Ecology of Food and Nutrition

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/gefn20

Measuring and Influencing Behavior Change in Dietary Intake: Integrated Photovoice Approach in Nutrition Interventions in Eastern Kenya

Catherine Mawia Mwema, Christine Wangari, Seetha Anitha, Cornellius Muendo, Simon Nyaga, Moses Siambi, Murali Krishna Gumma, Pranay Panjala & Joanna Kane-Potaka

To cite this article: Catherine Mawia Mwema, Christine Wangari, Seetha Anitha, Cornellius Muendo, Simon Nyaga, Moses Siambi, Murali Krishna Gumma, Pranay Panjala & Joanna Kane-Potaka (2021): Measuring and Influencing Behavior Change in Dietary Intake: Integrated Photovoice Approach in Nutrition Interventions in Eastern Kenya, Ecology of Food and Nutrition, DOI: 10.1080/03670244.2021.1982709

To link to this article: https://doi.org/10.1080/03670244.2021.1982709

Published online: 03 Oct 2021.

Submit your article to this journal

View related articles

View Crossmark data

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=gefn20

ECOLOGY OF FOOD AND NUTRITION
https://doi.org/10.1080/03670244.2021.1982709

Routledge
Taylor & Francis Group

Check for updates

Measuring and Influencing Behavior Change in Dietary Intake: Integrated Photovoice Approach in Nutrition Interventions in Eastern Kenya

Catherine Mawia Mwema [a], Christine Wangari [b], Seetha Anitha [c], Cornellius Muendo [d], Simon Nyaga [e], Moses Siambi [f], Murali Krishna Gumma [g], Pranay Panjala [g], and Joanna Kane-Potaka [c]

[a]WorldFish, Lusaka, Zambia; [b]Eastern and Southern Africa Research Program, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Nairobi, Kenya; [c]Smart Food Initiative, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India; [d]School of Nursing and Public Health, Chuka University, Chuka, Kenya; [e]Nutrition, Tharaka Nithi, Kenya; [f]Regional representative for Africa, International Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya; [g]Geospatial and Big Data Sciences, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India

ABSTRACT

A study conducted in two wards of Tharaka Nithi subcounty in Kenya documented the impact of using photovoice as a learning tool to build awareness about diets in order to influence behavior change, as well as a method to measure dietary intake. After a year's nutrition awareness drive using Smart Food branding, in the intervention area, a total of 60 participants from intervention and control areas were identified for the photovoice exercise. The analysis showed household and women's dietary diversity scores to be higher in the intervention group by 35% and 45%, respectively. An estimate of nutrient intake revealed a higher intake of calories, protein, calcium, iron and zinc ranging from 70% to 205% in the intervention group. Qualitative feedback on the photovoice approach reflected increased nutrition awareness and behavior change. Results showed the efficacy of the approach in evaluating diets while simultaneously improving participants' realization of what they were consuming using images captured and a one-on-one discussion with nutritionists. The improvement in dietary diversity scores reflected the effectiveness of this creative participatory and branded approach in imparting a strong message on and enthusiasm for learning about nutrition, resulting in behavior change.

KEYWORDS

Photovoice; dietary diversity; Smart Food; dietary intake assessment

Introduction

Malnutrition levels are high in Kenya, with 26% of children under five years suffering from chronic malnutrition (stunting or low height-for-age) (Kenya DHS 2014). Malnutrition is generally associated with a myriad of other

CONTACT Catherine Mawia Mwema c.mwema@cgiar.org WorldFish, Lusaka, Zambia; Seetha Anitha s.anitha@cgiar.org ;dr.anithaseetha@gmail.com International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India

© 2021 Taylor & Francis Group, LLC

issues including food insecurity, health, hygiene, nutrient deficient food intake and development issues such as stress, fatigue, poor growth, increased vulnerability to diseases and impaired cognition. Maternal malnutrition and inadequate infant and young child feeding (IYCF) practices play big role in causing child malnutrition (Reinbott and Jordan 2016). Together, these can disrupt the economy of a country due to its debilitating effect on a population.

Nutrient-rich and drought-tolerant crops like millets, sorghum and grain legumes are mainly grown in Arid and Semi-Arid Lands of Kenya (ASAL), serving as a means to manage and contribute to reducing malnutrition and combating hidden hunger. For instance, pearl millet contains high levels of phosphorus, iron, zinc and folic acid (Anitha, Govindaraj, and Kane-Potaka 2019; Longvah et al. 2017). Studies show that the bioavailability of iron from high iron pearl millet (7.5%) can meet the physiological requirement of iron if it is eaten in adequate quanties of 200 to 300 g a day (Finkelstein et al. 2015). Finger millet has the highest calcium content among all cereals (Pradhan, Nag, and Patil 2010), and its 28% bioavailability can meet more than 60% of the body's requirement (Amalraj and Pius 2015). Legumes like pigeonpea and green gram are a good source of protein (Devesh, Kumar, and Raj 2017). In addition, legumes and millets complement each other for protein and micronutrients, and can create a complete protein (Anitha, Govindaraj, and Kane-Potaka 2019). Besides their nutritional value, these crops are known to be climate resilient (Saxena et al. 2018). The Smart Food global initiative recognizes millets, sorghum and legumes like pigeonpea as smart food crops (www.smartfood.org).

In 2015, the International Crops Research Institute for the Semi-Arid Tropics and its partners[1] launched the Smart Food initiative, an awareness programme in Kenya. The initiative sought to promote the utilization and commercialization of nutritious drought-tolerant crops termed as "smart food." Smart foods fulfil the criteria of being good for you (nutritious and healthy); good for the planet (environmentally sustainable); and good for the farmer (resilient, climate smart, potential to increase yields, multiple uses, etc). The term is also a 'branding' used to make it easier for the consumer to understand the crops and create a buzz around them. In addition to creating a demand pull by urban consumers, the initiative aimed to increase the consumption of smart food, particularly in rural semi-arid areas.

