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ASSOCIATIONS AMONG FOOD SECURITY, BMI, DIET DIVERSITY AND FOOD CONSUMPTION PATTERNS OF WOMEN IN RURAL KENYA

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ABSTRACT

Enhancing food security is one of the United Nations Sustainable Development Goals. Improved agricultural production is an approach to addressing food insecurity. However, these efforts can result in significant changes that are associated with increased risk of non-communicable chronic diseases. Previous research with women in Central Kenya found that the number of years a woman-farmer was engaged in dairy development was associated with greater food security and energy (kJ) intake. No studies have examined food security and the nutrition transition among rural farm women involved in dairy development initiatives. A cross-sectional survey was conducted in 2009 and again in 2017. Chain referral sampling was used in 2009 to recruit 111 women in five groups based on how long they had been a dairy group member (non-members and members from one to more than 10 years). In 2017, 20 women were randomly selected from 85 of the dairy-group member households surveyed in 2009 and a comparison group of 20 women was randomly selected from a list that was generated by referral from the participants. In person one-on-one interviews were conducted with a translator. Demographic, household food security, and dietary intake were collected in both years. In 2009 women's height and weight data were collected for BMI calculation. Associations among food security, BMI, dietary intake, and year of data collection were examined. Demographic characteristics were comparable between 2009 and 2017 and between food secure and food insecure households. In both years, the majority of households were categorized as not food insecure (67% and 75%; 2009 and 2017, respectively). In 2009 almost half the women (49.4%) had BMIs in the overweight and obese category. Food secure women had a significantly higher median BMI (26.5) compared with food insecure women (24.0). Diet diversity was low ($\leq$5) for all women and there was little evidence for a classic "western diet" of the nutrition transition. There was evidence of globalization in food availability and greater purchasing capacity that was demonstrated by the high proportion of women that consumed sugar, refined fats and oils, refined maize and wheat flours, and bread. Household food security was associated with the consumption of sugar, cabbage, wheat flour and bread. These findings support a unique rural nutrition transition, with food security, characterized by low dietary diversity, access to refined basic foods and high unhealthy BMI. Governments and non-governmental organizations need to support nutrition-sensitive agriculture and public health programs to curb the crisis of overweight, undernourishment and chronic diseases.

Key words: agriculture, nutrition transition, rural, farm, Kenya, women, BMI, diet diversity

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BACKGROUND

Enhancing food security is a key element of the United Nations Sustainable Development Goal of ending hunger [1]. Improved agricultural production is one approach to addressing food insecurity, poverty and malnutrition [2,3,4]. However, the role of agriculture with nutrition in Ethiopia, Kenya and Uganda was examined and the authors concluded that "we don't really know how income influences nutrition" or "what we actually eat" [5]. While rising income could result in more diverse and more balanced diets, it is also possible that less healthy foods may be chosen due to preference and cost [6]. Evidence for shifts with development in low- and middle-income countries include the nutrition transition, from a healthier traditional diet to a more 'Western diet' (high in fat, animal protein, sugar and energy and a low in plant foods), urbanization, sedentary lifestyle, and lower fertility and infectious disease rates [7,8,9]. As a result, rates of overweight and obesity (OWOB) have increased along with an increased risk of non-communicable chronic diseases (NCD) such as cardiovascular disease, type-2 diabetes, and some cancers [9]. This increased burden of malnutrition in all its forms has the potential to hinder development and productivity and increase the burden on health care [7,10,11].

The nutrition transition for urban populations is characterized by access to street foods, supermarkets and ultra-processed foods, which may have unhealthy nutritional profiles [8]. By contrast, a study with women in rural Tanzania found that a "purchase" dietary pattern, which was distinct from the 'Western diet', was positively associated with high BMI [12]. In a separate study in rural Tanzania, being household food secure was associated with more frequent intake of meat, eggs, fruits and vegetables [13]. A study in rural Botswana found that farm women had low diet diversity and high central obesity that presented an increased risk for metabolic complications [14].

