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DIETARY DIVERSITY AMONG CHILDREN AGED 6-59 MONTHS FROM SETTLED PASTORAL COMMUNITIES IN MARSABIT COUNTY, KENYA

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ABSTRACT

Settlement among pastoralists is expected to facilitate access to social amenities. However, information on its impact on dietary changes and undernutrition under five children is limited. This study aimed to determine dietary diversity among children aged 6-59 months in settled pastoral households. In a cross sectional survey, 394 households with index child were randomly sampled using multistage technique. A pre-tested questionnaire was used to collect information on population characteristics and dietary diversity. A dietary diversity score and minimum dietary diversity of the children were then calculated by summing the number of food groups from 0 to 7 eaten by the child 24 hours from the previous day. Categorical data was presented as proportions, while continuous variables mean ± standard error. Chi-square and analysis of variance were used to establish population differences. Linear regression was used to assess the relationship between population characteristics and dietary diversity. Logistic regression was used to assess the association between food groups and child nutritional status. Results showed that 51.5% of children never met minimum dietary diversity. Cereals, roots and tubers were the most frequently consumed food group at 97%. Distance to market ($P<0.05$), household head education ($p<0.05$), caregiver occupation ($p<0.05$) and income were associated with dietary diversity. Eating legumes (OR= 0.50, 95% C.I (0.30, 0.85); $p = 0.010$) and vitamin A rich fruits and vegetables (OR= 0.50, 95% C.I (0.30, 0.85); $p = 0.010$) showed reduced odds of stunting while dairy products reduced the risk of a child becoming underweight [AOR=.2.09, 95% C.I (1.16 - 3.79); $p = 0.015$]. Overall, the findings highlight significant gaps in meeting dietary diversity recommendations among children in settled pastoral areas. Household head and caregiver attributes were identified as key influencing factors. It is recommended that county governments in northern Kenya promote optimal complementary feeding guidelines among settled pastoral caregivers to improve child nutrition.

Key words: Pastoralists, children, under-five, dietary diversity, stunting, wasting, underweight, northern Kenya

INTRODUCTION

Optimal infant and young child feeding (IYCF) practices are critical to the health and survival of young children. Recommended IYCF practices include early initiation of breastfeeding within the first hour of life, exclusively breastfeeding for the first 6 months of life and feeding child solid and semisolid nutritious food in addition to breastfeeding up to 2 years and beyond and feeding children a diet that meets a minimum diversity standard [1]. Minimum dietary diversity (MDD) can be defined as the consumption of four food groups of the seven food groups that are safe and meet nutritional requirements of a growing child aged 6-23 months [2, 3]. The seven food groups include 1) grains, roots, and tubers; 2) legumes and nuts; 3) dairy products (milk, yogurt, cheese); 4) flesh foods (meat, fish, poultry, and liver/organ meats); 5) eggs; 6) vitamin-A rich fruit; and 7) vegetables, other fruits and vegetables [2]. These foods, in addition to breast milk, guarantee a child-balanced diet that includes macro- and micronutrients, hence enhancing survival. Any deviation from these recommendations may result in undernutrition in early life.

Undernutrition in children below five years of age remains a public health challenge and is attributed mainly to sub-optimal complementary feeding practices [3]. Inappropriate complementary feeding negatively impacts child mental, social and cognitive development and linear growth [4, 5, 6]. Worldwide, 22.3% (or 148 million) of children under 5 years are stunted, and 6.8% (or 45.0 million) are wasted due to malnutrition [7]. This is an increase from 22% (149.2 million) and 6.7% (45.4 million) of children who were stunted and wasted, respectively [1]. In Africa, stunting increased from 41% (or 54 million) to 43% (or 61.3 million) while in east and west Africa where most pastoralists inhabit stunting prevalence is 30% [7]. Wasting has shown marginal decline with prevalence of 5% down from 5.3% in east Africa [1, 7]. In Kenya, while stunting and underweight decreased from 26 and 11% [8] to 18 and 10%, respectively [9], children in pastoral Arid and Semi-Arid Land (ASAL) still show a high prevalence of stunting is higher than national levels in counties such as west Pokot (33.5%) and Marsabit (29%) [9]. Dietary intake in terms of diversity, quality and safety of foods remains critical in addressing undernutrition in under five children.

Globally, less than 25% of children under five years of age meet the recommended criteria for MMD, and only a few of them receive a nutritionally adequate diet [2,10]. According to the latest demographic and health survey in Kenya, only 37% of children aged 6–23 months had an adequately diverse diet and had been given foods from the appropriate number of food groups [9], leaving out more than 50% of children exposed to suboptimal complementary feeding practices.

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Traditionally, pastoralists rely mainly on milk from livestock for complementary feeding [11]. However, with changes in lifestyle occasioned by drop out from nomadism to sedentism, many pastoral households experience changes in dietary intakes away from the known milk, meat and blood diets [12,13]. As pastoralists engage more with markets, they might develop different dietary tastes and rely on lower-quality foods available in markets, potentially disrupting their traditional eating habits. This shift becomes particularly worrisome during extended drought periods, as the shortage of traditional foods compels pastoralists to rely increasingly on cash-based economies [14]. Currently, limited information is available regarding dietary changes and likely impact on child nutritional status. This study therefore attempts to answer the research question, 'What is the current dietary diversity and nutrient intake among settled pastoralists children aged 6-59 months?'. Information generated in this study will support efforts aimed at upscaling maternal nutrition education on optimal complementary feeding practices in northern Kenya.