A pre-requisite to achieving adequacy in dietary diversity in rural areas is diversity in production, knowledge on the health and nutritional benefits of consuming diverse foods, social and behavior change messaging to change dietary intake patterns and the adequate consumption of nutritious foods. The diets in most parts of Kenya are monotonous with a starch and lacks important nutrients such as protein, iron, zinc and calcium combined with poor feeding practices in infants and young children. Millets, sorghum and legumes are produced seasonally in rainfed farming systems while vegetable production which is possible through kitchen gardens/home gardens /vegetable gardens is neglected. Vegetable gardens are important to address food insecurity and malnutrition and also provide additional income and livelihood opportunities for resource-poor families and women (Galhena, Freed, and Maredia 2013; Osei, Pandey, and Nilesen 2017).

Photovoice is a novel method that uses photography to raise awareness and stimulate mind-sets to bring about behavior change (Wang 2006). The method has been applied previously to assess youth perspectives on school food environments (Spencer et al. 2019) and in understanding the health and well-being of primary school children (Abma and Schrijver 2019). Among farming communities, photovoice has been applied to examine how farmers on small family farms are experiencing vulnerability to climate change (Bulla and Steelman 2016), and in understanding the unique challenges facing rural women working in agriculture. To the best of our knowledge, this is the first time the photovoice method has been tested as a multipurpose tool for studying and influencing dietary diversity, which in this pilot included training on nutrition, measuring dietary diversity and bringing behavior change by stimulating self-understanding on what is consumed.

To create awareness about nutrition, it is important to first understand the gaps in dietary and nutrient intake in order to design integrated agriculture and nutrition-based interventions. This calls for assessments of dietary intake and social and behavioral issues that influence diets. In most studies, data collection to assess dietary intake is done through the conventional recall method (Legwegoh and Hovorka 2013; Muthini, Nzuma, and Nyikal 2020). However, memory-dependent recall of 24-hr dietary intake together with low literacy levels in rural areas play a major role in over- and under-reporting issues.

To our knowledge, there have been no studies conducted so far using photovoice method, both as a tool to bring about behavior change and to assess dietary diversity.

The major objectives of this study were to (i) determine the effectiveness of training activities conducted using the photovoice method; ii) determine its effectiveness in capturing data on household dietary intake; (iii) assess the effectiveness of the nutrition awareness drive and training on dietary diversity and (iv) determine the effectiveness of photovoice in capturing data on dietary intake and influencing nutritional behavior change

Methodology

The study area for training on smart foods and undertaking the photovoice was selected as it suited the criteria of a location where these crops are grown, their consumption is inadequate as well as poor IYCF practices that prevail (Signorelli, Azzarri, and Roberts 2016).

Study site

The study areas, Marimanti and Gatunga wards are located in Tharaka Nithi County, Eastern province, Kenya and it is bound in between coordinates: 00° 02′ 00” N – 00° 17′ 00” S and 37° 52′ 00” E – 38° 19′ 00” E. The Marimanti ward covers around 267 sq.km and most of the area lies between 500 to 700 m of altitude. The Gatunga ward covers around 655 sq.km and there are variations in altitudes; the eastern part lies in between 500 to 750 m, whereas the western part lies in less than 500 m altitude (Figure 1).

Both wards lie in semi-arid climatic zones and have mean annual temperatures ranging from below 21°C in the west to above 25°C in the east, and annual rainfall less than 700 mm. These areas have a bi-modal rainfall pattern, during the first cropping season, rainfall is during March to May and during the second cropping season, rainfall is during October to December. Most of the farmers are dependent upon rainfall and practice rainfed agriculture. The major crops grown in these areas are sorghum, millets, pigeon pea, grams and maize.

Spatial distribution of croplands

The spatial distribution of croplands shows the domination of forests and shrubs in both study regions (Figure 2). In Marimanti ward, there is a dominance of pigeonpea and sorghum followed by maize in next season, and smaller amounts of millet’: whereas in Gatunga ward, there is a dominance of millet and sorghum but also with significant pigeonpea and maize. Overall, there are similarities in the types of crops grown (i.e. pigeonpea, sorghum, millet and maize); with each ward showing a slightly different mix in proportions of each crop grown.

The Marimanti ward shows good distribution of croplands, mainly double crops, whereas in Gatunga ward, there is mixing of single and double crops and also a domination of shrubs. The estimated various Land Use Land Cover (LULC) area in Gatunga shows that the main crops are as follows, nearly 10,304 ha of sorghum-millet, 6,711 ha of pigeonpea-maize, 6,239 ha of sorghum-maize, 6,209 ha of millet-sorghum and 5,272 ha of millet, and other LULC includes forest covering almost 20,000 ha and settlements about 11 ha.

In Marimanti, the major crops are as follows, nearly 5,595 ha of pigeonpea-maize, 4,754 ha of sorghum-maize, 2,864 ha of sorghum-millet, 1,172 ha of millet-sorghum, and only 120 ha of millet crop, and other LULC includes forest of about 9,979 ha and settlements about 30 ha.

In Tharaka Nithi county, 32.9% of the children are stunted compared to a national estimate of 26% (KNBS 2015) and 10.8% are reported to be underweight (KNBS 2015). The county is also experiencing an increased burden of non-communicable diseases (DHIS 2017), a trend that has an empirical association with poor nutrition (Nishida et al. 2004).

