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Research Article

Biochemical Nutritional Indicators in Children Attending School Canteen Compared to Control Group in Cocody (Abidjan)

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Abstract

Nutritional status is one the key indicators of health and individual development particularly for school children. In Cote d'Ivoire, malnutrition is steel a public health problem. The aim of that study was to evaluate the nutritional status by anthropometry and biochemical parameters in school children attending school canteen in comparison to control group.

Anthropometrics measurements and Biological variables were evaluated. Anthropometric values were determined using WHO standard anthroplus 2007 software. Biochemical parameters such as serum protein, albumin, lipid profile, glucose, transaminase, C reactive protein, sodium, potassium and chloride were determined with a ROCHE/HITACHI 902 Japan counter analyzer.

Ours findings revealed that the mean age was 8.89 ± 1.64 years in MDM group against 9.59 ± 2.13 years in non MDM (P < 0.05). Underweight (0.81%), overweight/obesity (5.69%) in MDM group. However underweight was 5.26%, stunting (7.52%), and overweight (3.76). There was significantly higher incidence of hypoproteinemia, hypoalbuminemia in MDM group compared to control group.

We can conclude that significant proportion of children in non-Midday Meal group had altered anthropometric and biochemical parameters. There was significantly higher proportion of Underweight, stunting and overweight, hypoproteinemia, hypoalbuminemia, anemia in children among non MDM group compared to MDM group.

Keywords: *Nutritional Anthropometry; Nutritional Status; Biochemical Parameters- Children; Scholl Canteens; Cocody-Abidjan (Côte d'Ivoire)*

Abbreviations

WFP: World Food Program; PEM: Protein-Energy Malnutrition; WHO: World Health Organization; MDM: School Mid-Day Meal; BMI: Body Mass Index; SD: Standard Deviation; Kg: kilograms; M: Meter; EDTA: Ethylene Diamine Tetra-Acetate; LDL: Light Density Lipoprotein; HDL: Hight Density Lipoprotein; TGP ALAT: Transaminase Aspartate Amino Transferase; TGO ALAT: Transaminase Glutamic Oxaloacetic Alanine Aminotransferase; CRP: C Reactive Protein; FAO: Food and Agricultural Organization; Na: Sodium; Cl: Chloride; K: Potassium

Introduction

Nutrition is the science of food and its relationship to health. It is also the sum of the processes involved in taking nutrients, assimilating and/or utilizing them in the body for good health of an individual. The science of nutrition deals with nutrients in food, their metabolic effects and consequences of intake of food inadequacy. Nutrients are chemical components of food that need to be absorbed properly in the body for optimal utilization [1].

Nutritional status is one of the key indicators of health and development of an individual. Good nutrition protects the infant, the children and the mother, strengthens the immune system and reduces the risks of non-communicable diseases related to foods. It can also help to get out gradually from the vicious circle of poverty and hunger [2]. Nutritional status is the balance between the intake and utilization of food nutrients by man in the process of growth and development and according to authors [3], it is an integral component of the overall health of an individual and provides an indicator of the well-being of children living in a particular region [4]. Most of researches concerning nutritional status have been done in children under five years in the detriment of children of school age [5].

However school age is the active growing phase of childhood; it represents a dynamic period of physical growth as well as of mental development and social adaptation of a child [6]. This age group (5 - 12 years old) is potentially vulnerable and susceptible to growth and general developmental challenges. Often, the adverse effects of poor nutrition at this age are not reversible and eating habits have not been established. Childhood is a time when food preferences and habits are shaped [7]. Feeding practices in early life are important in cognitive development of the child and overall well-being of an entire lifetime [8]. Researches indicates that health problems due to miserable nutritional status in school-age children are among the most common causes of low school enrolment, high absenteeism, early dropout and unsatisfactory classroom performance [9].

School children as most of children under 12 years are faced to nutritional problem especially protein energy malnutrition which is a very common problem in Africa particularly in low incomes countries. Malnutrition is then a result of less or excess of one or more nutrients [10]. In all its forms it has serious health consequences and now, there is a double burden of malnutrition especially in developing countries for nowadays more and more children are being overweight in developing countries whereas some of them are underweight and stunted in the same population or family [11]. According to Food and Agriculture Organization (FAO), more than 3.5 billion people are suffering in the world, for malnutrition and hunger. Each year, almost 9 million deaths of children fewer than 5 years, estimated from 33 to 56% are attributable to malnutrition [12]. Malnutrition, if not controlled at the youngest age will lead to chronic diseases at adulthood. Schoolchildren are also one of groups severely affected by malnutrition, after infants and young children. Long term poor eating habits affect lifestyle and cause related chronic diseases including obesity, diabetes, cardiovascular diseases and some cancers [2].

A recent report of FAO (Food and Agricultural Organization) and WFP (World Food Program) reckons almost 10.9% persons in the world are underfed, 20¨% in Africa, 9.60¨% in West Africa and 13.3% in Cote d'Ivoire during the period of 2014 - 2016 [13].

