Original Research Article

Assessing Effectiveness of UNICEF Multiple Micronutrient Powder for Foods Fortification on the Reduction of Child stunting rate: a survey in Kisangani, DR Congo

ABSTRACT

Background: Home fortification of foods with Multiple Micronutrient powders has been proposed to maintain normal growing and health of children living in chronic malnutrition conditions.
Objective: This study was set to evaluate the difference in stunting rates among 24-36 mo children fed or not with UNICEF Multiple Micronutrient powder at the age of 6 to 23 months.
Study design: A community based prospective cross-sectional survey conducted from April 14 to June 13, 2016 in Kisangani city. The effectiveness indicator was the prevalence of stunted children in treated and untreated children.
Methods: The study was conducted in two health zones, one (Mangobo) representing areas where the intervention was conducted and the other (Lubunga) representing areas without intervention. Three groups were constituted: Mangobo (MMN+), Mangobo (MMN-), and Lubunga (MMN-).
Results: The stunting prevalence was 36.2% in Mangobo-MMN+, 74.1% in Mangobo-MMN-, and 54.1% in Lubunga-MMN-. The global stunting rate was 49.5% for the entire population independently of MMN intervention. The difference was significant between MMN untreated and treated children (p=0.007). Stunting was significantly higher among boys than girls and among children whose mothers were uneducated.
Conclusion: The use of MMN 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 Child Funds
WHO: World Health Organization
DRC Democratic Republic of the Congo
HZ: Health Zone
HA: Health Area

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 WHO and 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 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 months, to compensate deficiencies and 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

proportions of stunting among children who benefited from MMNP programme and compare whether the rates differ with untreated children. In other terms, we conducted the present survey to measure the post-intervention effectiveness, comparing the prevalence of stunted children aged 24-36 years in areas where MMN programme was administered and those living in areas where the intervention was not yet applied to assess the impact of the intervention on stunting and factors associated with, shortly after the intervention.

METHODS

Study design

Nutrition surveys are usually conducted to provide a snapshot of the health and nutritional status of the population or coverage of relief interventions. The technical names for these studies are cross-sectional surveys aimed at collecting data at a single point in time from a specific population.[1] This study was designed as an epidemiological cross-sectional survey aimed at giving a snapshot of stunting status among 24-36 mo children who had been given MMNP as food supplement one year before the study.

Study setting

The study was conducted among children living in two urban health zones (HZ) in Kisangani city, namely: Mangobo and Lubunga. Kisangani is the capital of Tshopo province in the DRC. It is the third largest urbanized city in the country (Fig 1). The health zone of Mangobo has 13 health areas (HA) for a total population of 200,059 inhabitants while Lubunga counts 18 HAs for a total population of 149,099 inhabitants.

Multiple Micronutrients 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.

Sampling technique for effectiveness study

The data was collected from April 14 to June 13, 2016 almost one year after the 2015 intervention. Instead of collecting information from all individuals or households in the community, we selected a representative sample, and, based on that sample, we produced an estimate of the indicators of interest which can be generalized to the entire population. The selection of the present sample was accomplished by cluster sampling (multistage) as schematized in Fig.2.

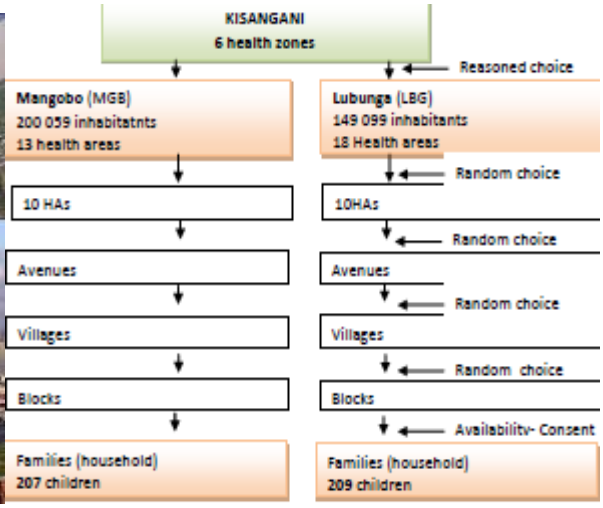

Fig.1. Health zones, river port, market, airport **Fig.2 Multistage sampling diagram**

