Original Research Article

Effectiveness Of UNICEF Multiple Micronutrient Powder On Child Stunting Rate And Influencing Factors In Kisangani

ABSTRACT

Home fortification of foods with Multiple Micronutrient has been proposed to maintain normal growing and health of children living in chronic malnutrition conditions. In December 2014, the National Nutrition Programme, in partnership with UNICEF, introduced multiple micronutrient powder as food supplement for children aged 6 to 23 months in DR Congo to prevent negative impact of chronic malnutrition. This intervention was conducted in some municipalities in Kisangani city. The aim of this study was to evaluate the potential of that intervention to reduce at short term the rate of stunting and measure a possible impact of socio-demographic factors. This was a community based prospective cross-sectional survey conducted from April 14 to June 13, 2016. The prevalence of stunted children was compared among children aged 24-36 months in areas where the programme was administered and those living in areas where the intervention was not yet applied and between children treated and not treated in a same municipality. Two health zones, Mangobo representing areas where the intervention was conducted and Lubunga representing areas without intervention were selected. Three groups were constituted: (i) Mangobo-children who received the powder, (ii) Mangobo-children not given the powder and Lubunga-children not given the powder. The effectiveness indicator was the prevalence of stunted children in treated and untreated children. The stunting prevalence was 36.2% in group (i), 74.1% in group (ii), and 54.1% in group (iii). The global stunting rate was 49.5% for the entire population independently of the intervention. The difference was significant between untreated and treated children (p=0.001). Stunting was significantly higher among boys than girls and among children whose mothers were uneducated. The use of the multiple micronutrient powder showed some benefits in reducing stunting at short term. But to effectively solve the problem of chronic malnutrition, the strategies should address globally different causes including socio-economic assets of the family, food quality, maternal nutrition, sanitation and mothers' education.

Keywords: Chronic malnutrition, Child stunting, Height-for-age index, Multiple Micronutrient

ABBREVIATIONS

MND: Micronutrient Deficiency
MMN: Multiple Micronutrient
MMNP: Multiple Micronutrient Powder
UNICEF: United Nations Children's Fund
WHO: World Health Organization
DRC Democratic Republic of the Congo
HZ: Health Zone
HA: Health Area
NUGAG: Nutrition Guidance Expert Advisory Group
mo: month

1. INTRODUCTION

Nutritional requirements for newborns, infants and young children (before the age of 3 years) have been addressed by many researchers over the past 30 years. By definition, malnutrition is a group of conditions in children and adults generally related to poor quality or insufficient quantity of nutrient intake,

absorption, or utilization [1]. Malnutrition is commonly divided in two major categories including protein-energy malnutrition (resulting from deficiencies in any or all nutrients) and micronutrient deficiency diseases (resulting from a deficiency of specific micronutrients) [1]. The protein-energy malnutrition in children is further subdivided in three forms: acute malnutrition presenting with wasting or thinness, chronic malnutrition presenting with stunting or shortness, and acute-chronic malnutrition characterized by underweight.

Acute inadequate nutrition leads to rapid weight loss or failure to gain weight normally; the resultant wasting is reversible with re-feeding, but because of its relatively high mortality rate, it deserves highest priority of intervention in humanitarian emergencies [2, 3, 4]. Chronic malnutrition is an inadequate nutrition over long period of time that leads to stunting or failure of linear growth. Yet stunting usually does not pose an immediate threat to life, the related deficiency in micronutrient affects the health of the children [2, 3, 4]. Micronutrient deficiencies (MNDs) are often referred to as 'hidden hunger' because they develop gradually over time [2]. Their devastating effect is not seen until irreversible damages have been done, including child stunting, cognitive delays, weakened immunity and diseases [2, 3]. A number of studies also have demonstrated that undernutrition of mothers often cause intrauterine lack of essential vitamins and minerals in foetus which consequently increases the risk of low birth weight, birth defects, stillbirth, and even death [5].

