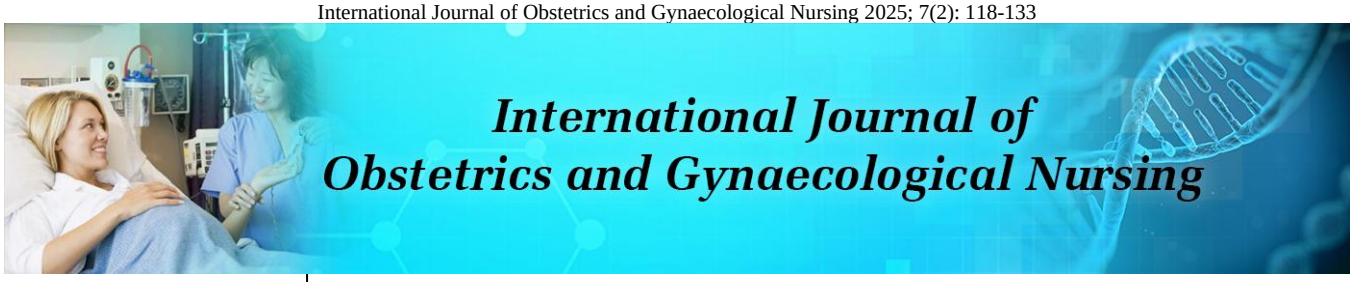

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Fostering behavioral change in maternal practices through nutrition and infant feeding education programs in rural Uganda

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Abstract
Achieving behavioral changes in essential maternal health and feeding practices requires continuous nutrition and health education. Our case study focused on the nutrition and infant feeding education programs of the Center for Sustainable Rural Livelihoods based at Iowa State University in the United States, which implemented the programs in Uganda through the Iowa State University Uganda Program based in Kamuli district. The program enhances the knowledge of communities through nutrition education to understand the root cause of malnutrition and how using food can manage the problem. Additionally, through reproductive and maternal health education, the program enhances community knowledge to influence behavioral change in related practices for the well-being of the mothers and their children. We compared the changes in maternal and infant feeding practices between trained and non-trained households. We surveyed 454 households, of whom 54.6% participated in nutrition and infant feeding education programs. All participations in training were high in the third quartile. However, most households participated in training on complementary feeding, balanced diet, breastfeeding, but low in malnutrition clinical signs and gender-based violence. We also assessed the mothers' antenatal clinic visit practices on the last four children born. Trained mothers of the youngest child, for instance, were 65.1% associated with attending at least four antenatal clinic visits, than 45.6% of the non-trained who attended at least four antenatal clinic visits. There was a positive behavioral change toward attending at least four antenatal clinic visits among trained mothers, but there was a negative trend among non-trained mothers. In the birthplace, we consider hospitals and health centers as *safe* places; homebirth with a nurse and traditional birth attenders as *risky*; and homebirth with relatives and friends as *extremely risky*. Overall, most mothers (83.0%) went to *safe* places; however, mothers consistently gave birth at home as the number of children increased. On exclusive breastfeeding for the first six months, non-trained mothers significantly (86.0%) breastfed than the trained mothers (76.9%). Most importantly, there was a positive behavioral change trend towards exclusive breastfeeding among trained mothers who were in the malnutrition rehabilitation programs. Household factors that influenced participation in the training included age, years lived in the community, membership of social groups, spatial location, household size, and mothers' education. We recommend more partnerships in monitoring the mothers' practices between program community extensionists and the government village health trainers. The growing vice of birthing from home denies the mothers' postnatal care valuable for their health in such limited resource communities. More mobilization for training participants is needed for the community to tap into this knowledge resource offered by the programs in partnership with the government and other stakeholders.

Keywords: Antenatal clinic visits, child birthplace, exclusive breastfeeding, gynecological functions, gender-based violence, maternal practices, nutrition and infant feeding, nutrition education, obstetric functions

Introduction
Investments in nutrition and infant feeding education programs are pathways to improving maternal practices of mothers. [1-4] Different government ministries are involved in the design of nutrition education programs and curriculum; however, they pass on the information in different ways, as accustomed to their operationalization, such as health promotion, behavioral change, infant feeding, school feeding, among others. [5]
Across the globe, policies to tackle the challenge of nutritional insecurity are present. However, an earlier meta-analysis of food and nutrition policies drafted for Nigeria in 2001, Uganda in 2003, Bangladesh in 2006, Malawi in 2009, and both Brazil and Costa Rica in 2011 found that most foundational nutritional policies had gaps related to the nutritional

education component. [5] Another challenge identified in those policies was the lack of a distinction between nutrition and nutritional education [5]. These terms were used interchangeably, yet they do not exactly mean the same [5-6]. Alvarez [5], for instance, provided an example of how Brazil and Kenya incorporated school meals, even though school meals do not necessarily mean nutrition education. These meals are considered sources of food; however, a curriculum must contain a learning component.

Different target groups, such as mothers, children, and students, need different nutrition and feeding education intervention programs, as do the line ministries and message layouts in different styles. For instance, the health ministry can use terminologies, such as infant feeding, maternity, and antenatal practices [4, 7-9]; the gender ministry can use gender-based violence in nutrition [10-12]; the education ministry can adopt school feeding [13-17]; and justice with terms like food as a human right. [18]

The design of the nutrition education curriculum must be congruent with the target population. This congruence influences the delivery methods for effective learning and implementation of learned lessons. Additionally, adherence to the standards and training of the nutrition education extension staff is required. The effectiveness of passing the message needs competent nutrition and health extensionists [6].

Nankumbi [4], for instance, found inconsistent information in maternal practices as a challenge in public hospitals in Uganda. Such situations support the need for professional development programs to equip nutrition and health service providers with the current knowledge and trends in their sector. [19] This form of empowerment improves the delivery of congruent information for effective learning of nutrition and health practices and provides them with the resources to facilitate their training.

Education is a long-term investment, as is nutrition education and the need for competent community nutrition and health extension professionals. [20] The main element in nutrition education is to make it a continuous form of learning to instigate behavioral change within the communities. Because of changes in demographic characteristics of households, it is necessary to have continuous education.

Different experimental studies [21-22] have revealed positive results associated with nutrition education; however, these were short-term experimental programs. For instance, a mother who is pregnant in January requires different training than when her baby is 10 months old. This scenario means nutrition and maternal education have to be stretched continuously to serve different purposes along the reproductive stages of mothers. [4]

Similarly, the obstetrical functions pregnancy health, antenatal, and childbirth; and gynecological functions reproductive health differ by the mothers' state, and the training has to be continuous [4, 7-9, 23-26]. The government of Uganda has, over the years, fostered public-private partnerships to improve the educational programs and structural functionality of the food and nutrition interventions [27-28].

Initiation of the Uganda Food and Nutrition Education and The Case Study

Uganda has a historical track of strategies for food and nutrition security since 1991. The country embarked on the drafting of a comprehensive roadmap named Uganda Food and Nutrition Policy that was completed in 2001, followed by its strategic plan and investment policy [27, 29-30].

The livelihood program of our study [31-34] is among the public-private partnerships that date back to the early 2000s, when Uganda drafted the food and nutrition strategic plans and sought support from stakeholders. The joint statement of the ministers reads: "We appeal to government ministries, local governments, national and international agencies, non-government organizations, and all other stakeholders, to work closely with the Ministry of Health and Ministry of Agriculture, Animal Industry and Fisheries, and the Uganda Food and Nutrition Council to implement the Uganda Food and Nutrition Policy" (p. v). [27]

Nutrition education programs were clearly stipulated in the nutrition policy [27] and its investment plan [30]. The intent was to create awareness and effect behavioral changes through the mobilization of communities to identify challenges and help them find solutions in food and nutrition areas.

