Effect of nutrition education on nutrition-related knowledge, attitudes, and consumption of diversified diets among families owning a home garden in northern Ghana

Mahama Saaka,[1] Fred Kizito,[2] Irmgard Hoeschle-Zeledon[3]

[1]University for Development Studies, School of Allied Health Sciences, P O Box 1883, Tamale
[2] International Institute of Tropical Agriculture (IITA), P O Box 6, Tamale-Ghana
Email: f.kizito@cgiar.org
[3] International Institute of Tropical Agriculture (IITA), PMB 5320, Oyo Road, Ibadan, Nigeria.
Email: i.hoeschle-zeledon@cgiar.org

Corresponding author: Dr. Mahama Saaka
Email: mmsaaka@gmail.com

Abstract

Introduction: Micronutrient deficiencies are widely prevalent, especially in low- and middle-income countries, and this may be addressed by increased consumption of fruits and vegetables (FV). However, the consumption of FV in many households is below the recommended levels. Though home gardens have the potential to increase this, their mere ownership may not be sufficient to ensure an increased consumption of FV. However, home gardens coupled with nutrition education can help in improving household diets. In this study, we evaluated the apparent effect of an ongoing nutrition education intervention on nutrition related knowledge, attitudes, and consumption of diversified diets in households with home gardens in rural areas of Northern Ghana.

Methods: A community-based study using a posttest-only nonequivalent groups design was conducted in February 2021 on a sample of 232 rural households that have access to home gardens and with children aged 6 to 36 months. One group of households (n= 110) had been assigned to receive a nutrition education intervention and the other group (n= 122) served as a comparison. Mothers were interviewed regarding their child's feeding practices while the fathers were interviewed on their knowledge and attitudes towards nutritional and health benefits of fruits and vegetables. Multivariable logistic regression was used to determine the association between the major independent variable and the outcome variables of interest after adjusting for some of the confounding factors.

Results: After the nutrition education intervention had been ongoing for 7 months, the mean nutrition knowledge scores regarding appropriate child feeding practices in the intervention group was significantly higher than in the comparison group (28.33±6.60 versus 25.38±5.22), $p = 0.009$. Similarly mean nutrition-related attitudes (NRAs) towards childcare and feeding practices were higher in the intervention than the comparison group 31.70±2.32 versus (29.52±2.85), $p < 0.001$. Members in households owning a home garden and who also received nutrition education were 3.53 times more likely to consume vitamin A- rich fruits and vegetables [AOR = 3.53, (95% CI: 1.68 - 7.43)], compared with their counterparts which had only home gardens.

Conclusions: Nutrition education in households possessing home gardens appeared to result in significantly higher over-all nutrition knowledge and attitude scores among fathers. The intervention also improved actual consumption of fruits and vegetables in the households. This study contributes to the already existing evidence that joint nutrition education and home gardening have a positive effect on the consumption of diversified diets including FV in low-income countries.

Keywords: Home gardens; Nutrition education; Fruit and vegetable consumption; Nutrition knowledge; Nutrition attitudes; Northern Ghana

Introduction

The quality of a child's diet is a key determinant of optimal growth, development, and health. In most households, there is inadequate intake of micro-nutrients partly due to limited access to variety of foods, and a low consumption of animal source foods. With poor nutrition, the proper growth and development of children is impaired and also increases their risk of developing chronic diseases such as obesity, increased cholesterol levels, and hypertension later in life (Berenson et al. 1998; Schneider et al. 2007; Skinner et al. 2004).

Regular and adequate intake of fruits and vegetables contributes to prevention of health-related risks of major lifestyle diseases including, diabetes, cancer, coronary heart disease (CHD), stroke and improves immunity against NCDs (Angelino et al. 2019; de Villier and Faber 2019; Rolls et al. 2004). Increased consumption of foods that are rich sources of micronutrients is also a necessary step towards reducing the consequences of micronutrient deficiencies. Fruits and vegetables are important sources of micro-nutrients including antioxidants and soluble fibres (Krolner et al. 2011b), but their consumption is often less than the recommended levels in most households especially in low-income countries. A food-based approach that could help improve the micronutrient status of a given population through the provision of nutrient-rich foods is home gardening (Berti et al. 2004; Holmer 2011; Keatinge et al. 2011; Shisanya and Hendriks 2011). Furthermore, vegetable gardening empowers women in particular, a greater authority over the quality of the family diet (Ruel and Levin 2001).

