

Dietary diversity interventions and its impact on iron status of preschool children 36-59 months in Emali, Kenya

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ABSTRACT

Background: Dietary diversity is considered crucial in ensuring adequate micronutrient intake, especially among children since they have increased nutrient requirements. Iron deficiency is the most common nutrient deficiency in the world and a major public health risk particularly in the developing countries. This study assessed the impact of dietary diversity interventions on iron status of preschool children in Emali Kenya.

Methods: A non-randomized pre-post intervention trial involving 495 pre-school children aged 36-59 months in Early Childhood Development (ECD) schools was conducted. Dietary diversity of the children was enhanced by establishing school gardens in the early-childhood education centers and innovative home-gardening techniques in the homes of selected children's caregivers. Poultry houses for rearing chicken were also constructed at the ECD centers to provide the children with good sources of protein and minerals. Structured nutrition education on appropriate child feeding was also offered to the children's caregivers. Children were clustered in two communities the Kamba and Maasai to represent the different ecological settings.

Results: Dietary diversity score improved significantly in the Kamba community which recorded a high uptake of the dietary diversity intervention programs. Only 9.1% of the children did not meet the minimum acceptable dietary diversity after the intervention from the 48.1% pre-intervention. The intake of iron-rich foods also improved considerably (77.5%) after the intervention with the prevalence of anemia reducing to 3.4%. Prevalence of anemia among the Maasai children remained high (58.3%) due to low intake of iron-rich foods such as green leafy vegetables (34.6%) and meat (21.8%).

Conclusion: Anemia is a matter of public health concern among preschool children. Dietary diversity interventions such as; kitchen gardening, nutrition education (enhancement of food nutritional value through better food preparation methods) and implementation of other nutrition-sensitive agriculture interventions can significantly enhance dietary diversity score and iron status of children.

Keywords

Anemia, Dietary Diversity, Iron Status, Preschool Children.

Abbreviations

DDS: Dietary diversity score; ECDs: Early Childhood Education Centers; FAO: Food and Agriculture Organization; MDDS: Minimum Dietary Diversity Score; WHO: World Health Organization.

Background information

Child micronutrients deficiency continues to be a major public health concern globally, contributing to poor child growth and development. The problem has resulted in substantial increases in overall child morbidity and mortality, causing long-term adverse consequences for child development and life-long health [1,2]. Undernutrition particularly micronutrients deficiency is not only linked to child morbidity and mortality but also to poor functional

and cognitive development of children [3]. The school performance of undernourished children is reported to be below potential. They are also reported to have lower work capacity and productivity as adults later in life [4].

Global statistics reveal that approximately 171 million children are chronically undernourished (stunted), 60 million are acutely undernourished (wasted) and 100 million are underweight [5]. The burden of child under-nutrition is high in developing countries with many cases of under nutrition being reported in sub-Saharan Africa and Asia. Kenya has had its fair share of this burden. According to the recent Kenya demographic and health survey report, about 26 %, 11% and 4% of Kenyan under five children are stunted, underweight and wasted respectively [6]. Similarly, micronutrient deficiencies are prevalent in many developing countries and are mostly due to inadequate food intake and poor dietary quality [7]. In Africa, the estimated prevalence of anaemia in preschool children is 67.6 percent [8]. In Kenya, the prevalence of anaemia among pre-school children is estimated to be at 26.3% [9].

Iron deficiency is the most common nutritional deficiency worldwide particularly affecting infants and children [10-12]. Globally, the most significant contributor to the onset of anaemia is iron deficiency [13,14]. Iron deficiency is most prevalent among preschool children and women of childbearing age, in Africa due to poor access of iron-rich foods [15]. Children are particularly vulnerable to iron deficiency anaemia because of their increased iron requirements in the periods of rapid growth, especially in the first five years of life [16]. Children who have iron deficiency have been linked to increased childhood morbidity and mortality. They are also at risk of long-lasting cognitive developmental disadvantages [16,17]. In Kenya, iron deficiency is a matter of public health concern, especially among preschool children [18].

