

A Tailored Nutrition Education Intervention Improves Women's Nutrition Knowledge and Dietary Practices in Farming Households of Tanzania

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Abstract

A study was carried out to assess the effectiveness of a nutrition education intervention among women residing in the villages of Dodoma and Morogoro regions of Tanzania. Prior to the intervention, a baseline survey was conducted in July-August 2016. The survey involved 663 women who completed a pre-test assessment for nutrition knowledge and practice and enrolled in nutrition education intervention. The intervention was carried out for 8 months (September 2017 to April 2018) including a 10 days group training per village with six-month individual training follow-ups in the household. Spouses/ adult men were also invited to participate in the intervention. Training content included; functions of food, food groups, malnutrition, food preparations, food consumption and homestead food production. Women were given a post-test during the end-line survey (July-August 2018) to assess the intervention. Nutrition knowledge (NK), Nutrition Practice (NP) as well as a combination of Nutrition Knowledge and Practice (NKP) were computed using a scoring method as per FAO guidelines. The test was scored in a range of 0-10 for NK and NP and 0-20 for NKP. The median scores before and after the intervention were compared using the Wilcoxon signed-rank test. The NKP scores among sub-groups of respondents were computed using Mann-Whitney and Kruskal Wallis tests. Changes in proportions were calculated using a McNemar test. Results indicated a significant increase in the post-intervention median scores (interquartile range) than the pre-intervention median scores (interquartile range) for NK, NP, and NKP; 7(5,7) vs 4(3,5), 5(4,6) vs 3(2,4) and 12(10,13) vs 7(5,9) respectively, $p < 0.01$. Higher scores were found among those who had received nutrition education, those who had frequently been exposed to nutrition education, those whose spouses/men participated in the intervention and those with a formal level of education than their counterparts. A significant increase in the frequencies of consumption of vegetables, fruits and legumes were noted from the baseline to the post-intervention phase in the end-line (87%-98%, 63%-69% and 76%-87%) respectively. The findings suggest the effectiveness of the nutrition education in the promotion of nutrition knowledge and desirable dietary practices in farming households of Tanzania.

Keywords: Nutrition education; Tailored training; Dietary practices; Nutrition knowledge; Food consumption; Rural households

Introduction

Malnutrition exists in various forms, affects many people and is the leading cause of ill-health worldwide [1,2,3]. Globally stunting affects 22% of children below the age of 5 years, while 39% of the adult population are overweight or obese, and about one-third of all women of reproductive age are anaemic [1]. The conceptual framework of malnutrition highlights the causative levels of malnutrition with a poor dietary intake being among the immediate causes of it [3]. The presence of foods alone does not necessarily translate into an optimal dietary intake. However, the choice of what, how, and when to eat is governed by several factors of which nutrition literacy is among the tops [4,5,6]. Studies have shown that poor dietary intake is linked with a high level of nutritional illiteracy in the population [7,8]. A poor dietary intake is a modifiable risk factor for dietary-related conditions such as nutrition deficiencies, overweight, obesity

and non-communicable diseases [5,9,10,11]. Unfortunately, the burden of these malnutrition conditions affects low and middle-income countries more than high-income countries because, historically, these countries are inflicted with undernutrition and are more affected by the rise of overweight, obesity and non-communicable diseases [1,12].

In Tanzania, the levels of malnutrition are still high for both women of reproductive age and children below five years of age. Currently, stunting affects 31.8% of children below five years of age while overweight and obesity for women of reproductive age increased its toll from 28% in 2015 to 31.7% in 2018 [13,14]. Feeding practices are also sub-optimal, with only 30% of children below five years of age are fed the minimum acceptable diet [13]. The country has been implementing interventions to scale-up nutrition such as the provision of folic acid and iron supplements to pregnant women, vitamin A supplementations

to children below five years of age and fortifications of staple foods with micronutrients of public health importance [15]. All these interventions need to be accompanied by a component of nutrition education and behaviour change communication, to increase their utilization, but this is not usually included in the programmes [5,16]. Nutrition education is defined as any combination of educational strategies accompanied by environmental supports, designed to facilitate the voluntary adoption of food choices and other food and nutrition-related behaviour conducive to health and well-being [17]. This suggests the potential of nutrition education in modulating dietary practices and therefore improves consumption and nutrition status.

Studies have shown that poor knowledge related to food consumption may affect dietary practices and suggest the need for behavioural change in the community [7,8,18,19,20]. While several studies regarding the positive impact of nutrition education on behaviour/change exist in Tanzania; the focus has been on the child feeding and nutrition status [20-25]. Effect of nutrition education on overall household dietary practices is not given much attention especially in rural parts of the country where the burden of malnutrition is high. Therefore, this study aimed to assess the effect of nutrition education on nutrition-related knowledge and dietary practices among women/caregivers in rural farming households of Dodoma and Morogoro regions, Tanzania.

Methods

Study Area

The study was part of the Scaling-up Nutrition project (scale-N), which was implemented in Dodoma and Morogoro regions, Tanzania [7,26,27]. These two regions differ in terms of agro-ecological characteristics (NBS 2015). Morogoro is located on the sub-humid climate while Dodoma features a semi-arid climate. In terms of food production, Morogoro is termed as a highly productive and food secured region while Dodoma is not, hence experience food inadequacy [27,28]. Despite these agroecological differences, these regions have a high prevalence of stunting and iron deficiency anaemia [14]. To understand the variations between two regions, data were collected from two purposively selected districts, one from each region. These districts were Kilosa from Morogoro region and Chamwino from Dodoma region. From each district, two villages were randomly chosen: Mzula and Chinoje in Chamwino district and Tindinga and Mhenda in Kilosa district [7,18,26,27].