Global statistics released by World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) show that chronic malnutrition affects more than 165 million children worldwide, a quarter of children under the age of 5 years [2, 3, 4]. Currently, the inequality in quality food consumption is blatant among children living in rich and poor countries. In wealthy countries, overnutrition leads to obesity while in resources-limited countries the majority of children are suffering from starvation [6, 7, 8]. Malnutrition remains thus a challenging public health problem in sub-Saharan regions where children may pass days and days up to death without food and water because of droughts, wars, or extreme poverty. Also, MNDs affect about one third of children living in low and middle income countries, mainly in sub-Saharan Africa and South Asia [2, 8, 9]. Mineral and vitamins deficiencies are especially common due to the low dietary intake of enriched foods and inadequate absorption caused by diarrhoea [6].

Stunting is relatively common in many populations in less-developed countries and has many causative factors yet poorly understood [5, 6]. To help mitigating the impact of malnutrition on the health and growth of infants, UNICEF recommends fortifying their foods with multiple micronutrient (MMN) preparations [10]. The infants aged 6 to 23 months (mo) are eligible to receive MMN supplement. Also, according to the Nutrition Guidance Expert Advisory Group (NUGAG) convened by the WHO, home fortification of foods is recommended for the populations where the prevalence of anaemia in children under 2 years or 5 years of age is 20% or higher [3, 10]. UNICEF and WHO regularly issue update recommendations for providing children with good nutritional quality food. One systematic review of scientific controlled studies has shown that dispersible micronutrient preparations for home fortification reduce anaemia by 34%, iron deficiency anaemia by 57% and retinol deficiency by 21% [11]. Efforts towards reduction of stunting have succeeded in some countries globally, but in sub-Saharan Africa and South Asia, stunting rates have unfortunately remained largely high [12, 13, 14].

Fourteen countries including Democratic Republic of the Congo (DRC) account for nearly 80% of malnourished children [2]. In DRC the latest demographic and health survey (DHS 2013-2014) showed that about 8% of children under five suffer from wasting, 43% from stunting and 23% from underweight. In addition, one household out of three is in food insecure [15, 16, 17]. In December 2014, the National Nutrition Programme, in partnership with UNICEF, introduced multiple micronutrient powder (MMNP) as food supplement for children aged 6 to 23 mo, to compensate deficiencies and prevent negative impact of

chronic malnutrition. This intervention was conducted in some municipalities in Kisangani city. The objective was to evaluate whether the intervention can reduce, at short term, the prevalence of stunting among the beneficiary children. We set to compare the prevalence of stunted children aged 24-36 mo in areas where MMN programme was administered and those living in areas where the intervention was not yet applied. The impact of socio-demographic factors was also examined.

2. METHODS

2.1. Study design and setting

The study was designed as an exploratory cross-sectional survey to have a snapshot of stunting status among 24-36 mo children who had been given MMNP as food supplement one year before. Physiologically, the linear growth of a child is related to the age and is significant during one year in normal nutritional conditions. The hypothesis was that giving a nutritional supplement in malnutritional conditions that may trigger a significant linear growth after one year. The survey was conducted among children living in Kisangani city. Kisangani is the capital of Tshopo province in DRC. It is the third largest urbanized city in the country (Fig 1).

Fig.1 Kisangani health zones, river port, market, airport

2.2. Sampling procedure

The study used a multi-stage cluster sampling procedure involving the selection of health zones (HZs) and households. The structural chart of HZs in Kisangani is shown in Fig.2. As an exploratory study, the selection of clusters was made either by reasoned choice or randomly. Two HZs out of 6 were taken on the basis of the objective of the study. Mangobo has been retained as an intervention HZ where the MMNP was given in 2015 to children aged 6 to 23 mo and Lubunga as a control zone without intervention. Mangobo has 13 health areas (HAs) for a total population of 200,059 inhabitants while Lubunga counts 18 HAs for a total population of 149,099 inhabitants.