At different stages, the selection was made either by reasoned choice or randomly. The sampling unit was the household. The choice of the two HZs was made on the basis of the objective of the study. Mangobo has been retained as an intervention zone where the MMNP was given in 2015 to children aged 6 to 23 mo and Lubunga as a control zone without intervention. The choice of HAs was made in a simple random way without replacement and 10 areas were drawn from each HZ. The selection of avenues, villages and blocks was made in a simple random manner without replacement. The number of children was made on the basis of the population density in each area. Thus in each area, two avenues or two villages were selected.

Sample size

All children aged 24 to 36 months living in the two selected HZs during the period of the study were eligible. This age range was selected as post-evaluation to see the impact one year after the intervention. Households without target children or those whose mother/caretakers were absent were excluded. Children whose mothers/ guardians consented to participate and allowed to perform anthropometric measurements were retained. 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 selection gave a sample size of 209 from Lubunga and 207 from Mangobo.

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 including socio-demographic information of the child and the mother/guardian (age, sex, education, occupation, family size, mother's occupation and education) as well as the MMNP intervention status (treated or untreated).

Demographics information was collected from the mothers/primary caregivers of the children using structured and pretested questions prepared in the local language. Anthropometric measurements consisting of height and age of children were gathered by deploying 12 trained data collectors and supervisors.

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 health zones according to previous observations. The statistical descriptive and multivariate logistic tests were operated with Microsoft Excel and SPSS 20 software at 95%CI and significance level of 0.05. Descriptive data are reported in mean with standard deviation. Comparative differences are presented using crude and adjusted odds ratio with their respective 95% CI and significance.

RESULTS

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 months was slightly lower than 30-36 months (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%) had 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.

Effectiveness of Multiple Micronutrient 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 among MMN+ and MMN- was significantly lower in the treated group compared with untreated group (36.2 vs. 74.5%); the intervention decreased stunting of about 38%.

Tableau 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	

Tableau 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		

Table 3 shows the impact of demographic covariates on the stunting outcome. Globally, the prevalence of stunting was statistically significantly higher in boys than girls (AOR=1.76); higher in 24-29 month old than 30-36 month 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.

Tableau 4 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.

DISCUSSION

We conducted the present survey as a post-intervention evaluation of the effectiveness of MMN in reducing stunted growth rates among children faced to chronic malnutrition. We set to compare the prevalence of stunted children aged 24-36 years in areas where MMN programme was administered and those living in areas where the intervention was not yet applied to assess the impact of the intervention and factors associated with, 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 WHO range of 79.1 to 88.7. 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 the 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. It is entirely possible that these two health zones differed at baseline data, but as stated in the methods section, the assumption was that the stunting baseline data was similar (43% to without intervention) in all health zones according to previous observations. The comparison showed that the prevalence of stunted children was higher among children in Lubunga (54.1%) than in Mangobo (44.9%); statistically the difference was not highly significant (p=0.063). The current rates indicate an increase from 43% baseline to 54.1% in Lubunga and small change in Mangobo (44.9%). However, 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 is 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 growth.[24, 25, 26, 27, 28] Some studies found significant improvement; others did not find benefits. In some cases, improvement can be worsened 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 reflects the long-term effects of malnutrition and does not vary appreciably following a recent dietary intake. Many studies have mostly shown the benefice of micronutrient supplementation in particular cases of preventing anaemia and childhood illness.[29, 30, 31]

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 months old than in 30-36 months 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 months.[32]
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 snapshot shows that giving MMN supplementation could better work if the basic minimal food is provided. Also, the challenging problem is the sustainability and the extent of the interventions. 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]

CONCLUSION

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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