In Cote d'Ivoire, protein energy malnutrition is not yet eradicated with a prevalence of 10% of wasting, 29.8% of stunting and 24.6% of overweight in adult. These values are not representative of the whole population for school children are most of time ignored by the survey conducted Demographic Health Statistic (DHS). However overweight and obesity is increasing in prevalence among children that represent a real heath problem that our government can't afford because it is difficult to eradicate after their settling up [14] (FAO, 2014). That represents the phenomenon of nutritional transition in which traditional and normal eating practices and habits are being given up in aid of occidental eating habits with dense and hyper caloric foods and snacks. This nutritional transition is the bed of several nutritional disruptions in the health and nutritional status such as diabetes and non-transmissible chronic diseases.

In order to interest children to attend and remain at school, most of government in the world instituted school feeding program in the academic program. Cote d'Ivoire like numerous countries in the world has its own school feeding program which depends on external aids from World Food Program (WFP) in order to fight again hunger and help children who belong to low socio economic families to benefits an balanced diet per school day.

Moreover, School feeding helps to eliminate hunger for millions of children around the globe and is contributing to their education, nutrition, health and future productivity as adults.

School feeding, defined by the World Bank as ‘the provision of food to schoolchildren”, is universally recognized as one of the key social safety net programs to protect the poor. In addition to reducing hunger, school feeding provides a potential means to increase attendance in schools. It also improves learning and educational achievement particularly when accompanied by complementary actions such as micronutrient fortification and de-worming [15].

Numerous methods are used to evaluate nutritional status of an individual such as anthropometry; clinical examination and biological parameters [16]. There are numerous biochemical parameters which become altered during protein energy malnutrition (PEM). Protein energy malnutrition (PEM) is the predisposing factors that lead to much of morbidity and mortality of children. Anthropometry is the main method to appreciate the nutritional status of an individual, but it doesn’t reveal nutrients deficiencies or the rate of blood parameters. Furthermore biochemical parameters provide the valuable information for the overall management and act as sensitive indicators especially in a tertiary health care center. Clinical and anthropometric features of PEM are late to appear. Hence biochemical parameters will prove as early and sensitive indicators of developments PEM. Biochemical value will trace a real nutritional status and also in optimal specific and precise management of PEM in tertiary care center [17]. The evaluation of nutritional status can be approached by using a combination of anthropometric, clinical, biochemical data and case history in combination, and not as individual parameters, because each of them may vary in a wide range. The evaluation of biochemical markers is a must nowadays, in order to complete the clinical and anthropometric diagnosis [16].

The aim of that study is to evaluate the nutritional status by biochemical parameters in school children attending school canteen in comparison to control group.

Firstly we will assess the nutritional status by anthropometry and then analyze the biochemical markers of nutritional status.

Materials and Methods

Study setting and Population

We have conducted a prospective study on 278 school children (stratified by gender; 139 boys and 139 girls) between March 2016 and June 2016 in three public primaries school in Cocody one of the most famous and upper socioeconomic status district of Abidjan (Côte d’Ivoire). Children aged 5 to 12 years were selected in those schools according to inclusion criteria. Inclusion criteria comprised apparently healthy children in the age group of 5 - 12 years. Participants with any chronic ailment, congenital diseases or any major surgery or taking any medication were excluded from the study. We have divided the children in two groups: the first group (n = 145) was composed of children who received School midday meal (MDM) and the second as control (n = 133) were consisted in children essentially who didn’t receive school midday meal (non MDM). We considered as nutritional deficient (ND) all the children with a body mass index (BMI) under –2 standard deviations (SD), according to the WHO standards [18].

Anthropometry

Height and weight were measured in light clothing without shoes. Standing height was measured to the nearest 0.1 cm, using a height gauge. Weight to the nearest 0.1kg was measured with an electronic scale beryl. Height, weight, and body mass index (BMI) Z score were computed. Anthropometric status were calculate by using Nutrisurvey Software [19,20].

Biochemical estimation

In all school children in fasting conditions, hemoglobin concentrations by cyanmethemoglobin method and biochemical parameters were measured after taking history and physical examination of the children. Five ml of venous blood was collected and kept in EDTA (Ethylene Diamine Tetra-Acetate), vial and tests tube early in the morning between 06 and 10 hours. In all the study-population (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.

Hematological parameters were estimated by using an automaton Coulter Syxmex KX21N analyzer. The blood sample collected in test tubes was quickly centrifuged at 4000 tours per minutes and for 5 minutes with a liquidizer device (EPPENDORFF) to separate serum from blood deposit. The serum aliquots were stored in cool place in a Freezer (SAMSUNG) at -20°C in the central biochemical laboratory of the University Hospital Complex in Treichville. Total proteins were analyzed by an automaton LYASIS analyzer. Biochemical markers were measured out by using a ROCHE/HITACHI 902 Japan counter analyzer. Blood protein by Buiret method; albumin by bromocresol green (BCG); Cholesterol by enzymatic end-point method in Sta Fax biochemistry analyzer, Sodium, potassium and chloride were measured by ion selective electrode (ISE) in NOVA biolytic analyzer.

