

## Dietary intake and diversity among children of age 6–59 months in lowland and highland areas in Kilosa District in Morogoro, Tanzania

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### ABSTRACT

Adequate nutrition during infancy and early childhood is essential to ensure children's growth, health, and development to their full potential. Geographical area may influence dietary intake and, hence, the population's nutritional status. This study aimed to assess dietary intake among children aged 6–59 months in the lowland and highland areas in the Kilosa District, Morogoro. A cross-sectional study involved 200 randomly selected households from the lowland and 141 in the highland areas. Socio-demographic characteristics, feeding practices, and 24-h dietary recall information were collected using a pre-tested questionnaire. In assessing dietary intake, a single day 24-h dietary recall was used where a mother/care giver was asked to recall foods and beverages fed to the child in the 24 h prior to the interview. Mean daily nutrient intake (calorie, vitamin A, iron, calcium and zinc) were estimated using NutriSurvey version 2007 with food database from Tanzania Food composition table. Furthermore, Dietary Diversity Score was done by grouping the mentioned foods into the seven main food groups which are grains, roots and tubers; legumes and nuts; Vitamin A rich fruits and vegetables; other fruits and vegetable; dairy products; and flesh foods and eggs. For each food group consumed, a score of one was assigned and a zero score for the non-consumed group. Inadequate intakes of vitamin A, calcium, and iron were observed more in younger children of age 6–12 months, where none of them met the RDA in both areas. There was a significant difference only in fat intake in children aged 12–36 months between the lowland and highland areas. Children who reside in the lowland area had a significantly more diversified diet. Nutrition education with promotion of home gardening and keeping small animals is necessary to ensure household food availability which subsequently will facilitate dietary diversification.

### 1. Introduction

Infant and young child feeding is key to improving child survival and promoting healthy growth and development [1]. As a case, World Health Organization (WHO) and United Nations Children's Fund (UNICEF) recommend exclusive breastfeeding at the first six months of a child's life and continue breastfeeding up to two years or beyond together with health complementary feeding [2]. World Health organization defines complementary feeding as "a process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk" [3]. Adequate nutrition during infancy and early childhood is essential to ensure children's growth, health, and development to their full potential [2]. Appropriate feeding practices during early childhood stimulate psycho-social development, lead to good nutritional status and

physical growth, reduce susceptibility to common childhood infections and improve resistance to cope with them [4].

Inadequate dietary intake is one of the immediate causes of malnutrition, especially undernutrition, including wasting, stunting, underweight, and deficiencies in vitamins and minerals. Iodine, vitamin A, and iron deficiencies represent a major threat to the health and development of populations worldwide, particularly children and pregnant women in low-income countries. Undernutrition makes children much more vulnerable to disease and death [5]. Nearly half of all deaths in children below five years are attributable to undernutrition, translating into the loss of about 3 million young lives a year [6]. Most deaths occur in low- and middle-income countries [5]. The high prevalence rate of nutrient deficiencies observed in developing countries is mainly due to inadequate dietary energy and protein intake, the low content of micronutrients in the diet, and poor bioavailability [7].

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Although WHO has clearly defined complementary food; as should be of appropriate diversity, frequency, portion size, safe prepared and feeding infant or young child in response to their cues [8]; it still practiced differently. The studies on feeding practices conducted in different rural African countries came up with different findings. Almost all mothers breastfed their children but prevalence of exclusive breastfeeding for six months is generally very low [9–11]. Furthermore, most studies reported less diversified diets as a problem among children, of which grains, tubers and roots food group was highly consumed while very few consumed dairy and egg food groups [12–16]. In addition, the studies which analysed the nutrient intake of children came with varied results. A study conducted by Abdul-Aziz and Devi [17] in Selangor Malaysia reported that calories, fat, iron and protein intake among rural children was higher than Recommended Nutrient Intake (RNI) while the study conducted in Nigeria by Akerele et al. [18] found substantial proportional of households suffer deficiency of calories, proteins and micronutrients. Furthermore, a review done by Govender et al. [19] reported that children in rural Kwa Zulu Natal consume more energy, protein, fat and carbohydrate while fibre and micronutrient intake is poor.