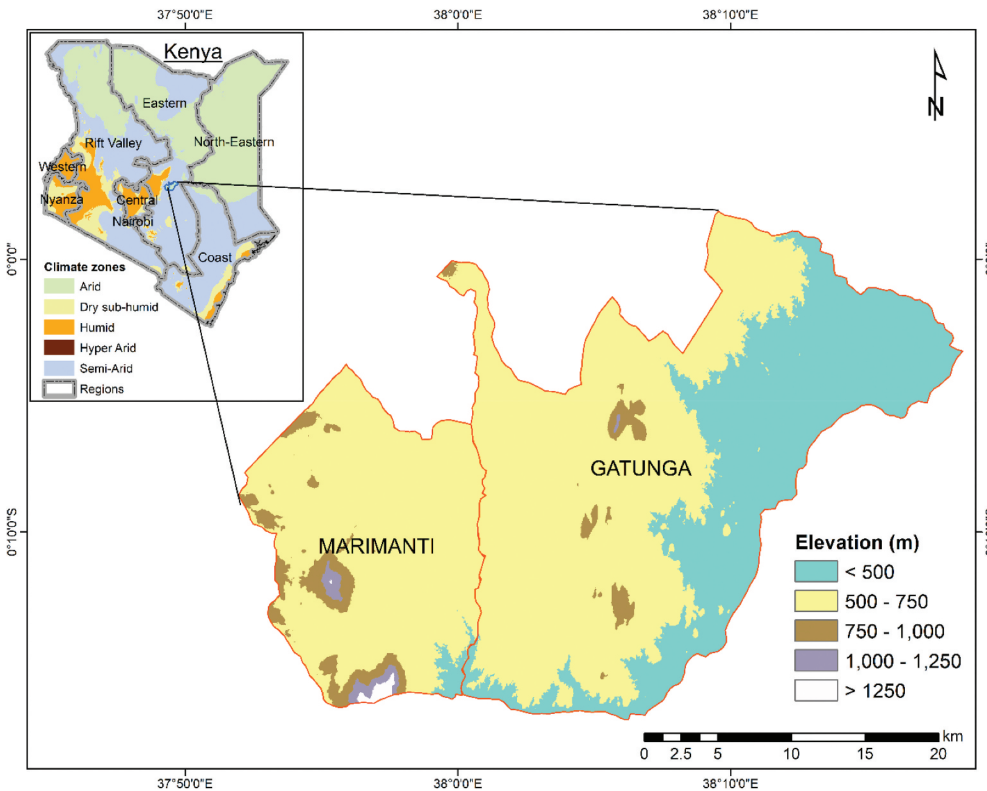

Figure 1. The study areas, Marimanti and Gatunga wards and their climate zones and altitude distribution.

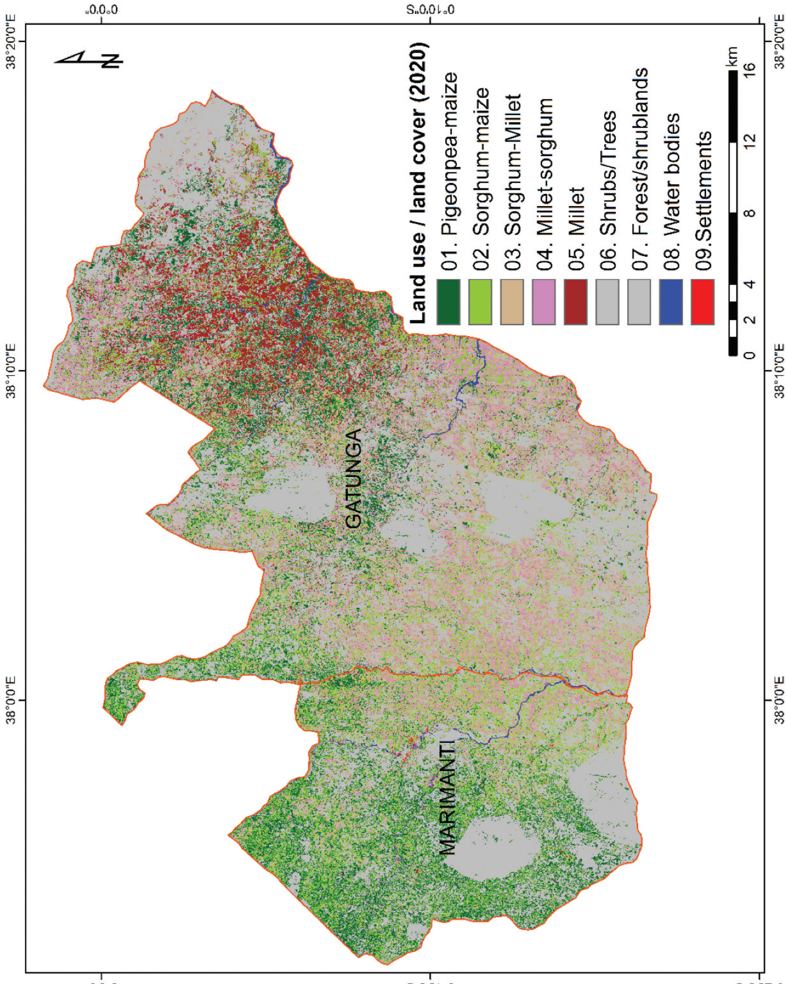

Figure 2. Spatial distribution of LULC in Gatunga and Marimanti regions.

Study design

In 2018, photovoice was used to conduct an assessment of 60 participants in Tharaka Nithi county, in which Marimanti and Gatunga wards represented the intervention (n = 30) and control groups (n = 30), respectively. Among the participants 50% were women with average age of 39.5 and 39.9 for treatment and control group respectively. Another 50% were men with the average age of 41.5 and 46.0 in treatment and control group respectively. Average household members size in treatment group is 3.81 and 4.03 in control group. The wards and the participants were selected with the help of the county's public health and nutrition officers who had been spearheading nutrition intervention activities. The interventions had taken place in the treatment area in the year 2017. The intervention ward (Marimanti) and control ward (Gatunga) are located at a distance of about 10–15 Km apart and have a similar agroecology, crop production (Figures 1 and 2), and consumption pattern but they lack the knowledge of cooking methods and nutritional value of Smart Food crops.

A purposive sampling approach was applied to select the participants for photovoice study. The selection criteria included that the participants (1) should have attended at least one training activity (a beneficiaries' program list was used to identify the eligible candidates) and (2) should be available and commit to three days of photovoice activities. The control group was chosen with the help of the local administration from among individuals who were willing to commit three days to the activities. A sample of 30 participants each in the intervention and control groups was logistically possible as each one needed a camera for the activities. Ethical approval was not obtained as it was not involving any human biological samples, however consent was obtained from all the participants. Moreover, the data collected were treated with all confidentiality adhering to the institutional data management policy.

Training on smart foods

A series of trainings were conducted in 2017 to impart knowledge on the nutritional benefits of smart foods and the importance of diversified diets. This process comprised of knowledge sharing and capacity building involving both farmers and household members of the community. The interventions were in the form of a range of creative, fun-filled and interactive approaches, and not based just on classroom teaching methods. Community volunteers took on the role of Smart Food ambassadors to spread nutrition messages and conduct the activities in the communities.