Though home gardens have the potential of enhancing the consumption of nutrient-rich fruits and vegetables, their mere ownership may not be sufficient to ensure that. This is because poor diets may not necessarily be the result of a lack of economic and physical access to food. People also need to have some knowledge of nutrition, including the choice of foods that are of high nutritive value, how to appropriately prepare the food, and how to do so in a way that is clean and safe for children's optimal growth.

The significant benefits of fruit and vegetable consumption to human health emphasize the urgent need to promote their consumption. Households having access to both home gardens and nutrition education may be more likely to serve diversified diets. Therefore, with financial support from the West Africa, Africa RISING Project. the Department of Nutritional Sciences of the University for Development Studies and Ghana Health Service embarked on concurrent nutrition education and establishment of home gardens in selected communities in Northern Ghana. In this study, we evaluated the effect of ongoing nutrition education on the nutritional knowledge, attitudes and consumption of fruits and vegetables among rural households already owning gardens.

Methods

Study setting

The study was carried out in five districts in northern Ghana, namely Nadowli-Kaleo, Wa West, Tolon/Kumbungu, Savelugu/Nanton and Kassena/Nankana. The main occupation in the study area is agriculture while some people are involved in trading (Ghana Statistical Service 2014). There are two seasons namely the rainy or wet period (May to September) and a long dry season (October – April). The main staple foods, including maize, sorghum, millet, and yam, are usually harvested from October through December. Home or backyard gardening is common practice and forms an integral part of the food systems in in many communities in northern Ghana, especially during the rainy season. However, due to lack of water, dry season gardening is practiced mostly in the Upper East Region, where irrigation facilities are available. The

vegetables commonly cultivated include cabbage, onion, tomato, chili pepper, sweet pepper, lettuce, cowpea, okra, spinach, eggplant, pumpkin, bean leaves, amaranths, and cucumber.

A high proportion of rural women work daily away from home to engage in livelihood activities and therefore frequently face challenges to childcare and feeding activities. The study districts are largely rural and poverty is common, with the average household per capita daily expenditure being $4.91 (Zereyesus et al. 2016).

Study design, population, and sampling

This is a community-based study using the static group design, also called the posttest-only nonequivalent groups design. It was conducted in February 2021 on a sample of 232 rural households having access to home gardens and with children aged 6 to 36 months. The study sample was selected from 25 intervention communities where nutrition education is being implemented, as described below. Some households were nonrandomly assigned to receive nutrition education intervention and the others served as the comparison group. In each of the intervention and comparison communities, a sample of 9 eligible households was systematically selected by the supervisor of the data collection team.

The proportion of households that consumed diversified diets including fruits and vegetables in the study area was earlier found to be 18% (Saaka et al. 2016). The minimum sample size of 227 was estimated with 5% margin of error at 95% confidence level (1.96). Making provision of 2 % to cater for unforeseen circumstances including incomplete and missing questionnaires, the sample size was adjusted to 232 households.

The intervention

Seven monthly nutrition education sessions were conducted using a modified version of the Care Group Approach/Model (Food Security and Nutrition Network Social and Behavioral Change Task Force 2014) for both men's and women's groups in 25 intervention communities. Each session was held at the community level in open shaded areas for a maximum of 2 hours. The nutrition education sessions were facilitated by trained community health workers of the Ghana Health Service.

The nutrition education component was expected to raise awareness and increase knowledge about the nutritive values and roles of vegetables in human health. This increased knowledge was then expected to stimulate the consumption and preferences for healthier food choices including fruits and vegetables, which should then lead to better diversified diets and improved nutritional status.

The content for the nutrition education sessions was based on the responses obtained in earlier formative research. The targeted nutrition education messages are shown in Table 1. These training guidelines were adapted from: *Care Groups Training Manual for Program Design and Implementation* (Hanold et al. 2012).

Data collection

A structured questionnaire was administered face to face to obtain information on socio-demographic characteristics of fathers and mothers; infant and young child feeding practices; child morbidity and utilization of health services; level of fathers' involvement in childcare and feeding activities; assessment of fathers' knowledge and attitudes towards childcare and feeding; consumption frequency of fruits and vegetables and household socio-economic status.