In light of this, there is a critical need for a better understanding of the public health dimensions of child under nutrition in order to provide targeted high impact interventions in local contexts that effectively address it [3]. It is documented that nutrition-specific interventions if globally implemented, could eliminate many cases of morbidity and mortality in children. Therefore, there have been numerous efforts currently in developing countries and globally to address the problem of child malnutrition [19]. Given these efforts, answers to the question of how to overcome child malnutrition are yet to be addressed sufficiently [4].

Furthermore, available literature suggests that the evidence to date on the links between nutrition sensitive agricultural interventions and dietary diversification strategies is scanty and inconclusive [20]. In that regard, this study contributes to the discussion by assessing the impacts of dietary diversity interventions and its impact on iron status of pre-school children (36-59 months) in Emali Kenya. It has also been reported that reducing childhood malnutrition is gaining momentum and high priority on the international development agenda, both as a maker and marker of development [4]. Therefore, this study will contribute to the much-needed development agenda.

Objectives of the study

To determine the impact of Dietary diversity interventions on the iron status of preschool children 36-59 months in Emali Kenya

Methods

Study design

A non-randomized pre-post intervention trial was conducted to determine the impact of Dietary diversity interventions on the iron status of preschool children 36-59 months in Emali Kenya

Study location

This study was conducted in Emali Kenya. The town of Emali located in the southern region of Kenya, is situated in the county of Makueni, and on the border of Kajiado County. The study targeted preschool children 36-59 months in two communities the Kamba community of Makueni County and Maasai Community of Kajiado County. The two populations were selected due to the soaring levels of food insecurity and malnutrition caused by frequent droughts. The majority of the Kamba community engage in subsistence farming. Dairy farming and beekeeping are also common agricultural activities in this area. Majority of the Maasai community on the other hand are mainly agro-pastoralist, predominantly cattle herders.

Study population and sampling

Pre-school children aged 36-59 months in early Childhood Development (ECD) schools were the target population for this study. This age category of children is most vulnerable to micronutrient deficiencies. A total of 495 children aged 36-59 months were recruited from 23 purposively selected ECD centers. Probability proportional to size sampling method was employed in the present study to determine the number of children to be recruited in each of the selected ECD centers. Children who were aged 36-59 months who were free from chronic illness were recruited in the study using a simple random sampling technique.

Description of the intervention

The nutritional value of the children's diet was enhanced by establishing school gardens in the early-childhood education centers and innovative home-gardening techniques in the homes of selected children's caregivers. This was done to enhance the dietary diversity of the children both at the ECD center and at their respective homes. At the ECD centers, the children were provided with enriched porridge and Githeri (boiled maize and beans meal) by adding extra micronutrient-rich ingredients such as oil and green vegetables. To enhance the bioavailability of micro-nutrients (iron) soaking of the maize and beans was done before their cooking. Standardized recipes for preparing children feeds were also developed to ensure that all the children consumed them at the same consistency. Poultry houses for rearing chicken were also constructed at the ECD centers. The chicken provided a cheap source of animal source protein and micronutrients every day in at least one of the children's meals each day. The children were fed with eggs and meat from the chicken. Nutrition education was conducted to increase the knowledge, skills and to influence a positive behavioral change of caregivers of the children. Aspects

such as, selection of a diverse diet, food preparation, food handling and hygiene were also included in the education sessions.

Data collection

Researcher administered semi-structured questionnaire was used in this study. The intervention base-line and end-line assessments were conducted. The children's caregivers were interviewed to elicit information on socio-demographic, economic and child feeding practices such as breastfeeding, meal frequency, dietary diversity, use of supplements among others. A pilot study was conducted before the actual study and the tools adjusted appropriately.