Earlier attempts to pass on the nutrition education knowledge were through primary health care workers, teachers, and agricultural extension staff, among other stakeholders. However, these efforts were fruitless since there were fewer educators compared to the number of people they had to serve. This period ushered in the partnership between the sustainable livelihoods programs of Iowa State University and Uganda to foster human capital development towards food and nutrition security. [31-34]

The Iowa State University Livelihoods Programs in Uganda

In a tripartite partnership arrangement, Iowa State University (ISU) through the Center for Sustainable Rural Livelihoods (CSRL), implements a livelihoods program in Uganda through a registered not-for-profit non-governmental organization, Volunteer Efforts for Development Concerns, 2003-2014, and Iowa State University Uganda Program (ISU-UP), 2014 to date in partnership with Makerere University, located in Kampala. [32, 35].

The CSRL looked toward ending hunger through operationalization of extension models, including farmer-to-farmer extension approaches, 2004-2014 [36-38], and a comprehensive human capacity development, 2014 to date [32-33]. The human development approach, as illustrated in Figure 1, strengthens the capabilities of rural people to improve agricultural and natural resource management practices, build assets, diversify income sources, and achieve food security, good nutrition, and health. [39-42]

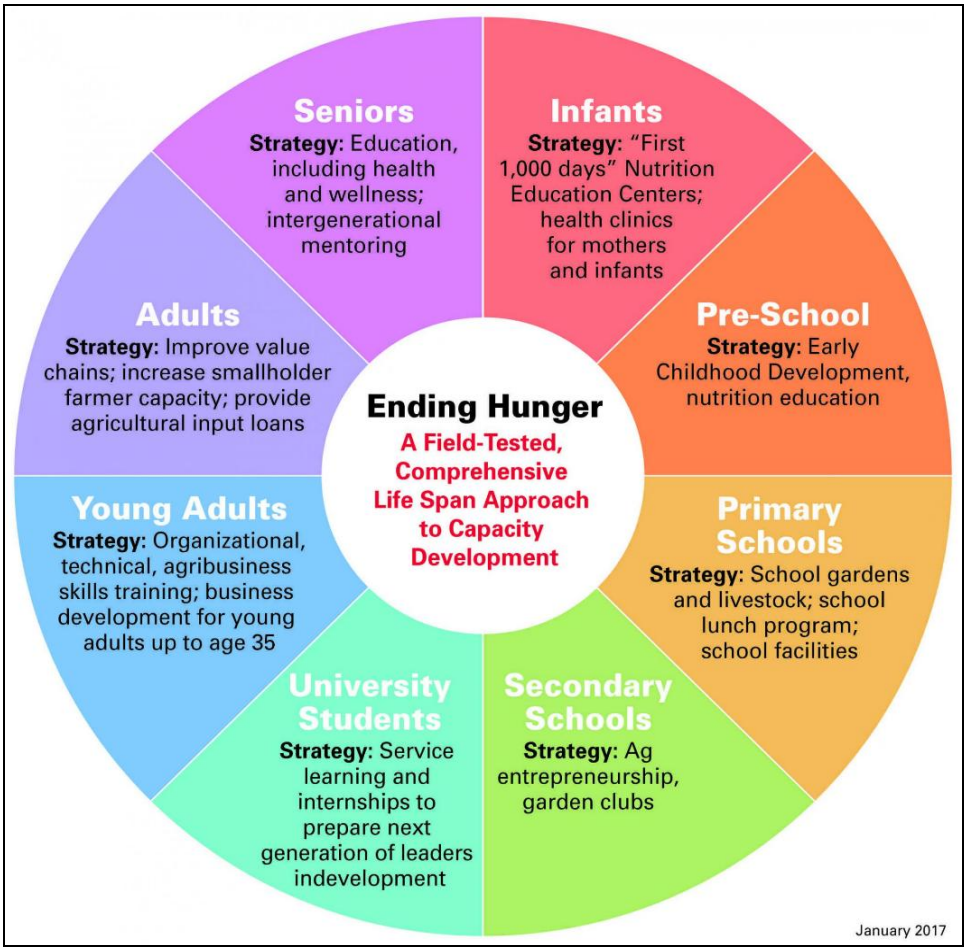


Fig 1: The CSRL/ISU-UP Human Capacity Development Model

The CSRL/ISU-UP's interrelated livelihood programs include agronomy, agroforestry, and postharvest [43], livestock health [44], youth entrepreneurship [33], food and nutrition security support groups and income innovations [33, 45], and water and public health [46]. In addition, the program builds the next generation of development experts through service-learning [16, 47-49].

This study focused on the nutrition and infant feeding educational program of the Nutrition Education Centers (NECs). [50-52] The NECs were initiated in 2010, seeking to reduce malnutrition levels through building the capacity of communities to improve nutrition and health-related behaviors, promoting access to and use of clean water and sanitation facilities, asset building through microfinance projects, as well as strengthening linkages with other partners, including the line ministries such as health and non-government organizations in maternal programs and service providers.

Purpose and Objectives of the Study

Because of the inaccessibility of nutrition education services, especially in rural communities, for instance, only women who visit government health facilities and a few private ones have access to maternal practice training. However, even within these trainings, some studies like Nankumbi [4] found nutrition education is allotted only a short time (i.e., 10-15 minutes of the 60-minute training session), which does not translate into effective learning.

This study, therefore, was carried out to investigate the effects of long-term training programs on key nutrition education themes during a 2014-2019 strategic plan evaluation. [32] We assessed the behavioral changes in antenatal clinic visits, birthplace, and exclusive breastfeeding for the first six months in comparison with the trained and non-trained mothers based on the four youngest children in the household. Six key objectives were sought:

1. Determine the state of household participation in nutrition and infant feeding education programs.
2. Assess knowledge comprehension and retention on nutrition and infant feeding education programs.
3. Identify the household characteristics perceived to influence their participation in the training and/or the maternal practices.
4. Examine the household antenatal clinic practices and compare to their participation in nutrition and infant feeding education programs.
5. Identify the household childbirth practices and compare to their participation in nutrition and infant feeding education programs.
6. Determine the household exclusive breastfeeding practices and compare to their participation in nutrition and infant feeding education programs.

Theoretical and Conceptual Frameworks of the Study

This study was grounded in the theory of planned behavior [53], which is among the learner-focused theories of motivation. The theory of planned behavior argues that when we plan to do something, we are driven by internal motives to do it. Our actions and behaviors are illustrated in three intentions/predictors of intentions: behavioral attitude, subjective norms, and perceived behavioral control.

Behavior attitude looks at how we think and feel about a behavior, for example, attending antenatal clinic visits, exclusive breastfeeding, giving birth in hospitals or at home, adopting balanced feeding practice, and prevention of gender-based violence. In the behavioral attitude are a) affective attitude belief about the attitude/behavior to be enjoyable or not, and b) instrumental attitude belief about the attitude/behavior, whether beneficial or harmful to practice.