Inadequate feeding has been reported as one of the immediate causes of malnutrition. In Tanzania malnutrition is still a significant health problem in infants and young children. Prevalence of stunting and underweight of 33.4% and 11.5% respectively was reported in Morogoro Region [20] and much higher prevalence of stunting (50.7%) and underweight (15.8%) were recently reported in Kilosa district [21]. It was further observed that children living in highland area of Kilosa District were more stunted and underweight (64.6 and 22%) compared to those living in lowland area (41.0 and 11.5%) respectively [21].

Although it is well documented that inadequate dietary intake is the immediate cause of undernutrition [22], the causes may differ from place to another. Due to different rates of undernutrition observed between lowland and highland of Kilosa District, therefore, this study aimed to compare dietary intake and diversification among children aged 6–59 months in lowland and highland areas of Kilosa District in Morogoro, Tanzania.

## 2. Materials and methods

**Study setting and design:** Kilosa district is one of the eight districts of Morogoro region. Kilosa extends between latitude 5°55' and 7°53' South and longitudes 36°30' and 37°30' East [23]. A cross-sectional study design was conducted in five randomly selected villages, three in lowland and two in highland areas. A total of 200 households with a child aged 6–59 months from the lowland and 141 from the highland areas were randomly selected to participate in the study. In case there was more than one child from the target age group in one household, the youngest child was selected. The main respondent was the mother/care taker of the index child. More households were taken in lowland areas to cover the population difference between lowland and highland area.

**Data collection:** Mothers with children 6–59 months of age who were willing to participate in this study were interviewed using a pre-tested questionnaire. Information collected included socio-demographic characteristics and child feeding practices (breastfeeding and complementary feeding). In assessing dietary intake, one day 24-h dietary recall was used where a mother/care giver was asked to recall foods and beverages fed to the index child in the 24 h prior to the interview using a validated questionnaire used by Tanzania Food and Nutrition Centre during conducting Demographic and Health Survey [20] and Tanzania National Nutrition Survey [24]. A mother/caregiver was requested to show the local utensils such as bowl, cup or plate used and amount of food fed to the child in order to estimate the food portion/weight in grams. Kitchen weighing scale (TANITA digital kitchen scale) was used to estimate actual weight of the foods and measuring cylinders were used for liquid foods. Other common household measures such as cups, plates, serving spoons and bowls were used to estimate

portion size. Fruits were purchased from the market/food stalls and different sizes were weighed and used to estimate portion size. The 24 h dietary recall information was used to calculate Dietary Diversity Score where the foods mentioned were then grouped into the seven main food groups which are grains, roots and tubers; legumes and nuts; Vitamin A rich fruits and vegetables; other fruits and vegetable; dairy products; and flesh foods and eggs [8]. For each food group consumed, a score of one was assigned and a zero score for the non-consumed group.

**Data processing and analysis:** Statistical Package for the Social Sciences (SPSS) version 20 was used to analyse data where descriptive statistics such as mean, standard deviations, frequencies and percentages were generated. Moreover, analysis of feeding practices was done by Chi square. Mean daily nutrient intake (energy, protein, fat, carbohydrate, vitamin A, calcium, iron and zinc) were estimated using NutriSurvey for Windows software version 2007 [25] with the standard food database. In case recipe information was not available, nutrient content of food from Tanzania Food Composition Table [26] were uploaded in nutrisurvey program. The mean intake values of energy, protein, fat, carbohydrate, vitamin A, calcium, iron and zinc were expressed as amount per day and compared by recommended daily intake (RDI/RDA) [27]. Comparison on nutrient intake between lowland and highland was done by Tukey's Honest Significant difference. Dietary diversity score (DDS) was calculated by summing up all the food groups eaten by the index child in the last 24 h preceding the survey [8]. Children who consumed four or more food groups were considered to have had a diversified diet. Comparison on dietary diversity between lowland and highland was analysed by *t*-test using continuous data.