Statistical analyses

Mean and standard deviation of anthropometrical and biochemical parameters were determined using excel 2013 software and graph-pad prism version 5.1.0.5 for different comparison we used student test t and the test of Mann Whitney for sample with a size under 50 individual.

Proportion of malnutrition and any deficiencies was determined by using Ratio version 2.10.1. P-value < 0.05 was considered statistically significant and p value > 0.05 was considered statistically non-significant.

Ethical approval and Consent

The purpose of the study and its importance was explained to the administrative authorities, principal and teachers of the schools along with children and their parents. An informed written consent was obtained from school authorities and parents, and an assent from school children participating in the study was also obtained. If the parents were not literate, the information was read out to them in local language by an interpret belonging to the family and if their 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, while others refused. Children and parents willing to take part in the part in the study were interviewed to fill a screening questionnaire; 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 their health status. Ethical approval was granted by the ethics Committee of Nangui Abrogoua University of Abidjan (Cote d'Ivoire).

Results and Discussion

Socio demographic characteristics

From the analysis of table 1, a total number of 278 children included for that study out of which 145 belonged to MDM group and 133 belonged to non MDM group. Concerning sex group table 1 showed 50% of boys and 50% of girls (56.55% of boys and 46.45% of girls against 42.86% of boys and 57, 14%) respectively in MDM group and non MDM group. The mean age in MDM group was 8.89 ± 1.64 years against 9.59 ± 2.13 years in non MDM pupils. Concerning age group, most of children belonged to 5-10 years group, 75.86% in MDM group against 7.14% in Non MDM group. In what concern the size of the household, most of the children belonged to family more than 5 persons. As for mother education level, 5.52% in MDM group against 36.09% in non MDM group were illiterate. Concerning father instruction's level, no case of illiteracy was observed in MDM group, however 7.82% of father in non MDM group were illiterate. Also 63.10% of children in MDM group against 9.02% in Non MDM group belonged to a family whose father had a high education (p < 0.05). According to fruits consumption, most of children in our study population had fruits consumption under the recommended value which is at least 5 fruits and vegetable or 400 g of fruits per day (93.10% in MDM group against 90.23% in Non MDM group).

Parameters	MDM (145)	Non MDM (133)	p
Sex[b]	N (%)	N (%)	
Male[a]	82 (56.55)	57 (42.86)	0.16
Female[a]	63 (43.45)	76(57.14)	0.17
Weight (Kg)[b]	29.05 ± 8.85	29.78 ± 7.88	0.59
Height (cm)[b]	131.91 ± 11.10	133.68 ± 11.61	0.15
BMI (kg/m^2)[b]	16.34 ± 2.80	16.40 ± 2.39	0.58
Mean age (years)[b]	8.89 ± 1.64	9.59 ± 2.13	< 0.0001
Age group[a]			
5 - 10	110 (75.86)	76 (57.14)	0.10
10 - 12	35 (23.14)	57 (42.86)	0.01
Size of household[a]			
< 5 persons	5 (3.45)	8 (6.02)	0.40
> 5 persons	140 (96.55)	125 (93.98)	0.85
Mother instruction level[a]			
Illiterate	8 (5.52)	48 (36.09)	5.4.10^{e}-7
Primary	22 (15.17)	50(37.59)	0.0-601
Second	84 (57.93)	23 (17.29)	1.48.10^{e}
Superior	31 (21.38)	12 (9.02)	0.02
Father instruction level[a]			
Illiterate	0 (0)	10 (7.52)	0.001
Primary	7 (4.23)	25 (18.80)	0.001
Second	46 (31.72)	71 (53.38)	0.01
Superior	92 (63.45)	12 (9.02)	1.17 e-11
Fruits consomption[a]			
< 5	135 (93.10)	120 (90.23)	0.83
> 5	10 (6.90)	13 (9.77)	0.48

Table 1: *Characteristics of the population.*

n: Number; %: Percentage; a: Cases number and percentages as values in table; b: Mean and standard deviation as values in table; MDM: Midday Meal; BMI: Body Mass Index; p: level of significant difference p < 0.05.

Anthropometric evaluation

Table 2 dealt with the anthropometrics parameters in the two subject groups. The distribution of anthropometrics indices was normal in our study population. However concerning Height for age mean value, children from Non MDM group (-0.18 ± 1.50 SD) had negative value as compared to MDM group (0.17 ± 1.09 SD; 0.12 ± 1.09 SD). A significant difference (p = 0.01; 0.006) was observed between Non MDM group and MDM group concerning Body Mass Index for Age (-0.13 ± 1.29 vs 0.16 ± 1.11 SD). However all the mean values of anthropometrics indices (Weight for Age and Body Mass Index) were normal according to WHO references [21].

