictograms; kg, kilograms; cm, centimeter; m, meter; g, gramme; dl, deciliter; ul, microliter; SD, standard deviation; EDTA, ethylene diamine tetra acetate; FAO, food and agriculture organization; SES, socio economical status

Introduction

Children living in developing countries are confronted by many nutritional challenges. On the one hand, food security, which is threatened with an inadequate supply of nutrients (energy, proteins, fats, minerals and vitamins) with low dietary diversity, is the bed of protein-energy malnutrition and, on the other hand, children are often exposed to a diet approaching occidental countries diet rich in empty calories and fat, most of time with unhealthy dietary practices, lead obviously to over-nutrition and obesity with its corollary of chronic non transmitted disease (diabetes mellitus, cardiovascular pathologies, hypertension).[1] Problems of macronutrient and micronutrient deficiencies most often associated with low protein foods and problems of overweight are the bed of malnutrition in developing countries. Today, malnutrition with its components namely: protein energy malnutrition, overweight and micronutrients deficiencies constitute a real public health problem in the world.[2]

Most of developing countries, characterized by widespread poverty due to scarce economic resources or an inequitable distribution of wealth accompanied by a fragile health system in society, remain the most affected, particularly countries from South-East Asia and Sub-Saharan Africa.[3] With 852 million malnourished between 2000-2002 according to Muller and Krawinkel,[3] today nearly one billion of individuals, (one in seven) suffer from malnutrition in the world.[4] Malnutrition remains one of the direct causes of infant mortality worldwide, with over 300,000 deaths per year among children under five years old and indirectly accounting for more than half of all deaths among young children.[5–8] Malnutrition is a state in which a deficiency or excess of nutrients may increase morbidity or mortality. Several investigators have reported on malnutrition and a risk of under-nutrition such as wasted or stunted condition or overweight in both healthy children and those with specific disorders.[9] The definition of malnutrition included both under-nutrition (underweight, stunting) and over-nutrition (overweight).

As every developing countries, Cote d'Ivoire doesn't escape from that scourge. In Côte d'Ivoire, the nutritional situation is worrying with regard to the background of the nutritional status of women and children who remain the most vulnerable people in society although the prevalence of malnutrition is decreasing. Malnutrition precisely under nutrition is the cause of nearly 33% of child and infant mortality. Stunting fell from 34% in 2006 to 29.8%; Underweight decreased from 20% to 14.9%, acute malnutrition was 7.5%, and overweight was 22.8%. Despite the decline in prevalence of protein-energy malnutrition observed these decades, we observe a more and more increasing number of individual who are overweighed and obese among the population. Unfortunately, children, do not escape from that situation. So malnutrition st ll remains a public health problem in Cote d'Ivoire.[10] However, these prevalence is not representative of the whole population. Most of survey carried out by demographic and health surveys (DHS), were focused on children under five years old, neglecting school-aged children whose number in developing countries is abundant. That's why, scarce are real data concerning them.[11]

While, primary school age is a dynamic period of physical growth and mental development of the child. Research indicates that nutritional deficiencies and poor health in primary school age children are among the causes of low school enrolment, high absenteeism, early dropout, learning difficulties and poor performance.[12] Malnutrition has serious impact on the heath by weakening the immunity system, decreasing the immune reactions, nutrients deficiencies leading to disease particularly anaemia caused by iron deficiency.[4,13] Also in these school-aged children the installation of malnutrition is insidious and asymptomatic, clinical signs being later to appear. Only biological examinations can detect nutritional disorders before appearance of clinical signs.[14] There are several methods for evaluating a patient's nutritional status, including anthropometric measurements, dietary intake, biochemical parameters, and resting energy expenditure.[9] In addition, the assessment of the nutritional status of a member or community is based on a number of clinical, biological, biophysical and anthropometric indices.[15] One of the most used method for nutritional status assessment in anthropometry.

Anthropometry is the only tool that is portable, universally applicable, inexpensive and non-invasive. Anthropometry is used to evaluate corpulence, proportions and composition of the human body and even the determination of nutritional and health status, predicting health and life-threatening of individual.[16] However, anthropometry is only limited for sub-clinical manifestations, so biological evaluation proves to be necessary. There are number of biological parameters which become altered during malnutrition. The privilege of biological evaluation of nutrition is the ability to detect changes long time before the biological and clinical disturbance becomes apparent.[17] Indeed, analysis of hemtological and biochemical parameters provide real information on the body's cells concentration. Blood analysis of the figurative and nutritive elements of the organism is a key mean to detect any metabolic abnormality and changes in an organism.[18] It is also the way to observe any variation (quantity and quality) of the rate body's cells. According to previous statement, we must know nutrition and food have an important effect on child growth and health among schoolchildren.

In Côte d'Ivoire, only few studies have been conducted on the impact of school food program on nutritional status and hemtological profile of school age children. Moreover, a recent global increase in both obesity and thinness urges us to evaluate the nutritional status in a general child population. Considering these facts, the purpose of that research is to determine the hemtological profile and nutritional status of school-aged children attending a canteen in comparison to their counterparts who take their lunch outside the canteen in Abidjan. That study is done in order to assess the effect of school midday meal on school children nutritional status. During that study we would determine the nutritional status of school children by anthropometry and haematological parameters by blood analysis in each child. After all we will appreciate the nutritional status of school children according to various groups.

Materials and methods

Design, setting of the study

This study was an introspective and observational study and was carried out for 4 months, from March 2016 to June 2016. The study site was government academic primary school situated in Abidjan (Côte d'Ivoire). Data for this study were obtained from a case and control regular survey designed to evaluate the nutritional status and hemtological profile of school children (aged 5-12years) in Cocody (Abidjan) Cote d'Ivoire. Cocody is a district of Abidjan (Abidjan). Abidjan is the economical capital of Cote d'Ivoire capital, the most populated and great town of the country. It occupies a total of 2119 square kilometers with an estimated population of more than 6 million of inhabitant with more than 160 nationalities.[19]

The climate in Abidjan is characterized by tropical humid and dry season with an annual average temperature ranging from 21°C and 31°C. The very hot month is March where temperature can reach sometimes 34°C. The annual rainfall of this region is estimated at 1152,2 mm , with approximately 90% of rain falls between April and October. The dry season normally begins in November and ends in March.

The city is bordered by the Atlantic Ocean and Ebrie Lagoon that makes Abidjan the pearl of lagoons. Abidjan houses the most important fishing, commercial port and harbor of West Africa and most of the main factories of the country. Abidjan is a cosmopolitan urban area with people from different regions, belonging to different ethnic group. Although a number of ethnic groups are represented in Abidjan, Ebrie Ethnic groups are the native of the area. The major language spoken in this area is French, although slang language (language of street) is also well spoken by everyone. That kind of language is a mix of different patois of the country with French. French is widely spoken in schools, offices and markets. Abidjan is acclaimed as Cote d'Ivoire "Food Basket", because of its diverse agricultural resources. Most of the food that comes from others regions of the country converge on Abidjan. For this regard, trading and agricultural are the mains activities in the area. Concerning activities, most of people are civil servant and business people. Apart from civil service, others people are mainly self-employed in companies, petty trading, private employed, fishermen, workers and wide proportion are unemployed person. Moreover, Abidjan knows the phenomenon of immigration. Rural and economical immigration from neighborhood countries is widespread involving working age men with a growing number of women and children, which lead to overpopulation, unemployment (youth unemployment), illiteracy, poverty and social insecurity.

The major staple foods are Attiéké (semolina of cassava (Manihot esculenta), yam (Dioscorea alata), plantain (Musa sinensis and Musa paradisiaca), Maize (Zea mais), bread, season fruits and vegetable are found abundantly on the market. Beef, fish, chicken, snail are the main sources of protein. However, some people in Abidjan didn't have normal diet and are still struggling to find their daily bread. More than 5% of the inhabitants do not spend more than one dollars US per day. High inflation, lowering of the population's purchasing power that leaded to increasing the level of poverty following the socio political instabilities the country faced from 2002 to 2012, contributed on a long term basis to the deterioration of nutritional status of the population. Cocody is the most expensive district in Abidjan, because it houses the best universities and high schools, primary schools of the country. Also the mains infrastructures such road, hospital, and banks are located in this area. In Cocody, most of foreign embassies and political party's headquarters are located. That's why Cocody claims to be the most peaceful, protected and safety residential district of Abidjan.