**Ethical consideration and study permit:** Research proposal was approved and research permit granted from Muhimbili University of Health and Allied Science (MUHAS) with Ref. No. 2016-10-19/AEC/Vol. XI/307. In addition, permission letter was obtained from Sokoine University of Agriculture (SUA) and District Executive Director of Kilosa. Details of the study were well explained to the mothers/caretakers, before commencement of data collection and they provided written consent.

## 3. Results

### 3.1. Socio-demographic characteristics

About 47% of the mothers were within the age range of 25–34 years and 82% were married. About half of the children were boys and majority were at the age range of 36–59 months. About three out of four respondents had attained primary education and agriculture was the main source of income for about half of the households (Table 1).

### 3.2. Infant and young child feeding practices

Almost all children were breastfed. However, only 57.2% were breastfed within 1 h after birth and about 98% were breastfed on demand. Different time for breastfeeding initiation was observed between lowland and highland areas of which nearly half of mothers in highland (49%) initiated breastfeeding after 1 h from birth. Majority of the children (74%) in lowland were exclusively breastfed for six months and compared to 65.2% in highland area. Early complementation was noted among about 30% of the children, majority being from the highland areas (Table 2).

### 3.3. Calories and selected nutrient intake in the lowland area

The mean calorie and nutrient intake of majority of children was below Recommended Dietary Allowance (RDA). All age groups did not meet the RDA for calcium. Generally, less than half of the children (43%) met their RDA for protein. All of infants (6–12 months of age) did not meet the RDA for fat, vitamin A, calcium and iron (Table 3).

**Table 1**  
Demographic characteristics of the studied population.

Socio-demographic information	Lowland (N = 200)		Highland (N = 141)		Total (N = 341)	
	n	%	n	%	n	%
<b>Marital status</b>						
Single	33	16.5	28	19.9	61	17.9
Married	167	83.5	113	80.1	280	82.1
<b>Maternal education level</b>						
Informal education	36	18	25	17.7	61	17.9
Primary	147	73.5	107	75.9	254	74.5
Secondary/university	17	8.5	9	6.4	26	7.6
<b>Occupation of mother</b>						
Farmer	185	92.5	139	98.6	324	95
Employed	5	2.5	0	0	5	1.5
Business	10	5.0	2	1.4	12	3.5
<b>Household main source of income</b>						
Salary/wage	9	4.5	0	0	9	2.6
Agriculture	107	53.5	69	48.9	176	51.6
Business	17	8.5	2	1.4	19	5.6
Casual labour	67	33.5	70	49.7	137	40.2
<b>Head of household</b>						
Male	169	84.5	115	81.6	284	83.3
Female	31	15.5	26	18.4	57	16.7
<b>Age of mothers/caregiver</b>						
14–24	56	28	57	40.4	113	33.2
25–34	98	49	62	44	160	46.9
≥35	46	23	22	15.6	68	19.9
<b>Sex of children</b>						
Boys	106	53	68	48.2	174	51
Girls	94	47	73	51.8	167	49
<b>Children age</b>						
6–23 months	63	31.5	51	36.2	114	33.4
24–35 months	58	29	44	31.2	102	29.9
36–59 months	79	39.5	46	32.6	125	36.7

### 3.4. Dietary intake in the highland area

Mean intakes of almost all nutrients in nearly all age categories were below RDA. Generally, 44.7% of the children met their RDA for protein and none met the RDA for calcium. In group of infants (6–12 months of age), very few (5.6%) met RDA for vitamin A but none met RDA for calcium, iron and zinc. About half of the children (52%) aged 13–36 months old met their RDA for protein compared to other age groups (Table 4).

### 3.5. Dietary energy intake

Generally, only 20.5% of children met their RDA for energy. More than half of the children below 24 months of age met their RDA for energy compared to the older children (24 months and above). Based on geographic area, majority of children (85.7%) aged 9–11 months in highland met their RDA for energy compared to their peers in lowland area (62.5%) (Fig. 1).