Anthropometrics parameters	MDM 1 J_0 (n = 145)	MDM 2 J_{100} (n = 123)	Non MDM (n = 133)	P 1	P 2	P 3
Weight for Age (SD)	0.04 ± 1.19	0.180 ± 1.14	0.16 ± 1.21	0.41	0.52	0.89
Height for Age (SD)	0.17 ± 1.09	0.12 ± 1.09	-0.18 ± 1.50	0.73	0.02	0.06
Body Mass Index (kg/m^2)	16.34 ± 2.80	16.69 ± 2.81	16.40 ± 2.39	0.27	0.82	0.35
Body Mass Index for Age(SD)	-0.13 ± 1.29	0.16 ± 1.11	-0.22 ± 1.14	0.04	0.55	0.006

Table 2: *Mean values of anthropometrics parameters in MDM group and Non MDM group.*

MDM: Mid-Day Meal; n: Number; P 1: Comparison between MDM 1 vs MDM 2; P 2: comparison between MDM-1 vs Non MDM; P3: Comparison between MDM 2 vs Non MDM; J_0: First day of nutritional survey, J_{100}: One hundred days after the first nutritional survey, p: Level of significant difference p < 0.05.

According to the findings in this table 3, children from non MDM group with 7.52% were significantly more stunted as compared to MDM group where no case of stunting have been noticed (p = 0.001). Concerning underweight we found a reduction of the prevalence from 6.25% at first survey (MDM J_0) to 0.8% at 100 days later (MDM J_{100}) with a significant difference (p < 0.05). no significant difference was observed between MDM group and Non MDM group. In what concern overweight and obesity, the prevalence was respectively 4.14% in MDM J_0, 5.69% in MDM J_{100} and 3.76% in Non MDM no significant difference was observed between MDM and Non MDM group (p > 0.05).

Types of malnutrition	MDM J_0 (n = 145)	MDM J_{100}(n = 123)	Non MDM (133)	P 1	P 2	P 3
Underweight (BAZ<- 2 SD) (%)	9 (6.21)	1 (0.81)	7 (5.26)	0.02	0.77	0.05
Wasting (WAZ<- 2SD) (%)	4 (2.76)	0 (0)	3 (2.26)	0.05	0.82	0.07
Stunting (HAZ< -2SD) (%)	0 (0)	0 (0)	10 (7.52)	-	0.001	0.001
Overweight/ Obesity (BAZ> - 2SD) (%)	6 (4.14)	7 (5.69)	5 (3.76)	0.68	0.89	0.52

Table 3: *Proportions of different forms of malnutrition in MDM group and Non SMDM group.*

MDM J_0: Midday Meal at the first day of survey; MDM J_{100}: Midday Meal at 100 days later; P 1: Comparison between MDM J_0: vs MDM J_{100}; P 2: Comparison between MDM J_0 vs Non MDM; P3: Comparison between MDM J_{100} vs Non MDM, WAZ: Weight for Age Z score; Body Mass Index for Age Z score; HAZ: Height for Age Z score; SD: Standard Deviation. p: Level of significant difference p < 0.05.

Biochemical evaluation

The different values of serum biochemical parameters registered in the table 4 showed that the mean serum total protein, albumin, urea, transaminases, total lipids, the LDL Cholesterol was significantly different in both MDM and Non MDM group (p < 0.05) and remained in normal rate in comparison to reference values, while mean value of serum glucose, creatinine, C Reactive Protein, HDL Cholesterol, Sodium, Potassium, Chloride was not significantly different in the both group (Table 4).

Biochemical parameters	MDM J_0 (n = 145)	MDM J_{100} (n = 123)	Non MDM (n = 133)	P1	P 2	P 3
Glycaemia (g/l)	0.74 ± 0.17	0.70 ± 0.24	0.84 ± 0.02	0.73	0.56	0.84
Total protein (g/l)	77.63 ± 8.03	80.85 ± 7.84	70.41 ± 8.23	< 0.0001	< 0.0001	0.0003
Albumin (g/l)	40.89 ± 5.69	41.86 ± 8.01	36.78 ± 6.13	< 0.0001	< 0.0001	0.27
Creatinin (mg/l)	10.10 ± 2.31	10.52 ± 2.10	10.95 ± 2.06	0.12	0.0018	0.10
Urea (g/l)	0.22 ± 0.06	0.23 ± 0.05	0.26 ± 0.07	0.77	0.0003	0.0003
TGO-ASAT (U/l)	22.35 ± 8.73	28.98 ± 13.01	29.08 ± 12.80	< 0.0001	< 0.0001	0.95
TGO-ALAT (U/l)	18.28 ± 8.09	21.87 ± 10.51	22.00 ± 10.52	0.0015	0.015	0.92
CRP (mg/l)	3.97 ± 0.14	4 ± 0.00	3.92 ± 0.26	0.09	0.04	0.08
Total lipids(g/l)	6.19 ± 8.23	6.90 ± 1.35	7.31 ± 1.07	< 0.0001	< 0.0001	0.0003
Triglycerids (g/l)	1.02 ± 0.31	1.25 ± 0.40	1.97 ± 6.71	< 0.0001	0.10	0.23
Cholesterol (g/l)	2.05 ± 0.28	3.78 ± 1.25	2.37 ± 0.75	0.25	0.25	0.35
LDL Cholesterol (g/l)	1.36 ± 0.19	1.44 ± 0.22	1.53 ± 0.24	0.0018	< 0.0001	0.002
HDL Cholesterol (g/l)	0.49 ± 0.06	0.50 ± 0.05	0.52 ± 0.15	0.35	0.10	0.26
Sodium (Na^+)	139.09 ± 1.74	148.47 ± 1.70	137.96 ± 1.36	0.31	0.08	0.26
Potassium (K^+)	3.98 ± 0.27	4.42 ± 3.80	4.04 ± 0.29	0.06	0.18	0.28
Chlorure (Cl^-)	106.36 ± 3.66	99.23 ± 5.66	98.99 ± 8.02	0.05	0.07	0.78