Subjective norms relate to the support given significantly by others, such as family members and friends, during periods of need, for instance, accompaniment to antenatal clinic visits. [54-55] Subjective norms have a) injunctive norms that seek to understand whether others encourage you to practice the behavior, and b) descriptive norms that look at whether others in our social circles engage in the same behavior. [53]

In this study, subjective norms are critical, especially as they relate to the programs' community-based nutrition trainers who are seen as key influencers in behavioral change since most of them were once members of the NEC malnutrition rehabilitation homes. [50-52] These trainers are empowered to lead community transformation through managing the nutrition education centers where the training and associated services take place, focused on managing malnutrition.

Perceived behavioral control looks at feeling capable and confident of doing a behavior. One must have the capability and intention to overcome barriers and challenges, such as exposure to WASH-related diseases, such as malaria and diarrhea [46]; malnutrition among children and mothers [40], food insecurity [39, 42], and low dietary status [41] within this population of study and its neighborhoods. [56]

When all three intentions: behavioral attitude, subjective norms, and perceived behavioral control are fulfilled, we feel strong and more likely to engage in the behavior. [53] We are driven by a belief in our ability to succeed despite the daily challenges. This sense of self-efficacy induces performance on actions that can accomplish goals to achieve the desired behavior, such as practicing exclusive breastfeeding and tackling gender-based violence.

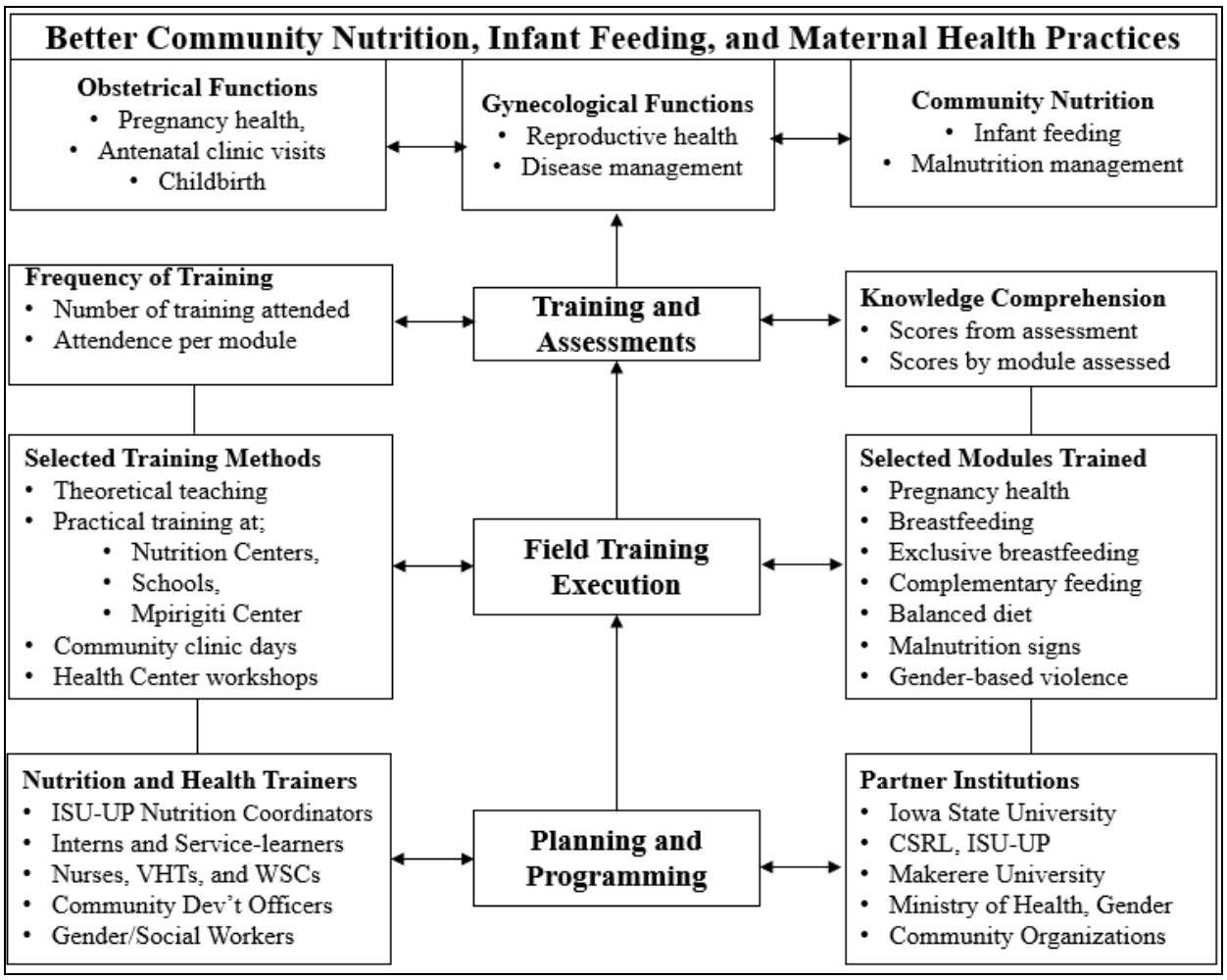


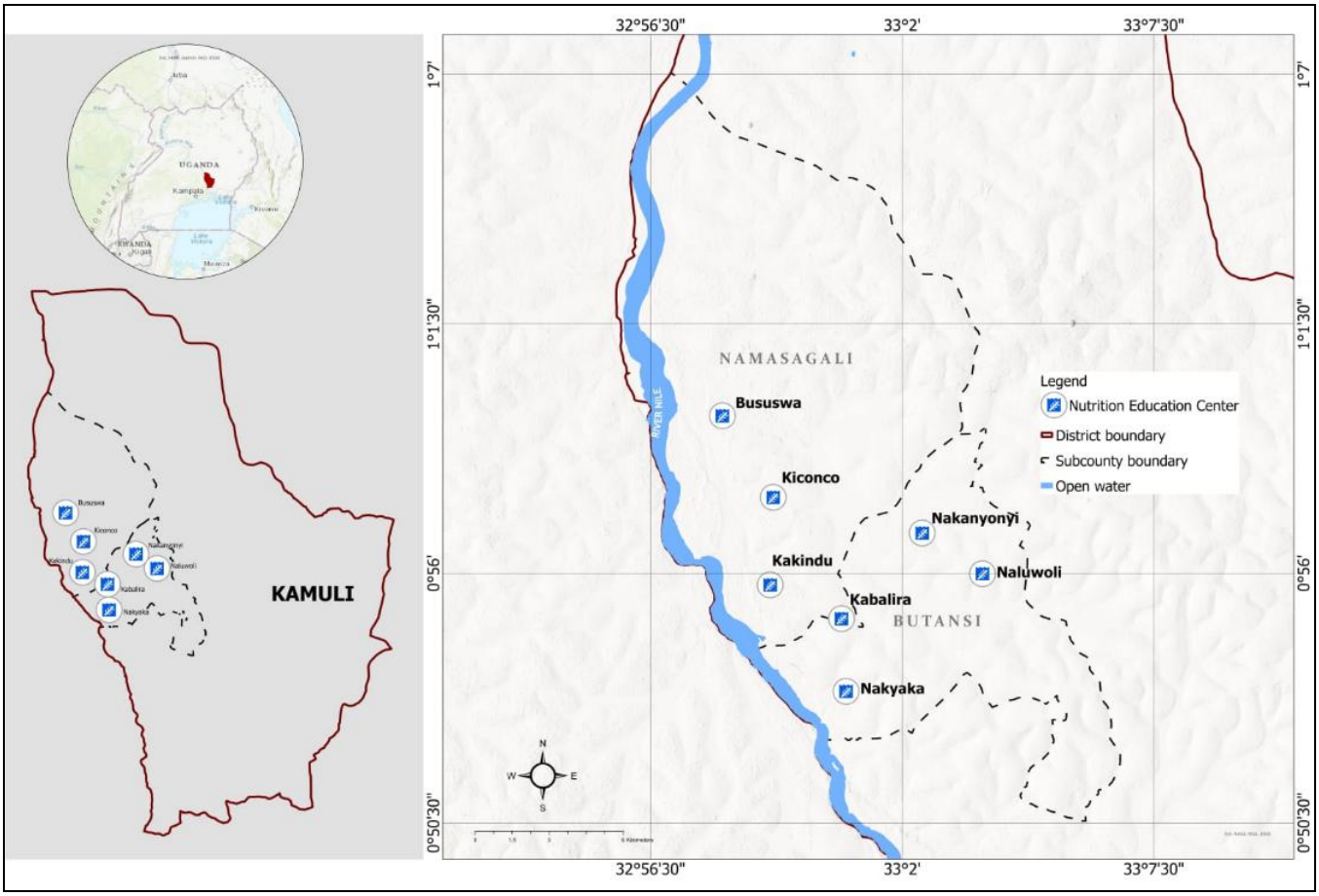
Fig 2: Nutrition and Infant Feeding Educational Conceptual Framework Designed for the Study