Sample

The study involved 3 publics school where school midday was given to the pupil. A total number of 500 children were selected to allow for refusals and complete data. Apparently 278 healthy children aged from 5 to 14 years where included for this research. A number of 222 children didn't give their agreement to be included. Out of 278 pupils, 178 who received regularly School Midday Meal constituted our study subjects (SMDM group) and 133 pupils who didn't not received School Midday Meals were our comparison or control group (Non SMDM group). Three primaries schools were visited (Kouadio Assahoré, Hoba Hélène and Rosiers primary school) from March to June 2016. The input variables of the study comprised the Midday meals and the outcome variables included anthropometric measurement and blood hemtological estimation. The first stage included the selection of schools and the second stage consisted of random sampling of boys and girls of each age category from the total enrolment in their school.

Only 278 children (139 boys against 139 girls) were included as pupils that filled out the questionnaire. Participating school were selected according to the fact that those school follow a school feeding program in the area of Cocody. In all the selected schools children within the age 5-12 years were eligible to participate in the study and were measured. Pupil birth's certificates were used to establish ages of participants in the study group. The selection of these three schools in Abidjan was possible with the help of department of education of Cocody1 (Abidjan). In Côte d'Ivoire, public schools cater low Socio Economical Status (SES) urban and rural children while High SES is educated in private school. School administration of the three schools gave their agreement to do that study. For each school, a list of all classes (grade one to grade 6) was obtained from the headmaster. Children who were unwell or didn't have any written parental consent were excluded from the study.

A total of 278 children (139 boys; 139 girls) were selected randomly from three government schools. The sample size estimation was done using previous cross-sectional studies on growth in the same area. Let us remember that school midday meal (SMDM) program is implemented by government in schools in order to help school children who live far away from the school to benefit a dieted meal per day and to fight against hunger at school. Major regions of both the cities were screened, and a list of schools was prepared which included government schools. Out of them, a total of 3 schools were included randomly. All the schools provided their consent for conducting the study. Participants with any chronic ailment, congenital diseases or any major surgery or taking any medications were excluded from the study. Inclusion criteria comprised apparently healthy children in the age group of 5-14 years. Out of those who satisfied the inclusion criteria, a total of 278 pupils (stratified by gender: girls, n=139; boys, n=139) were chosen from three public schools. The selection of participants was done using computerized random number generation.

Data collection

Anthropometry

Data collection's activity was planned to avoid biased measurements. We started collecting data during the first two weeks of a new school year or immediately after a major holiday. All the instruments we used, were standardized before starting measurements. Also scales were zero calibrated each day before the measurements. Height and weight were measured without shoes, the pupils wore the school uniforms and were in fasting condition. Height and weight were measured according to the standard procedures of World Health Organization .[16] Weight was measured to the nearest 0.1 kg with electronic bathroom scale (Béryl China). Weight was recorded twice and the mean value was recorded. If there was an exceeded difference of 0.2 kg between two measures, the child was sent to rest for 2 minutes before weighting again. After one hour of measurement the scale was calibrated immediately if mistake was found in the weight of the child. Individual height was measured with a wooden stadiometer placed on a flat surface twice. The subject stood on the basal part of the device by putting one's feet together without shoes. The shoulders, the buttocks and the heels were stuck on the vertical measuring board. Children standing up with eyes in the Franckfort horizontal plane, the height was measured to the nearest of 0.1 cm. However when the difference between two measures was higher than 0.3 cm the exercise was taken again with more carefully attention. Nutritional indices or Z score of Body Mass Index for Age (BAZ), Weight for Age (WAZ) and Height for Age (HAZ) were used to assess different nutritional status such as thinness/ overweight/obesity, underweight and stunting respectively, using the new reference values for school boys and girls based on the 2007 WHO Growth Reference for children 5-19 years.[20] We used WHO AntroPlus software 1.0.4 version for calculating nutritional indices and Excel 2013 software for data recording and processing.

Hemtological estimations

In all pupils (n=278), 5 ml of venous blood was collected by venipuncture using a fixed hypodermic needle under aseptic conditions, after cleaning the venipuncture site with 90% alcohol. The blood specimen was decanted into a sample tube containing ethylene diamine tetra acetate (EDTA) and gently mixed to avoid clotting. Then the entire sample was carried to laboratory to be analyzed by using an automated blood analyzer model Sysmex KN 21.

Hemoglobin concentrations were measured by cyanmethemoglobin method (differential lysis with Beckman Coulter principle; Coefficient of variance=1.5%). The others blood parameters such Leucocytes, lymphocytes, platelets were determined by the automate blood analyzer.

Erythrocytes indices such Mean Hemoglobin Concentration (MHC), hematocrit, Mean Corpuscular Volume, Mean Corpuscular Hemoglobin Concentration (MCHC) were determined automatically by the Automate Analyzer KN 21.

The normal range for hemoglobin concentrations in children is 11.5 g/dl and more for age 5-11 years, and 12 g/dl for adolescent or higher for age 12-14 years. Hemoglobin concentrations between 11.0-11.4 g/dl (5-11 years) and 11.0-11.9 g/dl (12-14 years) represent the cutoff values for mild anemia, hemoglobin concentration between 8.0 and 10.9 g/dl (5-11 years and 12-14 years) represents the cutoff values for moderate anemia and hemoglobin level below 8.0 g/dl (Hb<8.0g/dl) represents the cutoff values for severe anemia.[21]

Sociodemographic variables

For each of the sampled classes, demographic information of all officially enrolled students was obtained before data collection. Those information included gender, date of birth, residential address and parental education. Parental education's level was based on the parent with highest total years of schooling or not, income's level was based on the approximate income estimate of parent's salary. The study instrument was a structured questionnaire; designed in French. The questionnaire was tested for reliability and accuracy. It included questions on family and socio cultural environment including parental working status, number of siblings, number of child's bedroom, and the size of the family. The students were interviewed in the presence of their class teacher and each pupil was asked regarding whatever his/her mother works or is a housewife, how many older/younger siblings he/she has? How many person were living in his bedroom? Quality control measurement and good practices included training of data collection team, pre testing of processes and materials field monitoring of data collection were checked before the beginning of the study. Verbal consent for the child to participate in the study was taken from class teachers and parents.

Statistical analysis

For easy sorting, the data obtained were entered into Microsoft Excel 2013, and different parameter related to subjects analyzed using GraphPad Prism software 7.00 version for comparison of mean value and the like hood Ratio software R.2.10.1 version for comparison of proportion. Descriptive characteristics (mean and standard deviations) were computed for anthropometric and haematological measures in boys and girls belonging to SMDM receiving and non-SMDM receiving group. Student's t-test a non-parametric unpaired test was used to compare the mean values of nutritional and hemtological parameters between SMDM receiving and non-SMDM receiving children with Graph Pad Prism 7.00 version software. Likelihood Ratio Statistic G-test x-squared was used to estimate the proportion of stunting, underweight, overweight, and anemia among SMDM receiving and Non-SMDM receiving children with Ratio R 2.10.1 version software. The analysis was stratified for gender and the statistical significance level was $p<0.05$.

Ethical approval and consent

The purpose of the study and its importance was explained to the administrative authorities, directors and teachers of schools along with children and their parents. An informed written consent was obtained from the school authorities and parents, and an assent from children participating in the study was also obtained. If the parents were illiterate, the information was read out to them in the local language by a literate member of the family and if they agreed to participate in the study, then their thumbprint or signature was taken. Some children and parents who were approached agreed to participate in the study, others refused to take part in the study. Children and parents, willing to take part in the study were interviewed to fill a screening questionnaire; the children also underwent a clinical examination at the baseline, so as to ensure that they did not have any major illness history in the past that might affect their health status. Ethical approval was granted by the Ethics Committee of Nangui Abrogoua University.

Children were classified into 2 groups according to their participation to School Midday Meal program or not. The children from government school receiving SMDM (target group) belonged to all Socio economic Status. The Non- SMDM children were selected as healthy control group to make a comparative analysis of nutritional status in SMDM children.

General characteristics of the study population stratified by gender

From the analysis of that study, Table 1 presents the general social and economic profile of the study population. According to the finding, a total of 278 children were involved in that study with 139 (50%) girls and 139 (50%) boys. In addition 186 (66.91%) children belonged to 5-9 years range and 92 (33.09%) were aged from 10-14 years. The children were grouped together in two groups: SMDM groups and Non SMDM. SMDM group concerned 145 children and Non SMDM group was concerned by 133 children. The pupils from the control group (Non SMDM) were statistically older than pupils from the target group (SMDM). The comparison of the mean age showed a significant difference between Non SMDM receiving group taken as control group and SMDM receiving group our target group (9.51±2.12 vs 8.70±1.68 years p=0.003). There was significant difference between control group and subjects in what concerning the age, children who received School Midday Meals were younger than those from Non SMDM receiving group. Concerning marital status of parents in Non- SMDM receiving group, 87.97% of parent was in couple and 12.03% was single. In SMDM receiving group, 78.62% of parent was in couple and 21.38% were single without any statistically difference (p>0.05).