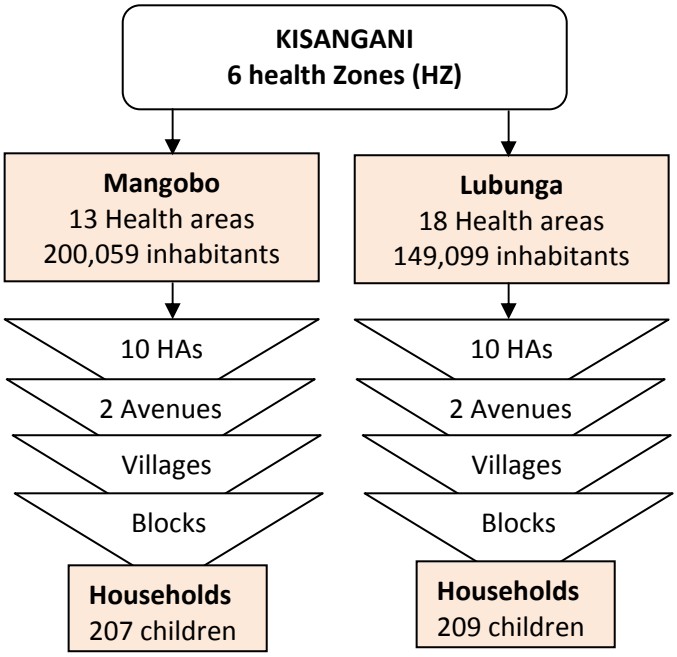

Fig.2 Multistage sampling diagram

The sample size was determined using the common formula for single population proportion with a 95% confidence interval, a precision of 5%, and an assumed prevalence of 43% stunting to get a minimal sample size for a population <1000 000.

$$SS = \frac{Z^2(P)*(1-P)}{\alpha^2} \rightarrow \frac{1.96^2*0.43(1-0.43)}{0.05^2} = 377$$

The number of children per HA was made on the basis of the population density. Thus, in each HZ, 10 HAs were drawn in a simple random way without replacement. The number of avenues, villages and blocks were censored. Then two avenues were randomly selected from each HA and two villages in each avenue using Excel generated random numbers. The primary sampling units in selected clusters was households. Systematic sampling technique was used to select the required number of households in each cluster. All children aged 24 to 36 mo living in the selected clusters during the period of the study were eligible for inclusion. Children whose mothers/guardians consented to participate and allowed to perform anthropometric measurements were retained. Households without targeted children or those whose mother/caretakers were absent were not included. The selection gave a sample size of 209 from Lubunga and 207 from Mangobo.

2.3. Data collection

The data set had complete information for 416 children aged 24 to 36 mo and was collected in the selected avenues by the door-to-door strategy using a data collecting form. Socio-demographic information of the child and the mother/guardian (age, sex, family size, mother's occupation and education) as well as the MMNP intervention status (treated or untreated) were collected. Demographics information was collected using structured and pretested questionnaire prepared in the local language.

Anthropometric measurements consisting of height and age of children were gathered by deploying 12 trained data collectors and supervisors.

2.4. Data management and analysis

The nutritional status of children was made according to WHO classification which devises stunting by height-for-age index by sex. The calculated index (HAZ-score) was operated with ENA software for SMART 2011. A child below two standard deviations (-2 SD) from the median of the WHO Child Growth Standards in terms of height-for-age is considered short for his/her age, or stunted. If a child is below minus three standard deviations (-3 SD) from the median of the WHO Child Growth Standards, then he/she is considered severely stunted. The outcome was measured in term of the prevalence of normal children over stunted children. Our assumption was that the stunting baseline data was similar (43% without intervention) in all HZs according to previous observations. Three groups were constituted: (i) Mangobo children who received the powder (MNN+), (ii) Mangobo children not given the powder (MMN-) and (iii) Lubunga children not given the powder. Microsoft Excel and SPSS 20 software were used for data analysis. Descriptive data are reported in mean ± standard deviation. Bivariate or multivariate logistic regression was operated at 95%CI and significance level of $p<0.05$.