Dietary assessment

The children dietary diversity score and meal frequency was assessed using repeated 24-hour dietary recalls. Mothers/caregivers and the ECD supervisors were asked to list all the foods and drinks that the child ate and drank in the previous day at school, at home and outside the home. Food and Agricultural Organization's (FAO) dietary diversity food groups and their standard procedure for assessing individual dietary diversity was employed for assessing each child dietary diversity. In this study, nine (9) food groups were used for tabulation of the children dietary diversity. These included: starchy staples; dark green leafy vegetables; vitamin A-rich fruits and vegetables; other fruits and vegetables; meat and fish/eggs; pumpkin, yellow yams, carrot; legumes, nuts and seeds; sour milk and milk products and oils, fat, butter. A score of 1 was allocated to each food group consumed and a score of 0 if the food group was not consumed. The sum total for each child was computed to establish each child dietary diversity score. Children who had consumed a minimum of four food groups were considered to have met the minimum acceptable dietary diversity recommended for micronutrient intake adequacy.

Assessment of iron status

A HemoCue was used to determine the concentrations of hemoglobin (hb) in the children blood. Blood Samples were collected by a laboratory technician, put in the microcuvette and analysed immediately for hemoglobin concentration using the HemoCue. The blood was obtained through the vein after cleansing the antecubital area with 70.0% alcohol.

Statistical Analysis

Data was entered and analysis performed using Statistical Package for the Social Sciences (S.P.S.S) version 20 software for windows. Frequencies, means, standard deviations and ranges were used to determine the prevalence of anemia and to describe the study population. T-Test and ANOVA were used to test for significant differences on the different means pre and post intervention. Association between categorical variables was determined using Chi-square test at the bivariate level. An association was considered statistically significant in cases where the p value was < 0.05. Children with hemoglobin (hb) values of $\leq 11.0\text{g/dl}$ were considered to be anemic [21].

Ethical considerations

Ethical clearance and research permit were sought from Kenyatta University Ethical Review committee and the National Commission for Science, Technology and Innovation (NACOSTI) respectively. Permission was also sought from the county directors of education, agriculture, health and public health, local county leaders and head teachers. Participation in this study was voluntary and the caregivers of the children gave a signed informed consent before data collection was undertaken.

Results

Table 1 presents the socio-demographic and economic characteristics of the households in the study sample. Majority of the caregivers in both communities were aged between 20-39 years. The distribution of mother's age by the community showed a higher proportion of younger Maasai mothers as compared to Kamba mothers. More than half (55.3%), of the caregivers in the Kamba community engaged in farming activities while 56.8% of the Maasai community were engaged as agricultural labourers. The majority (65.2%) of the participants in the Kamba communities reported having attained primary school education as their highest level of education while 49.4% of the Maasai community said they had no any form of education. Furthermore, most participants in both communities were married at the time of data collection [Kamba (80.6%) and Maasai (90.5%)].

Children characteristics

Slightly more than half (51% and 52.3%) of the children were females from both Kamba and Maasai community respectively. Majority (54%) of children in the Kamba community were aged 36-48 months while majority (62.5%) of the Maasai community were aged between 49-59 months.

Deworming and micronutrient supplementation of the children

Nearly three-quarters (68%) of Kamba children had been given de-wormers in the six months prior to the study. In contrast, 55.6% from the Maasai community had not de-wormed their children in the same period. The majority of both Kamba (73.9%) and Maasai (95.5%) respondents reported that their children had received supplements in the past one year. Of the Kamba respondents, 69.3% reported that their children had received vitamin A supplements, 68.7% reported that their children were using iodized salt and 11.5% had received iron supplements. Comparatively, of the Maasai children, 63.4% reported that their children had received vitamin A supplements, 97.9% were using iodized salt and 1.6% had received iron supplements.

Dietary diversity scores pre and post-intervention

Frequency of food groups consumption by the children pre-intervention

Table 4 shows that below half of the children consumed iron rich foods before the intervention such as dark green leafy vegetables (Kamba 36.5%, Maasai, 28%) and meat (Kamba 8.3%, Maasai, 24.7%) in both communities. The most consumed food group was the starchy staples by 99.6% among Kamba children and 98.4% among Maasai children.