Table 1. Guide for nutrition education sessions held

Session	Topic	Supportive Messages	Materials and resources
1	Importance of establishing home gardens	Establishment of home garden can improve access to fresh fruits and vegetables thereby providing variety and diversity of meals	Behaviour change nutrition education flip chart Materials for setting up gardens Discuss potential barriers and solutions Practice and coaching on skills acquired
2	The Importance of consumption of fruits and vegetables for health	Vegetables help combat malnutrition and diversify diets. The regular consumption of a variety of fruit and vegetables is essential for a well-balanced diet and for avoiding non-communicable diseases (NCDs).	Care Group (CG) register Samples of fruits and vegetables Game or Ice breaking activities Practice and coaching on skills acquired
3	Processing and preservation techniques to preserve the nutritional content of vegetables during cooking, preparation of nutritious and safe meals (Part I).	Preparation of green leafy vegetables to get maximum nutritional benefit. Reduce the amount of water used in cooking vegetables in order to preserve water soluble nutrients Maintain hygienic cooking practices	Behaviour change promotion through pictures, cooking demonstration
4	Processing and preservation techniques to preserve the nutritional content of vegetables during cooking, preparation of nutritious and safe meals (Part II).	i. Wash vegetables before cutting them and save the nutrient-laden water for soup stock. ii. Purchase fresh vegetables whenever possible. iii. When vegetables are boiled, endeavour to save the nutrient-rich water for soup stock.	Behaviour change promotion through pictures, cooking demonstration, Local food resources Discuss potential barriers and solutions, practice and coaching on skills acquired
5	Different ways men can help their wives to improve nutrition in the family	i. Men can support their wives to access diverse diets during and after pregnancy (e.g., proving money for food ingredients like meat, fish eggs). ii. Men can help improve women's nutrition by helping them with their workload such as fetching water, helping with childcare or sweeping the compound. iii. Men can also take up a supportive role in agricultural activities, providing women with productive farming land	Behaviour change promotion through pictures Practice and coaching on skills acquired
6	Optimal complementary feeding with breastfeeding (Part I)	i. Breast milk contains vitamins and special proteins that nourish your baby; it is insufficient as the only food for babies up to 6 months. ii. At 6 months the child needs additional food to provide more blood and nutrients for growth iii. Therefore, start giving complementary foods such as enriched porridge, soft mashed yam with palm oil, weanimix at six months of age and continue breastfeeding till two years of age.	Behaviour change promotion through pictures Cooking demonstration Local food resources Practice and coaching on skills acquired

7	Optimal complementary feeding with breastfeeding (Part II)	i. Always remember that your baby's stomach is small and so cannot take large amounts of food at a go. ii. Therefore, feed your baby frequently with small amounts of thick porridges so that she/he grows strong and healthy. iii. A thick food is one that does not fall easily from the spoon and that you can prepare it according to the age of the child).	Behaviour change promotion through pictures Practice and coaching

The data collection teams collected the data electronically using smartphones. The mother of the child was interviewed on children's feeding practices and fathers were interviewed on their knowledge and attitudes towards childcare and feeding.

Measurement of dietary practices

The main dependent variables of interest were (1) nutrition-related knowledge and (2) consumption of fruits and vegetables which was measured by asking respondents to recall the number days fruits and vegetables consumed in the past 7 days prior to the study. The consumption frequency was set as low (less than 3 days in a week) or high (at least 3 days in a week).

Dietary diversity is commonly used as a proxy measure for diet quality(Arimond and Ruel 2004; Arimond et al. 2010) which was measured in this study using a 24-hour dietary recall methodology (Kennedy et al. 2011). The dietary practices of children were determined based on a 24- hour dietary recall of mothers. The eight food groups used for determination of these indicators were: (i) grains, roots & tubers; (ii) legumes and nuts; (iii) dairy products; (iv) flesh foods (meat, poultry, and fish) (v) eggs; (vi) vitamin A-rich fruits and vegetables; (vii) other fruits & vegetables; and (viii) breastmilk

The indicators of minimum meal frequency (MMF), minimum dietary diversity (MDD), and minimum acceptable diet (MAD) were used for assessing child feeding practices as per WHO guidelines (WHO et al. 2010). The WHO defined MDD as the proportion of children aged 6–23 months who received foods from at least four out of seven food groups (WHO 2007). A combination of MMF and MDD gives MAD. Appropriate complementary feeding practice was defined as timely introduction of complementary foods at 6 months and meeting MAD.

