Nutrient intake of Women of Child Bearing Age from Two Agro-climatic zones of Rural Areas in Tanzania

***Mbwana H.A. and J. Kinabo**

Sokoine University of Agriculture, Department of Food Technology, Nutrition and Consumer Sciences, P.O. Box 3006, Morogoro-Tanzania
*Corresponding author e-mail: *hadija27@yahoo.com*
Phone: +255 713 385631

Abstract

Nutrient deficiencies impose significant public health problems in many developing countries affecting especially women of child bearing age and children. A household cross-sectional survey involving a sample of 351 households was conducted in four villages of Morogoro and Dodoma regions, representing two different agro-climatic regions, to examine nutrient intake from food in rural women of childbearing age. The respondent was the mother/caregiver in the household. Dietary intake data were collected by using a quantitative 24 hour dietary recall questionnaire. Nutrient intake was analyzed using NutriSurvey program. Nutrients consumed was classified into energy, protein, fat, carbohydrate, vitamin A, vitamin B_1, vitamin B_2, vitamin B_6, vitamin B_{12}, folic acid, vitamin C, calcium, iron, and zinc. The mean daily intake of energy was 1976 Kcal (95% CI: 1886.1-2066.5) for Morogoro and 1651 Kcal (95% CI: 1553.0-1747.0) for Dodoma. Daily mean intake of protein was 61.2g (95% CI: 56.9-65.4) for Morogoro and 36.7g (95% CI: 32.3-41.1) for Dodoma. Mean fat intake was 33.0g (95% CI: 30.1-35.9) for Morogoro and 23.9g (95% CI: 20.8-27.0) for Dodoma. Vitamin A (retinol equivalents) intake in Dodoma was higher than the recommended amounts at 823.4g (95% CI: 710.1-916.1) but lower than the recommended intake in Morogoro at 335.3g (95% CI: 271.0-400.0). Even though both districts did not meet the recommended nutrient intake for vitamin B12, Dodoma had the lowest intake at 0.6mg (95% CI: 0.31, 0.83) compared to Morogoro 1.5 mg (95% CI: 1.13, 1.84). The results of this study suggest different nutrient consumption patterns between Dodoma and Morogoro based on the agro-climatic condition of the districts which also influence the type of foods produced in particular areas. This calls for support for education on food and dietary intake that purposely accentuate increasing production and consumption of a diversity of foods preferred in a certain agro-climatic environment. This should include consumption of animal source foods to increase the intake of nutrients.

Keywords: Macro and micro-nutrient intake, rural women, Morogoro, Dodoma, Tanzania

Introduction

Macro and micro-nutrient deficiencies inflict significant public health problems in many developing countries affecting especially women of child bearing age and children. Dietary intake has a key effect on nutritional status, making essential the revealing of both nutritional insufficiencies and extremes that would have detrimental outcomes on health (Alao, 2015). According to the Tanzania Demographic and Health Surveys (TDHS), about 34% of children aged 6-59 months and 37% of women of reproductive age (15-49 years) were vitamin A deficient (National Bureau of Statistics (NBS) and ICF Macro, 2010) and about 58% of children below five years of age suffered from anaemia (MoHCDGEC *et al.*, 2016). About 33% of women of age 15-49 years were iron deficient, but about 45% had anaemia. Results of the rapid iodine test indicated that, 17% of the households used salt that did not contain iodine, 23% used salt with inadequate iodine content (NBS and ICF International, 2016; NBS and ICF Macro, 2011).

In many rural areas of developing countries, women play a fundamental role in sustaining food supply and nutrition for their families in the course of their tasks as food producers, processors, traders and household income earners (Dickson, 2015). Inadequate food consumption is a main ground of undernutrition in such communities and the majority of such rural population depends on small scale agriculture for food which usually does not produce enough supply to meet the needs of the family. Foods imported from other regions or from outside the country are usually very expensive for the majority of households to afford. This results in relying on cereal staples for satisfying hunger (Clapp, 2017; Sneyd, 2013). The high intake of cereal based foods and those high in energy among rural communities is linked with low micronutrient intakes. This trend is supported by the availability and low cost of energy rich foods (Temple, Steyn, Fourie and De Villiers, 2011) and the good flavour of sugar and fat (Drewnowski, 2004).

In Tanzania, data to describe the macro and micro-nutrient intake among rural women are comparatively lacking apart from the few studies targeting women living with HIV (Lukmanji, *et al.,* 2013) and mixed population in urban areas (Mazengo, *et al.,* 1997). Determining and evaluating what people eat may provide important information on the nutrient intake of populations, and can give an opportunity to determine the possible health risks associated with dietary intake and hence solutions. This study examined the nutrient intake from foods consumed by women in rural areas and explored how patterns of intake vary by agro-climatic regions and the variations between women consuming green leafy vegetables and animal based foods and those who did not consume these foods in order to inform education and interventions specific to this rural population.

Materials and methods

Study areas

The study was conducted in four villages from two contrasting agro-climatic zones in Tanzania, Morogoro and Dodoma regions. Morogoro is sub-humid whereas Dodoma is semi-arid. Morogoro and Dodoma represent two different food systems and have sufficiently diverse environmental and socio-economic conditions for investigating causative factors for food and nutrition insecurity, thus allowing for the transfer of results to many other similar regions in Tanzania. In sub-humid Morogoro region, Changarawe, Ilakala and Nyali villages were selected from Morogoro district. In semi-arid Dodoma region, Ilolo, Idifu and Ndebwe villages were selected from Chamwino district. The food systems in Morogoro are varied, mainly relying on maize, sorghum and rice as staples. Legumes such as common beans, pigeon peas, green peas, cow peas, chick peas and green gram and horticulture crops such as carrots, cucumber and tomatoes. There is also oil crops such as simsim and sunflower; fruits such as mangoes, pawpaws, oranges, pineapples and water melons as well as livestock (Mnenwa and Maliti, 2010).