### 3.6. Comparison of nutrients intake between lowland and highland areas

Dietary intake was compared between lowland and highland areas (Table 5); there was a significant difference only in fat intake in children aged 13–36 months between the lowland and highland areas. Differences in other nutrients between lowland and highland areas were observed although the difference was not significant.

### 3.7. Dietary diversity among children of age 0–59 months

Grain, roots and tubers (starchy foods) were the most popular food groups consumed by children (99.1%) followed by legumes and nuts

**Table 2**  
Young children feeding practices in the lowland and highland areas<sup>3</sup>.

Variable	Lowland (N = 200)		Highland (N = 141)		Total (N = 341)		P value
	n	%	n	%	n	%	
<b>Breast feeding</b>							
No	2	1	0	0	2	0.6	
Yes	198	99	141	100	339	99.4	
<b>Initiation of breast feeding*</b>							
I don't know	2	1	7	5	9	2.6	
Within 1 h	132	66.7	63	47.7	199	57.2	
1–6 h	64	32.3	69	48.9	134	39	
More than 6 h	2	1	2	1.4	4	1.2	
<b>Frequency of breastfeeding/day</b>							
On demand	195	97.5	138	97.9	333	97.7	
Twice	0	0	1	0.7	1	0.3	
Three times	1	0.5	0	0	1	0.3	
Four times	4	2	2	1.4	6	1.7	
<b>Exclusive breastfeeding (6 months)</b>							
No	52	26	49	34.8	101	29.6	0.069
Yes	148	74	92	65.2	240	70.4	
<b>Breastfeeding duration</b>							
7–12 months	4	2	3	2.1	7	2.1	0.484
13–18 months	16	8	15	10.6	31	9.1	
24+ months	128	64	76	54	204	59.8	
Were continue breastfeeding	52	26	47	33.3	99	29	
<b>Time started complementary food*</b>							
<6 months	52	26	49	34.8	101	29.6	0.04
On 6 months	138	69	87	61.7	225	66	
>6 months	10	5	5	3.5	15	4.4	
<b>No. Of meals per day*</b>							
One	6	3	2	1.4	8	2.4	0.009
Two meals	25	12.5	23	16.3	48	14.1	
Three meals	134	67	109	77.3	243	71.2	
Four meals	22	11	5	3.6	27	7.9	
More than four meals	13	6.5	2	1.4	15	4.4	

\*Significant difference between highlands and lowlands ( $p < 0.05$ ) (Chi-square).

<sup>a</sup> Chi-square test done when the n values are >1 in most of the cells.

(64.2%). Eggs and dairy products were the least consumed. It is important to note that vitamin A rich fruits and vegetable were also rarely consumed (Table 6).

### 3.8. Dietary diversity score

Dietary diversity scores of children in the lowland and highland areas are summarized in Table 7. Majority of children (80.6%) consumed less than four food groups. Only 19.4% consumed a minimum of four or more food groups. Children in the lowland area had more diversified diet compared to the highland area children ( $p = 0.04$ ).

## 4. Discussion

The present study aimed to assess dietary intake and diversity in children aged 6–59 months in Kilosa District and has highlighted inadequate nutrient intake and poor dietary diversity. Almost all children were breastfed in both lowland and highland areas of Kilosa where majority were exclusively breastfed for six months. The observed exclusive breastfeeding rate is higher compared to country average reported in TDHS-MIS [20] and it was also higher compared to world-wide exclusive breastfeeding rate (40%) [28]. Currently, exclusive breastfeeding rate increased in Tanzania from 41% in 2004/05, 50% in 2010 to 59% in 2015 [20]. The observed high rates in this study could be a result of recent emphasis of exclusive breast feeding during antenatal clinic visits. Exclusive breastfeeding could be one of the factors contributed to the observed decrease of undernutrition in Tanzania, as human milk contains hundreds to thousands of distinct bioactive molecules protect against infection and inflammation and contribute to immune maturation, organ development, and health microbial

**Table 3**  
Protein, fat, carbohydrate, vitamin A, calcium, iron and zinc intake of children 6–59 months in lowland area.