Assessment of nutrition-related knowledge and attitudes

A secondary outcome measure was nutrition related knowledge score which was assessed based on 15 nutrition knowledge related questions. For each correct response, a point was awarded, and the total score was computed. The questions covered areas such as the benefits of consuming variety of food groups, including fruits and vegetables, protein sources, dairy products; processing and preservation techniques to preserve the nutritional content of vegetables during cooking, preparation of nutritious and safe meals, ways to encourage young children to eat well; ways men can help their wives to improve nutrition in the family. Scores of respondents were then categorized as high if total correct responses were ≥ median score, otherwise it was regarded as low. Also. as per FAO guidelines, nutrition-related knowledge thresholds for a nutrition intervention were applied. Consequently, all fathers who score > 70% in the knowledge test were classified as having high level of knowledge and those scoring ≤ 70% were classified as having a low level of knowledge (Marıas and Glasauer 2014).

Attitudes towards fruit and vegetable consumption were estimated by the fathers' ratings of 12 positive statements about the nutritional and health benefits of fruits and vegetables (e.g., 'Consumption of fruits and vegetables daily is important for the survival of human beings'). This was measured on a three-point scale, ranging from completely agree" (+1), do not know (Neutral) to completely disagree" (-1). Higher score meant more positive attitude for preventive nutrition/health behaviours including appropriate infant and young child feeding practices. The summative scores of respondents were categorized as high if total correct responses were ≥ median score of questions related to health/nutritional attitude, otherwise it was regarded as low.

Statistical analysis

The Statistical Package for the Social Sciences, version 23.0 (SPSS, Chicago, IL, USA) was used to perform the statistical analyses. A chi-square was used to investigate associations at the bivariate level. Using forward methods, multivariable logistic regression was used to determine the association between outcome variables of interest and main independent variable, adjusting for confounding factors. The results were presented with adjusted odds ratio (AOR) and their 95% confidence interval (CI). P-values less than 0.05 were considered statistically significant.

Ethical Considerations

The School of Allied Health Sciences, University for Development Studies, Ghana approved the study protocol. Ethical clearance was obtained from the Institutional Review Board (IRB) of the Navrongo Health Research Centre (No. NHRCIRB372). After providing the required information and explanation, all participants signed an informed written consent.

Results

Socio-demographic characteristics of study participants

The study groups differed significantly in various ways (Table 2). These differences were adjusted for in assessing the combined effect of household gardens ownership and nutrition education on the outcomes of interest in this study.

Post-intervention effect of nutrition education on nutrition related knowledge, attitudes and consumption of diversified diets

Seven months post-intervention, participants in the intervention group (nutrition education) had significantly higher mean nutrition knowledge scores regarding appropriate child feeding practices. Similarly mean nutrition-related attitudes (NRAs) towards childcare and feeding practices was higher in the intervention than in the comparison group. The mean dietary diversity score for children was significant higher in the intervention than the comparison groups (4.8 versus 3.9) ($p < 0.001$). Compared to households that received nutrition education, a significantly lower proportion of comparison households (45.1 % versus 62.7 %) reported cultivating vegetables such as salad greens, peppers, eggplant, tomatoes, beans and cucumbers mainly for consumption. (Table 3). Nutrition education in homes with home gardening significantly increased nutrition related knowledge and attitudes, as well as impacting positively on all child dietary intake indicators including minimum acceptable diet (MAD) and appropriate complementary feeding.

Table 2. Socio- demographic characteristics of study groups

	Study Groups		Test Statistic
	Household garden only (N = 122)	**Household garden + nutrition education (N = 110)**	
Characteristics	**n (%)**	**n (%)**	
Mother's age (years)			
Under 30 years	71 (57.7)	52 (42.3)	Fisher's Exact Test = 3.8, p = 0.09
30-45	50 (46.3)	58 (53.7)	
> More than 45	1 (100.0)	0 (0.0)	
Father's age (years)			
Under 30 years	38 (65.5)	20 (34.5)	$\chi^2 = 6.9$, p = 0.03
30-45	71 (50.7)	69 (49.3)	
> More than 45	13 (38.2)	21 (61.8)	
Educational level of mothers			
None	44 (37.9)	72 (62.1)	$\chi^2 = 20.1$, p < 0.001
Low (Primary & JHS)	62 (68.1)	29 (31.9)	
High (At least SHS)	16 (64.0)	9 (36.0)	
Religion			
Christianity	91 (65.9)	47 (34.1)	$\chi^2 = 24.4$, p < 0.001
Islam	31 (33.0)	63 (67.0)	
Classification of child's age (months)			
6-11	42 (60.9)	27 (39.1)	$\chi^2 = 11.5$, p = 0.003
12-23	71 (55.0)	58 (45.0)	
24-36	9 (26.5)	25 (73.5)	
Classification of household wealth quintiles			
First quintile (Poorest)	22 (44.0)	28 (56.0)	$\chi^2 = 9.3$, p = 0.05
Second quintile (Poorer)	26 (54.2)	22 (45.8)	
Third quintile (Middle)	20 (40.0)	30 (60.0)	
Fourth quintile (Richer)	32 (64.0)	18 (36.0)	
Fifth quintile (Richest)	22 (64.7)	12 (35.3)	