In 2017, farmers in the intervention areas had gone through a series of agri-nutrition trainings in the Smart Food training sessions that included the following

(1) Detailed information on what nutrition is and the importance of having a nutritious diet, best management practices in the production of nutritious crops, nutrition needs of expectant and breastfeeding mothers, infant feeding practises (0–6 months) and appropriate complementary feeding for children aged 6–23 months.
(2) How to set up kitchen gardens to produce nutritious vegetables for their consumption. In addition, training was imparted on the importance of vegetables in their diets.
(3) Sessions were conducted on how to cook diverse dishes from smart foods using a learning-by-doing method. The dishes had been developed through a participatory approach involving local chefs and the Smart Food reality show aired on national television in Kenya. This was aimed at enhancing knowledge and creating enthusiasm which would eventually contribute to social and behavior change in dietary intake.

Photovoice

Later, in the year 2018 the photovoice method was used to understand the effectiveness of the awareness program and to assess its impact on dietary diversity, nutritive dietary intake of the household members and to also build self-realization and behavior change. Photovoice reinforced the connection between nutrition information and how it influenced what the farmers grew and their dietary intake.

In 2018, the photovoice sessions included 60 participants (both intervention and control groups) who underwent the following activities:

(1) A photography training was conducted over a three-day period by a certified Canon trainer to capture dietary intake data and for advocacy and sensitization for use in photo exhibitions and documentaries. They were taught how to operate a digital camera and how to charge the camera. After this training, participants were asked to take pictures of all the food consumed by themselves and members of their households for the next 24 hours, from the time they woke up to the time they went to bed. They were informed that the assignment was in an effort to assess the photography skills they had acquired in order to distract them from, and reduce the influence of the food being served. The research team also ensured that the two days of photography training and the assignment day did not coincide with the market days so that regular meal patterns were captured. Respondents' consent was sought to use the photographs. On the third day, the participants brought back the cameras with the images captured. They were allowed to retain the printed pictures as keepsake, and were awarded a certificate of

participation. This exercise also facilitated discussions among participants on the use of the pictures they had taken and a reflection of their dietary intake during leisure time.

(2) After recording the 24-hr dietary intake through photovoice, the participants and nutritionist together reviewed the images taken. This was meant to double check the information on food consumed, which was used to score dietary diversity and to estimate the nutrient content of the diet that was consumed. The pictures were used to address the nutritional needs of the participants in order to improve their nutrient intake. The data captured was used to custom design further interventions which is beyond the scope of this paper.

(3) The photovoice training was also used as a tool to bring about behavior change and to create enthusiasm in learning. The pictures taken were used in a one on one discussion between participants and nutritionists to help them realize what had been consumed, the quantity consumed and the food groups the food consumed belonged to, and how they can make improvements on their dietary intake.

4. After the dietary assessment was conducted, the 30 participants in the control group were additionally taken through a one-day agri-nutrition training. The training integrated agricultural production of locally produced crops with nutrition. This was in an effort to impart knowledge to the control participants who had received no prior training from the Smart Food nutrition awareness program.

5. In addition to taking pictures, a video documentary shooting exercise took place concurrently. Key community influencers and the team were interviewed. The daily activities of some participants in their homesteads, particularly during meal preparation, were also captured. This was followed by facilitating the community to conduct photo exhibitions for advocacy and community sensitization on the importance of dietary diversity and the nutritional value and health benefits of Smart Food.

Data collection and analysis

Images of the foods consumed and household members were printed and the participants provided the captions, as they had been taught to do in the photography training. The food consumed on normal week days and no special occasions was captured, considering the weekend and special occasions usually leads to bias. Each food and its quantity consumed was estimated by having a discussion with each participant and with the support of the pictures taken. The name of the consumer, age, type of food and the ingredients in the food were also captured during the discussion. This information was used as a data source of the food groups consumed in order to analyze the dietary diversity score. The household dietary diversity score and women dietary diversity score was measured by following the guidelines provided by (FAO 2011), in which household dietary diversity score ranges between 0 and 12 food groups and women dietary diversity score ranges between 0 and 9 food groups. The minimum dietary diversity for 0–23 month old children is defined by the percentage of children that consumed at least four out of seven food groups apart from breast milk (WHO, 2010); said to be 100% if all children consume four or more food groups. A three-member team of trained data clerks with a background in nutrition entered the data from the captioned images into the data sheet, which was then analyzed using SPSS 20.0 software.

The major nutrient constituents of the diet consumed (protein, iron, zinc and calcium) were estimated using the Kenya food composition table (FAO/ Government of Kenya 2018) based on the information captured during the discussions on types of food, food groups and ingredients used and the quantity consumed in a local measurement.

Mapping croplands using satellite imagery

The preparation of the LULC map including cropland extraction for the study area of crop year 2020 starts with obtaining Sentinel-2 time series normalized difference vegetation index (NDVI) imagery (10 m resolution) followed by stacking monthly maximum NDVI images into a single composite cube (12 layers, one layer for each month) (Gumma et al. 2020, 2021).

Then the single composite cube was classified using unsupervised ISOCLASS cluster Isodata classification giving inputs as 60 classes and 60 iterations to stretch until the convergence threshold of 0.99. The output generates the spectral signature/profiles for 60 individual class and identified classes based on visual interpretation, known spectral profiles, Google Earth high resolution imagery. The classes were clustered based on class similarities and labeled accordingly. If any class mixing or disproportions were found in the classification, the specific class was reclassified by the above procedure until significant results was obtained. However, it is noted that there can be some mixed classes, because of the high dominance of vegetation in the study area (Gumma et al. 2019)

Results

Photographs captured by the participants were used to assess the dietary intake of the participants. A hundred percent participation was recorded in capturing photographs of the diets consumed in the past 24 hrs from the time the participants and their family members woke up to the time they went to bed. It was observed (Table 1) that dietary diversity scores were highest among those in the intervention group who had received training in nutritious food intake compared to the control. The mean Household Dietary Diversity (HDD) and Women Dietary Diversity (WDD) of the participants in the intervention group were 8.1 ± 1.1 out of 12 food groups and 5.5 ± 0.9 out of 9 food groups, respectively, which was 35% and 49% higher than in the control group. All the participants in the intervention group fed their children aged between 6 and 23 months at least four of the WHO & UNCEF jointly recommended seven food groups (WHO 2010), in contrast to less than half (46%) in the control group.