Table 1 General characteristics of study population stratified by gender

Variables	Non SMDM			SMDM			P1	P2	P3	P4	P5
	Total (133)	Male (57)	Female (76)	Total (145)	Male (82)	Female (63)					
Age (years)	9.51±2.12	9.94±2.03	9.2±2.13	8.70±1.68	8.78±1.74	8.59±1.59	0.003*	0.05	0.55	0.003*	0.23
5-9 (186)	76(57.14)	30(52.63)	46(60.63)	110(75.86)	59(71.95)	51(80.95)	0.1	0.45	0.46	0.08	0.08
10-14 (92)	57(42.86)	27(47.37)	30(39.47)	35(24.14)	23(28.05)	12(19.05)	0.02	0.39	0.18	0.02	0.006
Parents demographics											
In couple (%)	117(87.97)	50(87.72)	67(88.16)	114(78.62)	67(81.71)	47(74.60)	0.46	0.97	0.56	0.64	0.28
Single (%)	16(12.03)	7(12.28)	9(11.84)	31(21.38)	15(18.29)	16(25.40)	0.1	0.92	0.28	0.27	0.02
Household size	7.03±2.68	7.03±1.42	7.50±3.32	6.90±1.62	6.80±1.65	7.03±1.57	0.13	0.76	0.45	0.19	0.82
<5	8(6.02)	2(3.51)	6(7.89)	5(3.45)	4(4.88)	1(1.59)	0.4	0.18	0.18	0.63	0.003
>5	125(93.98)	55(96.49)	70(92.11)	140(96.55)	78(95.12)	62(98.41)	0.85	0.74	0.81	0.92	0.64

Table continued

Variables	Non SMDM			SMDM			P1	P2	P3	P4	P5
Mother's education level											
Post-secondary	12(9.02)	4(7.02)	8(10.53)	31(21.38)	20(24.39)	11(17.46)	0.02	0.4	0.28	0.001	0.18
Secondary	23(17.29)	10(14.54)	13(17.10)	84(57.93)	48(58.54)	36(57.14)	$1.48.e^{-6}$	0.64	0.89	$9.95.\ e^{-8}$	$1.81.\ e^{-6}$
Primary	50(37.59)	22(38.60)	28(36.84)	22(15.17)	11(13.41)	11(17.46)	0.001	0.83	0.46	0.0003	0.007
None	48(36.09)	21(36.84)	27(35.53)	8(5.52)	3(3.66)	5(7.94)	$5.41\ e^{-7}$	0.87	0.2	$1.92.\ e^{-8}$	$1.35\ e^{-5}$
Mother's activity											
Civil servant	9(6.77)	3(5.26)	6(7.89)	63(43.45)	35(42.68)	28(44.44)	$4.54\ e^{-8}$	0.46	0.85	$7.93\ e^{-9}$	$1.11\ e^{-7}$
Private servant	27(20.30)	4(7.02)	23(30.26)	53(36.55)	33(40.24)	20(31.75)	0.02	$7.77\ e^{-5}$	0.31	$3.78\ e^{-7}$	0.85
Self employed	25(18.80)	18(31.58)	7(9.22)	13(8.97)	4(4.88)	9(14.29)	0.05	0.0003	0.02	$2.96.\ e^{-6}$	0.29
Unemployed	72(54.13)	32(56.14)	40(52.63)	16(11.03)	10(12.20)	6(9.52)	$2.48.\ e^{-8}$	0.73	0.56	$3.14\ e^{-8}$	$9.52\ e^{-9}$
Father's education level											
Post-secondary	27(20.30)	11(19.30)	16(21.05)	92(63.45)	53(64.63)	39(61.90)	$1.35.\ e^{-6}$	0.78	0.8	$3.71.\ e^{-8}$	$4.54.\ e^{-6}$
Secondary	71(53.38)	33(57.89)	38(50)	46(31.72)	26(31.71)	20(31.75)	0.01	0.44	0.99	0.005	0.04
Primary	25(18.80)	10(17.54)	15(19.74)	7(4.83)	3(3.66)	4(6.35)	0.002	0.71	0.39	0.001	0.007
None	10(7.52)	3(5.26)	7(9.21)	0(0)	0(0)	0(0)	0.001	0.29	-	0.006	0.0003
Father's activity											
Civil servant	19(14.29)	4(7.02)	15(17.74)	65(44.83)	34(41.46)	31(49.21)	$4.72.\ e^{-5}$	0.02	0.41	$1.92.\ e^{-7}$	$8.73.\ e^{-5}$
Private servant	64(48.12)	29(50.88)	35(46.05)	72(49.66)	44(53.66)	28(44.44)	0.87	0.62	0.35	0.78	0.86
Self employed	48(36.09)	24(42.11)	24(31.58)	8(5.52)	4(4.88)	4(6.35)	$5.41\ e^{-7}$	0.21	0.66	$6.09.\ e^{-9}$	$1.87.\ e^{-5}$
Unemployed	2(1.50)	0(0)	2(2.63)	0(0)	0(0)	0(0)	0.14	0.05	-	-	0.05

SMDM, school midday meal; P1, comparison between total in Non SMDM and SMDM; P2, comparison between male in Non SMDM and male SMDM; P3, comparison between male in Non SMDM and Female in Non-SMDM; P4, comparison between female in Non SMDM and female SMDM group; P5, comparison between male and female in SMDM group

Concerning the household size, 7.89% of children lived in a family with less than five individuals, 93.98% in Non SMDM group and 96.55% in SMDM group belonged to family with more than five individual. Concerning mother's education level, 9.02% in Non SMDM receiving group had post-secondary level against 21.38% in SMDM receiving group (p=0.02). Moreover 36.09% of mother in control group were statistically illiterate comparatively to target group (SMDM group) with a percentage of 6.52% ($p=5.41.e^{-7}$). In what concern mother's activity, 54.13% were statistically unemployed in Non SMDM receiving against 11.03% in SMDM receiving group ($p<0.05$). In another way 43.45% of mother in SMDM group were civil servant in relation to Non SMDM group with 6.77% of civil servant with a statistically significance difference ($p<0.05$). Concerning father's education, 63.45% children belonging to SMDM group had father with a post-secondary level against 20.30% in Non SMDM group ($p<0.05$). In SMDM group, none case of illiteracy had been found compared to SMDM group with 7.52% of illiteracy (p=0.001).

Most of father in Non SMDM group were in secondary level (53.38%) against 31.72% in SMDM group, 18.80% of father in SMDM group against 4.83% in SMDM group were primary level (p=0.002). Concerning father activity, 44.83% in SMDM group against 14.29% in Non SMDM group were civil servant. More than 36.09% of parents in control group against 5.52% in target group (SMDM group) were self-employed or belonged working class.

Diet

Target group (SMDM receiving) children received Midday meal once in their school during the recess time per day. The average menu comprised rice (Oryza Sativa), potatoes (Ipomea Batats), bread, and spaghetti and cassava semolina (Manihot exculenta) nationally called Attiéké, as carbohydrates. Proteins provided from vegetables, meat, chicken, fishes and oil prepared. Recipes were various such as Attiéké with fried fish or chickhen, vegetable sauce with rice called N'troh, potatoes stew with meat, Fatty rice called Tchep guen. SMDM (School Midday Meal) program is designed to provide 450kcal of energy and 12g of proteins for primary classes (grade 1-5) while 700kcal of energy and 20g of proteins for upper primary classes (grade 6-8).[22,23]

A weekly menu for the school was pre-decided and accordingly the recipes served throughout the week at home. All children reported the quantity of the SMDM recipes consumed through .the midday meal provided to them in their school, during their 24 hours of diet recall.

Results

Changes of anthropometrical and haematological parameters in study population

According to Table 2A, the mean value of Height for Age (HAZ), was significantly lower in Non SMDM group (control) (-0.18±1.50

SD) as compared to SMDM group (target group) (0.17±1.09 SD) at the first survey (p1=0.02). But no significant difference was observed at the second survey J100) between control group (Non SMDM receiving group) and target group (SMDM receiving group) (p2=0.06). Concerning Body Mass Index for Age (BAZ), the mean values were respectively (-0.22±1.14 SD) and (-0.13±1.29 SD) at J0 in Non SMDM receiving group and SMDM receiving group. At the second visit (J100), BAZ mean value was significantly higher in SMDM group (0.16±1.11 SD) in comparison with Non SMDM group (-0.22±1.14 SD) and SMDM group (-0.13±1.29 SD) at the first survey (J0) (p^2=0.006; p^3=0.04). Furthermore the children belonging to control group (Non SMDM group) were significantly older than those of target group (SMDM group) (114.06±25.53 vs 104.41±20.23 months.