Categorization of fathers' involvement in childcare			
Low (Less than median score of 7)	37 (50.0)	37 (50.0)	χ^2 = 0.3, p = 0.6
High (At least median score of 7)	85 (53.8)	73 (46.2)	

In the multi-variable logistic regression analysis, which controlled for potential confounding factors, nutrition education remained a significant independent predictor of fruit and vegetable consumption (Table 4). Members in households which received nutrition education were 3.53 times more likely to consume vitamin A- rich fruits and vegetables at least three days in a week [AOR = 3.53, (95% CI: 1.68 - 7.43)], compared with comparison households. Consumption of vitamin A- rich fruits and vegetables was significantly higher among older children (24-36 months), compared to younger children AOR = 7.12 (95% CI: 2.06–24.54). Compared to households in the Upper West Region, households in the Upper East Region were 5.7 times more likely to consume fruits and vegetables at least 3 days in a week AOR = 5.68 (95% CI: 2.17–14.85). Households in which fathers were highly involved in childcare and feeding activities were 6.1 times more likely to consume fruits and vegetables AOR = 6.11 (95% CI: 1.69–22.05) compared to those in which fathers were less involved in such activities. The set of predictors accounted for 24.3% of the variation in appropriate complementary feeding (Nagelkerke R Square = 0.243).

Table 3. Association between nutrition education and selected variables

	Study Intervention Groups		Test Statistic
	Home garden + nutrition education (N = 110)	Home garden only (N = 122)	
Characteristics (Mean ± SD)			
Respondent's Nutrition-related attitudes score (NRAs)	31.3±2.5	29.5±2.9	F (1, 230) = 24.29, p < 0.001
Respondent's nutrition related knowledge score	29.6±5.9	25.4±5.2	F (1, 230) = 33.41, p < 0.001
Child's Dietary diversity score	4.8±1.4	3.9±2.1	F (1, 230) = 12.55, p < 0.001
What do you think is the main function of home gardens? n (%)			
Provide daily food needs	69 (62.7)	55 (45.1)	Chi-squared ($\chi^{2)}$) = 23.2, p < 0.001
Income	14 (12.7)	3 (2.5)	
Both food and income	27 (24.5)	64 (52.5)	
Frequency of fruit and vegetable consumption by adult household members in the past 7 days n (%)			
At least 3 days in a week	67(60.9)	48 (39.3)	χ^2 = 10.8, p = 0.001

Less than 3 days in a week	43 (39.1)	74 (60.7)	
Core IYCF indicators n (%)			
Complementary feeding at 6 mo	89 (80.9)	80 (65.6)	$\chi^2 = 6.9$, p = 0.009
[1]Minimum meal frequency	93 (84.5)	76 (62.3)	$\chi^2 = 14.5$, p = 0.001
[2]Minimum dietary diversity (≥ 5 food groups)	73 (66.4)	60 (49.2)	$\chi^2 = 6.9$, p = 0.008
[3]Minimum acceptable diet	66 (60.0)	49 (40.2)	$\chi^2 = 9.1$, p = 0.003
[4]Appropriate complementary feeding	55 (50.0)	36 (29.5)	$\chi^2 = 10.2$, p = 0.01
Fed child fruits and vegetables in the past 24 hours	76 (69.7)	45 (40.9)	$\chi^2 = 18.4$, p < 0.001
Fed child animal source foods in the past 24 hours	87 (79.8)	73 (66.4)	$\chi^2 = 5.0$, p = 0.03

[1]Minimum meal frequency is defined as 2 times for breastfed infants 6-8 months; 3 times for breastfed children 9-23.9 months; 4 times for non-breastfed children 6-23.9 months. "Meals" include both meals and snacks, and frequency is based on mother's report.
[2]Minimum dietary diversity defined as including ≥ 5 food groups in the past 24 hours
[3]Acceptable diet is defined as meeting at least the minimum dietary diversity and the minimum meal frequency during the previous day.
[4]Appropriate complementary feeding is defined as having met minimum acceptable diet and complementary food being introduced at 6 months.