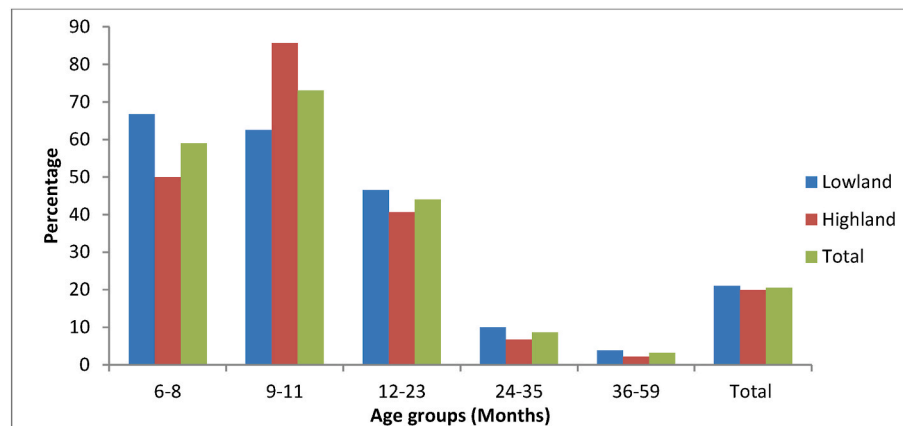
	Nutrients						
	Protein (g)	Fat (g)	Carbohydrate (g)	Vit. A (µg)	Calcium (mg)	Iron (mg)	Zinc (mg)
<b>6–12 months</b>							
Mean (±SD)	8.7(7.5)	5.5(5.7)	61.0(33.8)	121.0(177.2)	52.5(51.8)	2.8(2.1)	1.4(0.9)
n(%) met RDA	7(28)	0(0)	4(16)	0(0)	0(0)	0(0)	2(8)
<b>13–36 months</b>							
Mean(±SD)	18.4(14.1)	14.7(10.8)	116.5(64.3)	234.9(282.5)	80.5(46.3)	6.5(4.4)	3.1(2)
n(%) met RDA	54(54)	6(6)	27(27)	34(34)	0(0)	19(19)	38(38)
<b>37–59 months</b>							
Mean(±SD)	19.8(9.4)	13.7(5.2)	129.2(43.9)	343.7(322.3)	94.8(39.6)	6.7(2.3)	3.5(1.4)
n(%) met RDA	25(33.3)	1(1.3)	29(38.7)	29(38.7)	0(0)	3(4)	9(12)
<b>Total</b>							
Mean(±SD)	17.8(13.1)	13.3(9.7)	114.0(61.9)	263.8(300.4)	82.4(47.9)	6.1(4)	3.0(1.9)
n(%) met RDA	86(43)	7(3.5)	60(30)	63(31.5)	0(0)	22(11)	49(24.5)

\*n (%) met RDA- Number and percentage of the children who met Recommended Daily allowance.

**Table 4**  
Protein, fat, carbohydrate, vitamin A, calcium, iron and zinc intake of 6–59 months children in highland area.