Table 4: *Serum nutritional parameters concentration in children from MDM group compared to Non MDM group*$^{\alpha}$*.*

α: Mean and standard deviation as values in main table; MDM: Midday Meal; HDL: Heavy Density Lipoprotein; LDL: Light Density Lipoprotein; CRP: C Reactive Protein; P: Comparison between *normonourished and malnourished children; P 1: Comparison between MDM* J_0 *vs MDM* J_{100}*; P 2: Comparison between MDM* J_0 *vs Non MDM; P3: Comparison between MDM* J_{100} *vs Non MDM;* J_0*: First day of nutritional survey,* J_{100}*: One hundred days after the first nutritional survey; n: Number; p: Level of significant difference p < 0.05.*

From the analysis of table 5, hypoproteinemia was significantly high in Non MDM group when compared to MDM group at different stage 3.76% at J0; 0.81% at J_{100} ($p < 0.05$). No significantly difference was observed in MDM J0 group as compared to MDM J_{100} group. That means that the risk of developing hypoproteinemia is approximately high in Non MDM group as compared to MDM group. There was significant decline in total protein in Non MDM group ($p < 0.05$).

Concerning serum albumin, the results in table 5 showed that hypoalbuminemia was significantly frequent in Non MDM group (9.77%) than among MDM group with different proportion 2.44% at the first survey (J0) and 2.44% at 100 days after the first survey (J_{100}) (p = 0.02). Serum albumin significantly correlates with the quality of the diet. This means that developing hypoproteinemia is increased in Non-Midday meal eaters as compared to School lunch eaters (MDM group) ($p < 0.05$).

From the analysis of transaminases, we observed that high proportion of children in both group had normal value of transaminases. High value of transaminase ASAT was observed only in non MDM group with the proportion of 2.26%. No significant difference was observed among MDM and Non MDM group (p = 0.07).

Concerning the serum transaminase TGP ALAT, no significant difference was observed among MDM and non MDM pupils. We observed that 1.38% of MDM J0 against 2.26% in Non MDM had high value of transaminase TGP ALAT without any significant difference (p = 0.07) (Table 5).

Serum proteins and enzymes parameters	MDM J_0 (145) n (%)	MDM J_{100} (123) n (%)	Non MDM group (133) n (%)	P1	P2	P 3
Serum total protein						
Hypoproteinemia	5 (3.76)	1 (0.81)	15 (11.28)	0.04	0.001	0.15
Normal	136 (93.79)	120 (90.22)	113 (84.96)	0.72	0.69	0.96
Hyperproteinemia	4 (2.76)	2 (1.63)	5 (3.76)	0.25	0.35	0.69
Serum albumin						
Hypoalbuminemia	9 (6.20)	3 (2.44)	13 (9.77)	0.36	0.02	0.19
Normal albuminemia	135 (93.10)	119 (96.75)	119 (89.47)	0.79	0.43	0.29
Hyperalbuminemia	1 (0.69)	1 (0.81)	1 (0.75)	0.92	0.96	0.97
Serum transaminases TGO ASAT						
Low values	0 (0)	0 (0)	0(0)	-	-	-
Normal values	145 (100)	123 (100)	130 (97.74)	0.87	0.87	1
High values	0(0)	0(0)	3(2.26)	0.07	0.07	-
TGP ALAT						
Low values	0 (0)	0 (0))	0 (0)	-	-	-
Normal values	143 (98.62)	123 (100)	130 (97.74)	0.96	0.92	0.87
High values	2(1.38)	0 (0)	3 (2.26)	0.64	0.16	0.07

Table 5: *Proportions of serum protein and enzymes concentration in MDM group and non MDM group.*

P 1: Comparison between MDM J_0 and Non MDM group; P2: Comparison between MDM J_{100} and Non MDM group; P3: Comparison between MDM J_0 and MDM J_{100}; group; J_0: first day of nutritional survey, J_{100}: one hundred days after the first nutritional survey; MDM: Midday Meal; n: number; %: Percentage; p: Level of significant difference $p < 0.05$.

According to the finds registered in table 6, most of the children had normal rate of total lipids without any significant difference between the both groups ($p > 0.05$). We observed hyperlipidemia with the proportion of 8.28%, 12.20%, 9.77% respectively in MDM J_0; MDM J_{100}; non MDM without any significant difference ($p > 0.05$).