The covariates adjusted for were: educational level of mother; age of child, father and mother; level of fathers' involvement in childcare and feeding activities; fathers' nutrition knowledge and attitudes; household wealth index, region of residence and religion of mother

Discussion

To the best of our knowledge the present study is the first to assess the effect of receipt of nutrition education on the nutritional knowledge and attitudes towards consumption of varied diet including fruits and vegetables in rural households of northern Ghana that possess gardens.

Effect nutrition education on nutrition related knowledge, attitudes and consumption of diversified diets

In this study, it was observed that nutrition education among families with home gardens resulted in a greater mean higher nutrition related knowledge and attitudes of mothers and fathers, compared to the comparison group of participants engaged in home gardening without concurrent nutrition education. Nutrition education combined with home gardening also

Table 4. Predictors of fruits and vegetables consumption frequency by adult household members in the past 7 days

	Wald	Sig.	Adjusted odds ratio (AOR)	95% C.I.for AOR	
				Lower	Upper
Region of residence (Reference: Upper West)	12.81	0.002			
Northern Region	0.21	0.644	1.20	0.55	2.61
Upper East Region	12.57	<0.001	5.68	2.17	14.85
Child's age (Ref: 6-11 months)	11.89	0.003			
12-23 months	6.52	0.011	2.53	1.24	5.17
24-36 months	9.65	0.002	7.12	2.06	24.54
Nutrition education	11.04	0.001	3.53	1.68	7.43
Father's involvement in childcare and feeding (Reference: Low)	8.57	0.014			
Moderate [>30 %-< =70%]	3.55	0.060	3.43	0.95	12.39
High [>70%]	7.65	0.006	6.11	1.69	22.05
Constant	10.34	0.001	0.10		

significantly increased actual consumption of diversified diets including fruits and vegetables in the households owning home gardens. A study in rural Nepal, which evaluated the effect of kitchen gardens and nutrition education, households that had access to the kitchen-gardens and nutrition education had significantly more nutrition knowledge than households that had kitchen gardens-only (38% vs. 13%), and consumed more of 16 types of home-produced micronutrient-rich vegetables and fruits (Jones et al. 2005a).

Improvement in nutrition knowledge is expected to lead to better nutrition outcomes in the long term (Bushamuka et al. 2005; Jones et al. 2005a; The World Bank 2007). If household members are empowered with nutrition knowledge, they stand a greater chance of making better food choices and that eventually would lead to better nutrition outcomes for household members (Galhena et al. 2013; The World Bank 2007; Webb 2013). In particular, when women participate in training programmes and gain better nutrition knowledge, there is an improvement in the nutrition of the household (Faber and Benadé 2003; Faber et al. 2002; Kulwa et al. 2014; The World Bank 2007). Other studies have reported a significant difference in nutrition knowledge between household participants that received both nutrition education and gardening as compared to comparison households that have home gardens (Jones et al. 2005b; Tumwebaze 2018). An integrated intervention consisting of home gardens livestock and nutrition education by Helen Keller International in rural Bangladesh reported of a positive impact on nutritional outcomes including dietary diversity (Iannotti et al. 2009; Karim et al. 2005; Talukder et al. 2000).

Predictors of fruits and vegetable consumption in rural households

In our study sample, the consistent predictors of consumption of fruits and vegetables in rural households were receipt of nutrition education, being resident in the Upper East Region, older children and high father's involvement in childcare and feeding. Fruit and vegetables are

essential components of a healthy diet but there have been few reports from low- and middle-income countries (LMICs) concerning determinants of fruit and vegetable consumption. The majority of studies have been conducted in the developed countries in Europe and North America (Krolner et al. 2011a; Rasmussen et al. 2006; Yeh et al. 2008).

We identified nutrition education on the nutritional benefits of fruits and vegetables as a predictor of the consumption of fruit and vegetables among households with a home garden. Home gardens are a crucial part of the household, as they provide families with an easy access to fresh vegetables and fruits (Burgess and Glasauer 2004; FAO 2001). In this study, over 50 % of respondents cited the production of vegetables for the household as the main reason behind owning home garden, an observation which is in agreement with other studies (Ali 2005; Faber et al. 2002). Having nutrition knowledge through the nutrition education received could also motivate caregivers to get fruits and vegetables through purchases even they are not available in their own gardens. Inadequate knowledge of the causes and consequences of nutritional deficiencies may adversely influence food choices.