Abbreviations: CSRL Center for Sustainable Rural Livelihoods, ISU-UP Iowa State University Uganda Program, VHTs Village Health Trainers, WSCs Water and Sanitation Committees.

This theory of planned behavior ties into the nutrition and infant feeding education programs of the CSRL/ISU-UP, as illustrated in the conceptual framework (Figure 2). This framework explains the steps in building the education programs, starting with the initial steps of planning and programming. This phase involves both the nutrition staff of the CSRL/ISU-UP and collaborating institutions and organizations. After identification of key training themes, schedules are drafted and synchronized with the availability of members (p. 12). [50]

Methodology

This study was a cross-sectional survey carried out in Butansi and Namasagali Sub-Counties, Kamuli district, Uganda (Figure 3), where CSRL/ISU-UP implements livelihood programs emphasizing human capacity building towards food and nutrition security. [57] The target population was 1, 503 who were clients of the nutrition education centers (NEC) who had undergone consecutive training on several programs, including nutrition and infant feeding practices. [50] At a 95% and 5% significance level and a margin of error, respectively, a representative sample of 306 potential participants was established.



Author note: The map of the study area was generated using ArcGIS tools with administrative layers adopted from the Uganda Bureau of Statistics. [58]

Fig 3: Map of the Study Areas in Kamuli District, Uganda

The community-based NEC trainers helped the research team locate the program clients in the communities. We accessed and interviewed 248 (81.1%) households. Additionally, we surveyed a corresponding neighbor of a trained household in a quarter-mile radius for comparison. In this process, we accessed and interviewed an additional 206 non-trained households, giving a total of 454 households.

Data collection

Data were collected on household characteristics such as gender, marital status, age, years lived in the community, membership of social groups, sub-county, household size, and education of the household heads. The household characteristics were believed to influence their participation in nutrition and infant feeding education programs and subsequent practices.

Related to training, we collected data on the modules trained and the number of times each module was trained. The modules included breastfeeding, exclusive breastfeeding, malnutrition physical signs, gender-based violence, complementary feeding, and balanced diets. We also assessed knowledge comprehension with a set of six short response questions. These questions were set by the lead author with consultations from the program community nutritionists based on what they train in nutrition and the infant feeding education program. Relatively correct answers were agreed on as a team and used by the research assistants in scoring the responses.

On application of lessons learned, we collected data on the maternal practices, specifically the number of antenatal clinic visits by the mother on the last four children, starting with the youngest in descending order. We also collected data on the birthplace of those four children, such as hospitals, homes, among other places. On infant feeding practices, we collected data on exclusive breastfeeding practices.

Data analysis and interpretation

Analysis, interpretation, and presentation of results were done simultaneously for the different research objectives. Data on household characteristics, a bivariate analysis using chi-square was performed at 5% level of significance, but also 10%, provided by Menard [59], because of the high rate of categorization, which reduced the predictive power. Data were presented in tabular form with frequencies and

percentages.

Data on the number of training sessions was first analyzed as a dummy variable for "yes" or "no" on participation. The CSRL/ISU-UP program provides a training schedule on a monthly and weekly basis, depending on community needs (p. 12). [50] Secondly, attendance by modules was categorized into three: i) below average, as those who attended one module, ii) average, with 2-3 modules trained, and iii) above average, with 4-5 modules trained.

Thirdly, the number of times attended training was recorded per module as estimated by each respondent. Participants who said they trained for less than 10 training times were categorized as one (1), those within 10-20 training were in category two (2), and those with over 20 times were in cluster three (3).

The number of training times was translated into three clusters as fair to very good attendance. This study focused on five modules; therefore, the minimum attendance was one and the maximum was 15 (i.e., for a household in category three for all five modules). The final analysis was in three tiers: (1) fair for 1-5, (2) good for 6-10, and (3) very good for 11-15 training.

On knowledge comprehension, for every correct response to the question, one point was earned, generating a minimum of zero and a maximum of six points. We presented data as frequency and percentages in three tiers: (1) 0-2 points as below average, (2) 3 points as average, and (3) 4-6 points as above average. We then explored the mean comparison between the three groups with reference to the number of training sessions using ANOVA. We further explored which group exhibited the difference from the other using *Tukey's post hoc* analysis.

Maternal practices

On maternal health practices, including antenatal clinic visits, birthplace, and exclusive breastfeeding on each of the four youngest children, we employed a Chi-square test. We sought to determine the likelihood of good practices either associated with the trained or non-trained at a 5% significance and a less conservative 10% significance. We presented data as percentages.

With antenatal clinic visits, we sorted the mothers into three categories, with the preferred as those who attended at least four antenatal clinic visits for each of the four children as recommended by the obstetricians and gynecologists [23, 25]. The other two categories were those of less than four antenatal clinic visits and those who did not respond because they were not the actual mothers of the babies, and/or could not recall.

Similarly, we categorized birthplaces into three clusters. We considered hospitals and/or health centers as *safe* places; homebirth with a nurse and/or traditional birth attenders as *risky*; and homebirth with relatives and/or friends as *extremely risky*. On exclusive breastfeeding, we categorized mothers into two i.e., those who exclusively breastfed for the first six months as desirable, and those who did not.

Results

Participation in Nutrition and Infant Feeding Education

Overall, 54.6% (*n*=248) of households participated in nutrition and infant feeding education (Table 1). By model, participation in complementary feeding and balanced diet, and breastfeeding were the highest and lowest in gender-based violence. At least 88.3% of households were trained in 4-5 models, and 84.7% attended at least 11-15 rounds of training.