Study Design, Participants and Sampling

This is a pre-post intervention study, utilizing both baseline and end-line data. The baseline data were collected on July-August 2016 while the end-line data were collected two years later in July-August 2018 following the intervention of nutrition education. The selection of study participants is described elsewhere [7,26]. This study received ethical approval from the National Institute for Medical Research in Tanzania (NIMR) with Reference number

NIMR/HQ/R.8a/Vol. IX/2226. In addition, mothers/caregivers and heads of households consented to participate in the study.

Description of Nutrition Education Intervention

Development of the nutrition education intervention involved different stages including; i) identification of the dietary gaps, ii) participatory analysis of the solutions iii) designing of nutrition education training packages and iv) the implementation of nutrition education training.

i. Identification of Dietary Gaps

The development of nutrition education intervention was grounded by the findings from the baseline survey, which was carried out during the initial phase of the Scale-N project. The findings of the baseline survey revealed several gaps and challenges including; high levels of nutrition illiteracy as well as inadequate skills related to food preparation, cooking, food allocation and undesirable food consumption practices [7]. Furthermore, community members especially men indicated that nutrition education was mainly given through health care providers in health centres targeting pregnant women or women with children below 5 years of age who attend to their scheduled antenatal clinic visits. Other community members especially men are left out in nutrition programmes. Figure one summarises the main dietary gaps found during the baseline survey. The detailed information on the dietary gaps is previously described in [7].

ii. Participatory Analysis of the Gaps

Feedback on the baseline findings was shared with the community. This was done in order to inform the community about the observed gaps and to engage them in planning the solutions thus, ensuring the process was participatory. The feedback also involved the identification of the community trainers. The feedback meeting included 145 representatives from participating villages with 64 participants from Dodoma and 81 from Morogoro. Participants included village chairpersons, village executive officers, Hamlet leaders, health workers, primary school teachers as well as female and males' representatives from each hamlet. After the presentation of findings, participants were given opportunities to ask questions and to seek clarification. The session of questions and answers was then followed by a discussion of gaps and intervention strategies. Participants from each village shared their experiences and suggested different means of resolving the identified research gaps. To capture different views from participants, points were recorded on the flip charts and stacked on the blackboard. In general, the discussion started with probing questions like what could be the cause of a problem? Could you suggest any technique that could be used to solve the identified challenge? After listing the challenges community representatives were asked to itemize and explore issues arose. The method helped the researchers to obtain in-depth qualitative information for inclusion in the nutrition education packages. The information related to dietary challenges and their proposed solutions is shown in [Figure 1].