Characteristic	Kamba		Maasai	
	Frequency	%	Frequency	%
Age of the mothers /Caregivers				
≤19	1	.4	4	1.6
20-29	89	35	125	51.4
30-39	123	49	80	32.9
40-49	30	12	28	11.5
50-59	6	2.4	6	2.5
>60	3.0	1.2	0	0
Total	252	100	243	100
Mothers' main occupation				
Farmer	140	55.3	6	2.5
Agricultural laborer	7	2.8	138	56.8
Non-agricultural laborer	26	10.3	14	5.8
Self-employed non-farming	29	11.5	8	3.3
Paid employment non-farming	18	7.1	18	7.4
Unemployed (housewife)	32	12.7	59	24.3
Total	252	100	243	100
Education level of the mother/caregiver				
No education	1	.4	120	49.4
Primary	265	65.2	73	30
Secondary	62	24.5	30	12.4
Tertiary	12	4.7	17	7
Vocational	12	4.7	2	0.8
Total	252	100	243	100
Marital status				
Married	203	80.6	220	90.5
Widowed	9	3.6	4	1.6
Divorced/ separated	7	2.8	1	.4
Single	33	13.1	18	7.4
Total	252	100	243	100
Mother's religion				
Muslim	0	0	2	.8
Protestants	145	57.3	228	93.8
Roman-Catholic	107	42.3	13	5.3
Total	252	100	243	100

Table 1: Socio-demographic and economic characteristics of the participants.

Characteristic	Kamba		Maasai	
	Frequency	%	Frequency	%
Sex				
Male	124	49	116	47.7
Female	128	51	127	52.3
Total	252	100	243	100
Age of child				
36-48 months	136	54	96	39.5
49-59 months	116	46	147	62.5
Total	252	100	243	100

Table 2: Distribution of the children by age and sex.

Frequency of food groups consumption by the children after the intervention.

The main food group consumed daily by both communities were foods from the starchy staples (cereals and grains, rice and potatoes). Most children from both communities consumed food from all food groups after the intervention. Iron rich foods such as dark green leafy vegetables were also highly consumed by the children especially by the Kamba children (77.5%).

The Table 5 below presents the percentage of consumption based on each food group. About half (Kamba, 48.1%, Maasai, 43.2%) of the children in both communities did not achieve the minimum acceptable dietary diversity before the intervention. Notably, only about nine percent (9%) of the Kamba children did not achieve the minimum dietary diversity as compared to 33% of Maasai children after the intervention (Table 6).

Characteristics	Kamba		Maasai	
	N	%	N	%
De-wormed				
No	80	31.8	135	55.6
Yes	172	68.0	108	44.4
Ever received supplements (vitamin A, iodine, iron or any other dietary supplement)				
No	65	25.7	11	4.5
Yes	187	73.9	232	95.5
Vitamin A supplement in the last six months				
No	77	30.7	89	36.6
Yes	175	69.3	154	63.4
Iodized salt				
No	79	31.3	5	2.1
Yes	173	68.7	238	97.9
Iron supplements in the last six months				
No	223	88.5	239	98.3
Yes	29	11.5	4	1.6

Table 3: Deworming and micronutrient supplementation status of Children

Food	Food group	Kamba n (%) consuming	Maasai n (%) consuming
1	Starchy Staples	251 (99.6)	239 (98.4)
2	Dark green leafy vegetables	92 (36.5)	68 (28.0)
3	Other vitamin A rich fruits and vegetables	22 (8.7)	10 (4.1)
4	Other fruits and vegetables	109 (64.8)	116 (47.7)
5	Meat and fish/eggs	21 (8.3)	60 (24.7)
6	Pumpkin, yellow yams, carrot	14 (5.6)	5 (2.1)
7	Legumes, nuts and seeds	9 (3.6)	182 (74.9)
8	Sour milk and milk products	12 (4.8)	4 (1.6)
9	Oils, fat, butter	124 (49.2)	221 (90.9)

Table 4: Frequency of food groups consumption by the children pre-intervention.