Morogoro is a bimodal rainfall area, with short (October – February) and long (March – May) rainy seasons with an average of 600-800 mm per annum. The long rainy season form the main production season while production during the short rain season is used to smoothen out the food supply over the year. In addition, the Morogoro district imports food crops from other regions during the deficit months which are sold in local markets. Foods sold in local markets include cereals such as maize and rice and legumes such as cowpeas, beans, pigeon and peas. The local food consumption in Morogoro is shaped by food cultural preferences. The food menu is highly cereal based. Maize and rice are major staples. Legumes are served as relish in the food menu. Vegetables are also consumed; predominantly leafy vegetables such as cowpea leaves and other wild vegetables (Mutabazi, 2013).

Food production in Dodoma is predominantly rain fed. Dodoma region receives rainfall in one season with an average of 350-500 mm rainfall per annum. Dodoma is characterized by a prevalence of highly food-insecure areas. Crops produced include cereals (sorghum, pearl millet and maize), roots/tubers (cassava and sweet potato), legumes (cowpeas, pigeon peas, bambara nuts, groundnuts, chickpeas, green grams and lablab beans), oil crops (sunflower, sesame, groundnuts) and fruits (pawpaws, guavas, mangoes, grapes, lemons and dates). There is also widespread collection of edible wild fruits and vegetables. The food system in Dodoma is mainly based on cereals with pearl millet as the preferred staple. Groundnuts are normally mixed in most relishes that are used with the main dish. Edible wild products, particularly vegetables and fruits, are important in local food menus (Mutabazi, 2013). The Chamwino district imports food crops from other regions during deficit months. These foods include maize, beans and pigeon pea. During deficit months imported food such as maize and pearl millet is sold at a price more than three times its price during the months of plenty. This is because there are no structured local markets in the study villages, only small grain and pulse traders. The two regions together account for 70–80% of the types of farming system found in Tanzania (Ronner and Giller, 2013).

Study design and sampling procedure

The study population comprised women or caregivers in the sampled households. A cross-sectional design was used whereby data were collected once from the respondents, which means the outcome and exposure were assessed at the same time. The respondent was the mother/caregiver or any other person responsible for food preparation and serving in the household. The households were randomly selected from village household lists provided by the Agricultural Research Institutes (ARI) Ilonga and Hombolo. The lists contained names of the household heads and names of hamlets (hamlets) they live in. After sorting the lists alphabetically for each hamlet, a total of 351 households were randomly selected to represent Dodoma and Morogoro. All hamlets were equally represented according to size or number of households. Study procedures were explained to eligible women and they were requested to participate in the study. Participants who agreed to take part in the study gave their written consent by signing informed consent form or applied a thumb print (in ink). Permission to conduct the study was granted by the District Commissioners' Offices and Ethical clearance was obtained from the Tanzania National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/2226). The sources of data for this study included both primary data and secondary.

Data collection

A structured questionnaire was used to collect socio-demographic information. Height (in cm) and weight (in kg) of mothers/caregivers were measured. The weight was measured to the nearest 0.01 kg using a SECA electronic bathroom scale. Participants were in minimal clothing and without footwear. Height was measured using a stadiometer (Shorr Productions). The measurements were taken while the subject was standing without shoes, on a horizontal flat plate attached to the base of the stadiometer with heels together; and stretched upwards to a full extent and the head in the Frankfurt plane. The study included a detailed dietary intake analysis by using a quantitative 24 hour dietary recall questionnaire. The women, who are usually responsible for food preparation and serving were asked to provide information on the fluids, foods and ingredients of composite dishes and showed the quantities they consumed by using common standardised household measures (e.g. spoons, cups, bowls, glasses, plates etc). Respondents were requested to recall all the foods and beverages consumed over the previous 24 hours preceding the survey. At the end of the interview, the interviewer summarized the items that had been eaten and checked with the respondent that nothing had been omitted. The objective of this recall was to obtain information on the quantity and quality of the current diet eaten by the women. Food consumption was assessed by using a quantitative 24 hour dietary recall questionnaire. The respondent was asked to recall all foods consumed in the previous 24 hours. Amount of food consumed was estimated by using pre-measured house hold utensils to obtain average amount consumed. The information collected on 24 hour dietary recall allowed to calculate a dietary diversity score (DDS), defined as the number of different food groups consumed by a participant over 24 hours. The DDSs were derived using the FAO guidelines for measuring dietary diversity (FAO, 2008). The questionnaire also included a section that captured information about foods consumed outside the household.

Data analysis and statistical methods

Statistical analysis was performed using the Statistical Product and Service Solution IBM SPSS Version 21 statistical software (SPSS Inc., Chicago, IL, USA). The demographic categorical variables were described by using the frequencies and percentages. Nutrient intake was analyzed by using NutriSurvey program (nutrisurvey2007.exe). Nutrient contents of all foods available in the Tanzania Food Composition Tables were uploaded to the NutriSurvey program. The mean intake values of energy, protein, fat, carbohydrate, vitamins A, B_1, B_2, B_6, B_{12} and C, minerals calcium, iron and zinc were expressed as amount per day (e.g. mg/d) and percentage of fulfillment of recommend intake by FAO/WHO (2001). Normality of all data was checked using the Shapiro-Wilks test. Mean and standard deviation were presented for normally distributed data.

Mann-Whitney-U-Test was used to compare differences between different groups, region of residence, consumption of green leafy vegetables/ no consumption of vegetables, consumption of animal based foods/no consumption of animal based foods), because the intake data were not normally distributed. Kruskal-Wallis test was used to assess significant differences between three and more groups. Significance was considered at $P<0.001$. For further descriptive analysis, error bar charts for age, height and weight were used.

Various patterns of consumption of green leafy vegetables and animal products were considered to examine the differences in nutrient intake. In addition to consumption of cereals, respondents were examined on a combination of consumption of vegetables and or animal products in the following patterns:

(i) No consumption of green leafy vegetables and animal products;
(ii) Consumption of green leafy vegetables but no animal products;
(iii) No consumption of green leafy vegetables and animal products and Consumption of animal products but no green leafy vegetables and (iv) Consumption of animal products but no green leafy vegetables.