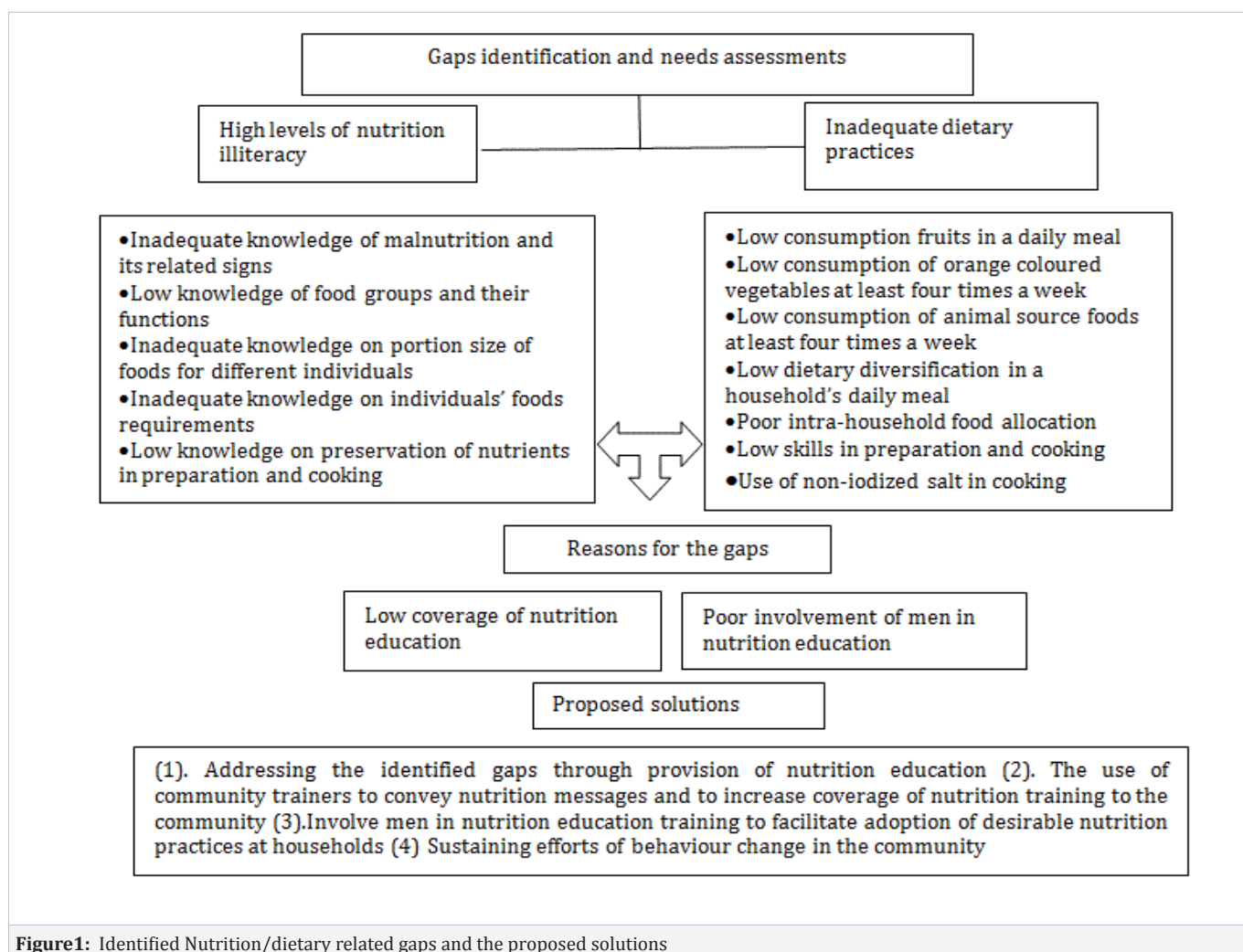


Figure1: Identified Nutrition/dietary related gaps and the proposed solutions

iii. Designing of Nutrition Education Training Package

Different materials were reviewed, these included various publications related to the development and implementation of nutrition education programs, previous nutrition education packages and workshop documentations that have discussed or reviewed nutrition education programs [6,17,18,20,22,29]. The purpose of the review was to identify existing nutrition education materials and gaps. The information was intended to guide the drafting of nutrition education package including materials to be used. After reviewing the existing literature, the drafting of the training package was done. The package was specifically designed to address the identified gaps found during the baseline survey. A one-day stakeholders' consultation meeting was held to discuss and solicit inputs for the drafted training package including the training materials. The participants were individuals from different institutions dealing with nutrition such as universities and research centres. Other participants came from health centres, local government authorities and Non-

Government organizations. The developed training package was presented to stakeholders to solicit their opinions. The inputs from stakeholders were incorporated into the drafted training package before the pretesting. Pre-testing of the materials was done at the community level in the study villages, aspects that were considered include; the appropriateness of materials for the local context, the flow of contents, its relevance, application, clarity, and adequacy. Further, participants were asked to identify any gaps. The changes were then incorporated prior to implementation. The detailed content of the nutrition education training package is presented in [Table 1].

Table 1: Content of nutrition education training package

Sessions	Topics	Sub-topics	Tools and materials used
Session 1	Introductory session	Aim and objective of the training Importance of good nutrition to the individuals, households and community	Pictorial demonstrations of healthy vs unhealthy individuals
Session 2	Malnutrition	Malnutrition and its different forms	Posters and picture cards of malnutrition-related signs
		The magnitude of malnutrition in the study villages	Graphical presentations of the magnitude of malnutrition
		Effects of malnutrition to the individuals	Picture cards of malnutrition-related signs
		Preventive measures of malnutrition	Graphical presentations of different measures
Session 3	Food preparations and cooking	Ways of preserving nutrients during food preparations	Picture cards of different methods of food preparation. Demonstrations of how to prepare foods
		Ways of preserving nutrients during cooking	Picture cards of poor vs good cooking practices
Session 4	Food consumption	Food groups	Poster of different pictures of food groups
		Functions of each food group	Poster of different pictures of food groups
		How much to eat	Posters and picture cards of portion sizes for each food group
		Intra-household food allocation	Poster of food allocation based on individual nutritional requirements
Session 5	Household food production	Ways of producing foods at the homestead level	Poster of different food production methods at households
		Importance of homestead food production for household consumption	Poster of how to use homestead produced foods

iv. The Implementation of the Nutrition Education Training

The implementation of the training involved two stages, the first stage being the training of community trainers and the second stage was the training of the targeted community. Twenty-five community trainers were identified during a feedback meeting, 6 from each village with the exception of one village which had 7 trainers. The criteria for selection of community trainers included those who participated in the baseline survey, those who are trusted by the community, those who could actively mobilize a group of people and those who had completed at least the primary level of education and could read and write. Another criterion was gender balance among trainers, this was made to ensure that men and women participate equally in delivering nutrition messages to the community. Training of trainers was done by 3 training supervisors. The supervisors had at least a bachelor's degree in human nutrition/agriculture and with vast experience with community nutrition researches and training. The identified community trainers were trained based on the content of the nutrition package developed. The trainees were given a pre-test before the training commenced. The questions were derived from different sessions of the training packages. At the end of the training, participants were given a post-test which was the same test that was given during the pre-test. This was

done to evaluate their understanding. Training methods included lectures, demonstrations, practices, group discussions, role-playing, and case studies. The community trainers were also given copies of training materials for their reference. The second stage involved training of the community, where the trained community trainers delivered the training to the targeted households. This was done in two stages; the first stage involved parallel sessions of group training conducted in 10 days by the community trainers and sessions were held in village primary schools. The second stage involved household follow-ups where the two community trainers with one supervisor visited each participant's household once a month for a consecutive 6 months in order to reinforce the nutrition messages, discussing challenges and negotiating for behaviour change. Different channels of communication were used to convey the messages during household visits. These included oral presentations, audio-visual presentations, demonstrations, display on colourful pictorial messages, and hands-on activities. Each household was given copies of colourful pictorial messages about food groups, a diversified meal, signs of malnutrition, home-stead gardening, and food preparation. The steps related to the implementation of training are shown in [Figure 2].