Kenya has a population of about 40 million people, 80% of whom live in rural areas and almost half (46%) lives below the poverty line [15]. From 2008 to 2014 the proportion of underweight women in Kenya decreased from 12% to 9% [16]. Over this same period the proportion of women categorized as overweight and obese (OWOB; BMI$\geq$25.0) increased from 25% to 33%. There was a higher rate of OWOB in urban women (43.3%) compared to rural women (25.8%) [16].

Dairy farmers in Mukurwe-ini district, Central Kenya, were involved in market-oriented dairy-farm development with a community-based Dairy Group, a Canadian Non-Government Organization (Farmers Helping Farmers) and researchers from the University of Prince Edward Island, Canada. Researchers found that longer term dairy group membership was associated with greater household food security and dietary diversity but raised concerns that dairy development may have an unintended negative impact on women's BMI [17,18]. Strategies to reduce food insecurity can reduce the risk of malnutrition and associated health conditions in the longer term; however, there is a need to understand the issues and explore options that can reduce the impact of development on OWOB and NCD for women in Kenya [8,19]. Rising rates of diet-related NCDs have been attributed to the consumption of "Westernized" foods in sub-Saharan Africa [19]. However, no studies have examined the nutrition transition to

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"Westernized" foods with rural farm women involved in agricultural production improvement initiatives. As more than 80% of the Kenya's population lives in rural areas and there is increasing emphasis worldwide on enhancing agricultural production, and there is a need to better understand the impacts on food security, diet and health [1,19]. The objectives of this research study were to describe and examine associations of food security and weight status, dietary diversity (DD) and food consumption patterns of rural Kenyan farm women involved in dairy farm development between 2009 and 2017. The overall aim of the research is to elaborate on the role of food security on food, diet and health and add to the body of knowledge that aims to support policy and programs to promote good nutritional health in Kenya and other developing countries.

METHODS

Study area and subjects

This study was conducted with women in the Mukurwe-ini constituency of Nyeri County, Kenya, with majority being members of the Wakulima Dairy Group (WDG). Nyeri County is located 150 km north west of Nairobi, Kenya and had a population of 762,860, in 2015. In 2014, Mukurwe-ini constituency was roughly 17% of the county's total population [16]

Study Design

This cross- sectional survey was conducted first in 2009 and again in 2017. The 2009 survey was part of a larger study examining relationships between WDG membership duration, sustainable livelihood assets, and food and nutrition security [17,18]. The 2017 survey was part of larger study that examined long-term impacts of nutrition education on nutrition knowledge and practices and explored knowledge and attitudes of food and diet-related non-communicable diseases [20].

Sampling

In August 2009, a cross-sectional survey of 88 WDG member women, and a group of 22 non-member women was conducted. A sample size of 20 women from each of four WDG membership-duration groups (1-3 years, 4-6 years, 7-9 years and 10+ years) was established in advance by the researchers to generate data with reasonable power to conduct the study. Similarly, a sample of 20 non-member women was established. Ten percent oversampling per group was included in case of spoiled or missing data. There was no central list with the duration status or contact information for the dairy group members, and no reasonable efficient manner to establish such a database to allow a stratified random sample to be drawn. As a result, the study group members were identified using chain referral sampling which is often used to access 'hard to reach' populations [21,22]. Sampling is described in detail elsewhere [17]. Briefly, eight WDG members who represented a wide range of age, geographic distribution, and involvement within the dairy group were selected to initiate the referrals. Each of these members referred to women in their areas who represented the four membership duration groups until the targeted number of women in each group were recruited. Participating member women referred non-members and a list of non-members was generated. Random selection of eligible participants was utilized, as much as possible and practical. School

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teachers and directors and managers of WDG were excluded in order to focus the research on women with farming as their primary livelihood strategy.