2.5. Ethics approval and Consent to participate

The protocol of the study was approved by the Research Ethical Committee of the Faculty of Medicine and Pharmacy of the University of Kisangani (Approval letter No 129/2015). The consent to participate was obtained from the children mothers/guardians. They were contacted and given all information about the study. Those who consented to participate and allowed to perform anthropometric measurement were recruited.

2.6. Multiple Micronutrient Powder administration

The administration of MMNP in Mangobo occurred in 2015. The recommended regimen was one sachet of MMNP every day for a period of 4 months, ideally on completion of 6 months of age as recommended by the National Nutrition Programme. One sachet of MMNP contains fifteen mineral vitamins and minerals: 400 mg vitamin A, 30 mg vitamin C, 5.0 mg vitamin D, 5.0 mg vitamin E, 0.5 mg vitamin B1, 0.5 mg vitamin B2, 0.5 mg of vitamin B6, 0.9 mg of vitamin B12, 150 mg of folic acid, 6 mg of Niacin. 4.1 mg of zinc, 0.56 mg of copper, 90 mg of iodine, 17 mg of selenium and 10.0 mg of iron. Not all children were given MMNP.

3. RESULTS

3.1. Demographic characteristics

Table-1 shows the comparative baseline characteristics of the sample in the two assessed HZs. Out of 416 children examined, there were 204(49.04%) boys and 212 (50.96%) girls; sex ratio=0.96. The age range 24-29 mo was slightly lower than 30-36 mo (48.3 vs.51.7%). The majority of mothers 246 (59.13%) had secondary school level, followed by 142 (34.13%) with primary level; 17(4.81%) were illiterate and only 8(0.48%) had university education. In Mangobo, out of 207 children selected, 160(77.3) had received MMNP and 47(22.7%) not.

Globally, the mean height of all children was 84.3 ±6.0 (63-105) cm; median=84 and mode=84. The mean age was 29.90 ± 4.07 (24-36) months; median=30. The mean HAZ-score was -1.97(-8.02 to 3.53),

SD=1.52. The mean age of mothers was 27.98 ± 6.42(16-48) years; median=27. The mean size of the family was 9±4 people (2-28); median=9 and mode=6 of which the mean number of children under 5 was 2 (1-6) with median=3.

Table 1 Comparative characteristics of the sample in the two health zones

Variables	Total		MANGOBO(M)		LUBUNGA(L)		L/M
	N	%	N	%	N	%	%Ratio
Child Age							
24-29 mo	201	48.3	103	49.8	98	46.9	***0.94***
30-36 mo	215	51.7	104	50.2	111	53.1	***1.06***
Child Sex							
Boys	204	49.0	102	49.3	102	48.8	***0.99***
Girls	212	51.0	105	50.7	107	51.2	***1.01***
Family size							
<1-5	55	13.2	35	16.9	20	9.6	***0.57***
6-28	361	86.8	192	83.1	189	90.4	***1.09***
Mother Age							
18-29 years	267	64.2	116	56.0	151	72.2	***1.29***
30-40 years	149	35.8	91	44.0	58	27.8	***0.63***
Mother Occupation							
Housewife	241	57.9	125	60.4	116	55.5	***0.92***
Farmer	54	13.0	4	1.9	50	23.9	***12.58***
Servant/business	121	29.1	78	37.7	43	20.5	***0.54***
Mother Education							
Illiterate	20	4.8	3	1.4	17	8.1	***5.79***
Primary	142	34.1	49	23.7	93	44.5	***1.88***
Secondary	246	59.1	148	71.5	98	46.9	***0.66***
University	8	1.9	7	3.4	1	0.5	***0.15***
MMN intake							
No	256	61.5	47	22.7	209	100	***4.41***
Yes	160	38.5	160	77.3	0	0.0	***0.00***
Total	416	100	207	100	209	100	