Table 1: Household participation in nutrition and infant feeding education

Variable	Indicator and Measure	Frequency	Percentage
Modules	Importance of breastfeeding	235	94.8
	Exclusive breastfeeding	228	91.9
	Complementary feeding and a balanced diet	238	96.0
	Malnutrition clinical signs	215	86.7
	Gender-based violence	211	85.1
Modules trained	Above average (4-5 modules)	219	88.3
	Average (2-3 modules)	20	08.1
	Below average (1 module)	11	04.4
Training attendance	Very good (11-15 training)	210	84.7
	Good (5-10 training)	23	09.3
	Fair (1-5 training)	15	06.0
Knowledge assessment questions	How soon after birth should a newborn baby be put on the breast?	248	100
	For how long should a baby be exclusively breastfed?	155	62.5
	What are the three food groups based on their roles in our bodies?	151	60.9
	Name some of the foods that give us energy	241	97.2
	Give an example of a balanced meal by listing all the foods that can be served together for a meal to be balanced	243	98.0
	What are the ingredients in porridge taken at nutrition education centers?	236	95.2
Knowledge assessment	Above average (4-6 points)	235	94.8
	Average (3 points)	12	04.8
	Below average (1-2 points)	01	00.4

On measuring knowledge comprehension, we established a relationship between the number of times trained and the type of module trained, to knowledge retention and application of learned lessons. We established significant differences (ANOVA, *p*=000) in knowledge comprehension by means and standard deviations.

As expected, households with participants who had more attendance (i.e., 11-15 times) significantly (ANOVA, *p*=000) had higher scores ($5.17^{b} \pm 0.84^{b}$) compared to those who trained for 1-5 times ($4.33^{a} \pm 0.62$). However, mean

scores of those who attended 5-10 times (4.61[a, b] ± 1.23) were not significantly different from the former group and the latter.

Household Characteristics Influencing Participation in Training and Behavioral Change in Maternal and Feeding Practices

Characteristics of the household head and the household itself, in general, have different effects on influencing members to attend the nutrition education training programs in the community, as well as the expectant and breastfeeding mothers' maternal and infant feeding practices. These can be supportive or otherwise.

Table 2 shows the association between the different characteristics in relation to training participation in nutrition education programs. From our results, the statistically significant characteristics included age, years lived in the community, membership of social groups, subcounty, and the average size of the household.

Table 2: Household characteristics influencing participation in nutrition and infant feeding education

Characteristics	Variable indictors	Not trained (*n*=206)	Trained (*n*=248)	Total (*n*=454)	χ^2
Gender	Female	19.9	16.1	17.8	0.178
	Male	80.1	83.9	82.2	
Marital status	Not Married	16.0	11.7	13.7	0.115
	Married	84.0	88.3	86.3	
Age	18-35 years	40.3	46.0	43.4	0.000
	36-59 years	41.7	48.8	45.6	
	60+ years	18.0	5.2	11.0	
Years lived in community	Utmost 10 years	45.6	55.2	50.9	0.026
	Over 10 years	54.4	44.8	49.1	
Membership of any social group	Non-member	31.6	0.0	14.3	0.000
	Member	68.4	100.0	85.7	
Sub-county	Butansi	52.9	61.3	57.5	0.044
	Namasagali	47.1	38.7	42.5	
Average household size	At least 6 members	29.6	36.3	33.3	0.080
	Less than 6 members	70.4	63.7	66.7	
Education	Primary level	66.5	69.0	67.8	0.324
	Post primary	33.5	31.0	32.2	

Maternal Practices on the Latest Four Children

We also traced the antenatal clinic visits for expectant mothers, by birthplace, and infant feeding practices of the last four children born to the same mother.

Antenatal clinic visits for expectant mothers

Our findings established promising results for the youngest child, where 65.1% of the program trainees were more likely to go for antenatal clinic visits at least four times, as compared to 45.6% of non-trained mothers (Table 3). Similarly, the trend of antenatal clinic visits was established as declining drastically for non-trained mothers over the past four babies, as well as the overall total. However, for trained mothers, the trend started high with the fourth child at 69.1% and reduced on the third to 62.4% but has kept on rising since then.

Table 3: Antenatal clinic visits for the last four children among mothers

Child rank	Variable Indictors	Not Trained (%)	Trained (%)	Total (%)	χ^2
First Youngest	Indictors	No (*n*=182)	Yes (*n*=238)	Total (*n*=420)	0.000
	Less than 4 visits	29.1	28.2	28.6	
	At least 4 visits	45.6	65.1	56.7	
	No response*	25.3	6.7	14.8	
Second Youngest	Indicators	No (*n*=153)	Yes (*n*=210)	Total (*n*=363)	0.200
	Less than 4 visits	25.5	21.0	22.9	
	At least 4 visits	55.6	64.8	60.9	
	No response*	19.0	14.3	16.3	
Third Youngest	Indicators	No (*n*=125)	Yes (*n*=170)	Total (*n*=295)	0.793
	Less than 4 visits	21.6	23.5	22.7	
	At least 4 visits	61.6	62.4	62.0	
	No response*	16.8	14.1	15.3	
Fourth Youngest	Indicators	No (*n*=100)	Yes (*n*=139)	Total (*n*=239)	0.125
	Less than 4 visits	28.0	18.0	22.2	
	At least 4 visits	64.0	69.1	66.9	
	No response*	8.0	12.9	10.9	

***No response:** Caretakers like grandmothers, aunties, and/or mothers who could not recall.

Birthplace of expectant mothers

We categorized birthplace in three clusters: cluster 1) as *safe*, which includes hospitals and/or health centers with the help of a skilled attendant; cluster 2) as *risky*, including birth at home with the help of a professional nurse and/or community traditional birth attendant; and cluster 3)

extremely risky, as birth at home with a relative and/or friend. We did not establish any statistically significant association between birthplace and training in nutrition and infant feeding education (Table 4). All clients across the first four children in the home were between 83.0 to 90.0 percent at birthplaces were considered safe.

However, among the risky categories, across all four babies, our results established that mothers have consistently given birth at home with the help of relatives. This unhealthy maternal practice depicts an increasing trajectory among all mothers from the second youngest baby to the current one. Despite the lack of statistical significance, the CSRL/ISU-UP trained mothers had the highest birth rates from risky places with the fourth child, and the trend had consistently been low compared to the overall and the non-trained.

Table 4: Child birthplace for the last four children among mothers

Child Rank	Indictors	Not Trained (%)	Trained (%)	Total (%)	χ^2
First Youngest	Indictors	No (*n*=182)	Yes (*n*=238)	Total (*n*=420)	0.143
	Safe	83.0	87.8	85.7	
	Risky	8.2	3.8	5.7	
	Extremely risky	8.8	8.4	8.6	
Second Youngest	Indicators	No (*n*=153)	Yes (*n*=210)	Total (*n*=363)	0.752
	Safe	86.9	89.5	88.4	
	Risky	5.2	3.8	4.4	
	Extremely risky	7.8	6.7	7.2	
Third Youngest	Indicators	No (*n*=125)	Yes (*n*=170)	Total (*n*=295)	0.146
	Safe	84.8	90.0	87.8	
	Risky	8.0	2.9	5.1	
	Extremely risky	7.2	7.1	7.1	
Fourth Youngest	Indicators	No (*n*=100)	Yes (*n*=139)	Total (*n*=239)	0.277
	Safe	89.0	87.8	88.3	
	Risky	5.0	2.2	3.3	
	Extremely risky	6.0	10.1	8.4	

One of the major factors that accounted for mothers producing from safe places was age. Most of the mothers were young, with an average of 18.94 years at first birth, a minimum of 12 years. Our findings significantly established (χ^2=9.035, df=2, *p*=0.001) that 73.9% of the mothers below 30 years were more likely to give birth in hospitals and health centers. However, over the past four births, between 11.7 and 14.3 percent of the fourth and first youngest, respectively, mothers gave birth at home.