	Nutrients						
	Protein (g)	Fat (g)	Carbohydrate (g)	Vit. A (µg)	Calcium (mg)	Iron (mg)	Zinc (mg)
<b>6–12 months</b>							
Mean (±SD)	6.4(5.1)	3.0(2.3)	69.7(57.9)	37.1(105.6)	30.4(23.1)	2.6(1.6)	1.3(0.8)
n(%) met RDA	3(16.7)	0(0)	5(27.8)	1(5.6)	0(0)	0(0)	0(0)
<b>13–36 months</b>							
Mean (±SD)	15.4(7.60)	11.4(5.6)	110.5(38.8)	290.8(215)	81.8(37)	5.6(1.9)	2.9(1.1)
n(%) met RDA	40(51.9)	1(1.3)	24(31.2)	37(48.1)	0(0)	13(16.9)	35(45.5)
<b>37–59 months</b>							
Mean (±SD)	19.2(5.7)	14.8(5.1)	121.1(36.2)	333.4(280.3)	98(38.2)	7.1(1.9)	3.6(0.9)
n(%) who met RDA	20(43.5)	1(2.2)	17(37)	17(37)	0(0)	6(13)	3(6.5)
<b>Total</b>							
Mean (±SD)	15.5(7.7)	11.4(6.2)	108.7(43.5)	272.3(245.4)	80.5(41.2)	5.7(2.3)	2.9(1.2)
n(%) who met RDA	63(44.7)	2(1.4)	46(32.6)	55(39)	0(0)	19(20.6)	38(27)

\*n(%) met RDA- Number and percentage of the children who met Recommended Daily allowance.



**Fig. 1.** Percentage of children who met RDA for energy intake.

**Table 5**  
Comparison on nutrients intake between lowland and highland\*.

Child Age	Location	Energy M±SD	Protein M±SD	Fat M±SD	CHO M±SD	Calcium M±SD	Iron M±SD	Zinc M±SD	Vitamin A M±SD
6–12 months	Lowland	300.3 ± 188.8 <sup>a</sup>	7.4 ± 7.0 <sup>a</sup>	4.9 ± 5.3 <sup>a</sup>	59.3 ± 36.3 <sup>a</sup>	35.9 ± 39.9 <sup>a</sup>	2.5 ± 2.1 <sup>a</sup>	0.8 ± 0.7 <sup>a</sup>	73.9 ± 147.8 <sup>a</sup>
	Highland	320.7 ± 246.8 <sup>a</sup>	6.4 ± 5.1 <sup>a</sup>	3.0 ± 2.3 <sup>a</sup>	69.7 ± 57.9 <sup>a</sup>	30.4 ± 23.1 <sup>a</sup>	2.6 ± 1.6 <sup>a</sup>	1.0 ± 0.6 <sup>a</sup>	37.1 ± 105.6 <sup>a</sup>
13–36 months	Lowland	642.6 ± 368.6 <sup>a</sup>	18.2 ± 13.9 <sup>a</sup>	14.5 ± 10.7 <sup>a</sup>	113.9 ± 64.4 <sup>a</sup>	82.6 ± 46.9 <sup>a</sup>	6.4 ± 4.4 <sup>a</sup>	3.1 ± 1.9 <sup>a</sup>	243.1 ± 278.8 <sup>a</sup>
	Highland	588.6 ± 201.3 <sup>a</sup>	15.4 ± 7.6 <sup>a</sup>	11.5 ± 5.7 <sup>b</sup>	109.7 ± 38.5 <sup>a</sup>	82.2 ± 37.0 <sup>a</sup>	5.6 ± 1.9 <sup>a</sup>	2.8 ± 1.1 <sup>a</sup>	294.1 ± 214.5 <sup>a</sup>
37–59 months	Lowland	705.9 ± 213.7 <sup>a</sup>	19.7 ± 9.3 <sup>a</sup>	13.7 ± 5.3 <sup>a</sup>	129.1 ± 43.4 <sup>a</sup>	91.7 ± 35.1 <sup>a</sup>	6.7 ± 2.3 <sup>a</sup>	3.5 ± 1.4 <sup>a</sup>	334.8 ± 322.8 <sup>a</sup>
	Highland	680.9 ± 162.2 <sup>a</sup>	19.1 ± 5.7 <sup>a</sup>	14.6 ± 5.1 <sup>a</sup>	122.0 ± 36.4 <sup>a</sup>	101.1 ± 42.2 <sup>a</sup>	7.1 ± 1.9 <sup>a</sup>	3.6 ± 0.9 <sup>a</sup>	327.2 ± 280.5 <sup>a</sup>

\*Values followed by the same superscript letters within the column do not differ significantly at  $p \leq 0.05$  according to Tukey's Honest Significant difference.