3.2. Effectiveness of Intervention

Table 2 shows the outcomes of the intervention in the two HZs. The global prevalence of stunting was 49.5% (206/426). The prevalence of stunted children was lower in Mangobo (44.9%) where MMN was administered compared to Lubunga (54.1%) the area without intervention. The odds ratio (OR) was 0.69 (0.471-1.92) for Mangobo/Lubunga. In Mangobo alone, the prevalence of stunting (36.2%) among children who received the powder (MMN+) was significantly lower (p=0.001) compared to the prevalence (74.5%) among children who were not given the powder (MMN-); the intervention decreased stunting of about 38%.

Table 3 shows the influence of demographic covariates on the stunting outcome. Globally, the prevalence of stunting was significantly higher in boys than girls (AOR=1.76); higher in 24-29 mo old than 30-36 mo old (AOR=1.37); higher in illiterate or primary educated mothers than those with secondary or superior education level (AOR=2.34). Only sex of child and mother's education were significantly associated with stunting ($p<0.05$) after adjustment for MMN treatment.

Table 2 Comparison of stunting rates in two health zones in Kisangani

Health Zone	Total	Normal		Stunted		OR (95%CI)	p-value
	N	N	%	N	%		
LUBUNGA	209	96	45.9	113	54.1	1	
MANGOBO	207	114	55.1	93	44.9	0.69 (0.471-1.92)	0.063
TOTAL	416	290	50.5	206	49.5		
MANGOBO							
MMN(+)	160	102	63.75	58	36.25	1	
MMN(-)	47	12	25.53	35	74.47	5.13 (2.47-10.65)	0.001
Total	207	114	55.07	93	44.93		

(MMN+)=Mangobo children who received the powder, (MMN-)=Mangobo children not given the powder

Table 3 Factors with impact on stunting

Covariates	AOR	CI 95%	Sig.
MMN intake			
Yes	1		
No	5.12	(2.41 – 10.89)	0.000
Health zone			
Mangobo	1		
Lubunga	8.59	(3.15 – 23.42)	0.000
Child gender			
Female	1		
Male	1.76	(1.16 – 2.65)	0.007
Child Age			
30-36 mo	1		
24-29 mo	1.37	(0.91 – 2.07)	0.130
Mother educ.			
High	1		
Low	2.38	(1.53 – 3.69)	0.000
Mother age			
18-29 y	1		
30-42 y	1.14	(0.73 – 1.77)	0.558
Family size			
1-5 people	1		
6-28 people	1.34	(0.72 – 2.49)	0.358

Reference=Stunted child; Adjusting =MMN intake.

4. DISCUSSION

This study was conducted as a post-intervention evaluation of the effectiveness of MMN to reducing stunted growth rates among children faced to chronic malnutrition. The prevalence of stunted children aged 24-36 mo was compared between Mangobo areas where MMN programme was administered and those living in Lubunga areas where the intervention was not officially applied to assess the impact of the intervention and factors associated with, one year shortly after the intervention. We adhered to the idea that measuring the prevalence of wasting, stunting and underweight is of particular importance because it reflects the long-term structural factors of undernutrition and can serve as an indicator of the well-being of a population [19].

As results, the mean height of all children studied was 84.3±6.0 (63-105) cm, falling within the WHO range of 79.1 to 88.7 cm. However, the general prevalence of stunting as indicator of chronic malnutrition here was 49.5% independently of MMN intervention. Based on the WHO classification, the prevalence of stunting <20% is considered as low degree of malnutrition, 20-29% as moderate, 30-39% as high, and ≥ 40% as severe chronic malnutrition in a community [19]. The 49.5% in children of Kisangani is thus a sign of severe chronic malnutrition. The rate is comparable to the rates found in other provinces of DRC like in South Kivu (46.1%) and in Kasai occidental (46.1%), but higher than the rate described in Kinshasa (16.7%) [16, 17, 18]. Kinshasa has a low rate because it is the capital of DRC having high level of business activities which assure more diet diversity than the provinces. Compared to other countries, the rate is similar to what has been found in many sub-Saharan countries, as illustrated by 47.4% in Ethiopia [20, 21] and 51% in Mozambique [22].