Food	Food group	Kamba N (%) consuming	Maasai N (%) consuming
1	Starchy Staples	250 (98.8)	243 (100)
2	Dark green leafy vegetables	196 (77.5)	84 (34.6)
3	Other vitamin A rich fruits and vegetables	66 (26.1)	5 (2.1)
4	Other fruits and vegetables	164 (64.8)	127 (52.3)
5	Meat and fish/eggs	50 (19.8)	53 (21.8)
6	Pumpkin, yellow yams, carrot	41 (16.2)	3 (1.2)
7	Legumes, nuts and seeds	20 (60.6)	180 (74.1)
8	Sour milk and milk products	32 (12.6)	17 (7.0)
9	Oils, fat, butter	222 (87.7)	227 (93.4)

Table 5: Frequency of food groups consumption by the children after the intervention

No. of food groups consumed	Kamba		Maasai	
	n% Pre-intervention	n% post-intervention	n% Pre-intervention	n% post-intervention
Unmet-MDDS				
1	3 (1.1)	8 (3.2)	6 (2.5)	12 (4.9)
2	6 (2.4)	40 (15.9)	9 (3.7)	17 (7.0)
3	14 (5.5)	73 (29.0)	64 (26.3)	76 (31.3)
Total	121 (48.1)	23 (9.1)	105 (43.2)	79 (32.5)
Met-MDDS				
4	51 (20.2)	63 (25.0)	61 (25.1)	65 (26.7)
5	44 (17.5)	79 (31.3)	44 (18.1)	53 (21.8)
6	31 (12.3)	53 (21.0)	21 (8.6)	29 (11.9)
7	5 (2.0)	20 (7.9)	9 (3.7)	16 (6.6)
8	0 (0)	10 (4.0)	3 (1.2)	1 (0.4)
9	0 (0)	4 (1.6)	0 (0)	0 (0)
Total	131 (52.0)	229 (90.8)	138 (56.7)	164 (67.5)

Table 6: Number of food groups consumed by the children pre and post the intervention

Iron status of the children pre and post-intervention Kamba children

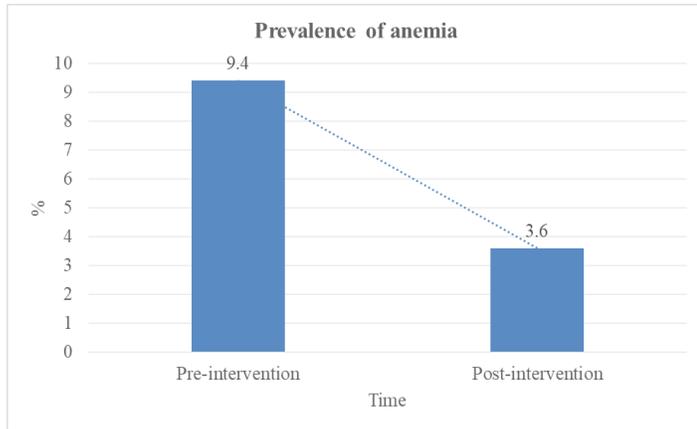


Figure 1: Prevalence of anemia among Kamba children pre and post intervention.

As reflected in Figure 1, the prevalence of anemia reduced from 9.4% pre-intervention to 3.6% post-intervention.

	Pre-intervention	Post-intervention	P value
Hemoglobin g/dl	12.01	12.52	0.02

Table 7: Average Hemoglobin levels pre and post intervention among Kamba children

Table 7 shows that the mean haemoglobin levels at pre-intervention and post-intervention among Kamba children were significantly different (p value = 0.02).

Maasai children

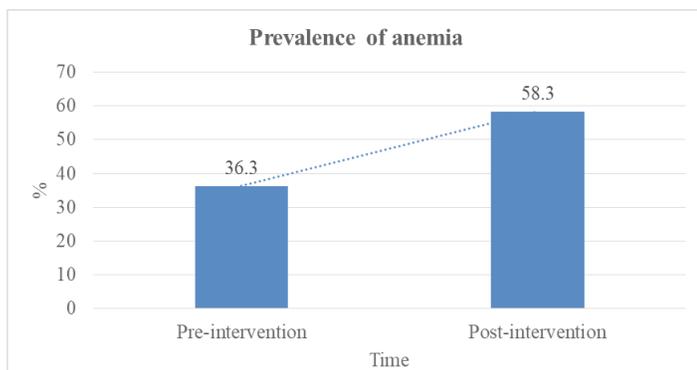


Figure 2: Prevalence of anemia among Maasai children pre and post intervention.