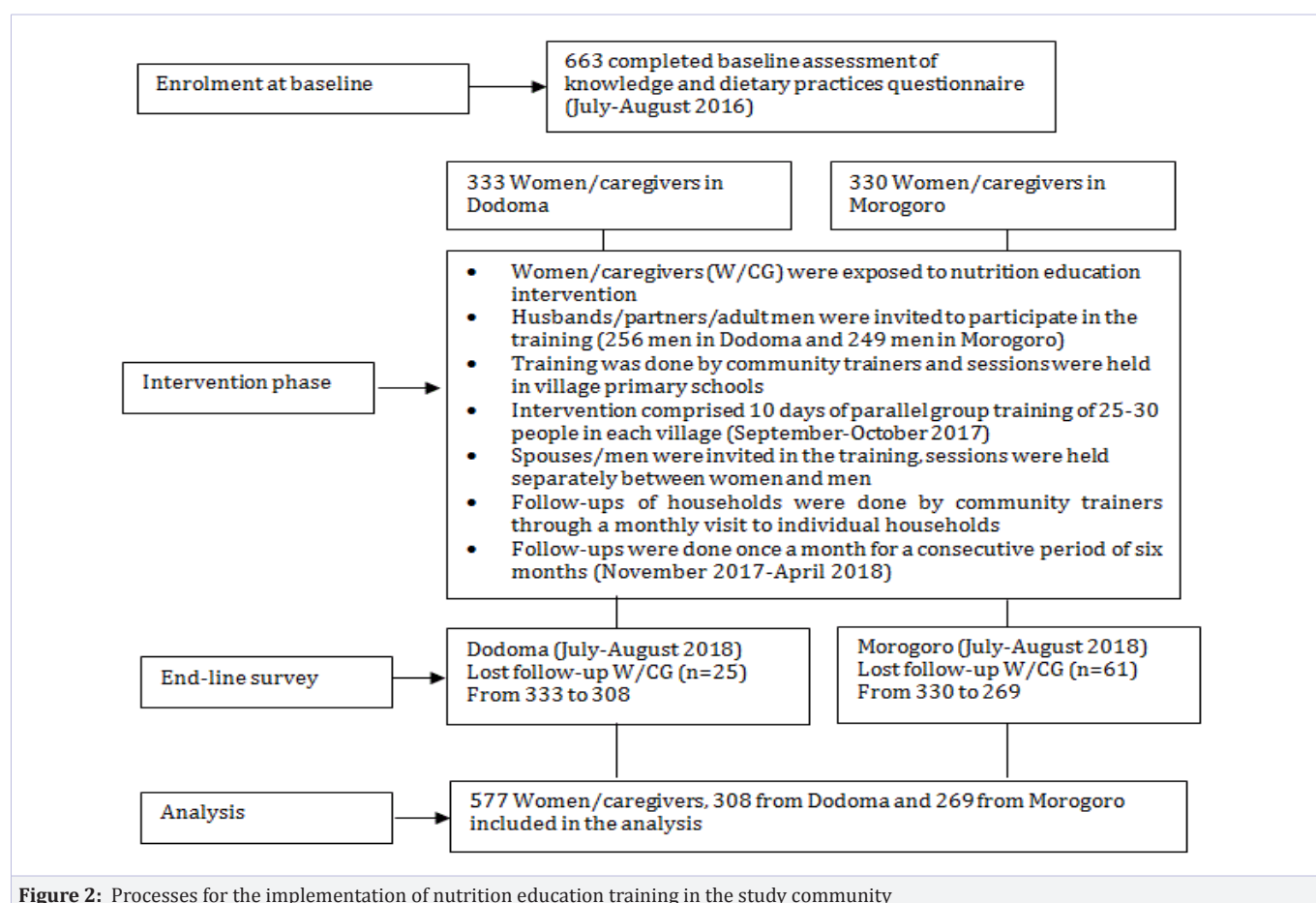


Figure 2: Processes for the implementation of nutrition education training in the study community

Data Collection and Tools

Data were principally collected during two phases, during the baseline and the end-line surveys. In both surveys, the data were collected by 10 trained field assistants who had a background of nutrition/agriculture/socio-sciences. The field assistants were guided by 2 supervisors to ensure the quality of the data collected. During the baseline survey, face-to-face interviews were carried out to establish dietary gaps. The interviews were held at village primary schools and took an average of 1 hour each. The pretested questionnaires were used to collect information. The questionnaires were designed to gather data on the demographic characteristics of the households, nutrition knowledge, nutrition-related practices, and food consumption. Similar information collected during baseline was also re-collected during the end-line survey to assess the impact of nutrition education training to the community. A descriptive summary of variables collected is described in [Table 2].

Table 2: Summary of variables collected during baseline and end-line survey in study regions

Variables collected	Descriptions
Socio-demographic	
Age	Age of mother/caregiver
Education level of a mother of caregivers	Number of years spent in school
Level of literacy of mother of caregivers	Ability to read
Marital status	Married/cohabited or single

Household size	Number of people living in the household
Headship of household	Sex of household head
Size of land owned	Land size in acreage
Income	Monthly average income
Nutrition knowledge (NK)	
Exposure to nutrition education	Received or not received nutrition education
Recognition of malnutrition signs	Able to mention at least one malnutrition sign