Results

Demographic characteristics

About 93% and 82% of household heads in Dodoma and Morogoro respectively were males. Overall, 71.8% were on monogamous marriage. The proportion of respondents who were single was 17.5% for Morogoro and 13.4% for Dodoma region. Household size ranged between 2 and 5 persons for 51% of the houseolds and between 6 and 8 persons for 43% of the households. The mean age of women was 42.5 ± 13 years for Dodoma and 39.9±11.2 years for Morogoro. About 9% of the women were underweight, 23% were overweight and 5% were obese. The level of education attainment was low; 31.2% of the women in Dodoma and 50.3% in Morogoro had not been through any formal education and only 2.9% in total had attained secondary education. The literacy level was also very low as only 43.1% in Dodoma and 33.6% in Morogoro could read and write. Other characteristics of the households and respondents are presented in Table 1.

Types of foods consumed

Types of foods consumed by members of the households over a period of 24 hours prior to the survey day are presented in Table 2. All households (100%) consumed cereals. The major foods contributing to cereal intake included maize, bulrush millet, wheat and rice. Vegetables were consumed by 61% of the respondents. The vegetables consumed included leaves of sweet potato, pumpkin, amaranth, cowpea, cassava, jute mallow, Chinese cabbage and wild sweet potato (*Ipomoea pandurata*) [a traditional leafy vegetable]. A high proportion of respondents (89%) consumed sugar basically by adding it to tea and or porridge and salt (96%) added to vegetables, legumes and meat during cooking. Only 25% of the respondents consumed vitamin A rich fruits comprising papaya, mango, oranges, pineapple, baobab and watermelon.

Daily nutrient intake

The respondents in Morogoro and Dodoma did not meet the recommended intake for all other macronutrients namely energy, protein and fat except for carbohydrate (Table 3). Vitamin

Table 1: Socio-demographic characteristics of participants (n=351)

Characteristics	Dodoma		Morogoro	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Age of rmother/caregiver (Years)	42.51	12.955	39.88	11.242
Weight of mother/caregiver (kg)	53.99	8.324	54.82	9.058
Height of mother/caregiver (cm)	154.46	4.444	155.01	4.891
	Dodoma % (n=202)		**Morogoro % (n=149)**	
Sex of household head				
Male	92.6		81.9	
Female	7.4		18.1	
Marital status of household head				
Married-monogamous	70.3		73.2	
Married-polygamous	12.4		6	
Widowed	5		10.1	
Divorced	5.4		4.7	
Single	3		2.7	
cohabitation	4		3.4	
Level of literacy of mother/caregiver				
Not able to read or write	31.2		52.3	
Can read and write to some extent	25.7		14.1	
Can read and write	43.1		33.6	
Occupation of mother/caregiver				
Farmer	96		94.6	
Employed formal sector	0.5		2.7	
Self employed/other	1		2.7	
Other	2.5		0	
Education level of mother/caregiver				
No formal education	31.2		50.3	
Primary education	62.9		48.3	
Secondary education	5		0.7	
Adult Education	1		0.7	

A (retinol equivalents) intake in Dodoma was higher than the recommended amounts at 823.4g (95% CI: 710.1-916.1) but lower than the recommended intake in Morogoro at 335.3g (95% CI: 271.0-400.0). Both districts did not meet the recommended nutrient intake for vitamin B12, but Dodoma had the lowest intake at 0.6mg (95% CI: 0.31-0.83) compared to Morogoro 1.5mg (95% CI: 1.13-1.84). Whereas mean intakes of energy, protein, fat, carbohydrate, vitamin B_6 and vitamin B_{12} were significantly higher in Morogoro than in Dodoma, mean intakes of vitamin A, vitamin C, calcium, iron and zinc were significantly higher (P<0.001) in Dodoma than in Morogoro (Table 3). Respondents in Morogoro were able to meet the RNI for protein (129.6%), carbohydrate (283%), vitamins B_1 (133%), B_6 and zinc (195%). Respondents in Dodoma attained RNI for carbohydrate (174%), retinol equivalent

Table 2: Common types of foods consumed by women: assessed by 24-hour recall

Food group	Percent food group consumption	Morogoro (Type of food consumed)	Dodoma (Type of food consumed)	Average portion size consumed (g)
Starchy staples/cereals	100%	Maize stiff porridge/ugali	Bulrush millet stiff porridge/ ugali	500
		Rice	Rice	315
		Chapatti		200
		African doughnuts	African doughnuts	180
		Makande/ succotash		500
		Bread		200
		Green bananas		500
Vegetables, Vitamin A Rich & other Vegetables and Tubers	61%	Sweet potato leaves	Sweet potato leaves	120
		Pumpkin leaves	Pumpkin leaves	120
		Amaranth	Jute mallow	200
		Cowpea leaves	Cowpea leaves	120
		Chinese cabbage	Cassava leaves	120
		Cassava leaves	Wild sweet potato (*Ipomoea pandurata*)	200
		Jute mallow	Other TLVs*	200
			Wild amaranth	120
White tubers and roots	8%	Cassava	Cassava	400
		Sweet potatoes	Sweet potatoes	400
Vitamin A rich & other fruits	25%	Papaya	Papaya	250
		Mango	Mango	155
		Oranges		170
		Pineapple	Baobab	100
		Water melon		230
Flesh & Organ meat (iron-rich)	4%	Beef	Beef	150
		Chevon/ mutton	Chevon/ mutton	100
		Pork	Pork	200
			Donkey meat	150
Eggs	2%	Chicken eggs	Chicken eggs	70
Fish	9%	Fish	Fish	120
		Sardines	Sardines	60

Food group	Percent food group consumption	Morogoro (Type of food consumed)	Dodoma (Type of food consumed)	Average portion size consumed (g)
Legumes, nuts and seeds	29%	Beans	Beans	80
		Cowpeas	Cowpeas	60
			Groundnuts	50
Milk and milk products	4%	Fresh milk	Fresh milk	150
		Yoghurt	Yoghurt	200
Oils and fats	70%	Cooking oil	Cooking oil	10
Sweets	89%	Sugar	Sugar	20
Spices & condiments	96%	Salt	Salt	-

**TLVs= Traditional Leafy vegetables*

(132%), vitamin C (135%), iron (154%) and zinc (247%). On average, 11.9%, 14.4% and 73.7% of dietary energy originated from protein, fat and carbohydrate in Morogoro and 10.9%, 18.1% and 71% of dietary energy originated from protein, fat and carbohydrate in Dodoma region. The contribution of fat to total energy was higher among respondents from Dodoma compared to Morogoro respondents.