For the 2017 survey, a sample consisting of 40 women was established in advance by the researchers and included 20 women that were previously involved in the research and 20 women who were not previously involved in order to create a comparison group. Twenty women were randomly selected from all women that had been surveyed in 2009 (informed consent included permission to re-contact). Women in the >10-year membership group were excluded due to their advanced age. A local research assistant/translator (RA) was hired to contact women using previously collected phone numbers. If an individual could not be reached, the next woman on the randomized list was contacted. This process was conducted until 20 women agreed to participate. To create a list of women that had not been previously involved in the research, each woman who agreed to participate was asked to forward the RA's contact information to several neighbour women. The neighbour women were asked to contact the RA if they were interested in participating in the survey. A list of interested women was created and 20 women were randomly selected for the survey.

Questionnaire design and administration

The survey included questions on household demographics, food insecurity and a 24-hour diet recall. Household food security was assessed using the "Household Food Insecurity Access (HFIA) Scale Version 3" [23]. The HFIA tool asks nine questions to find out about household experiences of anxiety and the need to reduce food quality and/or quantity due to food shortages or a lack of resources to buy food. If an individual responded yes to the experience, the frequency-of-occurrence was assessed as never, rare (one to two times), sometimes (three to 10 times), or often (more than 10 times). The HFIA questions were culturally adapted to include local examples for prompts, as recommended. A 24-hour diet recall was used to obtain information on all food and beverages consumed by an individual in the previous 24-hours using a four-pass method [24]. Prior to use, the questionnaire was revised after review by WDG management and pre-testing on three households.

The survey interview was conducted in person, using a translator, where needed. The person responsible for food preparation in the home, usually the mother, was interviewed alone (when possible) for food security and dietary recalls. In 2009, women were asked to be measured for height and weight in order to estimate each woman's BMI. These measures were not collected in 2017 as they were deemed unnecessarily intrusive.

Data handling and analysis

All data were coded and manually entered using Microsoft Excel. Descriptive statistics of demographic characteristics were computed for each year. Food security responses were tabulated according to standardized methods and used to describe the prevalence of households categorized as food secure, mildly food insecure, moderately food insecure, and severely food insecure [23]. A dichotomous 'food secure' variable was created to enable comparisons between groups of 'food secure' (secure and mild food insecurity) to 'not food secure' women (moderate and severe food insecurity).

Dietary recall data were used to create a DD score, using a 15 g cut-off [25] and to create a list of food and beverages consumed by the women. The proportion of women that consumed each food was computed for each year. The proportion of women that consumed food eaten by more than 10% of women (commonly consumed foods) was compared between years to determine if the food consumption pattern had changed significantly. Dietary diversity and the proportion of women that consumed each food and DD food group were examined for association with food security status.

Height and weight data (2009) were used to compute BMI (kg/m^2) for each individual and BMI values were used to assess associations of BMI with food security level and food security status. Individuals were categorized according to their BMI as underweight (<18.5), normal weight (18.5-24.9) and overweight (≥25). The proportion of women in each BMI category was examined for an association with food security status.

Significant associations among demographics, food consumption, BMI, year and food security status were assessed using aχ^2 test or Fisher's-exact test. Associations of food security status with diet diversity and BMI were assessed using t-test and Wilcoxon-Mann Whitney tests, respectively. Body Mass Index data were not normally distributed and no transformation resulted in normally distributed data. The association of BMI and food security level was examined using a Kruskall-Wallis test. A $p \leq 0.05$ was used to establish significance. STATA (Stata Corp. College Station, TX) statistical software was used for all statistical analyses.

Ethics approval was obtained through the UPEI Research Ethics Board and approval to conduct for this research was obtained from Farmers Helping Farmers and Wakulima Dairy Ltd before beginning the study. Researchers gained informed consent by reading the ethics statement to participants and getting their signature.