Residents of the Upper East Region were 5 times more likely to consume fruits and vegetables, compared to their counterparts in the Upper West Region of Ghana. This may be attributed to easy access and affordability of vegetables in the region, where families who do not own gardens can still buy them. In the dry season, most families will not have their own vegetables and will have to purchase them. Some studies have reported that when women have some control over their own income, family nutrition stands to improve because women tend to invest their earnings for the well-being of the household more than men (Galhena et al. 2013; The World Bank 2007). As reported from Bangladesh, home gardens are a source of empowerment for women, as extra income generated by selling the excess produce supplements their income (Bushamuka et al. 2005).

A high father's involvement in childcare and feeding was seen to have positive influence on the consumption of fruits and vegetables in the household. Traditionally, fathers are expected to provide financial and logistical resources for the family (Bilal et al. 2016; Dougherty et al. 2017; Rakotomanana et al. 2021; Thuita et al. 2015; Wambui 2020). Though most interventions aiming to improve feeding practices target mothers, there is an emerging evidence of positive outcomes for child nutrition when fathers are involved in nutrition education sessions in low- and middle-income countries (LMICs) such as Kenya, Ethiopia, and Vietnam (Bich et al. 2019; Han et al. 2019; Mukuria et al. 2016).

In particular, the economic challenges that mothers encounter with regards to childcare suggest that fathers' involvement in childcare and feeding is an equally important aspect that deserves additional attention by policy makers. Interventions to improve household nutrition are less likely to succeed if fathers have inadequate knowledge of proper child-feeding practices, and if they do not support their wives. However, a clustered randomized controlled trial conducted in Ethiopia showed that **"**Nutrition [behaviour change communication] programs that target both fathers and mothers have greater impact on father's knowledge but the additional knowledge gain had limited impact on IYCF practices and child anthropometry" (Han et al. 2019).

Consumption of fruits and vegetables was significantly higher among older children (24-36 months), compared to younger children. Most children tend not to like leafy green vegetables, perhaps because of their bulky and rough nature and in some cases, bitter taste. Caretakers will in most cases feed older children with vegetables, with the perception that younger children will refuse to take them if offered. Older children are also more likely to be eating foods usually

consumed by adults, compared to younger children who are still partially on breast milk. Our finding is consistent with some studies which reported that frequency of fruit and vegetable consumption increased with age of child (Cooke and Wardle 2005; Health Survey for England 2016; Łuszczki et al. 2019; Nu et al. 1996)

Conclusions

Nutrition education among households with home gardens significantly improved the over-all nutrition related knowledge and attitudes scores of fathers. The intervention also improved the actual consumption of fruits and vegetables in the households. This study contributes to the evidence that nutrition education in households with home gardening can have a positive effect on the consumption of diversified diets, including fruits and vegetables, in low-income countries. The modifiable factors such as father's involvement identified as predictors of fruits and vegetables consumption in this study need to be accorded high priority in designing interventions for increased intakes of fruit and vegetables by rural families.

Study limitations

There are several limitations that need to be considered. The static-group comparison design used is prone to selection bias because the treatment and comparison groups have a high risk of being non-equivalent, and indeed ours were different in several ways at baseline. The study groups may therefore not be comparable with regard to some characteristics which may offer an alternative explanation of the outcome, therefore confounding the relationship between the intervention and the outcome.

The 24-hour recalls used rely on participants' ability to remember what foods were consumed and can thus be a source of measurement error. A desire to provide responses that respondents believe researchers would approve of can lead to further error and bias. The cross-section study design precludes the establishment of causality relationships. The limitations notwithstanding, the findings in this study add to exiting evidence that households that have access to gardens and nutrition education concurrently are more likely to have nutritional knowledge and attitudes towards consumption of varied diet including fruits and vegetables in rural developing country settings.

Authors' contributions

MS, FK and IH conceived, designed, and supervised the execution of the study. MS analysed the data set with inputs from FK. MS, FK, and IH were involved in drafting the manuscript and revising it critically for important intellectual content. All authors read and approved the final draft version submitted for publication.

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Conflicts of Interest:

The authors declare that they have no competing interests.

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