Nutrient intake among women with and without consumption of green leafy vegetables and animal products relative to the recommended nutrient intake/RNI

Variations in nutrient intake were significant between the group that consumed green leafy vegetables and animal products which was statistically significantly higher ($p<0.01$) than the group that only consumed green leafy vegetables but not animal products. Another pattern indicated that the group that consumed animal products but no green leafy vegetables had significantly higher nutrient intake compared to the group that consumed green leafy vegetables but no animal products. Results of other patterns are presented in Table 4. Respondents who did not consume green leafy vegetables and animal products were able to attain energy intake level of 100% of the RNI in Morogoro and 50% in Dodoma. Similarly for respondents who consumed animal products and green leafy vegetables were able to attain high intake in relation to RNI (Fig. 1). Respondents who consumed green leafy vegetables with no animal products attained retinol intake of 8% of RNI in Morogoro and 14.2% in Dodoma region (Fig. 2).

The levels of nutrient intake among categories of weight, age and height were not statistically significant ($p>0.05$). However, the total energy, protein, vitamin A, vitamin B6, fat and iron consumed were higher for respondents of 66.6 kg and above than respondents in lower weight categories. Fig. 3 indicates that the intake of fat increased with weight of respondents. The same trend of intake was observed in the nutrient intake by age categories. Fig. 4 indicates the intake of iron being highest for respondents of age 61 years and above compared to the level of intake in lower age categories.

Discussion

This study aimed to examine the nutrient intake of women in rural areas and explore how patterns of intake vary by agro-climatic regions. The mostly consumed foods included cereals, vegetables, legumes and fruits. Cereals contributed a high proportion of the amount of food consumed. Animal source foods were rarely consumed. Foods such as oils and fats, salt as well as sugar were highly ranked and showed that a high proportion of respondents having consumed them during the period of 24 hours prior to the survey. This is because oils, fats and salt are the commonly used ingredients in preparation of vegetables, legumes, meat and

Table 3: Daily nutrient intake of women compared to recommended intake/RNI

Nutrient	Region	Mean intake	SD	Confidence interval (95%)	Recommended intake/RNI	% of recommended intake/ RNI met	*p*-value
Energy (kcal)	Morogoro	1 976.3	647.0	1886.1-2066.5	2250a	86.6	<0.001
	Dodoma	1 650.6	595.4	1553.0-1747.0		71.3	
Protein (g)	Morogoro	61.2	30.3	56.9-65.4	46b	129.6	<0.001
	Dodoma	36.7	27.0	32.3-41.1		75.3	
Fat (g)	Morogoro	33.0	20.6	30.1-35.9	70b	47.3	<0.001
	Dodoma	23.9	19.1	20.8-27.0		34.2	
Carbohydrate (g)	Morogoro	378.6	123.5	361.3-395.8	130b	282.9	<0.001
	Dodoma	239.8	97.6	223.9-255.7		174.4	
Retinol equivalents (µg)	Morogoro	335.3	461.3	271.0-400.0	600c	55.0	<0.001
	Dodoma	823.4	645.2	710.1-916.1		132.2	
Vitamin B1 (mg)	Morogoro	1.5	0.5	1.4-1.57	1.1c	133.4	0.364
	Dodoma	1.5	0.6	1.36-1.56		127.6	
Vitamin B2 (mg)	Morogoro	1.6	0.6	1.50-1.68	1.1c	140.3	0.329
	Dodoma	1.6	0.7	1.53-1.75		143.1	
Vitamin B6 (mg)	Morogoro	2.1	0.9	1.94-2.20	1.3c	155.34	<0.001
	Dodoma	1.8	0.9	1.69-1.99		135.2	
Folic acid (µg)	Morogoro	436.9	211.6	407.4-466.4	400 c	108.5	0.340
	Dodoma	419.8	210.6	382.8-449.6		101.8	
Vitamin B12 (µg)	Morogoro	1.5	2.6	1.13-1.84	2.4 c	60.40	<0.001
	Dodoma	0.6	1.6	0.31-0.83		23.0	
Vitamin C (mg)	Morogoro	38.1	40.3	32.5-43.7	45 c	83.1	<0.001
	Dodoma	65.1	51.7	56.1-72.4		135.0	
Calcium (mg)	Morogoro	332.3	324.4	287.1-377.5	1000 c	33.4	<0.001
	Dodoma	566.6	321.3	510.5-612.4		56.2	
Iron (mg)	Morogoro	19.5	9.1	18.3-20.8	29.4 c	71.3	<0.001
	Dodoma	40.0	18.3	36.9-42.7		154.3	
Zinc (mg)	Morogoro	9.9	4.5	9.23-10.50	4.9 d	194.6	<0.001
	Dodoma	12.9	5.6	11.97-13.79		246.5	

a Source-FAO/WHO/UNU: Human energy requirements (2001),

b Source-Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (2002/2005),

c Source-FAO/WHO: Vitamin and Mineral Requirements (2004): 10% iron bioavailability,

d Source-FAO/WHO: Vitamin and Mineral Requirements (2004): moderate zinc bioavailability.

Table 4: Nutrient intake in women with and without consumption of green leafy vegetables and animal products relative to the recommended intake/RNI