Heard about anaemia	Able to explain what anaemia is
Had knowledge on food groups	Can name at least two food groups or can explain the meaning of food group
Had knowledge of orange coloured fruits	Know the importance of orange coloured fruits
Had knowledge of foods rich in dietary fibre	Mentioned foods which contain high dietary fibre
Know the foods that increase the iron uptake	Mentioned foods that help to increase the use of iron in the body
Can recognise iodized salt	Identified iodized salt for household consumption
Know the importance of homestead livestock production for consumption	Mentioned importance of homestead livestock production for animal source food consumption
Know the importance of homestead vegetable production for consumption	Mentioned importance of growing vegetables for household consumption
Nutrition Practice (NP)	
Translate nutrition messages taught into action	Able to implement at least one of nutrition messages taught
Sought help for malnutrition	Received professional for malnutrition-related signs
Took measures to prevent anaemia	Took iron supplements and/ deworming for prevention of anaemia
Consumed at least five food groups in a meal	Ate at least five food groups in a meal taken 24 hours prior to the survey
Consumed orange-coloured fruits	Ate orange-coloured fruits at least four times a week
Consumed high dietary fibre rich foods	Ate high dietary fibre rich foods such as fruits in 24 hours prior to the survey
Consumed foods that help to increase the use of iron in the body	Ate foods that help to increase the use of iron in the body (such as citrus fruits) at least four times a week
Used iodized salt for cooking a household meal	Used iodized salt for cooking a household meal in 24 hours prior to the survey
Consumed at least poultry or poultry product at a household	Consumed at least poultry or poultry product at a household at least four times a week

Consumed at least one type of vegetable at homestead level	Consumed at least one type of vegetable at homestead level in 24 hours prior to the survey
Measurements of food intake	
Food frequency	A woman/caregiver was asked to recall each food item consumed by the household in a reference period of one week prior to the survey. The foods were then grouped into: (i)Cereals (ii)Roots tubers and plantains (iii) Legumes, pulses and nuts (iv) vegetables (v) Fruits (vi) Meat and meat organs (vii) Fish, sardines and seafoods, (viii)Eggs (ix)Dairy and dairy products (x)Fats and oil (xi)Sugar

Statistical Analysis

Analysis of Nutrition Knowledge and Practice (NKP) uses a scoring method as described by FAO [7]. For scoring of nutrition knowledge (NK), we computed a score ranging between 0 and 10. The scores reflected a total of 10 NK responses, with each earning a score of 1 for a correct response and a score of 0 for an incorrect response or if a respondent was not aware of the question asked. We did the same for NP scores, where a score range of 0-10 was computed, these scores reflecting a total of 10 NP responses. The score of 1 was given for desirable nutrition/dietary practice and the score of 0 was given for undesirable nutrition/dietary practices. The scores for both NK and NP were summed up to obtain NKP; the computed score range for NKP was 0-20. The data were analysed using SPSS 20, scores for NK, NP and NKP were shown to be skewed (using Shapiro test), and therefore were presented as median with interquartile range (25th and 75th percentiles). The median scores before and after the intervention were compared using the Wilcoxon signed ranks test. Further comparison of NKP score with different sub-groups of respondents was done using Mann-Whitney U, for comparison of two groups and Kruskal Wallis test for comparison of more than two groups. The McNemar test was applied to establish differences in frequencies of consumption of various food items during baseline and end-line.

Results

Out of 663 women/caregivers interviewed in the baseline survey prior to nutrition education intervention, 577 were successfully assessed in the post-intervention phase during the end-line survey. Thus, the study was able to reach about 87% of the target population who completed the assessment of nutrition

knowledge and dietary practices in both surveys. The majority of the study participants were mothers of older than 35 years. Over 75% of households during both the baseline and end-line surveys were headed by males. At baseline, only 14% of the study population reported having received nutrition education compared to 91% during the end-line [Table 3].

Table 3: Demographic characterization of study participants

	Baseline n= 663		End-line n = 577	
	n	%	n	%
Status of respondent				
Mother	562	85	491	85
Caregiver	101	15	86	15
Age				
15-35 years	322	49	231	40
36 years and above	341	51	346	60
Headship of household				
Female	156	24	137	24
Male	507	76	440	76
Marital status				
Married/cohabited	513	77	443	77
Single/Separated	92	14	78	13
Widowed	58	9	56	10
Number of people living in a household				
1-4 people	177	27	139	24
4 people and above	486	73	438	76
Education level of Mother/Caregiver				
Had formal education	380	57	344	60
Had no formal education	283	43	233	40
Exposed to nutrition education				
Yes	93	14	523	91
No	570	86	54	9
Regions				
Dodoma	333	50	308	53
Morogoro	330	50	269	47
Villages`				
Mzula	167	25	158	27
Chinoje	166	25	150	26
Tindiga	166	25	141	25
Mhenda	164	25	128	22

Variables are presented as number of observations (n) and percentages (%)

Nutrition Knowledge Indicators at Baseline and End-Line

Key indicators for nutrition knowledge of mothers/caregivers at the baseline and end-line are presented in [Figure 3]. Generally, the majority of women/caregivers responded more correctly to the questions related to various aspects of nutrition knowledge in the post-intervention phase (end-line) than prior to the intervention (baseline). Knowledge regarding signs of malnutrition, food groups, dietary enhancers of iron absorption, and the identification of iodised salt increased from baseline to end-line. Although knowledge regarding the importance of vegetable consumption was high during the baseline (72%), but

a slight increase was noted during the end-line 82%.