	Pre-intervention	Post-intervention	P value
Hemoglobin g/dl	11.39	10.23	0.001

Table 8: Average Hemoglobin levels pre and post intervention among Maasai children

Table 8 shows that the mean haemoglobin levels at pre-intervention and post-intervention among Maasai children were significantly different (p value = 0.001).

Discussion

In this study, the dietary diversity of the children was assessed using multiple 24-hour dietary recalls. The individual dietary diversity score gives a reflection and an estimate of nutrient adequacy of one's diet (It has been observed that improving dietary diversity of children increases the likelihood of meeting their daily energy and nutrient requirements which ultimately leads to improved nutrition status. Jomaa et al. [22] in their study revealed a positive outcome of school feeding program on energy intake and micronutrient status of children.

After the intervention, almost all (91%) of the children in the Kamba community met the minimum dietary diversity score. This is attributed to the high uptake of the dietary intervention program as compared to the Maasai community. This reveals the role dietary diversity interventions would play in enhancing children and other vulnerable groups' dietary diversity, this findings agree with those by Christian et al. [23] which reported that interventions involving a school gardening were effective in increasing daily consumption of fruit and vegetable in children which could result in enhancing dietary diversity. Work done by Gibbs et al. [24] also reported an increased willingness of children to try new foods following two year of school gardening and cooking programme.

The Maasai community which is largely a pastoralist community had many children (33%) not meeting the minimum dietary diversity because their uptake of the dietary intervention programs was poor. This was attributed to their cultural practice of livestock keeping as their main livelihood and thus the kitchen gardening strategy was not well accepted. This further reveal that cultural practices are key determinants of the dietary practices of populations, this result agrees with those of a study by Chege et al. [25] that concluded that, culture influences the dietary practices among Maasai children under five years.

The high prevalence of anemia and especially among the Maasai children (36.3% & 53.8%) confirms that indeed anemia among preschool aged children in Kenya is an important public health problem. Notably, the relatively high and worsening prevalence of anaemia among Maasai children could be explained by their poor dietary diversity, low intake of iron rich foods and poor uptake of nutrition interventions. Their cultural nomadic practice led to poor uptake of the nutrition interventions such as kitchen gardening initiated by this study.

Comparatively with other studies, a study conducted in Ethiopia reported anemia prevalence of 41.1% among under children aged 6-59 months [26]. Another study conducted in western Kenya reported an anemia prevalence of 25% among preschool children [27]. The differences in these prevalence's could be attributed to different access to iron rich foods among the participants. This study observed a significant decline in prevalence of anemia among Kamba children whose caregivers had commendable uptake of the nutrition interventions initiated by this study. A similar observation was reported in a study conducted in Jordan where the prevalence of anaemia in pre-school children declined from 40.4% to 33.9%

after implementation of wheat flour fortification with multiple micronutrients program [28]. This demonstrates the important role of nutrition specific interventions in enhancing child nutrition and health.

Conclusion

Anemia remains a matter of public health concern among preschool children. Further and based on findings from this study, dietary diversity interventions such as kitchen gardening, nutrition education on good dietary sources of nutrients and enhancement of food nutritional value through better food preparation methods and implementation of other nutrition sensitive agriculture interventions can significantly enhance dietary diversity score and nutritional status of children and other vulnerable groups. There is also a need for urgent and practical efforts to change the behaviour of communities through appropriate community mobilisation to enhance the uptake of high impact nutrition interventions that would impact on improved iron status of children.

Limitations of the study

This study focused mainly on dietary practices and its effect on iron status of the children, it did not however include the morbidity factors and other confounding factors such as food and nutrition security indices and seasonality in the analyses. There was also a lapse of one year between pre and post-intervention assessments which could also have had some impact on the outcomes.

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Availability of data and materials

The data supporting the conclusions of this article are included within the manuscript. Additional data is available on upon reasonable request.

Authors' contributions

JK– conceived the idea and supervised the study. CL and WK helped in conducting the research, data analysis and writing the manuscript. All authors read and approved the final manuscript.

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