		No consumption of green leafy vegetables and animal products (Pattern 1) $N_{Morogoro}=35$ $N_{Dodoma}=9$		Consumption of green leafy vegetables but no animal products (Pattern 2) $N_{Morogoro}=95$ $N_{Dodoma}=113$		Consumption of green leafy vegetables and animal products (Pattern 3) $N_{Morogoro}=59$ $N_{Dodoma}=38$		Consumption of animal products but no green leafy vegetables (Pattern 4) $N_{Morogoro}=32$ $N_{Dodoma}=4$		p-value
	District	Mean	% of re-commended intake/RNI	Mean	% of re-commended intake/RNI	Mean	% of re-commended intake/RNI	Mean	% of re-commended intake/RNI	
Energy (kcal)	Morogoro	2 193.1	96.6	1 863.5	81.5	1 967.7	85.8	2 084.2	91.4	$0.001^{a,d,e}$
	Dodoma	1 263.7	50.9	1 617.7	70.3	1 848.9	78.3	2 410.0	107.1	
Protein (g)	Morogoro	57.1	121.8	45.6	96.5	77.9	164.4	91.9	194.5	$<0.001^{a,b,c,d,e,f}$
	Dodoma	30.0	52.8	30.9	64.0	56.8	114.2	111.3	241.9	
Fat (g)	Morogoro	38.5	55.0	27.9	40.0	33.2	47.2	42.0	60.1	$<0.001^{a,b,d,e}$
	Dodoma	18.3	22.4	21.9	31.4	32.4	47.1	49.6	70.9	
Carbohydrate (g)	Morogoro	416.9	314.4	375.7	278.5	348.9	260.2	380.4	286.9	$<0.001^{a,b,e}$
	Dodoma	201.5	148.5	239.4	174.8	253.0	176.4	269.1	207.0	
Retinol equivalents (µg)	Morogoro	51.2	8.0	507.2	84.6	378.7	61.3	84.4	14.0	$<0.001^{a,b,e}$
	Dodoma	84.8	14.2	965.7	154.9	524.4	77.6	36.4	6.1	
Vitamin B_1 (mg)	Morogoro	1.6	146.1	1.5	133.6	1.4	127.2	1.4	126.1	0.840
	Dodoma	1.1	78.4	1.5	130.2	1.4	122.1	2.0	179.5	
Vitamin B_2 (mg)	Morogoro	1.2	108.1	1.6	141.5	1.9	168.7	1.6	140.0	$<0.001^{a,b,c,d,f}$
	Dodoma	0.9	63.6	1.7	146.9	1.8	145.8	2.0	181.8	
Vitamin B_6 (mg)	Morogoro	1.7	124.3	1.9	140.9	2.6	194.5	2.5	186.8	$<0.001^{a,b,c,d,e}$
	Dodoma	1.0	64.4	1.9	139.1	1.9	130.0	2.5	192.3	
Folic acid (µg)	Morogoro	542.8	134.3	482.8	120.1	351.2	86.8	286.7	70.9	$<0.001^{b,c,d,e-f}$
	Dodoma	286.5	61.9	457.9	111.7	316.1	73.3	187.4	46.8	
Vitamin B_{12} (µg)	Morogoro	0.0	0.0	0.0	0.0	4.0	165.2	4.6	187.9	$<0.001^{b,c,d,e}$
	Dodoma	0.0	0.0	0.0	0.0	3.2	132.4	4.2	176.0	
Vitamin C (mg)	Morogoro	13.0	15.5	54.0	36.9	45.7	39.0	9.4	36.7	$<0.001^{a,b,d,e,f}$
	Dodoma	11.0	11.4	74.4	62.0	50.6	46.7	0.5	28.1	
Calcium (mg)	Morogoro	155.3	27.9	361.9	119.4	391.8	99.4	367.5	20.8	$<0.001^{a,b,c,e,f}$
	Dodoma	188.3	8.6	620.5	156.1	493.3	93.8	281.1	1.1	
Iron (mg)	Morogoro	18.5	66.0	19.9	74.0	19.6	68.8	19.4	72.4	$<0.001^{a,b,d,e}$
	Dodoma	19.0	52.1	42.5	163.9	35.0	145.0	40.2	136.8	
Zinc (mg)	Morogoro	8.8	174.9	8.5	166.8	12.0	235.6	12.7	250.1	$<0.001^{a,b,c,d,e}$
	Dodoma	8.0	134.7	12.7	246.6	14.4	259.7	19.7	401.5	

a Pattern 1 and 2 are significantly different, b Pattern 1 and 3 are significantly different, c Pattern 1 and 4 are significantly different, d Pattern 2 and 3 are significantly different

e Pattern 2 and 4 are significantly different, f Pattern 3 and 4 are significantly different

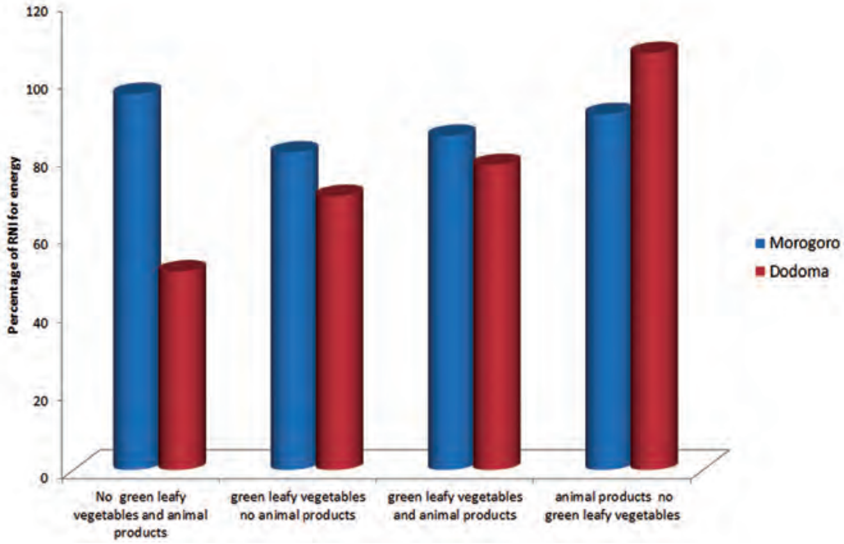

Figure 1: Energy intake in women with and without consumption of green leafy vegetables and animal products relative to the recommended intake/RNI

rice or chapatti. Sugar is usually added to tea or porridge. Basically these are the main food groups that were commonly consumed by the respondents. This observation suggests that nutrient contribution to these women's diet is limited to only few food groups. The types and amounts of foods consumed and therefore amounts of nutrients intake varied between study areas.