The pictures captured by the intervention group showed that they had consumed a diverse variety of meals made from pearl millet, sorghum, wheat flour and green gram in contrast to the control group whose pictures didn't have any of these grains and pulses. Images of *mandazi* (fried bread) made from pearl millet (originally made with wheat) were presented by some participants in the intervention group. Other images of smart food dishes in the intervention group included a nonalcoholic beverage made from roasted sorghum grains; sorghum *pilau* cooked with a mix of sorghum and green gram (originally a rice-based dish cooked with spices); pearl millet *chapati* (flat bread) made from a mix of pearl millet and wheat flours and green gram *chapati* made from a mix of wheat flour and green gram. The smart food dishes had been learnt as part of the practical cooking training sessions undertaken in 2017.

The control group's pictures were of meals largely made from cereals, particularly maize (either maize porridge or *ugali)* with less than 30% legumes and a cereal-legume ratio of 3:1 or 4:1. Notably, green gram consumption was extremely low in the control group. All the participants in the intervention group consumed millets while 87% of them included a good portion of millet to legumes in a ratio of 1:2 or 1:1.

Table 2 presents key emerging patterns of participants' meal practises, drawn from the individual sessions with the team of nutritionists and based on the images presented by them.

The photovoice images show that farmers mix cereals and legumes to prepare *githeri* (a mix of maize and legume) which is a common food in many households in the study area. However, most of the time, the ratio of maize to legumes in *githeri* has very low levels of legumes (3:1 or 4:1) which is improved in intervention site. This was evident from the pictures taken by participants in the control and intervention sites (Figure 3). Legumes are the

Table 1. Dietary diversity scores of household members.

Indicators	Intervention Mean ± SD	Control Mean ± SD	*P* value
Household Dietary Diversity (HDD)	8.1 ± 1.1	6.0 ± 1.8	.000
Women Dietary Diversity (WDD)	5.5 ± 0.9	3.7 ± 1.3	.000
Minimum Dietary Diversity (MDD) (%)	100*	46.2	-

*Minimum dietary diversity of 0–23 month old children is defined by the percentage of children consumed 4 or more food groups out of 7 food groups apart from breast milk.

Table 2. Food consumption practices captured through photovoice.

Intervention group	Control group
Consumed carbohydrates from a variety of cereals and traditional crops such as millets and sorghum	Mostly consumed carbohydrates from maize
Ratio of legume to millets in *githeri* ranged from 1:2 to 1:1	Ratio of legumes to maize in *githeri* was low, ranging from 3:1 to 4:1
Notably high consumption of animal source food	Low consumption of animal source food
Increased consumption of sorghum beverage mixed with milk	Most households use diluted milk in tea.
High consumption of porridge made from pearl millet, sorghum and finger millet and fermented porridge	High consumption of fermented porridge made from maize Milk added to children's porridge while cooking
Consumption of vegetable doubled (pigeonpea leaves, cowpea leaves, pumpkin leaves, spinach)	Consumption of vegetable is very low or nil
Some households consumed nuts	No consumption of nuts
Double the number of households consumed seasonal fruits.	Minimal consumption of seasonal fruits

most common source for proteins in the study area. The low consumption of legumes as well as the scarcity of animal meat implied that protein consumption among the families was inadequate.

Milk and milk products are another important food group which saw poor consumption in the control group compared to the intervention group. The ratio of milk to water in tea was low, resulting in dilution of milk and less dietary calcium intake.

The consumption of vegetables was higher among the intervention group than in the control group. Most of the farmers in the intervention group consumed a variety of vegetables, including pigeonpea leaves, cowpea leaves, pumpkin leaves and spinach, among others because they cultivated their own vegetables in kitchen gardens and gained more awareness about the benefits of consuming them in their diets, resulting in the addition of the food group in their meal.

The food consumed and estimated nutrient value of the food consumed by the control and intervention groups per adult show (Tables 2 and 3) the superior nutrient profile of the intervention group compared to the control group. Energy, protein, calcium, iron and zinc intakes in the intervention group were 82%, 70%, 210%, 205% and 46% more respectively compared to that in the control group (Figures 4–7).

Table 4 includes some examples of participants' reflections about the training and capturing dietary diversity. Participants reported that photovoice increased their awareness about consumption behavior and the intent for nutrition-based social and behavior change as pictures and personalized communications were powerful tools.

Discussion

The current study shares the experiences gained from agri-nutrition and community household nutrition interventions supported by the photovoice approach, conducted in Kenya under the Smart Food initiative. The approach

A

B

Figure 3. Githeri prepared in intervention group (a) and control group (b) after the training.

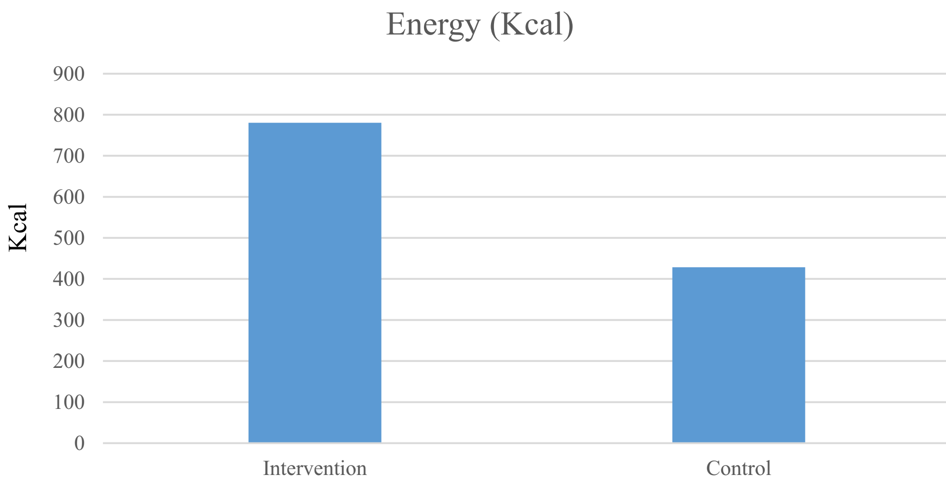

Figure 4. Estimated energy from an average meal/adult (intervention Vs control).