RESULTS AND DISCUSSION

Demographic characteristics were similar between years (Table 1) and were not different between food secure and food insecure groups. Few women had secondary or post-secondary education and farm size (land and cattle), land ownership and number of individuals in the homes were consistent. In 2017 farmers were slightly older and significantly fewer homes had mud/dirt floors ($p<0.05$).

Household food insecurity was experienced by 80% (2009) and 87% (2017) of households and was not different between years (Table 2). Most households were categorized as moderately and severely food insecure. There were no significant differences in food security status between years ($p=0.47$). Fewer households were food secure (33% and 26%; 2009 and 2017, respectively) compared with not food secure (moderate and severe food insecurity) (67% and 74%; 2009 and 2017, respectively).

The mean HFIA score was higher, representing greater severity of food insecurity, for households categorized as food insecure (9.9, SD 4.9 in 2009;11.6;SD4.5 in 2017) compared with those categorized as food secure (1.6,SD2.2 in 2009; 1.1,SD1.5, in 2017)($p<0.001$). By contrast, the Kenyan Demographic and Health Survey (KDHS)

found that17.1% of households in Central Kenya lacked food or money to buy food in the 7 days preceding the survey [16]. The KDHS food insecurity rates of 54% and 42% for households in the lowest and second lowest wealth quintiles, respectively, were similar to the food insecurity rates in the current study which suggested that the study group households were in the lower wealth quintiles. The differences in the prevalence of food insecurity may also be the timing of the data collection. In both 2009 and 2017, data were collected in a lean time of the year (August and June), prior to the harvest of food crops (maize) and after a drought the previous growing season. In contrast, the KDHS was conducted May to October 2014 [16] after a successful maize harvest in 2013 [26]. At this time Kenya reported the production of 40.3 million bags of maize and government officials felt the country was in a good position to avoid food insecurity [26]. As well, different tools were used to assess household food insecurity. The HFIA may be more sensitive to less severe food insecurity, notably the anxiety, reduction in meal size and consumption of less preferred foods associated with food insecurity.

Women's BMI, assessed in 2009, were evenly distributed across the healthy (22-24.9; 49.4%) and unhealthy (overweight and obese; OWOB; $\geq$25; 49.4%) categories. One woman was classified as underweight (<18.5). Similarly, in 2014, 47% of women in Central Kenya had BMI in the OWOB categories [16] and in rural Tanzania the prevalence of OWOB that was three-times higher than underweight [12]. Mean BMI of women in the study group (25.2) which was similar to findings from a national survey conducted in 2014 that found the mean BMI for women in Central Kenya was 25.3 [16]. The proportion of OWOB women was high for both women in food secure (61.5%) and not food secure (44.8) groups of women (Table 3). Women from the food secure household had a higher mean BMI (27.2, SD4.8) compared with women from food insecure households (24.5, SD4.1). The median BMI was significantly higher for women in the food secure group (26.5; IQR 24, 30) compared with the food insecure group (24; IQR 21, 27) (p=0.01). Higher and unhealthy BMI was significantly associated with lower severity of food insecurity (p=0.05; Table 4). In Kenya, women's BMI was lowest (21.1) in the lowest wealth quintile and highest (25.6) in the highest wealth quintile in 2014 [16]. This suggested that women in the study group were in a high wealth quintile despite experiencing food insecurity. Similarly, women in 'individual food insecure households' in rural Tanzania had a larger waist circumference (another indicator of NCD risk) compared with food secure women whereas women in 'child food insecure households' had lower mean BMI compared to women categorized as 'household food secure' [13].

Our data suggests that dairy farm development in the Mukurwe-ini area created the situation of reduced poverty and food insecurity, which enabled the more food secure women to regularly consume more food and to consume refined sugar, fats and grains more often leading to OWOB and increased risk for NCD. Similarly, researchers in Brazil proposed that where income constraints among the poor were not too severe many risk factors for cardiovascular disease, including high BMI and large waist circumference, would likely be greater [27]. In the situation of lower severity of food insecurity, women would experience fewer periods of insufficient amounts of food (days without food, missed meals, smaller portions). These conditions within a context of historically persistent food insecurity and an attitude toward food of 'eat like you won't

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eat tomorrow' (personal communication, 2009) may result in women consuming an excess of food energy that would be stored and ultimately increase their BMI and risk for conditions such as diabetes and cardiovascular disease.