Nutrient intake in this study was compared to FAO/WHO/UNU recommendations (FAO/WHO/UNU, 2001; FAO/WHO, 2004) and dietary reference intake (Institute of Medicine, 2005). The recommended energy intake for this group of women was calculated at the level of 1.75 which corresponds to the activity level of rural women in less developed traditional villages who participate in agricultural work or walk long distances to fetch water and firewood. For lactating women, an energy increase of 500 Kcal/day was considered (FAO/WHO/UNU, 2001). Generally, women in the present study had less intake of energy compared to the recommended amounts. It was not immediately apparent as to what could be a contributing factor. However, it is suspected that it could be due to the limited knowledge among women as to what is considered to be

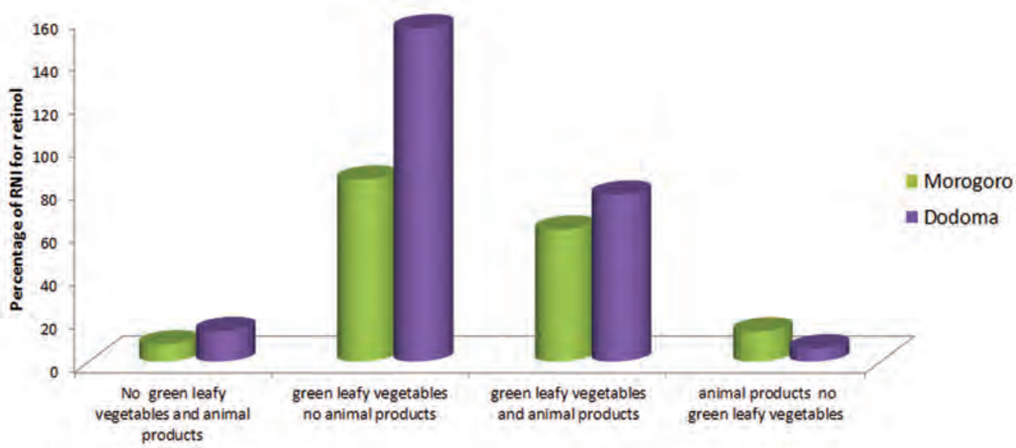

Figure 2: Retinol equivalent intake in women with and without consumption of green leafy vegetables and animal products relative to the Recommended intake/RNI

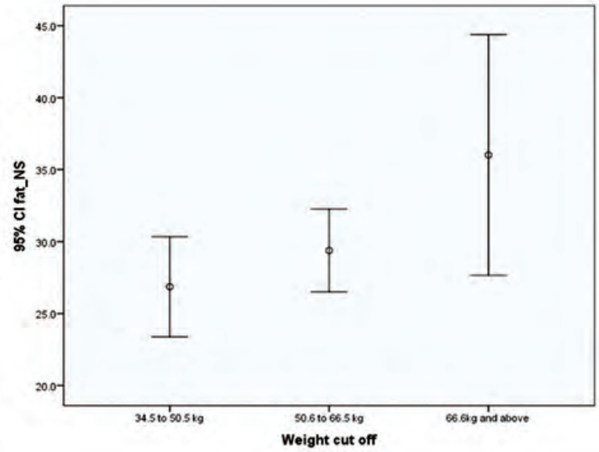

Figure 3: Weight of respondents and fat intake; the error bar represent 95% CI of the mean for each value. Each bullet represents an average intake for a given weight category

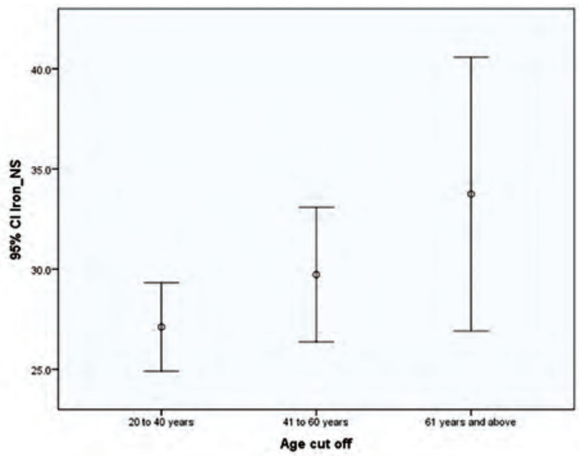

Figure 4: Age of respondents and iron intake; the error bar represent 95% CI of the mean for each value. Each bullet represents an average intake for a given age category

adequate intake. The low energy intake may imply that food production activities which are a major factor for this rural community welfare is lowered and may lead to low production and poor nutritional status of household members. These results are similar to other studies in rural areas in developing countries which found lower intake of energy than the recommended daily intake (Kinabo *et al.,* 2016). Much as both the two regions did not meet the recommended intake for energy, but the intake in Dodoma was even lower than that of Morogoro. This may be because in semi arid areas like Dodoma with only one rainfall season, food is much more scarce and production is lower due to the dry conditions compared to sub humid areas like Morogoro which have two rainfall seasons per year (Liwenga, 2003; Mnenwa and Maliti, 2010).

In addition, the study was conducted during a pre-harvest season where there is low food availability, which may have contributed to the observed low energy intake.

The mean total carbohydrate intake of women from both regions exceeded the RDA of 130 g/day. The higher carbohydrate intake observed could be because of the persistent pattern of cereal based food production and consumption in the study areas and the frequent consumption of tea/porridge with sugar and tea with meals usually reported for rural households (Mbwana *et al.,* 2016). Results from the 24 hour dietary recall indicated that the majority of respondents ate large amounts of food from staple cereals on a daily basis. In other studies in rural settings both higher (Hattingh, Walsh, Bester and Oguntibeju, 2008; Kinabo *et al.,* 2016) and lower (Martin, Pammla and Buza, 2014) carbohydrate intakes have been reported. This may have been contributed by the agro-climatic conditions of the areas and also food availability to meet the nutrient requirements. The mean total intake of protein among women from Morogoro met the recommended intake (Institute of Medicine, 2005), but in Dodoma, protein intake was below the recommended daily intake. The high intake of protein in Morogoro could be attributed to high and frequent consumption of legumes. In the current study legumes were reported to be consumed in place of meat which is very expensive. The low intake of protein in Dodoma may have resulted from inadequate intake of protein rich foods such as meat and dairy products as well as legumes. Another a study (Kinabo *et al.*, 2016) also reported low consumption of protein from rural farming households in Tanzania. This study suggested that the very low consumption of eggs and other animal foods reported by household members could have lead to the low intake.