Table 2B showed the mean values of haematological parameters, all the values were normal comparing to the reference values in control (Non SMDM) and target (SMDM group) in the red corpuscle except the mean value of MCV that was under the normal value (71.65±7.32 fl). However, children from target group (SMDM group) showed high level red blood cells at first survey J0 (4.49±0.46 x106/µl) and second survey J100 (4.45±0.12x 106/µl) in comparison to control (Non SMDM) group (4.24±0.29 x106/µl). Concerning the white corpuscle, the mean value of white blood cell (WBC) and neutrophils (3551.09±683.18/µl) were significantly higher in Non SMDM group (6310±870/µl) as compared to SMDM group respectively at J0 and J100 (5044±1640/µl; 4370±660/µl). Concerning the other parameters SMDM group showed high rate as compared to the Non SMDM group.

Table 2A Mean values of anthropometrical parameters in the study population

Variable	Non SMDM -133	SMDM		P1	P2	P3
		J 0 (145)	J 100 (130)			
AGE (Month)	114.06±25.53	104.41±20.23	104.02±19.69	0.001	0.001	0.85
Weight (Kg)	29.79±7.88	29.05±8.25	30.13±9.14	0.468	0.73	0.3
Height (Cm)	133.72±11.61	131.91±11.10	132.93±11.14	0.17	0.58	0.43
BMI (Kg/m²)	16.41±5.80	16.34±2.80	16.69±2.81	0.82	0.35	0.27
WAZ (SD)	0.16±1.21	0.04±1.19	0.18±1.14	0.52	0.89	0.41
HAZ (SD)	-0.18±1.50	0.17±1.09	0.12±1.09	0.02	0.06	0.73
BAZ (SD)	-0.22±1.14	-0.13±1.29	0.16±1.11	0.55	0.006	0.04

SMDM, school midday meal; BMI, body mass index; WAZ, weight for age Z score; HAZ, height for age Z score; BAZ, BMI for age Z score; J0, first survey; J100, second survey; P1, comparison between Non SMDM receiving group and SMDM receiving group at J0; P2, comparison between Non SMDM receiving group and SMDM receiving group J100; P3, comparison between SMDM receiving group at J0 and SMDM receiving group at J 100; SD, Standard Deviation

Table 2B Mean values of hematological parameters in the study population

Variables	Non SMDM(133)	SMDM		P1	P2	P3
		J0(145)	J 100 (130)			
RBC (106/µl)	4.24±0.29	4.49±0.46	4.45±0.12	<0.0001	<0.0001	0.29
Hemoglobin (g/dl)	11.89±1.04	12.14±1.18	12.08±0.58	0.58	0.06	0.07
Hematocrit (%)	36.59±3.00	38.08±2.11	38.24±2.24	<0.0001	<0.0001	0.53
MCV (fl)	83.86±4.04	71.65±7.32	87.70±2.38	<0.0001	<0.0001	<0.0001
MCH (pg)	27.67±1.86	27.28±1.94	28.82±1.35	0.09	<0.0001	<0.0001
MCHC (g/dl)	32.50±1.72	32.16±3.44	32.49±1.35	0.28	0.89	0.31
Platelets (103/µl)	239.2±24.43	285.2±71.91	242.93±34.03	<0.0001	0.31	<0.0001
WBC (/µl)	6310±870	5044±1640	4370±660	<0.0001	<0.0001	<0.0001
P. Neutrophils (/µl)	3551.09± 683.18	1813.93± 1263.78	2364.44± 416.1	<0.0001	<0.0001	<0.0001
Lymphocytes (/µl)	2489.26± 444.85	2795.29± 1047.45	1793.43± 375.34	<0.002	<0.001	<0.0001
Monocytes (/µl)	243.50±18.56	313.55±181.99	213.59±93.96	<0.0001	<0.01	<0.0001

SMDM, school midday meal; RBC, red blood cells; MCV, mean corpuscular volume; WBC, white blood cell; MHC, mean hemoglobin concentration; MCHC, mean corpuscular hemoglobin concentration; P, polynuclear; J0, first survey; J100, second survey; P1, comparison between Non SMDM receiving group and SMDM at J0; P2, comparison between Non SMDM receiving group and SMDM at J100; P3, comparison between SMDM receiving group at J0 and SMDM receiving at J100

Variation of anthropometrical and haematological indices in study population according to sex

The finding registered in Table 3, presented the general mean values of anthropometrical and haematological parameters in male population. From those findings, Non SMDM children were older than SMDM group with statistical difference (119.28±24.42 versus 105.43±20.98 month; p=0.0005).

Concerning height for age z score (HAZ) value, children from SMDM who received Midday Meal had higher mean value at J0 and J100 in comparison to Non SMDM receiving group (0.11±1.13 SD; -0.05±1.14 SD vs -0.65±1.23 SD).

Table 3 Means values of anthropometrical and hematological indices in male population

Variables	Non SMDM	SMDM		P1	P2	P3
		J 0	J 100			
	Male (57)	Male (82)	Male (71)			
Age (month)	119.28±24.42	105.43±20.98	104.93±20.36	0.0005	0.0005	0.88
Height (cm)	132.98±10.53	132.05±10.97	132.41±11.27	0.62	0.77	0.84
Weight (kg)	28.83±6.88	28.42±8.41	29.43±8.81	0.76	0.67	0.47
Body Mass Index (kg/m^2)	16.08±1.95	15.97±2.66	16.46±2.79	0.78	0.38	0.26
WAZ(SD)	-0.27±1.17	-0.09±1.25	0.09±1.22	0.52	0.2	0.44
HAZ(SD)	-0.65±1.23	0.11±1.13	-0.05±1.14	0.0002	0.0053	0.36
BAZ(SD)	-0.38±0.94	-0.34±1.39	0.01±1.16	0.86	0.03	0.08
Family rate	7.47±3.48	6.80±1.65	6.89±1.64	0.27	0.34	0.82
Red Blood Cell (106/µl)	4.25±0.29	4.44±0.46	4.44±0.09	0.0088	<0.0001	0.05
Hemoglobin (g/dl)	11.87±1.12	11.99±1.38	12.02±0.32	0.57	0.31	0.85
Hematocrit (%)	36.67±3.14	38.05±2.22	38.21±2.19	0.031	0.015	0.65
Mean Corpuscular Volume (fl)	84.02±4.15	71.62±7.34	87.71±2.57	<0.0001	<0.0001	<0.0001
MHC (pg)	27.77±1.92	27.26±1.98	28.68±1.36	0.13	0.0026	<0.0001
MCHC (g/dl)	32.45±1.72	32.25±3.44	32.50±1.35	0.32	0.78	0.35
Platelets (103/µl)	240.87±26.17	289.24±73.65	246.85±30.77	<0.0001	0.24	<0.0001
White Blood Cell (/µl)	6100±890	4970±180	4370±580	<0.0001	<0.0001	0.008
Polynuclear Neutrophilis (/µl)	3419.61±745.08	1777.5±1355	2373.6±399.3	<0.0001	<0.0001	0.0005
Lymphocyt (/µl)	2425.61±468.54	2754.20±1131	1773.4±1349.	0.041	<0.0001	<0.0001
Monocyt (/µl)	232.43±91.26	230.31±194.29	209.7±87.27	0.002	0.15	<0.0001

SMDM, school midday meal; RBC, red blood cells; MCV, mean corpuscular volume; WBC, white blood cell; MHC, mean hemoglobin concentration; MCHC, mean corpuscular hemoglobin concentration; BMI, body mass index; WAZ, weight for age Z score; HAZ, height for age Z score; BAZ, body mass index for age Z score; J0, first survey; J100, second survey; P1, comparison between Non SMDM receiving group and SMDM receiving group at J0 in male; P2, comparison between Non SMDM receiving group and SMDM receiving group at J100 in male; P3, comparison between SMDM receiving group at J0 and SMDM receiving group at J100 in male; SD, standard deviation

For body mass index for age z score mean (BAZ), target group (SMDM) had an elevated mean value as compared to control group (SMDM) with a significant difference between SMDM J100 (0.01±1.16 SD) and Non SMDM (-0.38±0.94 SD) (p=0.03). The mean value of RBC (red blood cells) was 4.44±0.46x106/µl in SMDM group against 4.25±0.29 x106/µl in Non SMDM group (p<0.05). The analysis of platelets mean count showed that SMDM male at J0 (289.24±73.65x103/µl) had the highest mean as compared to Non SMDM (240.87±26.17 x 103/µl).

For the mean value WBC (White blood cells), Non SMDM male had the highest value (6100±890 /µl). According to our findings, SMDM group presented the highest mean value of lymphocytes (2754.20±1131/µl) comparatively to Non SMDM group (p<0.005). The mean value of monocyte was normal conforming to reference (218.37±101.2/µl).