Serum lipid	MDM J0 (n = 145) n (%)	MDM J100 (n = 123) n (%)	Non MDM (n = 133) n (%)	P1	P 2	P 3
Serum total lipids						
Hypolipidemia	0	0	0	-	-	-
Normal	133 (91.72)	108 (87.80)	120 (90.23)	0.769	0.912	0.855
Hyperlipidemia	12 (8.28)	15 (12.20)	13 (9.77)	0.384	0.725	0.603
Serum Cholesterol						
Hypocholesterolomia	0	0	0			
Normal	138 (95.17)	116 (94.31)	124(93.23)	0.95	0.93	0.88
Hypercholesterolemia	5 (3.45)	5 (4.06)	8 (6.90)	0.82	0.38	0.27
High LDL	2 (1.38)	2 (1.63)	1(0.75)	0.88	0.66	0.56
Serum total triglycerides						
Hypotriglycerimia	0 (0)	0(0)	2 (1.503)	-	0.148	0.148
Normal	138 (95.17)	120 (97.56)	115 (86.47)	0.863	0.518	0.413
Hypertriglyceremia	7 (4.83)	3 (2.44)	16 (12.03)	0.370	0.07	0.008
Total	145 (100)	123 (100)	133 (100)			

Table 6: *Serum lipid proportions in MDM group and Non MDM group.*

MDM: Midday Meal; n: number; P 1: Comparison between MDM J_0 and Non MDM group; P2: Comparison between MDM J_{100} and Non MDM group; P3: Comparison between MDM J0 and MDM J100 group; J_0: First day of nutritional survey, J_{100}: One hundred days after the first nutritional survey

MDM: Midday Meal, LDL: Low Density Lipoprotein; P 1: Comparison between MDM J0 and Non MDM group; P2: Comparison between MDM J_{100} and Non MDM group; P3: Comparison between MDM J_0 and MDM J_{100} group; J_0: First day of nutritional survey, J_{100}: One hundred days after the first nutritional survey; n: Number; %: Percentage; p: Level of significant difference $p < 0.05$.

Concerning serum cholesterol, no significant value was observed between MDM and Non MDM group ($p > 0.05$).

Hypercholesterolemia proportion was observed respectively in 3.45% at MDM J_0, 4.06% at MDM 100 against 6.90% in Non MDM group without any significant difference. Concerning high LDL rate, we observed 1.38% of MDM at J_0, 1.63% in MDM at J_{100} and 0.75% in non MDM group (Table 6).

The result confined in the table 6 showed that hypertriglyceremia was 12.03% in non MDM group against 4.83% in MDM J_0 and MDM J_{100} with significant difference between MDM group and Non MDM group ($p < 0.05$). Concerning hypotriglyceremia non-significant difference was observed between Non MDM and MDM group ($p > 0.05$).

From the analysis of table 7, only a child had hyponatremia in non MDM group; most of the children had normal serum sodium value (Table 7).

Hypokaliemia was very low in our study, proportion of hypokaliemia was respectively 1.38% in MDM, against 2.26% in non MDM group ($p = 0.07$). No case of hyperkalima was observed in our study (Table 7).

We did not observe any significant difference between MDM group and Non MDM group concerning serum chlorides concentration (Cl-). Only a child had hypochloridemia in MDM group at J_{100}. Most of the children had normal value of serum chloride (Table 7).

Minerals	MDM J_0 (n = 145) n (%)	MDM J_{100} (n = 123) n (%)	Non MDM (n = 133) n (%)	P1	P 2	P 3
Serum Sodium (Na^+)						
Hyponatremia	0 (0)	0 (0)	1 (0.75)	-	0.30	0.30
Normal	145 (100)	123 (100)	132 (99.25)	1	0.95	0.95
Hypernatremia	0 (0)	0 (0)	0 (0)	-	-	-
Serum Potassium (K^+)						
Hypokaliemia	2 (1.38)	0 (0)	3 (2.26)	0.16	0.64	0.07
Normal	143 (98.62)	123 (100)	130 (97.74)	0.92	0.95	0.85
Hyperkaliemia	0 (0)	0 (0)	0 (0)	-	-	-
Serum Chloride (Cl^-)						
Hypochloridemia	0 (0)	1 (0.81)	0 (0)	0.28	-	0.28
Normal	145 (100)	122 (99.19)	133 (100)	0.95	1	0.95
Hyperchloridemia	0 (0)	0 (0)	0 (0)	-	-	-
Total	145 (100)	123 (100)	133 (100)	1	1	1

Table 7: *Serum mineral proportions in MDM group and Non MDM group.*

MDM: Midday Meal; P 1: Comparison between MDM J_0 and Non MDM group; P2: Comparison between MDM J_{100} and Non MDM group; P3: Comparison between MDM J_0 and MDM J_{100} group; J_0: First day of nutritional survey, J_{100}: One hundred days after the first nutritional survey; MDM: Midday Meal; P 1: Comparison between MDM J_0 and Non MDM group; P2: Comparison between MDM J_{100} and Non MDM group; P3: Comparison between MDM J_0 and MDM J_{100} group; J_0: First day of nutritional survey, J_{100}: One hundred days after the first nutritional survey; n: Number; %: Percentage; p: Level of significant difference $p < 0.05$.