**Table 6**

Distribution of the children by food group they consumed in lowland and highland.

Food groups	Lowland (n = 200)		Highlands (n = 141)		Total (N = 341)	
	n	%	n	%	n	%
Grains, roots and tubers	197	98.5	141	100	338	99.1
Legumes and nuts	136	68	83	58.9	219	64.2
Other fruits and Vegetable	114	57	93	66	207	60.7
Flesh food	52	26	51	36.2	103	30.2
Vitamin A rich Fruits and vegetable	34	17	8	5.7	42	12.3
Dairy product	6	3	2	1.4	8	2.3
Egg	3	1.5	1	0.7	4	1.2

**Table 7**

Dietary diversity scores in lowland and highland.

Geographic area	Lowland (N = 200)		Highland (N = 141)		$\chi^2$	Degree of Freedom	P value
	n	%	n	%			
<b>Dietary diversity scores</b>							
<4 food groups	154	77	121	85.8	4.12	1	0.04*
≥4 groups and above	46	23	20	14.2			

\*Significant at  $p < 0.05$ .

colonization [29]. However, it may also not reflect the true picture because in the rural communities, water and other drinks are not considered as foods hence the actual exclusive breastfeeding rate may be lower than reported in this study. A study by Kulwa et al. [13] in rural central Tanzania reported that majority of the children were breastfed as recommended but many were introduced to liquids earlier than recommended six months.

Initiation of breastfeeding within 1 h after birth was higher in lowland than in highland areas but in both areas children were breastfed on demand. Most mothers in highland area had few antenatal clinic visits ( $\leq 3$ ) due to long walking distance to the health facility so are not well informed on importance of early initiation of breastfeeding. There was relatively high home delivery in the highland areas hence limited emphasis for initiation of breastfeeding within 1 h. To improve the current situation on early initiation of breast feeding, facility delivery should be emphasized especially for women residing in highland areas.

Majority of the mothers/caregivers introduced complementary food at the right time though diversification was a problem where about 81% of the children failed to meet a minimum dietary diversity of four or more food groups. The foods introduced were mostly starchy foods with limited animal source foods. Animal source foods are very important to children as it fills multiple nutrient gaps at lower volume of intake than can plant source foods. Animal source foods not only having many micronutrients but also the nutrients are often more bioavailable [30]. It is hard to attain the recommended amount of zinc, iron and riboflavin by eating only plant source foods. Observed poor diversification can be due to poor knowledge on nutrition. For example, the period of data collection was mango season and almost all households had mango trees but only 12.3% of the children consumed vitamin A rich fruits. It is a usual practice that fruits are not given to children especially for those who are below two years of age and are unable to pick on their own. Another reason could be due availability where grains (maize and rice) are produced by almost all households and due to low purchasing power, many households cannot afford to buy other foods that they do not produce. Poor dietary diversity is also the problem at national level. Tanzania Demographic and Health Survey reported that only twenty six percent of children had an adequately diverse diet while 40% had been fed the minimum recommended number of times according to their age [20]. Most studies in rural population from different countries reported

low dietary diversification [12–16].

Nearly, all the infants did not meet RDA for almost all nutrients except dietary energy. Twenty-four-hour dietary recall revealed that most of the infants were only fed maize or rice porridge with sugar or salt which are poor sources of other nutrients such as protein, vitamins and minerals. Children who do not consume a recommended minimum dietary diversity reported to have an increased odds of being malnourished compared to their counterpart [14–16]. This was proven by nutritional status assessment of the same children in the study area (Kilosa district) where young children (6–23 months) had higher prevalence of stunting compared to older children [21].