According to Table 4, the mean age of female in SMDM group (103.08±19.18 month) was statistically lower than female's from Non SMDM group (110.40±25.67 month; p<0.05). Concerning the mean value of Red Blood Cell (RBC), we noticed that the mean value of RBC was 4.56±0.45 x106/µl at J0 and at 4.46±0.15 x106/µl at J100 in SMDM group with a statistically difference in comparison with Non-SMDM (4.24±0.29 x106/µl, p<0.0001). The mean value of hemoglobin was 12.33±0.94 g/dl and 12.13±0.64 g/dl respectively at J0 and J100 in SMDM group against 11.90±0.98 g/dl in Non SMDM group with a statistically difference (p=0.02).

Concerning platelets count, the mean value was higher at J0 (279.93±69.23 x103/µl) than platelets count at J100 (238.20±37.04 x103/µl) in SMDM female. But, those values were higher than those in Non SMDM female (238±22.96 x103/µl) with significant value (p<0.0001). Concerning the mean value of White Blood Cell

(WBC) count, female belonging to Non SMDM group showed the highest count of WBC with 6460±820/µl with statistically significant difference (P<0.0001) as compared to SMDM female respectively at J0 and J100 (5130±1390/µl; 4380±740 /µl) (Table 4).

The finding mentioned in the table 5, showed a statistically difference between male (15.97±2.66 kg/m^2) and female (16.81±2.81 kg/m^2) among SMDM receiving group at J0 concerning BMI (Body mass index) mean value in favor of female (p<0.0001). The mean value of Weight for Age Z score was 0.44±1.45 SD for female and -0.27±1.77 SD for male (p=0.02). Concerning the value of Height for Age Z score (HAZ), female presented higher value than the male in Non SMDM group and SMDM group with significant difference (0.16±1.59 SD vs 0.37±0.99 SD, P<0.05).

Table 4 Means values of anthropometrical and hematological indices in female population

Variables	Non SMDM	SMDM		P1	P2	P3
		J 0	J 100			
	Female (76)	Female (63)	Female (59)			
Age (month)	110.40±25.67	103.08±19.13	102.92±18.78	0.0005	0.0005	0.88
Height (cm)	134.21±12.32	131.73±11.27	133.41±11.33	0.23	0.7	0.41
Weight (kg)	30.50±8.48	29.86±9.33	31.17±9.98	0.5	0.9	0.46
BMI (kg/m^2)	16.64±2.64	16.81±2.90	17.08±3.01	0.72	0.53	0.61
WAZ(SD)	0.44±1.45	0.20±1.10	0.18±1.06	0.43	0.31	0.34
HAZ(SD)	0.16±1.59	0.25±1.02	0.37±0.99	0.51	0.18	0.41
BAZ(SD)	-0.09±1.26	0.14±1.10	0.21±1.07	0.39	0.24	0.76
Family rate	7.17±2.34	7.03±1.57	7.16±1.60	0.54	0.68	0.89
RBC (106/µl)	4.24±0.29	4.56±0.45	4.46±0.15	<0.0001	<0.0001	0.05
Hemoglobin(g/dl)	11.90±0.98	12.33±0.94	12.13±0.64	0.02	0.34	0.16
Hematocrit (%)	36.56±2.89	38.12±1.96	38.28±8.30	0.008	0.003	0.39
MCV (fl)	83.8±3.95	71.70±7.22	87.68±2.14	<0.0001	<0.0001	<0.0001
MHC (pg)	27.59±1.80	27.30±1.88	29±1.31	0.47	<0.0001	<0.0001
MCHC (g/dl)	32.54±1.92	32.26±1.44	32.49±1.35	0.31	0.87	0.43
Platelets (103/µl)	238±22.96	279.93±69.23	238.20±37.04	<0.0001	0.22	<0.0001
WBC (/µl)	6460±820	5130±139	4380±740	<0.0001	<0.0001	0.0082
P. Neutrophils (/µl)	3651.67±612.35	1861.36±1132	2353.4±434.9	<0.0001	<0.0001	<0.0001
Lymphocytes (/µl)	2538.11±419.71	2848.69±924.7	1817.4±402.9	0.06	<0.0001	<0.0001
Monocytes (/µl)	251.77±102.92	316.25±164.6	218.37±101.2	0.08	0.08	0.97

BMI, body mass index; WAZ, weight for age Z score; HAZ, height for age; BAZ, body mass index for age; RBC, red blood cell; Hb, hemoglobin; MCV, mean corpuscular volume; MCHC, mean corpuscular hemoglobin concentration; MCH, mean hemoglobin concentration; WBC, white blood cell; PN, polynuclear neutrophils; SMDM, school midday meal receiving; J0, first survey; J100, second survey; SD, standard deviation

Table 5 Means values of anthropometrical and hematological indices in the study population

Variables	Non SMDM (133)		SMDM				P1	P2	P3
			J 0 (145)		J 100 (130)				
	Male (57)	Female (76)	Male (82)	Female (63)	Male (71)	Female (59)			
Age (mois)	119.28±24.42	110.40±25.67	105.43±20.98	103.08±19.13	104.93±20.36	102.92±18.78	0.08	0.35	0.41
Height (cm)	132.98±10.53	134.21±12.32	132.05±10.97	131.73±11.27	132.41±11.27	133.41±11.33	0.42	0.72	0.77
Weight (kg)	28.83±6.88	30.50±8.48	28.42±8.41	29.86±9.33	29.43±8.81	31.17±9.98	0.33	0.48	0.36
BMI (kg/m^2)	16.08±1.95	16.64±2.64	15.97±2.66	16.81±2.90	16.46±2.79	17.08±3.01	0.29	<0.001	0.26
WAZ(SD)	-0.27±1.17	0.44±1.45	-0.09±1.25	0.20±1.10	0.09±1.22	0.18±1.06	0.02	0.1	0.48
HAZ(SD)	-0.65±1.23	0.16±1.59	0.11±1.13	0.25±1.02	-0.05±1.14	0.37±0.99	0.001	0.68	0.03
BAZ(SD)	-0.38±0.94	-0.09±1.26	-0.34±1.39	0.14±1.10	0.01±1.16	0.21±1.07	0.02	0.0095	0.04
Family rate	7.47±3.48	7.17±2.34	6.80±1.65	7.03±1.57	6.89±1.64	7.16±1.60	0.93	0.45	0.27

RBC (106/l)	4.25±0.29	4.24±0.29	4.44±0.46	4.56±0.45	4.44±0.09	4.46±0.15	0.76	0.03	0.4
Hemoglobin (g/dl)	11.87±1.12	11.90±0.98	11.99±1.38	12.33±0.94	12.02±0.32	12.13±0.64	0.79	0.02	0.24
Hematocrit (%)	36.67±3.14	36.56±2.89	38.05±2.22	38.12±1.96	38.21±2.19	38.28±8.30	0.98	0.66	0.94
MCV (fl.)	84.02±4.15	83.8±3.95	71.62±7.34	71.70±7.22	87.71±2.57	87.68±2.14	<0.001	0.7	0.64
MHC (pg)	27.77±1.92	27.59±1.80	27.36±1.98	27.30±1.88	28.68±1.36	29±1.31	0.4	0.89	0.15
MCHC (g/dl)	32.44±1.42	32.53±1.35	32.47±1.35	32.34±1.32	32.36±1.44	32.59±1.35	0.31	0.87	0.43
Platelets (103/µl)	240.87±26.17	238±22.96	289.24±73.65	279.93±69.23	246.85±30.77	238.20±37.04	0.73	0.77	0.25
WBC (/µl)	6100±890	6460±820	4970±180	5130±139	4370±580	4380±740	0.04	0.27	0.85
P N (/µl)	3419.61±745.08	3651.67±612.35	1777.5±1355	1861.36±1132	2373.6±399.3	2353.4±434.9	0.1	0.32	0.81
Lymphocytes (/µl)	2425.61±468.54	2538.11±419.71	2754.20±1131	2848.69±924.7	1773.4±1349.	1817.4±402.9	0.13	0.19	0.45
Monocytes (/µl)	232.43±91.26	251.77±102.92	230.31±194.29	316.25±164.6	209.7±87.27	218.37±101.2	0.35	0.86	0.66

BMI, body mass index; WAZ, weight for age Z score; HAZ, height for age; BAZ, body mass index for age; RBC, red blood cell; MCV, mean corpuscular volume; MCHC, mean corpuscular hemoglobin concentration; MCH, mean hemoglobin concentration; WBC, white blood cell; PN, polynuclear neutrophils; Lymph, lymphocyte; SMDM, school midday meal receiving; P1, comparison between male and female in Non SMDM receiving group; P2, comparison between male and female in SMDM receiving group at J0; P3, comparison between male and female in SMDM group at J100; J0, first survey; J100, second survey; SD, standard deviation

In what concern Body Mass Index for Age (BAZ), the female had the highest mean value within Non SMDM as compared to SMDM group ($p<0.05$). Children from SMDM group at J0 especially female presented higher mean value of Red Blood Cell (4.56±0.45 x106/µl) and Hemoglobin (12.33g/dl) in relation to male belonging to the same group with respectively the mean value (4.44±0.46x106/µl and 11.99g/dl; p=0.03; p=0.02). The mean value of WBC in female with 6460±820/µl was higher than the one that male presented (6100±890/µl) with a statistically difference (p=0.04) among children from Non SMDM group (Table 5). Those mean values were respectively lower for male and female in SMDM group at J0 (4970±1800 /µl; 5130±1.39/µl) and J100 (4370±580/µl; 4380±740 /µl). No statistically difference between male and female was found ($p>0.05$).