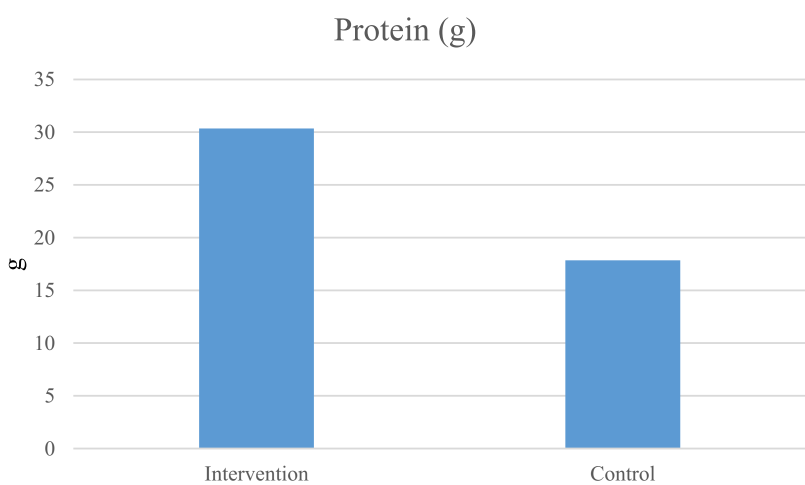

Figure 5. Estimated protein from an average meal/adult (intervention Vs control).

used photographs of food items consumed over a 24-hr period taken by participants as data sources to evaluate dietary intake and dietary diversity among the project beneficiaries and non-beneficiaries. The photovoice approach served as an opportunity to gather evidence-based data through a combination of research data collection and engagement with participants in nutritional social behavior change, as was clearly evident during the recollection process to countercheck with the contents of the pictures. This is in contrast to the 24-hr recall approach that relies on memory and a minimum level of literacy to describe the food along with its quantity.

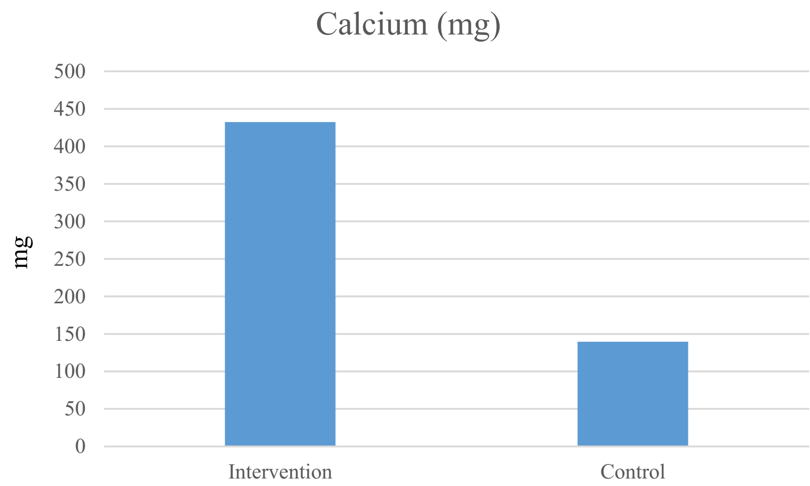

Figure 6. Estimated calcium from an average meal/adult (intervention Vs control).

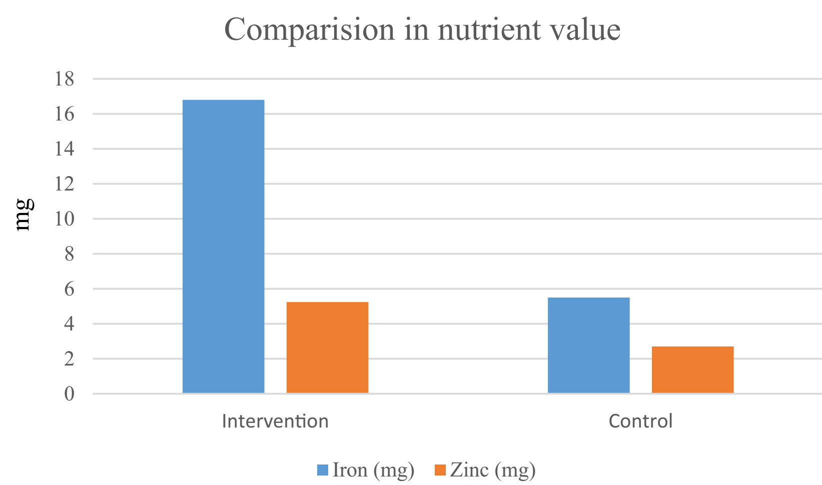

Figure 7. Estimated iron and zinc from an average meal/adult (intervention Vs control).

Table 3. Estimated nutrient values of one average meal/adult in intervention group.

One average meal	Energy (Kcal)	Protein (g)	Calcium (mg)	Iron (mg)	Zinc (mg)
Intervention group					
Githeri with 50% more pigeonpea –300 g	780.5	30.35	432.45	16.8	5.24
Papaya – 100 g					
Leafy vegetable – 100 g					
Finger millet porridge with milk – 1 cup					
Control group					
Githeri (normal) – 250 g	428.5	17.85	139.5	5.5	2.7
Tea (1 cup)					

Source: Kenyan Food composition table; Longvah et al. (2017).

Table 4. Participants reflection on self-realization after implementing photovoice method.

Questions	Participants reflection after capturing the dietary intake of past 24 hr
What aspect of the photovoice method you think was useful?	Taking pictures was really fun filled. Having the images printed and handed over to us actually helped us to reflect on what we could have improved – participant from a control group. The discussion with the nutritionist on a one to one basis helped me to recollect some of the aspects that I forgot after training – participant from an intervention group.
What do you think about your own dietary intake after the Smart Foods Training conducted last year in 2017 and now?	Our dietary composition and variety of foods we consume from Smart Foods improved compared to previous diets however, going through this session with photographs has also helped to recollect some of the information on dietary diversity, adequacy and balanced diet using food groups that we learnt during training – Participant from intervention area.
What need to be changed in terms of dietary intake?	We need to still improve our dietary diversity in terms of adequacy of some food groups although we are generally doing fine now after training. During one of the Smart Food Trainings, food adequacy of the different food groups was highlighted, we still need to improve on some food groups like nuts and fruits – participant from intervention group. I had no information on how to eat a balanced diet and will mostly consume carbohydrates with little or no proteins and vitamins. By retaining some of the legumes I grow for consumption, my family will have a better diet – Participant from control group.