Nutrition Practice Indicators at Baseline and End-Line

Figure 4 represents the key indicators for the nutrition practice of mothers/caregivers at the baseline and end-line. At the baseline, only 8% of mothers/caregivers were able to translate some nutrition messages received from health centres into practice. The increase in percentage (84%) of those who were able to implement the taught nutrition messages was seen during the end-line, following the implementation of nutrition education intervention. Almost half (54%) of mothers/caregivers reported

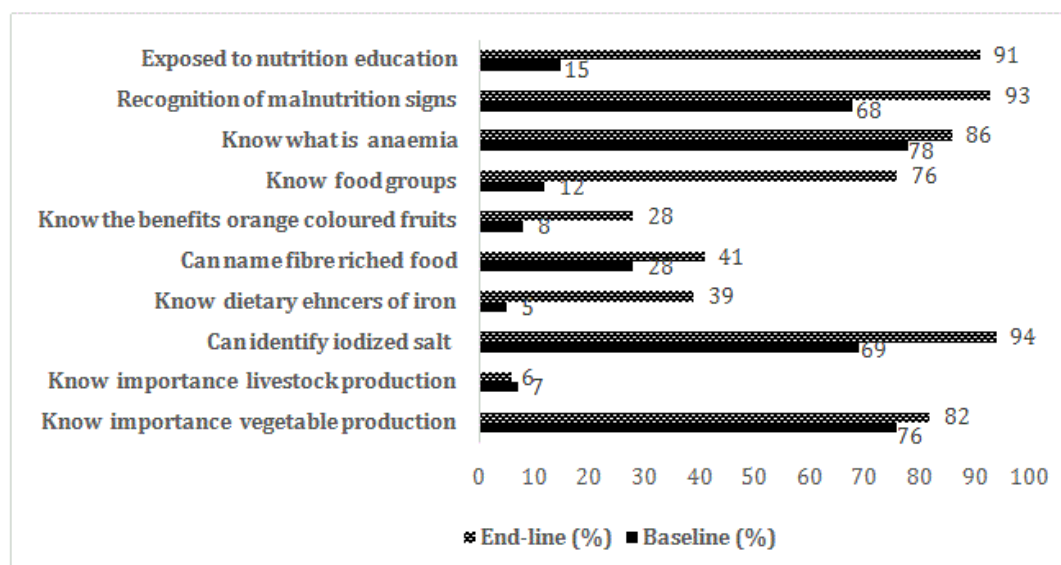


Figure 3: Nutrition knowledge indicators at baseline and end-line, values are presented as percentages of correct responses. The sample comprises only those who participated in both the baseline and end-line surveys (577)

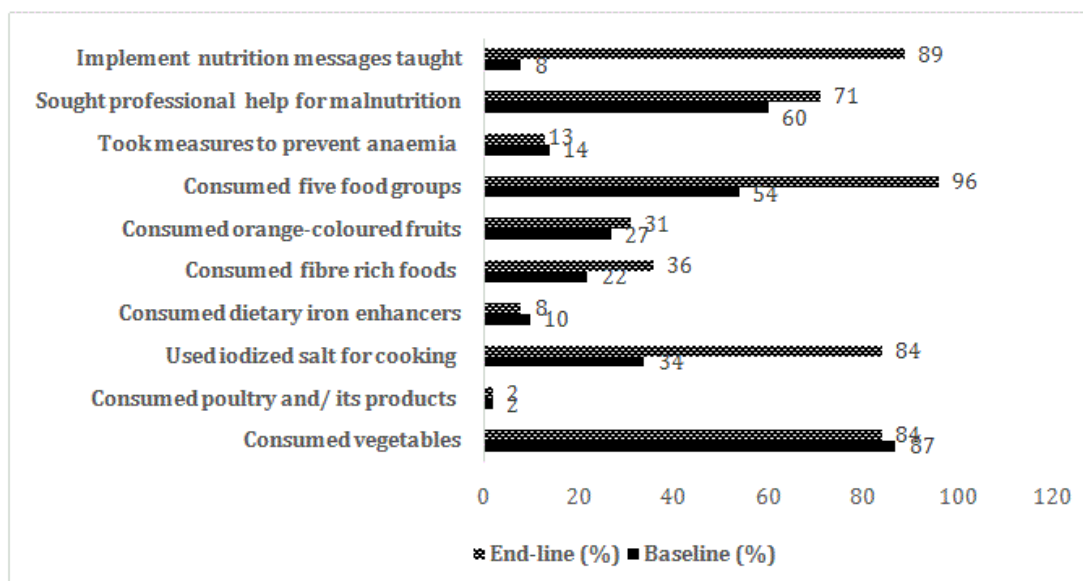


Figure 4: Nutrition practice indicators at baseline and end-line values are presented as percentages of correct responses. The sample comprises only those who participated in both the baseline and end-line surveys (577)

having included at least 5 food groups in their household meal during baseline and 96% in the end-line. Despite the changes, consumption of poultry and poultry products was minimum both at the baseline and end-line (2%).

NKP Scores at the Baseline and End-Line in the Study Regions

Table 4 shows the median scores of knowledge, practice as well as the total knowledge and practice scores of respondents at baseline and end-line. A significant improvement of scores for knowledge and practice was seen in all regions after the

intervention. The median NKP score for end-line was higher (12.2) compared to the baseline NKP scores 7.0 as shown in [Table 4].

Frequency of Food Consumption at Baseline and End-Line

The frequency of food items consumed regularly (at least five times a week) in a household is presented in [Table 5]. The proportion of those who consumed vegetables, fruits and legumes increased significantly in the post-intervention phase compared to the pre-intervention phase (98%, vs 87%, 69 vs 63% and 87 vs

76%, $p = 0.000$), respectively. Despite the positive changes in the consumption frequencies of vegetables, fruits and legumes, the intake of animal source foods such as meat, eggs, and dairy products did not significantly change after the intervention (5% vs 4%, 1% vs 1%, and 2% vs 2%), respectively. Notably, a significant decrease in regular consumption of fish was seen during the post-intervention phase than prior to the intervention (9% vs 11%, $p=0.019$) [Table 5].