Hemtological parameters and nutritional status in study population

Table 6, established a relationship between under nourished and normally nourished children. From the analysis of the Table 6, the result showed that undernourished pupils had lower hemoglobin level than normally nourished children without any statistically difference ($p>0.05$). Concerning the mean value of White Blood Cells, undernourished children had higher value than normal one with statistically difference (p=0.01). Table 7 showed different proportion of nutritional status. According to ours findings 6.36% among SMDM children at the first survey (J0) aged 5-9 years suffered from under nutrition ($p^2=0.01$). However, at the second visit (J100), none child suffered from underweight. Concerning stunting, except the percentage of 2.86% against 2.56% in SMDM group among 10-14 range, a statistical difference was observed between Non SMDM and SMDM group ($p<0.05$). Children aged from 10-14 years were more stunted than children from 5-9 years old ($p<0.05$).

Furthermore, children under 10 years old were more affected by microcytic anemia in the Non SMDM group with a proportion of 40.79% in comparison to children from SMDM group (22.79%; 9.89%) belonging to the same age group at J0, J100 ($p^1=0.02$; $p^2=0.0005$). within SMDM group, we observed 22.72% of children were suffered from anemia at J0 and 9.89% at J100 (p=0.02). No significant difference was observed in children with 5-9 years old in relation to children above 10 years.

Concerning thrombopenia, we observed a statistically difference between children under 10 years and children old than 10 in SMDM group at J0 and J100 (Table 7). A proportion of 5.71% in SMDM receiving group more than years 10 olds at J0 presented Neutropenia and none case of neutropenia was observed in Non SMDM group with significant difference (p=0.004). Concerning lymphopenia, it was observed among SMDM group aged from 10-14 with a percentage of 2.86 % compared to Non SMDM group (p=0.04).

Table 8 presents the proportions of different nutritional indices. According to our findings overweight was more frequent in all the different study groups with respectively 11.28% in Non SMDM group, 11.03% in SMDM group at J0 and 10.76% at J100 with none statistically difference ($p>0.05$). Concerning the percentage of underweight, 5.26% of children belonging to Non SMDM group were concerned, 6.20% in SMDM group at J0 and 0.76% at the second survey with statistically difference (p=0.02). However 6.77% of children in Non SMDM group was significantly more stunted as compared to SMDM group with 0.68% and 0.76% respectively at J0 and J100 ($p^1=0.01$). We noticed that anemia was significantly higher among Non SMDM group with 37.59% versus 21.37% at the first survey in SMDM group and 11.53% at J100. No significant difference was observed within the SMDM group (21.37% versus 11.53%). None child in Non SMDM group presented thrombopenia against 3.44 % in SMDM group at J 0 with significant difference (p=0.02).

The analysis of Table 9 revealed different kind of malnutrition and haematological indices. Concerning underweight, male from SMDM group at J0 were more affected with the prevalence of 9.75% against 1.75% in Non SMDM group with a statistically difference ($p^1<0.005$). But at J100, that prevalence fell down from 9.75% to 1.41% in SMDM group with statistically difference as compared to male in Non SMDM and SMDM group ($p^5<0.05$). The comparison between sexes showed those males were more underweighted in SMDM than female group.

But in Non SMDM group, female were more affected than male ($p<0.05$). Concerning Stunting, children from Non SMDM group were more stunted than SMDM group (8.77%) with a statistically significant difference ($p^1<0.005$). No significant difference was observed between male and female ($p>0.05$).

Table 6 Mean value of hematological parameters between undernourished normally nourished children

Variables	Non SMDM		SMDM				P1	P2	P3
			J 0		J 100				
	Under nutrition	Normal	Under nutrition	Normal	Under nutrition	Normal			
RBC (x 106/ µl)	4.35±0.24	4.23±0.29	4.27±0.37	4.50±0.48	4.40±0.00	4.43±0.12	0.59	0.13	0.48
Hemoglobin (g/dl)	11.80±1.05	12.51±0.84	11.8±1.16	12.13±1.25	11.75±0.75	12.03±0.58	0.24	0.16	0.68
Hematocrit (%)	38.32±2.42	36.36±3.03	38.11±1.28	38.14±2.19	37.15±2.05	38.15±2.24	0.24	0.2	0.34
MCV (fl)	85.85±3.93	83.59±4.05	73.33±1.28	71.31±7.59	87.75±0.25	87.57±2.40	0.0007	0.9	0.01
MHC (pg)	28.47±1.52	27.53±1.87	28±1.63	27.18±2.06	29.2±0.2	28.73±1.32	0.52	0.48	0.34
MCHC (g/dl)	33.6±1.33	32.39±1.74	31.22±2.61	32.11±3.66	32.95±0.15	32.44±1.36	0.09	0.1	0.19
Platelets(103/ µl)	235.85±19.20	238.86±25	294±76.71	283.15±74.13	285.5±38.5	241.13±33.74	0.11	0.2	0.6
WBC (/µl)	6000±920	6330±850	4100±172	5060±168	4800±0.0	4370±660	0.01*	0.02*	0.3
P. Neutrophilis (/µl)	3284.71±632.88	3568.40±682.37	1579.22±1460	1829.23±1304.43	2527±113	2365.03±416.76	0.0007	0.11	0.06
Lymphocytes (/µl)	2500.71±493.49	2498.25±449.21	2182.22±485.66	2816.32±1074.95	2036±164	1787.49±366.23	0.29	0.26	0.48
Monocytes (/µl)	183.71±88.62	245.37±99.96	245±100.79	317.57±190.57	219±69	214.86±96.56	0.15	0.3	0.92

SMDM, school midday meal; RBC, red blood cell; MCV, mean corpuscular volume; MCHC, mean corpuscular hemoglobin concentration; WBC, white blood cells; Poly, Polynuclear; J0, first survey; J100, second survey after 100 days; P1, comparison between undernourished in control group and canteen (J0) group; P2, comparison between undernourished in control group and canteen (J100) group; P3, comparison between undernourished in canteen group at J0 and J100; fl, femtolitre; pg, pictograms

Table 7 Proportions of nutritional indices according to age group

Variables	Non SMDM (133)		SMDM				P1	P2	P3	P4	P5	P6
			J0 (145)		J100 (130)							
Year groups	5-9 (76)	10-14 (57)	5-9 (110)	10-14 (35)	5-9(91)	10-14(39)						
	n %	n %	n %	n %	n %	n %						
Underweight	3 (3.94)	4 (7.01)	7 (6.36)	2 (5.71)	0 (0)	1 (2.56)	0.44	0.01	0.002	0.71	0.14	0.26
Stunting	2 (2.63)*	7 (12.28)*	0 (0)*	1 (2.86)*	0 (0)	1 (2.56)	0.009	0.05	0.05	0.01	0.008	0.89
Overweight	12 (15.79)	4 (7.01)	11 (10)	5 (14.29)	10 (10.99)	4 (10.26)	0.25	0.35	0.82	0.11	0.44	0.41
Obesity	3 (3.94)	2 (3.50)	5 (4.55)	1 (2.86)	4 (4.40)	2 (5.13)	0.83	0.87	0.96	0.79	0.57	0.28
Anemia	31 (40.79)	19 (33.33)	25 (22.72)	6 (17.64)	9 (9.89)	6 (15.38)	0.02	0.0005	0.02	0.02	0.09	0.69
Thrombopenia	0 (0)	0 (0)	2 (1.82)*	3 (8.57)*	0 (0)*	2 (5.13)*	-	0.11	-	0.0005	0.007	0.35
Leucopenia	1 (1.31)	1 (1.75)	3 (2.73)	0 (0)	1 (1.10)	0 (0)	0.47	0.89	0.39	0.11	0.11	-
Neutropenia	2 (2.63)	0 (0)	4 (3.64)	2 (5.71)	1 (1.10)	1 (2.56)	0.68	0.42	0.23	0.004	0.05	0.26
Lymphopenia	2 (2.63)	0 (0)	3(2.73)	1 (2.86)	1 (1.10)	0 (0)	0.96	0.42	0.05	0.04	-	0.05