Diet diversity (DD) was low (≤5) for all groups of women regardless of year or food security status, although in 2009, DD was marginally higher for food secure households (Table 5). In both years, a high proportion of women consumed "starchy-staples" (maize, wheat flour), "dairy" (milk) and "other fruit and vegetables" (often cabbage) and only a few consumed foods in the "organ meat", "eggs" or "flesh foods" groups. In 2009 the proportion of women that consumed any DD food group was not associated with food security status (Table 6). In 2017, more women in the food secure category consumed "Other vitamin A-rich fruit and vegetable" (for example carrots) although this difference was marginally significant ($p=0.06$). This typical Kenyan diet, high in starchy-staples and with low diversity, has been associated with inadequate intake of multiple micronutrients [24] even when energy intake is adequate. In contrast to our low DD findings, a national survey found few (13.7%) households in Central Kenya had 'poor' or 'borderline' food consumption scores [16]. Interestingly, in this national survey the proportion of households with low food consumption scores was similar to the proportion of food insecure households (17.1%). Our findings suggest that a majority of women in Central Kenya do not consume a sufficiently diverse diet (DD>5) and the authors speculated that the food consumption score was interpreted by survey participants as having enough food (food security) and not related to the nutritional quality of the food being consumed as intended. The low diversity diet and high levels of OWOB and food insecurity in the current study align with findings in rural Tanzania [13] and rural farm women in Botswana [14].

The number of different foods consumed by women was similar in 2009 (45 foods) and 2017 (49 foods). As well, the list of foods consumed by more than 10% of women was similar between years (Table 7). Compared with 2009, a significantly higher proportion of women in 2017 consumed tomatoes, liquid oil (such as palm kernel oil), *terere* (indigenous leafy green), arrowroot and bread and fewer women used solid fat (such as hydrogenated palm oil), whole kernel maize and avocado. Several of these differences may be explained by previous research in this area that included a nutrition education intervention that aimed to improve knowledge of food, nutrition and health and promoted the consumption of vitamin A-rich plant foods (for example carrots and indigenous leafy greens) and liquid oil over solid fat [18] and suggests that nutrition education can have longer term positive impacts and should form part of the development strategy although further research over a longer time period is needed to confirm effects on nutrition and health outcomes. Lower maize consumption in 2017 was reflective of the season (pre-harvest), a recent maize crop failure and a limited supply of maize in the country. These factors may also explain the higher proportion of women (in 2017) that consumed rice as a starchy-staple food. However, no investigations were conducted to specifically examine what motivated and limited women in their food attitudes and choices.

Of the foods consumed by more than 10% of women, being household food secure was significantly associated with consumption of sugar, cabbage, wheat flour, tomatoes and bread in 2009 and with only bread in 2017 ($p<0.05$; Table 8). These findings suggested

increased household access to sugar, cabbage, wheat flour and tomatoes in 2017 as these foods were consumed regardless of food security status. By contrast, food secure individuals in rural Tanzania were more likely to consume meat, eggs, fruits and vegetables [13] and a greater reliance on home food production was used to explain why rural diets changed less with food security compared with urban diet in Malawi [27].