Nutritional deficiencies are a real problem throughout the world, especially in developing countries and must be properly evaluated. The assessment of nutritional status can be evaluated by many anthropometrical measurements, also by biological parameters. Many means are used to evaluate children nutritional state, but biochemical parameters provide the valuable information the overall management because clinical and anthropometric feature of Protein Energy Malnutrition are late to appear [17]. School age is considered as a dynamic period of growth and development because children undergo physical, mental, emotional and social changes. In others words the foundations of good health and sound mind are laid during the school age period. Hence the present study was formulated with the objective to determine the nutritional status and dietary habits of school aged children attending public MDM and non MDM group [4].

After analyzing our findings, education status of parents of children from MDM group was found to be significantly better as compared to their non MDM counterpart. The results showed higher rate of illiteracy among mothers in children from non MDM group than MDM group ($p < 0.05$). According to our findings parent's education was the key factor for a child to attend school feeding program. Similar findings have been observed by some authors [22]. In their study those authors stated that children belonging to well-educated family had an important regard for the school midday meal.

The educational status of parents of children in non MDM group was found to be significantly less as compared to MDM counterparts. Our findings revealed that children whose mothers were literate had better nutritional status compared to children whose mothers were illiterate. The result showed that education was the key factor of determining the nutritional status of children especially under five. Similar results were observed by authors [17]. In their study, they showed the impact of maternal literacy status on the nutritional status of children was studied.

Concerning parents activities, most parents of the children who attended school midday meal were civil servant, private servant and self-employed in comparison to non MDM group where the parents were housewives, workers, traders, street sellers and farmworkers with low monthly incomes.

According to Mishra., *et al*. parent's occupation and economic status had an important impact on children nutritional status especially the women occupation [17].

Concerning fruits consumption, our findings showed that children had poor consumption of fruits and vegetables. That could be due to the fact that children most of time dislike fruits and vegetables in comparison to sweat and sugary candies.

Also, parents haven't good practice and habits of eating fruits and vegetable at home, so their children were not educated in an environment with eating fruits and vegetables. Culturally some people are always ignorant about the importance and the role of fruits and vegetable in the diet [8]. Sometimes the fruits and vegetables are expensive and not accessible to the all categories of population also for those populations of low income and high family size, it is difficult to store fruits and vegetable in cool place that could cause the decay or the loss of nutritive of those fruits and vegetables.

Concerning the mean value of anthropometrics parameters, children from our study showed normal status. No difference was observed between MDM group and non MDM group. That could be due to the fact that our study was conducted in urban and the most developed area in the city of Abidjan. Similar findings were observed by some authors in their study in children in Paris [22]. According to those authors, if the daily nutritional allowance of an individual is within the limits of recommended daily allowance, the risks of deficiency and excess are restricted. However, the prevalence of underweight was higher in non MDM (5.26%) against 0, 81% in MDM group. Stunting was also higher in non MDM group with the prevalence of 7.52%. None child from MDM group was concerned by this form of malnutrition. Those findings showed that children from MDM group had better nutritional status in comparison to their counterpart from non MDM group. That could be due to the fact our study sample lived in an urban area and school feeding program have a real impact on children growth. Ours findings are similar to those observed by authors [23]. In their study, theses authors found that improving children dietary habits and socio economic status help to improve children nutritional status. Contrary to our findings some authors, found that children receiving MDM had lower anthropometric parameters as compared to non MDM [21]. Contrary to our study, the mean age of the study population was 12.2 ± 1.1 years. However in our study the mean age was 8.89 ± 1.64 years old. Feeding program has real impact during the growth period of children. Concerning the type of malnutrition, all form of malnutrition was moderate, we did not observe any case of severity in the both groups. That can be explained by the fact that the study took place in an urban area where the conditions of life are improved. Also according to literature school feeding program are important to improve nutritional status [24,25]. Concerning the dietary habits, our findings showed that the children had low consumption of fruits and vegetable below the recommendation of food based dietary guidelines [26].

Biochemical evaluation may be the most objective and quantitative tools for appreciating the nutritional status [16].

Concerning the mean glucose concentration, no significant difference was observed among MDM and non MDM group. But level of glucose concentration was normal. That could be due to the fact that the children have good stock of energy. No case of hypoglycemia was observed. Concerning hyperglycemia no case was observed. In the study conducted by Bhattarai, found similar results [17].

Children from MDM group had higher level of serum total protein as compared to non MDM group. Children from MDM group comparatively to non MDM group had good diet. That could be explained by the fact that children from MDM group benefit from balanced meal and had access regularly to good diet at home and at school. Similar results had been observed by authors [17].

For albumin concentration, children from MDM group had better albumin level compared to non MDM. Albumin is a type of protein specialized in the transportation of proteins. Albumin is responsible of oncotic pressure between the cells of the body. In Protein Energy Malnutrition albumin rate could be reduced, so albumin is important biomarkers to evaluate nutritional status of an individual [27].

The mean glucose concentration in MDM group and non MDM was not significantly different. The prevalence of hypoglycemia was also not significantly different in MDM and non MDM group. A few numbers of children was concerned by hyperglycemia but no significant difference was observed. In spite of frequent occurrence of hypoglycemia, the level of glucose was not extremely low, the lowest value being 0.32 g/dl in non MDM group and 0.51 g/dl in MDM group. Our findings are similar to those of authors in their study [17]. During their study carried out on the undernourished children and normo nourished those authors didn't find any significant difference concerning the mean glucose concentration. However the study conducted by author, children of both group were found to have hyperglycemia [17].