SMDM, school midday meal; J0, first day of survey; J100, second survey after 100 days, P1, comparison of proportions between Non SMDM group and SMDM group aged 5-9 years at J0; P2, comparison of proportions between Non SMDM group and SMDM group aged 5-9 years at J100; n, number; %, percentage; P3, comparison of proportions within SMDM aged 5-9 years (J0 vs J100); P4, comparison of proportions between Non SMDM group and SMDM group aged 10-14 years at J0, P5, comparison of proportions between Non SMDM group and SMDM group aged 10-14 years at J100; P6, comparison of proportions within SMDM group aged 10-14 years at J100; (*), comparison proportion of 5-9 years against 10-14 years in Non SMDM group and SMDM group level of significance ($p<0.05$)

Table 8 Proportion of different parameters of nutritional status in the whole population

Variables	Non SMDM (133)	SMDM		P 1	P2	P3
		J 0(145)	J 100(130)			
	n %	n %	n %			
Underweight	7 (5.26)	9 (6.20)	1 (0.76)	0.78	0.05	0.02
Stunting	9 (6.77)	1 (0.68)	1 (0.76)	0.01	0.01	0.94
Overweight	15 (11.28)	16 (11.03)	14 (10.76)	0.95	0.91	0.95
Obesity	5 (3.76)	6 (4.13)	5 (3.84)	0.89	0.97	0.91
Anemia	50 (37.59)	31 (21.37)	15 (11.53)	0.03	0.0001	0.08
Thrombopenia	0 (0)	5 (3.44)	2 (1.54)	0.02	0.14	0.38
Leucopenia	2 (1.50)	3 (2.07)	1 (0.76)	0.76	0.61	0.42
Neutropenia	2 (1.50)	6 (4.14)	2 (1.54)	0.25	0.98	0.26
Lymphopenia	2 (1.50)	4 (2.73)	1 (0.76.)	0.54	0.61	0.27

n, number; %, percentage; J0, first survey, J100, second survey after 3 months; SMDM, school midday meal; P1, p value for comparison of proportion of Non SMDM group versus SMM group at J0; P2, p value for comparison of proportion of Non SMDM group versus SMDM group at J100; P3, p value for comparison of proportion among SMM group (J0 versus J100); p< 0.05, level of significance

Table 9 Proportion of nutritional indices according to gender

Variables	Non SMDM		SMDM				P1	P2	P3	P4	P5	P6
			J 0		J 100							
	Male (57)	Female (76)	Male (82)	Female (63)	Male (71)	Female (59)						
	n %	n %	n %	n %	n %	n %						
Underweight	1 (1.75)*	6 (7.89)*	8 (9.75)*	1 (1.59)*	1 (1.41)	0 (0)	0.01	0.84	0.008	0.03	0.0009	0.13
Stunting	5 (8.77)	4 (5.26)	1 (1.22)	0 (0)	1 (1.41)	0 (0)	0.01	0.01	0.9	0.006	0.06	-
Overweight	4 (7.01)	11 (14.47)	7 (8.54)	9 (14.29)	9 (12.68)	10 (16.95)	0.69	0.19	0.36	0.97	0.65	0.63
Obesity	2 (3.50)	3 (3.94)	3 (3.67)	3 (4.76)	2 (2.82)	3 (5.08)	0.94	0.78	0.73	0.78	0.7	0.91
Anemia	21 (36.64)	29 (38.15)	23(28.05)*	8 (12.70)*	9 (12.68)	6 (10.17)	0.28	0.0004	0.01	0.0002	$5.56e^{-5}$	0.59
Thrombopenia	0 (0)	0 (0)	2 (2.44)	3 (4.76)	2 (2.82)*	0 (0)*	0.06	0.04	0.86	0.01	-	0.01
Leucopenia	2 (3.50)*	0 (0)*	2 (2.44)	1 (1.59)	0 (0)	1(1.69)	0.66	0.02	0.06	0.13	0.12	0.95
Neutropenia	2 (3.50)*	0 (0)*	4 (4.88)	2 (3.17)	1 (1.41)	1 (1.69)	0.63	0.33	0.15	0.03	0.12	0.49
Lymphopenia	2 (3.50)*	0 (0)*	3 (3.67)	1 (1.59)	1 (1.41)	0 (0)	0.94	0.33	0.3	0.13	-	0.13

J0, first survey day 0; J100, second survey after 100 days; SMDM, school midday meal; n, number; %, percentage; P1, comparison between male in Non SMDM and male in SMDM group at J0; P2, comparison between male in Non SMDM and male in SMDM group at J100; P3, comparison between male in SMDM at J0 and male in SMDM group at J100; P4, comparison between female in Non SMDM and female in SMDM group at J0; P5, comparison between female in Non SMDM and female in SMDM group at J100; P6, comparison between female in SMDM at J 0 and female in SMDM group at J100 (p<0.05); (*), significant comparison between male and female in Non SMDM and SMDM group (p<0.05)

Concerning anemia, male in Non SMDM group with 36.64% were more affected than male in SMDM group at J100 with the prevalence of 12.68% (p=0.0004). A significant difference was observed between male at J0 (28.05%) and female at J100 (12.68%) (p=0.01). Female in Non SMDM group were more anemic with the prevalence of 38.15% than female at J0 and J100 respectively 12.70% and 10.17% with significant difference (p<0.05). In what concern thrombopenia, no child was affected in Non SMDM group, female in SMDM group were more affected at J0 with a statistical difference as compared to female at J100 (p=0.01). No significant difference was found between SMDM group and Non SMDM receiving group concerning leucopenia, neutropenia and lymphopenia.

Discussion

The assessment of nutritional status is pivotal in the pediatric field for dealing with both healthy and sick children. This study concerning the nutritional status in relation to their haematological profile confirmed that malnutrition is not yet eradicated in our study population. The prevalence of underweight was 5.26% in Non SMDM group against 6.77% at J0 and 0.76% at J100 in SMDM group. The prevalence of stunting was 6.77% in Non SMDM group, 0.68% and 0.76% respectively in SMDM group at J0 and J100. The prevalence of overweight was 11.28% in Non SMDM group; 11.03% and 10.76% at J0 and J100 in SMDM group. The prevalence of obesity was 3.76% in Non SMDM group; 4.13% and 5.38% respectively at J0 and J100 in SMDM group. Anemia, with the prevalence of 37.59% in Non SMDM group and 21.37% at J0, 11.53% at J100 in SMDM group. While the proportion of protein-energy malnutrition was decreasing, we observed an increasing level of overweight/obesity reaching almost 11% of children in our study.

That prevalence was higher compared to the prevalence that we observed in a preview study in Abidjan with a prevalence of 8.94%.[24] That prevalence is lower than what is observed by authors in United States with the prevalence of 16% among children aged from 6-16 years old.[25] Also we noticed low percent of under nutrition at second survey J100, in comparison to J0 and Non SMDM receiving group.[24] That can be explained by the fact that children from target group (SMDM group) belonged to family that was well educated with good socio economic status. And those pupils comparatively to the control group enjoyed balanced diet at home and at school. That can explain why children receiving School Midday Meal were well nourished in comparison to Non-receiving School Midday Meal children. Our finds are similar to those of Sabely et al.[26] in Egypt and in India.[26,27] In their study, these authors found that school meal improved nutritional status of primary school children. In children from Non-receiving School Midday Meal, we found that stunting and underweight were higher as compared to SMDM receiving group. Both groups were significantly different in nutritional status, and percentage of anemia.[28] The possible explanation for Non SMDM being the most affected by malnutrition may be attributed to various reasons such as poor socio economic conditions of parents, exposure to unhygienic environment with the lack of proper care and attention for adequate nutrition that is required during the growing year.[29]

Children male genre was suspect to suffer from malnutrition more than the female. Furthermore, children aged from 5-9 years were more malnourished than the elders (10-14 years). That result can be explained by the fact that girls grow up more quickly than boys. Concerning the age group, children from 5-9 years needs more nutrients to grow up and is very vulnerable to nutrients deficiencies. Also children from control group sometime didn't have a balanced diet at midday, so they cannot reach the adequate quantities of proteins and micronutrients such as vitamins and minerals recommended to their growth.[30] As seen in our study, the difference in stature and weight between SMDM and Non SMDM group and an increased percentage of under nutrition/stunting in Non SMDM receiving group and overweight has been reported in India.[31,32] The prevalence of under nutrition observed in this study particularly in control group can be also explained by the fact that most of the children belonged families with lower education level. Parental education had been identified in other population as a predictor of under-nutrition. Poorest population segments are the least educated that increases the gap between the richest and the poorest.[33,34] However, the proportion of stunting and under nutrition found in our study population was lower than those reported by the previous authors. This low prevalence of under nutrition can be explained by fact that our study was carried out in residential area where most of parents have good social conditions, for socio-demographic factors correlates with nutritional status according to Mushtaq et al.[35,36] When compared to the prevalence cut-off values of World Health Organization, the prevalence of stunted and wasted children in our study was under the critical category (≤15%).[37] Stunting is an indicator of chronic malnutrition during the first years of life.