This study provides evidence that supports a unique nutrition and epidemiological transition in rural areas of low-income countries. The situation of low dietary diversity, a food pattern characterized by access to refined sugar, fats and oils, and starchy-staples and high rates of OWOB is similar to an "early rural" nutrition transition (NT) described in Tanzania and Benin that was characterized by the rapid integration of vegetable oils into local diets [4,29]. The association of bread consumption with food security aligned with findings in farming villages in Tanzania that food security was associated with a food "purchase pattern" characterized by the consumption of more bread or cakes, sugar, and tea; foods that were desirable, readily available and relatively inexpensive [12]. The "purchase pattern" was associated with women being involved with business, service, or the sale of surplus farm products which is similar to the majority of women in the current study that sold surplus milk as part of the dairy development. In Benin, a transitional diet high in sweets and low in legumes was associated with OWOB and increase risk of NCD [30]. The Kenyan tradition of making tea with ample milk and sugar further aligns the current study with the concept of a transitional diet characterized by globalization and access to basic refined food [31]. This transitional diet, combined with improved food security and fewer periods of famine may be fueling the epidemiological transition without the "Western diet" and sedentary lifestyle that are characteristic of the urban nutrition transition [8,9,32]. The current study provided evidence that being food secure had little effect on food consumption pattern or dietary diversity but was associated with higher unhealthy BMI with and supports other evidence for individuals being overweight and undernourished as part of a leading global health crisis [33]. This issue needs to be addressed by including nutrition interventions with development initiatives in rural areas of developing countries.

The authors acknowledge limitations that should be considered in interpretations of the results. The small sample size in this study may limit generalization of these findings; however, the results align with other research of "transitional diets" in rural areas of developing countries that are evolving with globalization [12,30,31]. The measurement of BMI does not account for variations in body fat accumulation. However, waist circumference was directly correlated with BMI [34] and BMI both above and below the range of about 22.5 to 25 kg/m^2 is one of the strong predictors of overall mortality rate [35]. Specifically, for black women in South Africa, overweight and obesity were associated with a higher risk for cardiovascular disease and stroke, respectively, independent of fat deposition pattern [36]. Although BMI was assessed only in 2009, the rate of obesity (BMI $\geq$30) in developing countries is increasing by almost 1% per year [37]. Without a BMI measurement in 2017 this trend cannot be confirmed for women in the Mukurwe-ini area but the high rate of OWOB found in 2009 supports the concern that the NCD health concerns need to be addressed. As well, the findings that food security was associated with high BMI and that basic refined foods were more widely consumed in 2017 points to a need for development work to be conducted in a way that

also addresses that potential for negative outcomes in nutrition and health [5]. A single 24-hour diet recall was used to describe a food consumption pattern. However, the use of a food frequency questionnaire may have provided insight into foods consumed less frequently and enabled further characterization of changes with food security.

The challenge of halting the obesity epidemic is especially significant in communities that have struggled with hunger and subsistence livelihoods [36] and have an approach to food as "eat like you won't eat tomorrow" [38]. This challenge is exacerbated in cultures, including Polynesia and the Cameroon, where larger stature is associated with power, beauty and affluence [39, 40] and which may be relevant in Kenya [41].

CONCLUSION

A high proportion of women in this study of rural Kenyan farm women were food insecure and being food secure was associated with high BMI (OWOB). Women's diet diversity was low regardless of food security status, reflective of inadequate intake of micronutrients and there were few differences in food consumption pattern between food secure and food insecure women. This study points to a transitional dietary pattern with accessible refined sugar, fats and grains that, with a greater food security and purchasing power, may fuel the transition to OWOB and risk of NCD for women in rural Kenya. The opportunity for the low-income countries to by-pass the transition to NCD that plagues higher income countries is no longer an option, but there remains an urgent need for the governments and non-government organizations to pursue nutrition sensitive agriculture [5] and development and to curb this transition. The measurement of BMI or waist circumference, two low-cost methods, is recommended for inclusion in monitoring of development projects that aim to improve household food security.