Equally, antenatal clinic visits have an influence on other maternity practices, including birthplace. In this study, using the youngest child, we established a significant association (χ^2=13.291, df=4, p=0.010) where 88.6% of mothers who had at least four antenatal clinic visits were more likely to give birth in safe places, including hospitals and health centers.

Infant feeding practices of mothers

We established a significant association with the youngest child between participation in nutrition and infant feeding education and breastfeeding among the mothers (Table 5). Non-trained mothers were 86.0% more likely to breastfeed their infants exclusively for the first six months than 76.9% trained mothers. Although the second and third children did not show statistical significance, their association still showed that the non-trained had higher percentages. In general, there was an improvement in the overall rate of exclusive breastfeeding from the third to the first youngest child.

Table 5: Exclusive breastfeeding practices for infants 0-6 months of age

Child Rank	Indicator	Not Trained (%)	Trained (%)	Total (%)	χ^2
First Youngest	Indicator	No (*n*=143)	Yes (*n*=221)	Total (*n*=364)	0.021
	Not exclusive	14.0	23.1	19.5	
	Excl. breastfed	86.0	76.9	80.5	
Second Youngest	Indicators	No (*n*=67)	Yes (*n*=131)	Total (*n*=198)	0.275
	Not exclusive	22.4	27.5	25.8	
	Excl. breastfed	77.6	72.5	74.2	
Third Youngest	Indicator	No (*n*=11)	Yes (*n*=30)	Total (*n*=41)	0.595
	Not exclusive	27.3	30.0	29.3	
	Excl. breastfed	72.7	70.0	70.7	

Author's note: The fourth youngest children are not included because of few numbers.

We established that antenatal clinic visits had a significant influence on exclusive feeding practice for the youngest child. The mothers (82.7%) who visited at least four times were likely to exclusively breastfeed for six months than 82.1 and 66.0 percent who visited less than four times and those who did not respond, respectively.

Discussion

Participation in Nutrition and Infant Feeding Education

Participation in training programs ranked high and was all

within the fourth quantile. By module, balanced diet/complementary feeding had the highest attendance. Most of the trainings are conducted at the nutrition education centers (NECs), which are rehabilitation homes for at-risk-for-malnutrition children and women of reproductive age. [50-52] Community health issues related to kwashiorkor prolonged protein deficiency and marasmus prolonged protein-energy deficiency are feeding-related [60-61], and most of the patients are referred to the NECs for malnutrition rehabilitation. [50-52]

Similarly, intermittently during training at the NEC, cooking demonstrations are done where food is cooked and served to the trainees in the learning process. [50] This practice, too, could have been an enticement to attend in large numbers to have a piece of the program's prepared meal. Higher attendance could also be attributed to the fact that all primary caretakers of infants and children are required to attend the feeding training to learn why their children or themselves are malnourished or at-risk-for-malnutrition and how to prevent it further.

Nutrition education programs are key to achieving food and nutrition security. Evidence from northern Uganda, Rohlig [22], performed a nutrition education intervention for infants, children, and family nutrition between June 2016 and June 2017. Results showed that a long spell of food insecurity among households was offset by the intervention and recommended a long-term program.

In our study, the long-term (2014-2018) lessons learned from complementary and balanced diets are useful for mothers to move away from the traditional cooking style to a more calculated meal, as well as apportioning the amounts given to their children by age. [62] This practice is the gist of the nutrition and infant feeding program. Once lessons are put into practice, households can have better ways of dealing with food production and nutrition-related diseases that are mostly covered in the malnutrition clinical signs theme.

The main nutritional-related diseases among children are kwashiorkor and marasmus, which gravely result in severe skin disease complications. [63] Most malnourished children in the community are referred to the NECs by community stakeholders, including local council leaders, NEC mothers, and nurses, among other stakeholders, for rehabilitation. [50-52]

During our study, we comparatively traced the signs of malnutrition, specifically the youngest child in the households surveyed. We compared the results between the NEC household and non-NEC households and found that most children with malnutrition signs were already at the NEC under rehabilitation. These results confirm the findings of Ikendi *et al*. [40] within this population, which indicated a high proportion of malnourished children and mothers at the NECs under rehabilitation. Our results are reflected in Figure 4.

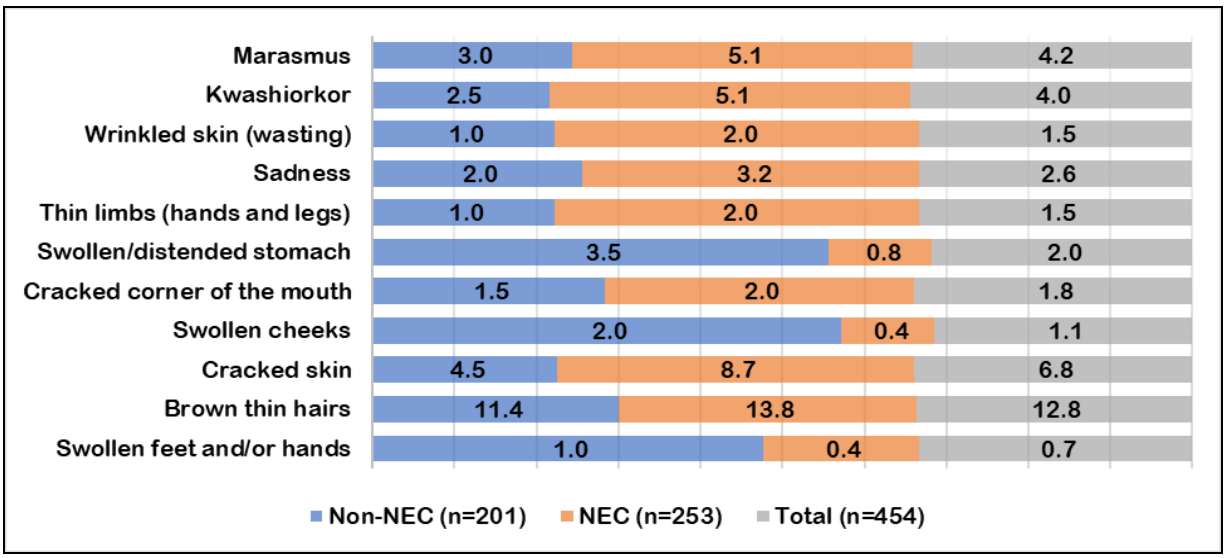


Fig 4: Malnutrition signs by percentage for the youngest child in the household

All children under the non-NEC category require attention to manage their malnutrition status. Mothers at the NEC through the nutrition and infant feeding program learn how to identify the clinical signs of malnutrition and are empowered to be change agents in their communities, especially as community-based NEC trainers. [32, 50]

The above kind of empowerment is the goal of the theory of planned behavior, especially as it relates to the concept of subjective norms with injunctive norms seeking to understand whether other members in the social circle encourage their peers to practice the behavior, and descriptive norms looking at whether others in our social circles engage in the same behavior. [53] Using mothers who are former enrollees of the NECs as community-based trainers increases the odds of influencing their fellow mothers into adopting recommended maternal practices.

The last theme of emphasis in nutrition and infant feeding is gender-based violence. This theme had 85.1% attendance and was the lowest among the modules. Gender-based violence was identified as a key component that influences household nutrition and health. Gender-based violence, along with sexual violence inflicted among couples, especially women [64], is a precursor of malnutrition for children due to deprivation of child care and welfare [10-12].