Some of the children aged above one year met RDA for protein, carbohydrate and vitamin A. This group eats family foods in which stiff porridge and rice are the good sources of carbohydrate. Kidney bean is a good source of protein and vitamin came from green leafy vegetables like sweet potato leaves, pumpkin leaves and amaranth. Like the infants, none in this group met RDA for calcium probably because foods rich in calcium like eggs and milk were rarely consumed. Egg and dairy products were least consumed, reported by only about 2% of the studied children. As Kilosa district is being engaged in both crop production and livestock keeping, cereals and animal source foods are available. Maize is a dominant crop grown by almost every household while cattle, goat, sheep, pig and poultry are kept by most households, with chicken kept by every household [31]. The study conducted in Dodoma and Morogoro found that the livestock keeping is a significant predictor for consuming animal source foods [32]. Despite being a significant predictor, the focus group discussion revealed that ASF consumption from homestead production is not part of the habitual household practice due to the monetary and socio-cultural value attached to the livestock. The motives for producing livestock is to sell and obtain household income as livestock is important means for providing immediate cash in case of unexpected events. Also, the same study found that having large number of livestock especially cattle, goat, sheep and pig, is a prestige for a family and a symbol of wealth [32].

Beside, literacy, status of the mother and prior nutrition training/knowledge reported as determinants for household dietary diversity in Morogoro [33]. This implies that the availability of nutritious food is not an assurance that will be consumed but nutrition education is also important to enhance the wise selection of food groups. This study concurs with a study conducted in Kenya, where it was confirmed that the diets of children were predominantly based on starchy staples [12]. Also, the similar results were reported in Tanzania that, there was limited inclusion of other nutrient-dense foods (e.g. legumes, beef, fish, sardines, vegetables) in the meals and only few infants consumed these foods [13]. Complementary foods being too dilute, not fed often enough or in too small amounts, or replacing breast milk while being of an inferior quality were mentioned as the challenges of complementary feeding [2]. Feeding frequency is generally low among the rural Tanzanian children. Though WHO recommends 3–4 meals per day plus 1–2 snacks, in this study majority of children were fed three times per day and less than 10% were fed four times per day. This could be the reason for the observed inadequate intake of most of the nutrients.

## 5. Conclusion

Generally, most complementary foods were cereal based with limited consumption of animal source foods and fruits. Majority of the studied children consumed less than four food groups hence had less diversified diets where a significant difference was noted; children in lowlands had relatively more diversified diet compared to those from the highlands. Most children did not meet iron, calcium, zinc and vitamin A intake and the results were similar in both geographic areas.

## Recommendations

The government and partners working in nutrition field should

provide nutrition education on proper child feeding practices and on the use of locally available foods to caregivers and household members. In addition, promotion of kitchen garden and keeping small animals is necessary to ensure food availability.

### Ethical approval

The research protocol was submitted to Muhimbili University of Health and Allied Sciences for review and approval. Permission and ethical clearance letter with the reference: 2016-10-19/AEC/Vol.X I/307 was granted. Permission was also granted by the Deputy Vice-Chancellor of the Sokoine University of Agriculture.

### Consent to participate

Informed written and signed consent was obtained from each participant. Parents of eligible children were informed of the objectives and activities of the research. The participants were also informed that no risks were anticipated from the study. Actually, participants were also informed the right to leave the study at any time. Confidentiality of the study participants were followed throughout the study and all information was stored in secured environment.

### Consent for publication

All authors consented to the publication of this manuscript.

### Authors' contributions

All authors have read and approved the manuscript and have agreed to its resubmission. All of them have contributed significantly. All authors have agreed that the corresponding author has the authority to act on their behalf. The manuscript has not been published and is not under consideration for publication elsewhere. None of the authors has any conflict of interest to declare.

### Data availability

The datasets used during the current study are available from the corresponding author on request.

### Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Jackline D. Mrema reports financial support was provided by One Health Central and East Africa (OHCEA).

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### Abbreviations

ASF	Animal Source Foods
DDS	Dietary Diversity Score
FAO	Food and Agriculture Organization
MUHAS	Muhimbili University of Health and Allied Sciences
RDA	Recommended Daily Allowance
RNI	Recommended Nutrient Intake
SPSS	Statistical Package for Social Sciences
TDHS	Tanzania Demographic and Health Survey
WHO	World Health Organization

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