In both regions fat, vitamin B_{12} and calcium intake among women were lower than the recommended dietary allowances. The inadequate intake of these nutrients could be explained by the low consumption of foods rich in these nutrients such as shell fish, beef liver, fish, milk and milk products, fresh green leafy vegetables and fortified cereals as indicated in our food consumption results. The low intake of vitamin B_{12} and calcium could also be caused by the low consumption of animal source foods as suggested in the research by the Nutrition Collaborative Research Support Program (NCRSP) which assessed the adequacy of the diet of children in Kenya, Egypt and Mexico and reported that consumption of animal based energy and protein were positively associated with intakes of Vitamin B_{12} and calcium among other nutrients (Neumann *et al.,* 2003). Also as indicated in the results of the current study, the consumption of dairy products was negligible. It should be noted that plant diets have relatively high quantities of nutrient inhibitors which decrease calcium absorption (Prentice *et al.,* 2009). In addition, when habitual diets are low in meat, it usually decreases the absorption of calcium by about 20 to 30% (Venti and Johnston, 2002).

Zinc intake of the women was far above the recommended values. The adequate intake of zinc may be a result of the fortification programme initiated by an alliance between the Tanzanian government, donors and food processing companies that was passed in the year 2012 which required all food manufacturing businesses to fortify wheat flour, maize flour and vegetable oil by adding trace amounts of zinc and/or other nutrients (MoHSWF, 2011). It has been reported that mandatory fortification of staple foods with micronutrients of interest may have influenced adequate intake in the diets of many people in South Africa (Kolahdooz, Spearing and Sharma, 2013). Another study assessed the impact of fortification with important micronutrients such as thiamine, riboflavin, niacin, vitamin B_6 and folate. Results indicated that mean levels of those micronutrients were increased (Steyn, Wolmarans, Nel, and Bourne, 2008). The evident zinc consumption seen could be explained by the fact that their bioavailability was not taken into consideration. However, Tanzania is far from achieving this level of intake because of the way households process their cereals.

The respondents in Dodoma met the recommended nutrient intake for vitamin A, vitamin C and iron; however in Morogoro the intakes were below the recommended values. This may be because the consumption of indigenous vegetables rich in vitamin A and C and iron in Dodoma was higher compared to that in Morogoro. Absorption of iron has been noted to be enhanced when consumed with vitamin C rich foods in the diet (Cook and Reddy, 2001). From the current study population, the consumption of vitamin C was mostly from green leafy vegetables. Consequently, the sufficient vitamin C intake from vegetables could perhaps have improved the iron in the diet of the women.

Consumption of both green leafy vegetables and animal source foods significantly increased micronutrient intake when compared with the consumption of green vegetables alone, animal source foods alone or non-consumption of the two groups. It is well documented that consumption of animal source foods is the key indicator of dietary quality. The inclusion of animal source foods in the diet promotes growth, cognitive function, physical activity and health, and is particularly important for children and pregnant women (Berti, Fallu, and Agudo, 2014; Ndlovu, 2010). In the current study, animal source foods had the lowest consumption in both regions. For example the consumption of fish was 9%, flesh, organ meat and milk and milk products were 4% each and that of eggs was 2%. Another study in the arid and semi-arid region in Kenya also reported very low consumption of animal source foods with consumption of only 4.6% by the respondents, and this low consumption was also reflected in the micronutrient intake of the respondents (Kimiywe and Chege, 2015).

As various minerals are more bio available from the animal source foods compared to the plant based foods, the observed lower intake of nutrients could be due to the low intake of animal source foods. Their low consumption may have contributed to the low intake of protein and inadequate intake of micronutrients (Bwibo and Neumann, 2003). Other studies in developing countries also reported scarcity of animal source foods in the diets of rural population even with the existence of a large local livestock (Bwibo and Neumann, 2003; Herrador *et al.*, 2015).
It is important to note that this study was cross-sectional in nature; so for this reason the reported intake reflects a one-day food consumption not usual intake, thus may vary over time.

Conclusions

The aim of this paper was to portray dietary patterns and to assess the nutrient intake of women of child bearing age in rural areas of Dodoma and Morogoro. Results suggest that the low intake of many nutrients important for women of child bearing age can mainly be ascribed to insufficient intake of fruits, vegetables, meat, milk and milk products and fish. Different nutrient consumption patterns between Dodoma and Morogoro were observed based on the type of foods produced in particular areas. Respondents in Dodoma generally had poorer nutrient intake compared to those of Morogoro. This provides a convincing evidence to support introduction of interventions and education on food and dietary intake that purposely accentuate increasing consumption of nutrients such as vitamin A, folic acid, vitamin B_{12}, vitamin C and calcium. Attention may be given at encouraging production and accessing different foods depending on the agro-climatic environment. This may be accomplished through supplementary education to rural households and especially on the significance of increasing their consumption of foods rich in the above nutrients. As the consumption of animal source foods was very low in this study, the role of animal source foods as a component of a healthy diet requires ongoing research. Provision of information leading to suitable strategies and recommendations to promote production and consumption of animal source foods is another area of focus.

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References

Alao, M. (2015). Dietary intake and nutritional status of the elderly in Osun State. Journal of Nursing and Health Science 4(1): 32–35.

Berti, P.R., Fallu, C. and Agudo, Y.C. (2014). A systematic review of the nutritional adequancy of the diet in the Central Andes. Review Panam Salud Publica 34(5): 314 – 323.

Bwibo, N.O. and Neumann, C.G. (2003). Animal source foods to improve micronutrient nutrition and human function in developing countries: Th need for animal source foods by Kenyan children. The Journal of Nutrition 133(5): 3875 – 4061.

Clapp, J. (2017). Food self-sufficiency: Making sense of it, and when it makes sense. Food Policy 66(2017): 88 – 96.

Cook, J.D. and Reddy, M.B. (2001). Effect of ascorbic acid intake on nonheme-iron absorption from a. The American Journal of Clinical Nutrition 73(3): 93–98.

Dickson, Y.N. (2015). Agricultural contributions of rural women to livelihood and food security: Case Study: Ngendzen Mbam, Nkum Sub Division, Cameroon. [http://www.paidafrica.org/paidwa/images/data/Ngah_Dickson.pdf] site visited on 2/2/2016.