Maintaining a strong bond between household members is a key component of a strong food system since members traditionally coalesce around food to build family bonds. [65] Fathers are strong pillars in household food, nutrition, and health interventions. [66-67] In a different study in this sample, fathers were mentioned as key people to rely on during food scarcity periods. [41]

Household Characteristics Influencing Participation in Nutrition Education

Household characteristics have an influence on attendance at training and practice of maternal and infant feeding practices. In this study, on the number of years lived in the community, those who had lived in the community for less than 10 years were more likely to participate in the training. Since the CSRL program was established in 2004, the first malnutrition rehabilitation center was set up in 2010. [50-52] By 2014, the program embarked on a comprehensive human capacity building model. [32-33]

Since this study was conducted in 2018, assessing the 2014-2018 cycle, the community members must have taken advantage of these near-reach education services. [50] Similarly, the vicinity of the training centers within the Butansi sub-county than Namasagali sub-county (see Figure 3) can partly explain the association of households in the former sub-county who significantly attended the training than in the latter. Other studies in this sample also found that households in Butansi sub-county were more likely to participate in other education programs, such as agronomy and postharvest programs [43], livestock [44], public health [46], and food safety [68-69] than households in Namasagali sub-county. Moreover, households in Butansi sub-county were also more food secure [39], with better diets [41], and nutritionally healthier mothers and children [40].

Another characteristic, membership in community social groups, influenced participation in nutrition education training. Social groups present some form of social capital, a sense of belonging, and togetherness, hence tending to do the same activity of value to their livelihoods. Social capital has been proven as a strong food security coping strategy. [39, 41-42]. Members can give a hand to each other in times of difficulty, for instance, in burials, they cater for food supplies.

Relatedly, the average household size, with emphasis on those with at least six members, was more likely to participate in the nutrition education training. In maternal practice, more members in the household have an accompaniment element for the expectant mothers to attend antenatal clinic visits, if they are mature.

Research has shown that some mothers did not attend antenatal clinic visits because of a lack of accompaniment. [54-55] Since this study established a positive relationship between training and antenatal clinic visits, we can foresee that feeling of togetherness physiologically when mothers move together with family members.

Although the education of the household head did not influence participation, the mother's education significantly influenced participation. Most of the trainees are mothers; we established that mothers whose level of education was between 0-7 years of school were 79.0% more likely to attend the training than 69.8% of non-trainees.

Education/adult education influences productive decision-making processes on issues concerning household food and nutrition. [70-72] Education is important, especially in our study sample with early birthing at 12 years, with an average age of birthing for the first child at 18.94 years. [40]

Maternal Practices on the Latest Four Children

Proper nutrition education training involving obstetric pregnancy, antenatal, and childbirth; and gynecological reproductive health functions are important to their welfare, children, and the household [23, 25]. Antenatal care, child birthplace, and their associated assistance from nurses are indicators of good maternity practices that have long been emphasized by the government of Uganda. [73-74]

Antenatal visits for expectant mothers

Maternity practices, especially antenatal clinic visits, are very crucial to the survival of infants after birth. The minimum recommended number of times for an expectant mother to visit the clinic for a health checkup and other associated vaccinations is four [23, 25, 74]. This study established promising results for the youngest child, where 65.1% of the program trainees were more likely to go for antenatal clinic visits at least four times, as compared to 45.6% of non-trained mothers.

Most importantly, in addition to the program's community-based nutrition trainers, the health centers' nurses who collaborate with the program to teach mothers at the NECs are the same nurses these mothers find at birthplaces. [50-51] This approach to handling maternal education resonates with the theory of planned behavior, where mothers adopt and practice the good maternal practices taught by members of the community who are familiar to them. [53]

The program-trained clients had a higher rate, 65.1% of antenatal clinic visits. However, within the program operation area, the overall antenatal clinic visits were 56.7%. This rate was below the national average, at 73% between 2011-2016 and 68% between 2016-2022 (p. 128) [74], but higher than 52% established at the African level [54]

Similarly, the trend of antenatal clinic visits declined drastically for non-trained mothers over the past four babies, as well as the overall total. This trend is in the same direction as the national positive trajectory. [74] However, for trained mothers, the trend started high with the fourth child at 69.1% and reduced on the third to 62.4% but rose since then. The increasing percentage of at least four antenatal clinic visits by trained mothers reflects a change in behavior over time. This change of behavior can be linked to the overall goal of the CSRL/ISU-UP comprehensive human capacity building of the vulnerable communities in Kamuli, Uganda [32-33] and a reflection of the operationalization of the theory of planned behavior [53] towards good maternal practices.

Birthplace of expectant mothers

The birthplace determines exposure to the risks after birth, including loss of life due to excessive blood flow, transmission of diseases, including tetanus and HIV, and access to postnatal care. [74] We categorized birthplaces in three clusters: cluster one as *safe*, which includes hospitals and/or health centers; cluster two as *risky*, including birth at home with the help of a professional nurse and/or community traditional birth attendant; and cluster three as *extremely risky*, including birth at home with a relative and/or friend.

In the study, all clients across the first four children in the home were between 83.0 to 90.0 percent who were birth in safe places, such as hospitals and/or health centers, especially among the trained households. However, we established a negative trend overall of giving birth in health facilities from 88.4% for the youngest child to 85.7% for the first youngest child. This trend is in the opposite direction of the national trajectory, which was established as increasing from 77% in 2016 to 86% in 2022. [74]

However, among the risky categories, across all four babies,

our results established that mothers consistently gave birth at home with the help of relatives. The non-trained mothers had higher birth rates from *risky* places (17%) with the fourth child than trained others (12.2%), and overall of 14.3%. Comparatively, the national data shows delivery from home was 22% in 2016 and reduced to 13% in 2022. [74] In relation to the fourth youngest child, the overall rate was 11.7% which rose to 14.3%, a negative trajectory in relation to the national data. However, the trend for non-trained mothers was higher at 11 to 17 percent than a slight reduction among the trained mothers from 12.3% to 12.2% between the fourth youngest child and the first youngest child, a window that would be comparable to the time series data of national demographic surveys 2016 and 2022. [74]

Nevertheless, one of the major factors that accounted for mothers producing from safe places, i.e., hospitals and health centers, was age. Most mothers were young, with an average of 18.94 years at first birth and a minimum of 12 years. This teenage motherhood has implications for their nutritional health, specifically underweight [40, 75], and psychosocial health. [76]

Homebirth makes it difficult for mothers to access postnatal care [24]. Nationally, there has been an improvement in access to postnatal care within 24 hours from 54% in 2016 to 58% in 2022 for the youngest child born. [74] However, there were more postnatal care services in the urban than rural areas.

In the literature, the motives and reasons behind homebirth we identified include lack of finances to pay for hospital bills, traditional norms and culture, gender parity where women cannot make decisions, lack of accompaniment, and long-distance. [54-55, 74] Also, mothers' belief and conviction of how the birthing will go well, and their desire to control their birthing process. [55]

In 2019, the WHO [26] established that every day, an estimated 810 women die of pregnancy and childbirth, with 94% within low-income countries, and linked to a lack of access to health facilities. In Uganda, the 2022 demographic survey data indicated a high maternal mortality of 189 deaths and pregnancy-related mortality of 228 deaths per 100, 000 live births. [74] Expectant mothers are designated as high risk, especially in rural areas with challenges of inadequate medical supplies. [77]

Given the average age of mothers in Kamuli, established at 18.94 years with a minimum of 12 years, this age puts these mothers on high alert. Because of their compromised biological immunity, these teenage mothers are predisposed to maternal mortality, pregnancy, and childbirth complications [26, 40, 75]. Therefore, education of mothers on maternal health is one way to achieve the 70 per 100, 000 live births by 2030 as set in the Sustainable Development Goals [26].