Contrary to our findings, some authors found that children from protein energy malnutrition were more hypoglycemic as compared to control group [1]. In our study the level of hypoglycemia can be explained by the fact that no case of severe malnutrition was observed in our study population. That showed that school feeding program help to preserve the level of glycaemia.

The mean Sodium concentration, in both groups was not significantly different ($p > 0.05$). Serum Sodium level was not significantly associated with nutritional status. That showed weak association of hyponatramia and hyperkaliemia with nutritional status. The serum sodium concentration was poorly correlated to the nutritional status of children.

Because of increase in intracellular water, the total sodium may be increased but the actual serum level may be relatively too decreased as a result of excessive increase in comparison to increase in sodium. Our findings are similar to those of some authors in Jamaica [28]. For those authors hyponatremia was very bad nutritional deficiency prognostics. In this present study, no significant difference in serum sodium, potassium and chloride was noted in MDM and Non MDM groups. These results contrasted with other studies done in others countries. In Nigeria some authors [29] found a significant decline in serum potassium level in PEM case when compared to control group. Similar results with low serum potassium were obtained from studies conducted by authors in India [30,31]. Those findings could be explained by the fact that our sample was composed of children in good health and the fact that no case of severe malnutrition was observed in our study. Also we didn't find any case of malnutrition with edema and skin disease.

The result of total protein estimation showed any risk of protein energy malnutrition. That meant developing hypoproteinemia was approximately in risk of developing protein energy malnutrition. This showed strong association of hypoproteinemia and protein energy malnutrition. But in this study, no significant difference was observed in MDM as compared to non MDM groups. That could explained by the fact that in our study the children well-nourished and healthier.

However the serum total protein in MDM group was significantly higher as compared to their counterpart in non MDM group. There was significantly higher decline in serum albumin level in non MDM group as compared to MDM group. The prevalence of hypoproteinemia and hypoalbumunenia was low in our population. The total serum protein and albumin were significantly low in non MDM group in comparison to control group. That could show the effect of school feeding program in improving and providing specific and essential nutrients to the organism. Our findings were similar to those obtained by authors in Egypt [32]. In their study the authors found that children in school feeding program have relatively normal level of biochemical parameters as compared to those who didn't attend school feeding program. However a study leaded by authors in India did not find any significant impact of Midday meal on children nutritional status. Total protein and albumin are good marker to appreciate nutritional status [21]. However serum albumin is useful for chronic and severe malnutrition (under nutrition) because of his long lifetime. Albumin is not a good marker of nutritional status because a good nutritional marker must have short lifetime and not be sensible to non-nutritional factors. Although, low serum protein and albumin in protein energy malnutrition existed, in our study we didn't find any significant relationship between MDM children and non MDM, which could be due to the fact that no case of severe malnutrition or severe under nutrition was found in our study.

In this present study, we found that the transaminases rate was not significantly different between MDM and non MDM groups, transaminases rate was normal in our study. Normal value of transaminase observed in both groups testified the absence of severe undernutrition such as kwashiorkor and marasmus. Transaminases are enzymes involved in hepatic cytolysis of the liver are degraded in case of severe undernourishment or hepatics diseases. In our study all the children were healthy, that could explain the normal level of transaminases in our study.

In what concern, serum cholesterol they were no significant decrease of cholesterol and triglycerides, and lipidemia was observed in our study. But we observed higher level of cholesterol in obese children at all the level. That corroborate the fact that hypercholesterolemia is strongly associated to overweight and obesity [33].

That study showed that chemical tests were particularly helpful, as early indicator of nutritional status before clinical and anthropometrics measures appeared. Limit number of sample were taken because of cost of biochemical parameters in the study.

Conclusion

The findings of this study showed that, different forms of malnutrition were met in that study but at lower proportion. Children who belonged to non MDM group were more stunted, underweighted than children from MDM group. Also biochemical parameters were not impaired in the whole study population. However children from MDM group showed better nutritional status as compared to non MDM group. Moreover we noticed the presence of overweight and obesity in the both group.

Hypercholesterolemia was strongly associated overweight and obesity in the both group. Children from non MDM group had altered biochemical parameters which were related to intake and biochemical metabolism mandatory during growth and development of children. There was higher proportion of hypoglycemia, hypoproteinemia, hypoalbuminemia in children from non MDM group as compared to their counterpart in MDM group.

The main cause of the presence of malnutrition among primary school pupils is attributed to socio economic background, poor dietary intake due to poverty, lack of knowledge of the simple facts of nutrition and dietary habit and behavior. Other factors related to poor nutritional profile may be low literacy status of the mother, large families, parents' occupations status, and dietary habit and practice. Hence the evaluation of biochemical indicators in children will be helpful for treatment, prevention of malnutrition and improvement of nutritional status by nutritious food supplementation.

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Conflict of Interest

The authors declare that they have no competing interests.

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