The availability of nutritious and diverse food in participants' own farms is critical in increasing dietary diversity; more so in rural households without adequate disposable income for food purchases. This was clearly evident in the case of farmers who had not been part of the interventions and had sold their whole produce (particularly high-return crops), saving none for domestic consumption. Farmers had sold their whole harvest of green gram, which is high in nutritious protein, partly due to inadequate knowledge about its nutritional composition. This required an intervention to sensitize them on the nutritional value of crops so that they could retain a part of the harvest for domestic consumption. The improvement in household dietary diversity, women's dietary diversity and the dietary nutrient intake interms of energy, protein and micronutrient content as a result of the training on food choices and selection from various food groups (Table 1, Figures 4–7) was testimony to its efficacy. The dietary and nutrient intake was similar to control group at the beginning which increased at the end of the intervention (Figures 4–7).

The one-on-one discussions were instrumental in capturing participants' views and attitudes and any changes in them, which were collated and analyzed qualitatively. By having participants share and discuss their own pictures, photovoice captures their viewpoint with the goal of empowering marginalized groups and raising awareness of nutritional deficits within a community (Wang and Pies 2004). Using photographs as a research tool has been found to have the potential to make participants feel more comfortable, enhance the quality of data and create a sense of agency among them (Epstein et al. 2006; Sopcak, Mayan, and Skrypnek 2015; Wang 2006). Participants showed a great deal of excitement in photographing the food that they were consuming at home. Any potential influence on the food served was controlled by a triangulation method of conducting focus group discussions, individual discussions and by talking to others in the village to cross verify and understand the regular eating pattern or changes due to training in order to ensure accuracy.

Limitations and recommendations of the study

Limitations and recommendations of the photovoice approach are 1. the use of digital cameras without complementary sensors to quantify the amount of food intake, which was offset by the information sought from participants on estimated food intake during discussion sessions. 2. this was a pilot study with successful results on the usefulness of photovoice, it forms the appropriate basis to take the photovoice approach to a large scale and test further for multiple purposes in agriculture and nutrition research for development activities. 3. the food consumed outside the home such as social outings, work and school were not captured, as this was not expected to be a major part of diet, however future studies could include this as part of photovoice by capturing the pictures of the food eaten outside home by themselves, family members or teachers. Socio-economic status also contributes to eating outside home and other consumption behavior, which needs to be captured in future studies.

Conclusion

The findings of this study reflects the importance of participatory and innovative approaches to nutrition interventions that aim to bring about social and behavior change in farming practices and consumption. The participatory fun-filled training activities resulted in improving dietary diversity. The photovoice method used was effective in measuring the change in dietary diversity based on the interventions and compared with the control group. Also, the photovoice method created enthusiasm and interest among the participants, leading to a 100% engagement in capturing dietary intake. The qualitative feedback reaffirmed that the photovoice method could be an effective approach for nutrition training. While photovoice has been effective and accurate in several similar studies, to the best of our knowledge this study is the first time it was used as a tool for training, capturing dietary diversity and as a tool for encapsulating behavior change among the participants. The change in behavior was based on qualitative results, the learning process using pictures and group discussions that involved sharing thoughts that helped participants gain more awareness about the food that they are eating. Considering the current COVID 19 situation, this study will serve as a guide for research and developmental organizations globally to use photo-voice as an effective multipurpose tool in virtual mode by providing phones with cameras and a simple platform like Whatsapp for training virtually and sharing photos.

Note

1. In Kenya, the Smart Food Initiative is implemented by ICRISAT and a variety of partners: Egerton University, Kenya Agricultural and Livestock Research Organization (KALRO), County Departments of Agriculture and Health, Nairobi Technical Training Institute and Kenyan Kitchen.

Acknowledgments

This research was supported by USAID. The authors acknowledge Ms. Sitaraman Smitha, ICRISAT, for editing the manuscript.

Disclosure statement

The authors declare there is no conflict of interest.

Funding

This work was supported by the United States Agency for International Development.

ORCID

Catherine Mawia Mwema http://orcid.org/0000-0001-8015-5747
Seetha Anitha http://orcid.org/0000-0001-7393-5489
Murali Krishna Gumma http://orcid.org/0000-0002-3760-3935
Pranay Panjala http://orcid.org/0000-0002-2111-6550
Joanna Kane-Potaka http://orcid.org/0000-0002-9772-8545

References

Abma, T. A., and J. Schrijver. 2019. ‘Are we famous or something?’ Participatory health research with children using photovoice. *Educational Action Research* 28 (3):405–26. doi:10.1080/09650792.2019.1627229.

Amalraj, A., and A. Pius. 2015. Influence of oxalate, phytate, tannin, dietary fiber and cooking on calcium bioavailability of commonly consumed cereals and millets in India. *Cereal Chemistry* 92 (4):150311095247000. doi:10.1094/CCHEM-11-14-0225-R.

Anitha, S., M. Govindaraj, and J. Kane-Potaka. 2019. Balanced amino acid and higher micronutrients in millets complements legumes for improved human dietary nutrition. *Cereal Chemistry* 1–11. doi:10.1002/cche.10227.

Bulla, B., and T. Steelman. 2016. Farming through change: Using photovoice to explore climate change on small family farms. *Agroecology and Sustainable Food Systems* 40 (10):1106–32. doi:10.1080/21683565.2016.1225623.

Devesh, R., J. P. Kumar, and C. Raj. 2017. *Pulses for nutrition in India: Changing patterns from farm to fork: Synopsis*. Washington, DC: International Food Policy Research Institute (IFPRI). doi:10.2499/9780896292574.

District Health Information Software (DHIS) 2017. Ministry of Health. Accessed from https://hiskenya.org/dhis-web-commons/security/login.action

Epstein, I., B. Stevens, P. McKeever, and S. Baruchel. 2006. Photo Elicitation Interview (PEI): Using photos to elicit children's perspectives. *International Journal of Qualitative Methods* 5:1–9.