To see the impact of administering MMNP, we compared the rates in two health zones, one (Mangobo) representing areas where the intervention was conducted and the other (Lubunga) representing naive areas. As shown in Table-1, there was no significant difference in the proportions of children in the two HZ. The composition of mothers presented however little differences for their occupation, age and education. The proportions of mothers having high level of education and doing business were higher in Mangobo than in Lubunga. Lubunga had more young mothers than Mangobo.

The comparison showed that the prevalence of stunted children was higher among children in Lubunga (54.1%) than in Mangobo (44.9%). The difference was not highly significant (p=0.063). As stated in the methods section, the assumption was that the stunting baseline was similar (43%)i n all HZs. The current rates indicate an increase from 43% baseline to 54.1% in Lubunga and small change in Mangobo (44.9%). The benefit of the intervention was much more evidenced by the difference between children who received MMN (36.2% stunting) and those who had not been treated (74.5% stunting), both living in the same municipality. The percentage of 36.2% in treated children was significantly low compared to the baseline 43% measured one year before. The percentage of 74.5% in untreated group could indicate that the situation of malnutrition was getting worse. That may be true since, on the economic ground, the situation of poverty is without doubt getting more and more difficult for the entire population of the DR Congo. Within one year (2015 to 2016), the living cost had been almost doubled (1$ exchanged at 930 Congolese franc is now 1700 franc).

Systematic review studies are otherwise conflicting about the effect of MMN on linear growth [24, 25, 26, 27, 28]. Some studies found significant improvement while others did not. Many studies have mostly shown the benefice of micronutrient supplementation in particular cases of preventing anaemia and childhood illness [29, 30, 31]. In some cases, improvement can be impeded by recurrent and chronic illnesses [2, 3]. In other cases, since the process of becoming stunted starts in utero when pregnant

women suffer from nutrient deficiencies and other nutritional insults, the height-for-age index may not appreciably vary following a recent dietary intake.

In the current study, the analysis of factors associated with stunting showed that the prevalence was higher in boys than girls; higher in 24-29 mo old than in 30-36 mo old, and higher in illiterate mothers than in educated mothers, consistent with other studies. It has been found that mother's education is the most reported factor associated with the child's stunting, followed by child's age, child's gender, household income, family size and child's morbidity status [23, 25]. In Mozambique, one study found that 24-month-olds were twice as likely to be stunted compared to 12-month-olds [22]. According to WHO reports, the prevalence of stunting increases with age of birth up to 24 - 36 mo [32]. Age and sex may be tributary to the physiological processes. Another factor that can impact on stunting in addition to undernutrition is the prevalence of HIV and tuberculosis. Our previous study showed a high prevalence of TB (40%) among children living in different municipalities in Kisangani [33].

Nevertheless, the result shows that giving MMN may reduce stunting provide the basic minimal food is given. Also, the sustainability of interventions remains challenging problem in poor communities. In many cases, the programmes are underestimated and often cover partially the actual needs. To plan for nutritional interventions for children with severe chronic malnutrition, it is necessary to estimate the number of children that will require treatment, as stated by others [34, 35].

5. CONCLUSIONS

The prevalence of stunted growth related to severe malnutrition remains high and strikes half of children living in different municipalities in Kisangani. UNICEF intervention with Multiple Micronutrient powder showed some benefits in reducing stunting and is recommendable to extend it. However to effectively solve the problem of chronic malnutrition, the strategies should address globally different causes including socio-economic assets of the family, food quality, maternal nutrition, sanitation and mothers' education.

Competing interests

The authors declare that they have no competing interests.

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