Growth deficit tends to accumulate with age and particularly in boys, as observed in our study and in other studies of school children in developing countries.[38] Children from Non SMDM receiving group suffered more from malnutrition than those from SMDM receiving group. Our results are similar to the results observed by Bhargava et al.[32] in India during their study.[32] Contrary to our study, some authors observed that children who used to take the lunch in school canteen suffered more from malnutrition than children who used to have their lunch in street.[28] In what concerning overweight or obesity, the rate is increasing reaching 11% in our study population that prevalence was higher than what observed with the proportion of 6.29% in Ouagadougou.[38] Nevertheless this prevalence was lower than those observed in India with the prevalence of 40.8%.[39] However a study conducted in Cote d'Ivoire by Lokrou and Nioblé,[36] in 2008 among schoolchildren was higher than the prevalence in our study. During their study the authors found that the prevalence of overweight and obesity was 12.5% among the subjects of their study.[36]

Anemia was observed in both control and target group. But children from control group (Non SMDM) indicated higher rate of anemia with the proportion of 37.59% against 21,37% and 11.53% in target group (SMDM) respectively at J0 and J100 (Table 8).

This study also confirmed that anemia is common to protein energy malnutrition. That confirms that anemia is the most widespread malnutrition problem in schoolchildren in developing countries.[40] Low mean value of hemoglobin, hematocrit and red blood cell observed in Non-SMDM receiving children as compared to SMDM receiving children in this study, were observed by Daboné et al.[38] and Kokoré et al.[41] during their study.[38,41,42] These authors observed that children who received school lunch had better haematological profile than children who took lunch outside the school canteen.[43] That could be explained by the fact that children from SMDM group had balanced and diversified diet with appropriated nutrients required for the growing and development of the students. In fact according to the recipes observed, the diet was balanced and varied with important nutrients (proteins, energy, lipid, and vitamins) intake in SMDM group. However, the high prevalence of anemia can be the fact iron deficiency which the main factor of anemia, but it is not the only one cause of anemia. Anemia can be the fact of infection, for infection plays a key role, notably malaria and hookworms in African schoolchildren.[38]

The meals were cooked in a clean and healthy environment as school Canteen. Besides school canteen represents an adequate environment for a good nutrition and an opportunity to inculcate good feeding practices to the school children. So canteen is an important tool to provide nutritional education.[44] In other hand, parent's education levels and activity play an important role concerning reducing malnutrition among children from SMDM group. In our study, we found that most of parents in this case, women benefited from good education and had good professional activity. Also most of them were civil servant or paid employee. A study conducted in Guatemala in 2007 demonstrated that children that lived in a family with important socio economic resources have better nutritional status.[45]

However, the current study didn't show significant differences between haematological parameters of malnourished children compared to normally nourished children among SMDM and Non SMDM groups. That can be explained by the fact that no case of severe malnutrition was observed in our study and malnutrition was mild to moderate. The prevalence of anemia in Non-SMDM receiving group was higher (37.59%) as compared to children belonging to SMDM group (with the prevalence of 21.38% at J0 and 11.53% at

J100). Our findings were lower in comparison to the result found by some authors in Ouagadougou (Burkina Faso) with the prevalence of 40.40%.[38] Boys were more anemic than girls and according to age the children from 5-9 years old were more anemic than the elders. Our findings were similar to those observed in Burkina Faso.[38]

Hemoglobin, Hematocrit, Red Blood Cell indices were normal in SMDM children and Non SMDM children. That could be explained by the fact that in our study, all form of malnutrition was moderate, none case of severe malnutrition has been observed. Yet, a study leaded by authors in Nigeria, showed that haematological indices decrease in protein Energy Malnutrition.[46]

According to these authors various factors contributed anemia such as

a. Iron deficiency

b. Reduced Red cell production in adaptation to lean smaller body mass

c. Erythropoietin deficiency

d. Folic acid and vitamin B12 deficiency

e. Deficiency in trace element (Cooper and Zinc)

f. Infections

Iron deficiency is the most common trace element deficiency worldwide, affecting between 20% and 50% of the world population mainly infants, children and women of child bearing age.[47,48] Severe acute malnutrition is always associated with increased severity of common infectious diseases and death among children with severe acute malnutrition is almost always as a result of infection such as malaria.[21] Even if malnutrition is known to be a factor associated with anemia, particularly in vulnerable group living in low income countries, such case has not been observed in our study, for malnutrition was moderate in our study population. That can be the fact that all the children included in our study were in healthy state and no one complained to suffer from any illness. Significant elevation of white blood cell count of Non SMDM receiving group compared to SMDM receiving group was observed. But all those mean value were normal according to references values.[37] Our findings were contrary to the results found by Patel et al. In their study, those authors observed statistically difference between SMDM group and non SMDM group.[28]

Furthermore, an inadequate dietary intake leads to weight loss, lowered immunity and invasion by pathogens and malnutrition predisposes to infection, increases the severity and morality of infections. Also malnutrition and infection tended to occur in the same population with poor setting resources and poverty.[49] In our study, we noticed that blood platelet count was normal they both SMDM group and Non SMDM group. No pathological difference was found between SMDM receiving children and Non SMDM receiving children. Contrary to our findings, some studies showed that blood platelets count significantly increased in malnourished children as compared to normally nourished children.

Others studies mentioned that platelet activation is not correlated with infection particularly malaria in which one, plasmodium can interact with different receptors on human platelet which shortened the life span and pathogens can induce removal of platelet from the circulation by stimulating their sequestration in organ or by triggering their clearance by phagocytosis, that can explain thrombocytopenia commonly associated with malaria.[50]

Others works conclude that platelet reactivity depends on the hemoglobin levels rather than the iron parameters with significant correlation between hemoglobin levels or serum iron and transferrin saturation on one hand and parameters of platelet aggregation on the other hand.[8]

Conclusion

The midday meal program was entitled towards providing nutritious diet to the school children with aim of at least covering 1/3 of child's daily calorie requirements and half of daily protein requirement to reduce hunger, malnutrition and improve school attendance. At the end of this study, based in our findings, it appears that protein-energy malnutrition, overweight and anemia were still present among urban schoolchildren. However school children from Non SMDM group our control group were the most affected by under nutrition, stunting and, anemia. SMDM group in the study showed better nutritional status than healthy comparison group who belonged to Non SMDM children. We noticed that school midday program reduced the rate of underweight and stunting, but it seems to have no effect concerning overweight. Concerning anemia, children from Non SMDM receiving children were more anemic than the SMDM receiving group. Children from SMDM group had better nutritional status than the Non SMDM group at J0 and J100. After all this argument we can conclude that school feeding program had a positive impact on the hemoglobin rate but not on the white blood cells and platelet. Our study showed that balanced and healthy diet acts as a supplement to fight against malnutrition and iron deficiency which is the main cause of anemia.

Also because of simultaneous presence anemia, under nutrition and over nutrion among the same population showed that country is faced to the triple burden of malnutrition (protein-energy malnutrition, micronutrients deficiencies and overweight). School midday meal improve schoolchildren nutritional status. However appreciate the nutritional status by anthropometric and hemtological parameters is limited because anemia can be caused by diseases. Thus, there is urgent to reassess the SMDM program, in light of findings of similar studies and assess the biochemical indices such as albumin, pre-albumin, vitamin A and E in those children in comparison to Non SMDM children.

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Author's contributions

JKA was the main investigator for the study, designed the study, supervised data collection, analysis on the field and wrote the manuscript under the supervision of MNB. MNB advised on data collection and helped to write the manuscript. He advised on the design of the study and wrote the demand for department of education authority consent to conduct the study in the area. MNB reviewed the draft and made some changes. Supervised and emended the final form of the paper to be submitted. PAY was the main director and the designer of the study, overall project management, reviewing of manuscript, supervised the setting, read and approved the final manuscript.

Conflict of interest

The authors declare that they have no competing interests.

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