FAO, 2011. Guidelines for measuring household and individual dietary diversity (pp 1–60). Rome, Italy. http://www.fao.org/3/i1983e/i1983e.pdf

FAO/Government of Kenya. 2018. *Kenya Food Composition Tables*, 254. Nairobi. http://www.fao.org/3/I9120EN/i9120en.pdf

Finkelstein, J. L., S. Mehta, S. A. Udipi, P. S. Ghugre, S. V. Luna, M. J. Wenger, L. E. Przybyszewski, and J. D. Haas. 2015. A randomized trial of iron-biofortified pearl millet in school children in India. *The Journal of Nutrition* 145 (7):1576–81. doi:10.3945/jn.114.208009.

Galhena, D. H., R. Freed, and K. M. Maredia. 2013. Home gardens: A promising approach to enhance household food security and wellbeing. *Agriculture and Food Security* 2:8. doi:10.1186/2048-7010-2-8.

Gumma, M. K., K. Tummala, S. Dixit, F. Collivignarelli, F. Holecz, R. N. Kolli, and A. M. Whitbread. 2020. Crop type identification and spatial mapping using sentinel-2 satellite data with focus on field-level information. *Geocarto International* 1–17. doi:10.1080/10106049.2020.1805029.

Gumma, M. K., T. W. Tsusaka, I. Mohammed, G. Chavula, N. Ganga rao, P. Okori, C. O. Ojiewo, R. Varshney, M. Siambi, and A. Whitebread. 2019. Monitoring changes in the cultivation of pigeonpea and groundnut in Malawi using time series satellite imagery for sustainable food systems. *Remote Sensing* 11:1475. doi:10.3390/rs11121475.

Gumma, M. L., M. Kadiyala, P. Panjala, S. S. Ray, V. R. Akuraju, S. Dubey, A. P. Smith, R. Das, and A. M. Whitbread. 2021. Assimilation of remote sensing data into crop growth model for yield estimation: A case study from India. *Journal of the Indian Society of Remote Sensing* 1–14. doi:10.1007/s12524-021-01341-6.

Kenya DHS. 2014. Kenya National Bureau of Statistics, Ministry of Health/ Kenya,National AIDS Control Council/ Kenya,Kenya Medical Research Institute, National Council for Population and Development/ Kenya,and ICF International (2015). https://www.dhsprogram.com/publications/publication-fr308-dhs-final-reports.cfm

KNBS, 2015. Kenya National Beuro of Statistics. Available online at www.knbs.or.ke

Legwegoh, A. F., and A. J. Hovorka. 2013. Assessing food insecurity in Botswana: The case of Gaborone. *Development in Practice* 23 (3):346–58. doi:10.1080/09614524.2013.781128.

Longvah, T., R. Ananthan, K. Bhaskarachary, and K. Venkaiah 2017. Indian food composition table. Hyderabad, India: National Institute of Nutrition, 578. District Health Information Software (DHIS2). Ministry of Health. https://hiskenya.org/dhis-web-commons/security/login.action

Muthini, D., J. Nzuma, and R. Nyikal. 2020. Farm production diversity and its association with dietary diversity in Kenya. *Food Security* 1107–20. doi:10.1007/s12571-020-01030-1.

Nishida, C., R. Uauy, S. Kumanyika, and P. Shetty. 2004. The joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: Process, product and policy implications. *Public Health Nutrition* 7(1A):245–50. PMID: 14972063. doi:10.1079/phn2003592.

Osei, A., P. Pandey, and J. Nilesen. 2017. Combining home garden, poultry, and nutrition education program targeted to families with young children improved anemia among children and anemia and underweight among nonpregnant women in Nepal. *Food and Nutrition* 38 (1):49–64. doi:10.1177/0379572116676427.

Pradhan, A., S. K. Nag, and S. K. Patil. 2010. Dietary management of finger millet (*Eleusine coracana Gaerth*) controls diabetes. *Current Science* 25:62–65.

Reinbott, A., and I. Jordan. 2016. Determinants of child malnutrition and infant and young child feeding approaches in Cambodia. Nutrition transition and nutritional deficiencies in low-income countries. In *Hidden hunger. Malnutrition and the first 1,000 days of life: Causes, consequences and solutions. World Review of Nutrition Dietetics*, eds. H. K. Biesalski and R. E. Black, Vol. 115, 61–67. Basel: Karger. doi:10.1159/000444609.

Saxena, R., S. K. Vanga, J. Wang, V. Orsat, and R. Vijaya. 2018. Millets for food security in the context of climate change: A review. *Sustainability*. doi:10.3390/su10072228.

Signorelli, S., C. Azzarri, and C. Roberts. 2016. Malnutrition and climate patterns in the ASALs of Kenya: A resilience analysis based on a pseudo-panel dataset. Technical Report Series No. 2: Strengthening the Evidence Base for Resilience in the Horn of Africa. https://www.ifpri.org/publication/malnutrition-and-climate-patterns-asals-kenya-resilience-analysis-based-pseudo-panel .

Sopcak, N., M. Mayan, and B. J. Skrypnek. 2015. Engaging young fathers in research through photo-interviewing. *The Qualitative Report* 20 (11):1871–80. http://nsuworks.nova.edu/tqr/vol20/iss11/12 .

Spencer, R. A., J. D. McIsaac, M. Stewart, S. Brushett, and F. L. Kirk. 2019. Food in focus: Youth exploring food in schools using photovoice. *Journal of Nutrition Education and Behavior* 51 (8):1011–19. doi:10.1016/j.jneb.2019.05.599.

Wang, C. C. 2006. Youth participation in photovoice as a strategy for community change. *Journal of Community Practice* 14:147–61. doi:10.1300/J125v14n01_09.

Wang, C. C., and C. A. Pies. 2004. Family, maternal, and child health through photovoice. *Maternal Child Health* 8:95–102. doi:10.1023/B:MACI.0000025732.32293.4f.

WHO. 2010. Indicators for assessing infant and young child feeding practices part 2. iycf-indicators-measurement_who_part2_eng.pdf (wordpress.com)