Comparison of NKP Scores among Sub-Groups of Women/Caregivers at the End-Line

There was a variation in scores between villages and regions; generally, Morogoro region had a significantly higher median NKP score (12.5) than Dodoma region (11.4), $p > 0.001$, likewise, Mhenda village in Morogoro region had significantly higher NKP scores than the remaining villages. Variations of scores were also seen among different groups of respondents, including those who had received nutrition education, those who had frequently been exposed to nutrition education, those whose spouse/men participated in nutrition education and those who had a formal level of education compared to their counterparts. In addition, the scores were found to be the same across different age categories, household sizes and marital status as shown in [Table 6].

Table 4: NKP scores for the baseline and end-line in the study regions

Characteristic	All Regions Median (IQR)	Dodoma Median (IQR)	Morogoro Median (IQR)
Nutrition Knowledge Score (0-10)			
Baseline	4.0 (3.0,5.0)	3.0 (2.0,4.0)	4.0 (3.0,5.0)
End-line	7.0 (5.0,7.0)*	6.0 (5.0,7.0)*	7.0(5.0,8.0)*
Nutrition Practice Score (0-10)			
Baseline	3.0 (2.0,4.0)	2.0 (1.0,3.0)	4.0 (3.0,5.0)
End-line	5.4 (4.4,6.4)*	5.4 (4.4,6.4)*	5.5 (5.0,6.5)*
Nutrition Knowledge and Practice Score (0-20)			
Baseline	7.0 (5.0,8.5)	5.0 (4.0,7.0)	8.0 (6.0,10.0)
End-line	12.2 (10.4,13.4)*	11.4 (9.5,13.2)*	12.5(11.0,14.4)*

Wilcoxon signed ranks test, variables are presented as median and in parentheses, the interquartile range, values marked by * indicate significance differences between baseline and end-line median scores ($p < 0.001$)

Table 5: Frequency of food consumption at baseline and end-line

Food items	Baseline		End-line		P-value
	n	%	n	%	
Cereals	574	99.5	572	99.1	0.500
Roots, tubers and plantains	138	23.9	152	26.3	0.001
Legumes, pulses and nuts	441	76.4	499	86.5	<0.001
Vegetables (fresh and dried vegetables)	503	87.2	564	97.7	<0.001
Fruits	365	63.3	396	68.8	<0.001
Meat (beef, poultry, meat organs)	24	4.2	28	4.9	0.454
Fish (fresh and dried, seafoods, sardines)	62	10.7	51	8.8	0.019
Eggs	4	0.7	4	0.7	1.000
Dairy and dairy products	13	2.3	11	1.9	0.727
Fats and Oil	324	56.2	347	60.1	<0.001
Sugar	182	31.5	202	35	0.001

McNemar test, for comparison of proportions, the sample comprises only those who participated in both the baseline and end-line surveys (577). Food items presented are based on regular consumption (food items consumed at least 5 times a week)

Table 6: Comparison of NKP scores among sub-groups of women/caregivers at the end-line

Characteristic	Median NKP score	P-value
Regions*		
Dodoma	11.4	<0.001
Morogoro	12.5	
Villages**		
Mzula	11.8	<0.001
Chinoje	11.2	
Tindiga	12.4	
Mhenda	13.2	
Status of respondent*		
Mother	12.4	0.019
Caregiver	11.4	
Age*		
15-35 years	12.4	0.247
36 years and above	12.2	
Headship of household*		
Female	12.2	0.261
Male	12.2	
Marital status**		
Married/cohabited	12.2	0.439
Single/Separated	12.4	
Widowed	11.8	
Number of people living in a household*		
1-4 people	12.2	0.624
4 people and above	12.2	
The education level of Mother/Caregiver*		
Had formal education	12.2	<0.001
Had no formal education	11.2	
Exposure to nutrition education*		
Yes	12.4	<0.001
No	9	
Participation of spouse/male in nutrition education*		
Yes	12.5	<0.001
No	9.5	
Frequency of receiving nutrition education*		
Up to 3 times	11.5	<0.001
More than 3 times	12.4	
*Mann-Whitney test was used for comparison of two group categories		
**Kruskal Wallis test was used for comparison of more than two group categories		

Discussion

Effect of Nutrition Education on Nutrition Knowledge and Practice Scores

The findings of this study indicate that nutrition education intervention effectively improves nutrition knowledge and dietary practice among mothers/caregivers in rural households. Aspects of knowledge and practices that improved are; recognition of malnutrition conditions and signs, the importance of food groups in diversifying diet, nutrition importance fruits, importance of vegetables, dietary enhancers of iron and the use of iodized salt. In our study, we found an increase in the number of participants who responded correctly to the questions related to nutrition knowledge and practice in the end-line survey compared to the baseline; this ultimately contributes to the increase of the nutrition knowledge and practice scores following the implementation of nutrition education. These findings are similar to other studies that reported a significant improvement of knowledge and practice scores with an increase in the percentage of correct responses regarding nutrition knowledge and practice questions after implementation of a nutrition education programme [25,30,31,32]. Likewise, Cannoosamy et al. reported a positive mean change of nutrition knowledge scores and an increase of desirable dietary practices such as fruits and vegetable consumption following the implementation of a nutrition education intervention among housewives in Mauritius[33]. The positive changes to nutrition knowledge and dietary practices observed in this study could be as a result of the multiple approaches used in conveying the nutrition education intervention to our study population. For example, the use of community trainers who are trusted and familiar with the study community helped to reach the community and convey nutrition messages easily. In addition, the involvement of spouses/men in nutrition training helped the retention of knowledge at the household level. Further, the use of different communication methods including presentations, demonstrations, and dialogues helped multiple transmission of nutrition education messages. In addition, the approach of individual household follow-ups also helped to discuss challenges, clarify misconceptions and negotiate for behaviour change within the targeted households. Studies from different literature concluded on the effectiveness of multi-strategy approaches used in delivering nutrition messages and achieving behaviour change to the targeted community [34,35,36].