Public health programs that are founded on an understanding and respect for the local circumstances and social contexts are needed to address negative perceptions about foods such as 'eating vegetables is a sign of poverty' [39] and other attitudes toward traditional foods that are major impediments to the rehabilitation of dietary patterns [29]. Although the need for education to limit the consumption of highly processed foods due to the increasing burden of OWOB in Kenya was suggested, this does not appear to be immediately relevant in the rural agricultural areas. There is a need for research to examine effective methods to improve dietary diversity and nutrition knowledge and practices among women and to align food production with food and nutrition security. Finally, there is an urgent need for food system programs and policies to improve accessibility and access to a wide range of nutrient dense foods as healthy dietary patterns can only be followed if the food items are available, accessible, and desirable.

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Table 1: Household demographics and home observations 2009 (n=111) and 2017 (n=39) (percentage of households)

Characteristics	**2009 % (n)**	**2017 % (n)**
Members of dairy group	79 (88)	95 (37)
Husband as head	83 (23)	90 (35)
MOTHER'S EDUCATION LEVEL		
No education	2.7 (3)	5.1 (2)
Primary education	69 (75)	54 (21)
Secondary education	28 (31)	41 (16)
FATHER'S EDUCATION LEVEL[1]		
No education	4.4 (4)	4.2 (1)
Primary education	63 (57)	54 (13)
Secondary education	30 (27)	38 (9)
Some College or university	3.3 (3)	4.2 (1)
Married (marital status)[2]	83 (92)	92 (36)
SIZE OF LAND		
< 1 acres	43 (48)	44 (17)
1 – 2 acres	41 (46)	38 (15)
>2 acres	15 (17)	18 (7)
Farm additional land	44 (49)	36 (14)
WALLS OF HOME		
Cement/brick	45 (50)	46 (17)[3]
Wooden planks	40 (44)	27 (10)
Mud/dirt	15 (17)	27 (10)
FLOORING OF HOME		
Cement/tile/brick	30 (33)	65 (24)
Mud	69 (77)	25 (13)
	Mean [sd]	**Mean [sd]**
Number of people in home	4.3 (1.8)	3.6 (1.3)
Mother's age	42 (12.7)	3.6 (1.3)
Father's age	48 (15.4)	56 (20.6)
Number of cattle owned	1.9 (1.3)	2.0 (1.7)

[1]In 2009, husband's education was unknown or not recorded if the husband was deceased (15 households)

[2]Remaining women were widowed, divorced, or single

[3]Home construction observations were not made for one woman interviewed away from her home

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Table 2: Proportion of Kenyan farm households categorized according to the four levels of household food insecurity in 2009 and 2017[1]

Food insecurity level	2009 Proportion of households n=110 % (n)	2017 Proportion of households n=39 % (n)
Secure	20 (22)	13 (5)
Mildly insecure	13 (14)	13 (5)
Moderately insecure	29 (32)	48 (19)
Severely insecure	38 (42)	26 (10)

[1]χ^2 p=0.15

Table 3: Association of women's BMI category with food security status (secure=secure+mild food insecurity; food insecure=moderate+severely food insecure) (percent of women) [1] (2009; n=85)

BMI	Food secure % (n)	Food insecure % (n)
"healthy"	38.5 (10)	55.2 (32)
"overweight/obese"	61.5 (16)	44.8 (26)

[1]χ^2 p=0.16

Table 4: Women's median BMI with level of household food insecurity level (2009; n=85)

	Food secure n=15	Mildly food insecure n=11	Moderately food insecure n=27	Severely food insecure n=32
BMI[**]Median (25^{th}; 75^{th})	27 (24,28)	26 (24,31)	25 (22,27)	23.5 (21, 26)

[**] Kruskal-Wallis test p<0.05

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Table 5: Mean diet diversity (of 9 food groups) for women in 2009 and 2017 with household food security status (secure=secure+mild food insecurity; food insecure=moderate+severe food insecure)

Diet diversity	2009 (n=106) mean (sd)	2017 (n=39) mean (sd)
Food secure	5.0 (0.94)	4.6 (0.92)
Food insecure	4.3 (0.97)	4.6 (0.94)
	p=0.07	p=0.65