Infant feeding practices of mothers

In this study, we focused on exclusive breastfeeding as one of the most important feeding practices that helps infants grow and develop resistance to diseases. [78-79] We established a significant association with the youngest child between participation in nutrition education training and breastfeeding among the mothers. Non-trained mothers were 86.0% more likely to breastfeed their infants exclusively for the first six months than 76.9% trained mothers. Although the second and third children did not show statistical significance, their association still showed that non-trained mothers had higher percentages.

In general, there was an improvement in the overall rate of exclusive breastfeeding from the third to the first youngest child. The probable explanation for the difference between trained and non-trained can be attributed to the kind of mothers that the program mostly trains. Most of the mothers who are enrolled at the NECs are at-risk for malnutrition and their children. [40, 50-52] These mothers are enrolled for rehabilitation from nutrition-related diseases, which are explained by the previous failure to adhere to proper maternal and infant feeding practices, and, among other factors, such as gender-based violence.

Most importantly, there were positive trends in exclusive breastfeeding practices. At least the first youngest being at least 76.9% higher than the national average at 75%. [73] This increase is a positive behavioral change towards proper feeding habits of infants for better growth and a reduction in the high incidences of malnutrition [40], a health issue that can impact future child development. [80]

In other studies, a lack of knowledge (57.1%) on exclusive breastfeeding accounted for 20.47% of mothers who reported having breastfed their children exclusively in Burao, Somalia [81], a call to scaling up nutrition and infant feeding education programs. [1, 2, 3, 4] Moreover, birthplace influences exclusive breastfeeding practices; for instance, in Debre Tabor, Ethiopia, 87.5% of mothers who gave birth at the hospital received counseling on exclusive breastfeeding [82]

Conclusions/Implications/Recommendations

Achieving behavioral changes in nutrition and infant feeding practices requires continuous education in a multifaceted approach in both the government and private sectors. We grounded this study in the theory of planned behavior, a learner-focused theory of motivation that predicts that our actions and behaviors are determined by three intentions: behavioral attitude, subjective norms, and perceived behavioral control.

The community-based education programs in this study had positive behavioral changes in nutrition and infant feeding, maternal, and reproductive health practices. This education is even more darlingly needed in such a period when mothers are going through physiological and psychological transformations during and after childbirth.

On the antenatal clinic visits, significantly, 65.1% of the program-trained mothers attended at least four visits than 45.6% of non-trained mothers. There was a positive behavioral change and a positive trajectory from the third youngest among trained mothers attending at least four antenatal clinic visits, to a negative trajectory established for non-trained mothers.

Mothers who attend less than four antenatal clinic visits need attention through mobilization and social networking with program participants to understand the different program offerings. [33] Once these members are mobilized and trained, they can influence other family members and friends to engage in good antenatal clinic visit practices. Studies have established that accompaniment with members in this physiological and psychological period of pregnancy increases the practices in maternal health. [54-55]

Similarly, with childbirth, whereas the overall percentages on all four children are over 83.0% of mothers giving birth in hospitals and/or health centers, the percentage of those opting for homebirth grew as the number of children

increased. Although we did not establish the motive behind homebirth in this study, we recommend a qualitative inquiry to establish the mothers' lived experiences and perceptions of homebirth. Results of such an inquiry can be a point of program planning to improve attendance at training and also influence behavioral change toward recommended maternal health, specifically childbirth.

Home birth by itself is extremely risky in cases where the mother fails to give birth naturally. It becomes difficult to find transportation to the main hospital and/or health center for specialized care, and likely to increase maternal mortality and transmission of diseases, including HIV/AIDs [83], tetanus, and after-birth disease like obstetric fistulas. [84]

Although we established a positive trajectory with exclusive breastfeeding among the trained mothers, the non-trained mothers had significantly higher rates throughout the three babies, i.e., 72.1% through 86.0% of the youngest child. While trained had 70 to 76.9 percent from the third to the first youngest, this trend can be related to the mothers' nutritional health status. [40] These revelations call for continued human capital development across the interrelated programs, especially to increase food production and promote health. [46]

Similarly, the fact that underweight mothers were associated with nutrition education centers in the study [40], this health condition would support exclusive breastfeeding. These are the same mothers under the malnutrition rehabilitation program [50-52]; therefore, a behavioral change has taken a positive trajectory and requires constant follow-up and monitoring. Most of them were teen mothers and spent less than seven years in formal education, and they need nutrition and infant feeding knowledge.

As we recommend continued education of the mothers, human capital empowerment of the community-based nutrition education trainers from the program, and the village health trainers on the side of the government [85] is vital. These trainers are fellow mothers and some fathers who live in the same community as the people they train. They too require continued refresher training programs to be updated with the latest trends in maternal health, feeding, and food production practices. These refresher trainings can help them gain more tactics to deal with adult learners, especially when it comes to influencing and monitoring the implementation of maternal practices.

The respective supervisors, including the community nutritionists and health center nurses, also require periodical professional development to improve their professional and teamwork skills [19], leading to successful planning and training of the trainers. These professional developments are important owing to the findings by Nankumbi [4], where nurses were giving inconsistent information on maternal practices. Professional development can be conducted in partnerships that already exist and need to be strengthened among the government ministries of health, gender, agriculture, education, and other related organizations in the maternal health field, like gender, to help with gender based violence issues.

This study has demonstrated that engaging mothers in nutrition and infant feeding education programs has a strong multiplier effect on behavioral change towards recommended practices. Specifically, the obstetrical functions pregnancy health, antenatal, and childbirth; and gynecological functions reproductive health critical to are critical to their welfare, children, and the household [4, 8-9, 23-25]. Moreover, these functions differ by stage of the mothers throughout their reproductive period.

Similarly, programs need to coax fathers to get involved in nutrition and maternal education programs. Fathers are key decision makers as household heads; their involvement in the training programs can ultimately result in better decision-making processes regarding nutrition and maternal practices. Moreover, they were specified as key players during lean periods to source food for their families. [41] Also, engage fathers in education programs related to gender-based violence to create awareness of the preventive measures that can lessen the efforts born to the children and mothers, and the households [10-12, 64].

Maintaining a strong bond between household members is a key component of a strong food system since members traditionally coalesce around food to build family bonds. [65] Fathers are strong pillars in household food, nutrition, and health interventions. [66-67] In a different study in this sample, fathers were mentioned as key people to rely on during food scarcity periods. [41]

Investments in the maternal educational programs ultimately contribute to Uganda's Vision 2040 of nurturing a healthy population. Fostering public-private partnerships will harness the ripple effects among stakeholders engaged in nutrition and maternal health programs amidst the global shifts in global funding priorities. [85-88]

Declaration by Authors

Author note

The first author's masters' graduate thesis (Ikendi, 2019) [57] formed the basis of this article.

Ethical Approval

Approval and oversight for the study was provided by the Institutional Review Board at Iowa State University under IRB Number: 18-356-1.

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Conflict of Interest

The authors declare no conflict of interest

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