Drewnowski, A. (2004). Special Article Poverty and obesity: The role of energy density and energy costs. The American Journal of Clinical Nutrition 79(1): 6–16.

FAO (2001). Human vitamin and mineral requirements: Report of a joint FAO/WHO Expert Consultation, Bangkok, Thailand. Food and Agriculture Organization, Rome.

FAO/WHO/UNU (2001). Human energy requirements: Report of a Joint FAO/WHO/UNU Expert Consultation. [http://www.fao.org/docrep/007/y5686e/y5686e00.htm] site visited on 2/2/2016.

FAO. (2008). Guidelines for measuring household and individual dietary diversity. Rome. Retrieved from http://agrobiodiversityplatform.org/files/2011/05/guidelines_MeasuringHousehold.pdf

Hattingh, Z., Walsh, C.M., Bester, C.J. and Oguntibeju, O.O. (2008). Evaluation of energy and macronutrient intake of black women in Bloemfontein: A cross-sectional study. African Journal of Biotechnology 7(22): 4019 – 4024.

Herrador, Z., Perez-Formigo, J., Sordo, L., Gadisa, E., Moreno, J., Benito, A. and Custodio, E. (2015). Low dietary diversity and intake of animal source foods among school aged children in libo kemkem and fogera districts, Ethiopia. PLoS ONE 10(7): 1–18.

Institute of Medicine (2005). Dietary Reference Intakes: Recommended Dietary Allowances and Adequate Intakes, Vitamins Food and Nutrition Board. Institute of Medicine, National Academies. Food and Nutrition Board, Washington, DC.

Kimiywe, J. and Chege, P.M. (2015). Complementary feeding practices and nutritional status of children 6-23 months in Kitui County , Kenya. Journal of Applied Biosciences 85 (2015): 7881–7890.

Kinabo, J., Mamiro, P., Dawkins, N., Bundala, N., Mwanri, A., Majili, Z. and Msuya, J. (2016). Food intake and dietary diversity of farming households in Morogoro region, Tanzania. African Journal of Food, Agriculture, Nutrition and Development 16(4): 11295–11309.

Kolahdooz, F., Spearing, K. and Sharma, S. (2013). Dietary Adequacies among South African Adults in Rural KwaZulu-Natal. PLoS ONE 8(6), 1-22.

Liwenga, E. (2003). Food Insecurity and Coping Strategies in Semiarid Areas The Case of Mvumi in Central Tanzania. Stockholm.

Lukmanji, Z., Hertzmark, E., Spiegelman, D., Spiegleman, D. and Fawzi, W.W. (2013). Dietary patterns, nutrient intake, and sociodemographic characteristics in HIV-infected Tanzanian pregnant women. Ecology of Food and Nutrition 52(1): 34–62.

Martin, H., Pammla, P. and Buza, J. (2014). Low macronutrients intake and associated factors among Maasai women of reproductive age. American Journal of Research Communication, 2(12): 10–21.

Mazengo, M.C., Simell, O., Lukmanji, Z., Shirima, R. and Karvetti, R. L. (1997). Food consumption in rural and urban Tanzania. Acta Tropica 68(3): 313–326.

MoHSWF/GoT/GAIN. (2011). Fortification of wheat flour and vegetable oil in Tanzania. [https://extranet.who.int/nutrition/gina/sites/default/files/TZA%202011%20National%20Nutrition%20S.pdf] site visited on 18/8/2016.

Mnenwa, B.R. and Maliti, E. (2010). A Comparative Analysis of Poverty Incidence in Farming Systems in Tanzania: Special Paper No. 4. Research on Poverty Alleviation, Dar es Salaam, Tanzania. 37pp.

Mutabazi, K.D. (2013). Identifying, Defining and Typologizing FVC and Upgrading Strategies. A Trans-SEC document, Morogoro. 50 pp.

NBS/ICFI (2016). Demographic and Health Survey and Malaria Indicator Survey 2015-16. Dar es Salaam, Tanzania, and Rockville, Maryland, USA. 65 pp.

National Bureau of Statistics and ICF Macro (2010). Tanzania Demographic and Health Survey 2009–10 Preliminary Report. National Bureau of Statistics. Dar es Salaam. 55 pp.

NBS/ICF Macro (2011). Micronutrients: Results of the 2010 Tanzania Demographic and Health survey. Dar es Salaam. 73 pp.

Ndlovu, L.R. (2010). The Role of Foods of Animal Origin in Human Nutrition and Health. National University of Science and Technology Zimbabwe.

Neumann, C.G., Bwibo, N.O., Murphy, S.P., Sigman, M., Whaley, S., Allen, L.H., Guthrie, D., Weiss, R.E. and Demment, M.W. (2003). Animal Source Foods to Improve Micronutrient Nutrition and Human Function in Developing Countries: The Impact of Dietary Intervention on the Cognitive Development of Kenyan School Children. Journal of Nutrition 133(11): 3965–3971.

Prentice, A., Schoenmakers, I., Jones, K. S., Jarjou, L.M.A. and Goldberg, G.R. (2009). Vitamin D deficiency and its health consequences in Africa. Clinical Reviews in Bone and Mineral Metabolism 7(1): 94–106.

Ronner, E. and Giller, K.E. (2013). Background information on agronomy, farming systems and ongoing projects on grain legumes in Tanzania.

Sneyd, L.Q. (2013). Wild food, prices, diets and development: Sustainability and food security in Urban cameroon. Sustainability Switzerland 5(11): 4728–4759.

Steyn, N.P., Wolmarans, P., Nel, J.H. and Bourne, L.T. (2008). National fortification of staple foods can make a significant contribution to micronutrient intake of South African adults. Public Health Nutrition 11(3): 307–313.

Temple, N.J., Steyn, N.P., Fourie, J. and De Villiers, A. (2011). Price and availability of healthy food: A study in rural South Africa. Nutrition 27(1): 55–58.

Venti, C.A. and Johnston, C.S. (2002). Modified food guide pyramid for lactovegetarians and vegans. The Journal of Nutrition 132(5): 1050–1054.