Table 6: Women's Dietary diversity in 2009 and 2017 and the association of DD with food security status (secure=secure + mildly food insecurity; food insecure=moderate + severely food insecure)

	2009 Food secure (n=37)		2009 Food insecure (n=69)		2017 Food secure (n=10)		2017 Food insecure (n=29)	
Food Group	**%**	**(n)**	**%**	**(n)**	**%**	**(n)**	**%**	**(n)**
starchy staples	100	37	100	69	100	10	100	29
legumes	76	28	83	57	70	7	62	18
all dairy	100	37	99	68	100	10	97	28
organ meat	0	0	3	2	0	0	0	0
eggs	14	5	3	2	0	0	7	2
flesh foods	24	9	4	3	10	1	3	1
dark green leafy (vit A rich)	51	19	62	43	70	7	72	21
other vit A-rich fruit and veg	30	11	39	27	60*	6	24*	7
other fruit and veg	95	35	96	66	90	9	69	20

*p=0.06

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Table 7: Foods consumed by women farmers in Mukerwe-ini, Kenya in 2009 and 2017 (% of women)[1]

	2009 % consumed	(n) of 105	2017 % consumed	(n) of 39	p*
Tea	99.1	(104)	100	(39)	1
Milk	92.7	(97)	97	(38)	0.45
Salt	95.5	(100)	95	(37)	1
Onion	90.9	(95)	95	(37)	0.51
Tomatoes	70.9	(74)	92	(36)	0.007
Maize flour	64.6	(68)	72	(28)	0.55
Potatoes	63.6	(67)	69	(27)	0.69
Oil (in cooking)	11.8	(12)	67	(26)	<0.0001
Beans	80.0	(84)	67	(26)	0.12
Sugar	66.4	(70)	56	(22)	0.33
Rice	34.6	(36)	51	(20)	0.08
Terere (leafy green)	11.8	(12)	49	(19)	<0.0001
Fat (solid, in cooking)	87.3	(92)	33	(13)	<0.0001
Carrots	22.7	(24)	33	(13)	0.21
Kale (leafy green)	40.9	(43)	31	(12)	0.34
Maize (whole kernel)	65.5	(69)	28	(11)	<0.0001
Pumpkin leaves (leafy green)	19.1	(20)	26	(10)	0.49
Banana (green cooked mashed)	24.6	(26)	23	(9)	1
Cabbage	19.1	(20)	23	(9)	0.64
Wheat flour	17.3	(18)	21	(8)	0.63
Arrowroot	0	(0)	18	(7)	<0.001
Bread (white and brown)	10.5	(11)	26	(10)	0.03
Banana (ripe, as fruit)	8.6	(9)	13	(5)	0.52
Avocado	42.7	(45)	13	(5)	0.001
Spinach (leafy green)	8.6	(9)	13	(5)	0.53

[1]Food consumed by fewer than 10% of women in both years are not listed

*P≤0.05 indicates a significant difference in the proportion of women that consumed the food in 2009 compared with 2017

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Table 8: Association of food consumption choices with food security status in 2009 and 2017[1]

Food	2009 % consumed (n)			2017 % consumed (n)		
	Food secure	Food insecure	p	Food secure	Food insecure	p
Sugar	80 (28)	58 (41)	0.03	50 (5)	59 (17)	0.64
Cabbage	34 (12)	13 (9)	0.01	10 (1)	28 (8)	0.26
Wheat flour	31 (11)	10 (7)	0.006	30 (3)	17 (5)	0.40
Bread	20 (7)	7 (5)	0.05	50 (5)	17 (5)	0.04
Cooking oil	17 (6)	8.6 (6)	0.19	90 (9)	59 (17)	0.07
Cooking fat (solid)	83 (29)	89 (62)	0.57	10 (1)	41 (12)	0.07

[1]only those foods with significant association at one or both dates are shown

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