Food Consumption Before and After Nutrition Education

Consumption frequencies of different food groups such as; vegetables, fruits, and legumes increased significantly after the implementation of the nutrition education intervention. The finding implies that if people are empowered with appropriate nutrition information, they are able to make informed dietary choices and modify their dietary habits. This finding concurs with that of Mahmudiono et al., who examined the impact of nutrition education on dietary related behaviour among obese women[37].

The authors found an improvement in the intake of fruits and vegetables among women in response to the provided nutrition education. Despite the positive dietary changes found in our study, the frequency of the intake of animal source foods such as meat, milk, eggs, and fish did not improve after the intervention. We found the same trend of low consumption of animal source foods prior to the implementation of nutrition education intervention. We showed in our previous findings that about 50% of the surveyed households had livestock in their homestead, but only a quarter of them consumed at least one animal source food in the 24 hours preceding the survey date[38]. We explained, further in our previous findings that slaughtering of livestock for household consumption or consumption of livestock products such as milk and eggs is not usually practiced, and whenever it is done there should be a justifiable reason such as ceremonial celebrations, holidays or when a household gets an important visitor/guest. Otherwise, the livestock is sold to get immediate cash or exchanged for important services like the milling of cereal grains, paying for water services or medical bills [38]. These results concurred with the findings of Nyantakyi-Frimpong et al., who elaborated on the cultural and economic values embedded in livestock among livestock keepers in Ghana, constrained optimal consumption of animal source foods[39]. These findings necessitate the need for designing long-term nutrition behaviour change strategies that promote and sustain the consumption of animal source foods in rural households.

NKP Scores Among Sub-Groups of Study Participants

A significant variation of scores was seen among different sub-groups of respondents. Those who reported having received nutrition education had higher nutrition knowledge and practice scores compared to those who did not receive nutrition education. Additionally, the scores were higher among the respondents who had attended nutrition education sessions more than three times compared to those who attended less frequently (less than three times). A study by Anetor et al., demonstrated the positive changes of knowledge and dietary practices to those participants who were exposed to nutrition education versus those participants who were not exposed[31]. Contento links the frequency of exposure to nutrition education, or repetition of nutrition messages to the community, with retention of nutrition knowledge and adoption of desirable dietary practices by the community [17]. Furthermore, the scores for both knowledge and practice were higher for mothers/caregivers who had a formal level of education than their counterparts. A similar observation was made by Christian et al., among 608 caregivers in rural parts of Ghana, where caregivers with a formal level of education had higher nutrition knowledge scores and higher dietary diversity than those who did not have a formal level of education[40]. However other studies indicated that the effects of the formal education on dietary practices can be seen indirectly through the improvement of socio-economic status such as increased purchasing power and access to diverse food choices [41,42]. The higher knowledge and practice scores were also noted among the group of mothers/caregivers who brought their spouse/

men to participate in the nutrition education intervention than their counterparts. This finding confirms what is found in other studies where a low priority accorded to household nutrition was found among men who were less involved in nutrition or those with low knowledge of nutrition than their counterparts[43,44]. In the present study, the felt need for contextualisation of barriers to nutrition knowledge and dietary practices came out vividly in the study villages and regions. The differences in knowledge and practice scores seen between study villages and regions call for further investigation of enhancers and barriers to the acquisition of knowledge and adoption of desirable dietary practices in specific regions and villages.

This study has some limitations; The data for this study relied on self-reporting; hence it is difficult to control bias as the respondents may give information which they think is widely acceptable. Although this study used a large sample size and gives useful findings that can guide future designing of nutrition programs in areas with similar settings, the information cannot be generalized to other areas with different contextual settings, hence further studies in other areas with different settings are necessary. Furthermore, this study primarily targeted women/caregivers, who are involved directly in household food preparations cooking and allocation hence there is no comparison between male and female in terms of levels of nutrition knowledge and practice

Conclusion

The findings of our study signify the positive effect of nutrition education in the promotion of nutrition knowledge and desirable dietary practices in rural families of Tanzania. The aspects of knowledge regarding malnutrition, food groups, and their function, nutrition importance fruits and vegetables, dietary enhancers of iron and the use of iodized salt increased after the intervention. Likewise, the aspects of nutrition practices such as consumption frequencies of vegetables, fruits, and legumes increased significantly after the intervention. The low consumption of animal source foods remains a challenge even after the implementation of the nutrition education intervention in our study population, this calls for further investigations on specific behaviour change program to address the issue. Our study underscores the need to involve spouses/men in nutrition education programmes to facilitate the retention of nutrition knowledge and the adoption of desirable dietary practices in households. We conclude that the nutrition education intervention among our study population provided the desired changes and that the approaches used in delivering nutrition messages to the community can inform the future designing of nutrition education interventions in other areas with similar settings.

Conflict of interest

The authors of this article declare no conflict of interest.

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Author Contributions

NB contributed conception and design of the study, organized the database, and performed the statistical analysis; NB wrote the first draft of the manuscript; JK, TJ, WS CR and SS critically reviewed and refined the manuscript. All authors contributed to manuscript revision, reading and approving the final submitted version of the manuscript.

Availability of data

Data used in this study can be made available up on request.

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