MATERIALS AND METHODS

Design and study population

A cross-sectional study of settled pastoral households with children aged 6-59 months was carried out in Marsabit County, northern Kenya (Figure 1), in the months of October and November, 2020. The research was conducted in Laisamis, Logologo, Karare, Central, Sagante/Jaldesa, and Bubisa, which reflected distinct agro-ecological zones, social, cultural, and livelihood patterns. Children under the age of six months, as well as those who were chronically or terminally ill, were excluded from participating in the study.

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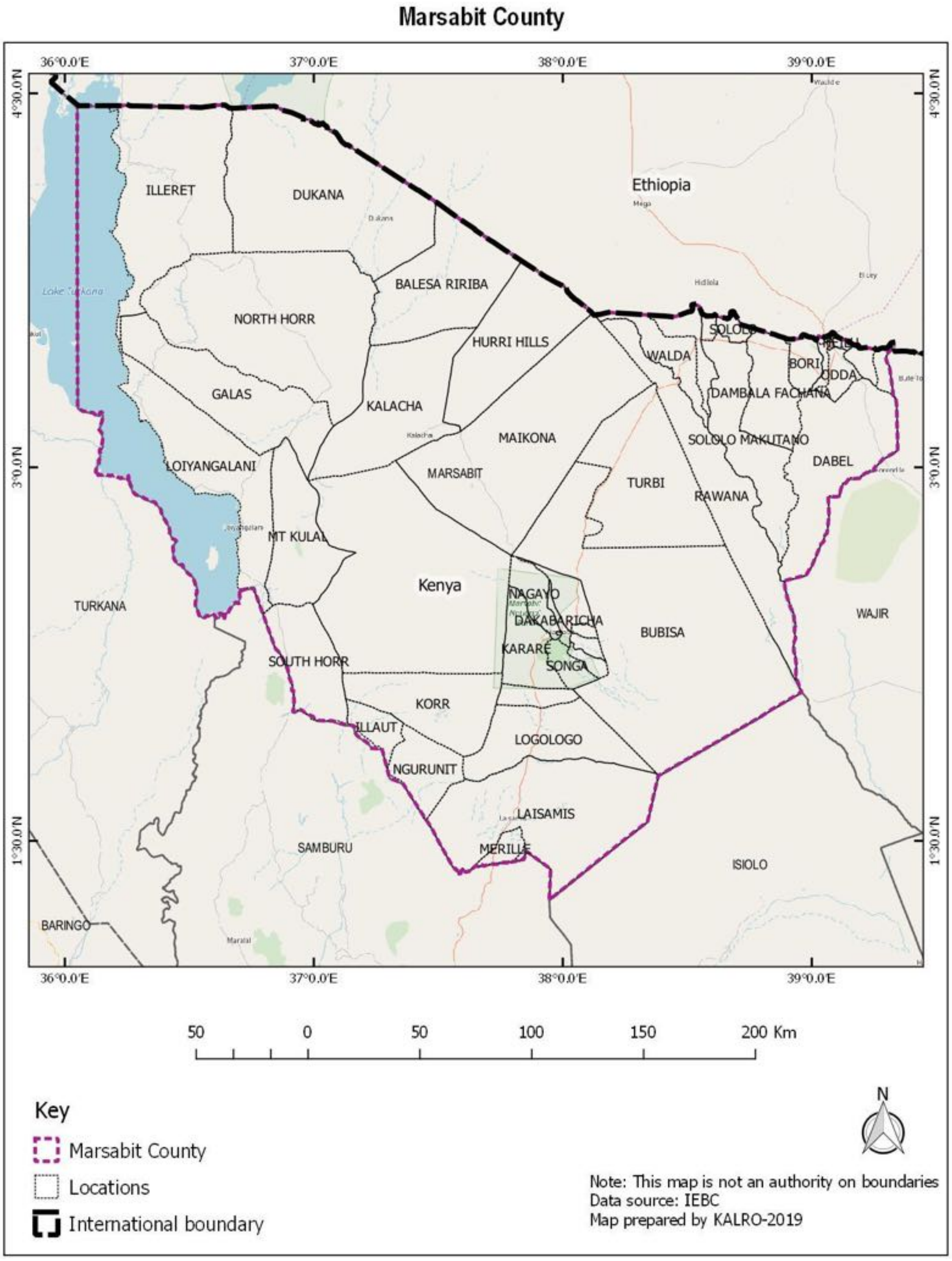

Figure 1: **Map of Marsabit County showing study sites**

Sampling Procedure

The sample size was determined following the methodology proposed by Magnani [15], focusing on a critical indicator, in this case, a minimum meal frequency of 49% in Moyale sub county [15] with a 10% expected change in minimum meal frequency. The study used a multistage sampling method outlined by Mugenda and Mugenda [17]. A total of 394 households with an index child aged 6-59 months were selected. The first stage involved purposive selection of sub counties

(Laisamis, Saku and North horr) and wards. A list of target children from various locations within each of the six wards was then compiled with the support of health officials and local leaders conversant with the study areas. The number of index children per ward was allocated proportionally to the population size and formed the sampling frame. In cases where more than one child between 6 and 59 months of age was encountered, the index child selected was the last born among the under-five. In cases of twins, their names were written in separate papers, folded and the caregiver given a chance to pick one paper with a name. A systematic sampling procedure was employed in which each household served as a sampling unit. Within each selected household, the index child and primary caregiver were randomly chosen for interviews after obtaining consent. The consent form was translated into Kiswahili and orally translated into local languages when necessary.

Social, economic and demographic questionnaire

Data pertaining to children, including their birth date, birth weight, sex, and vaccination status, were gathered from their health clinic records. In addition, a pretested semi-structured questionnaire was administered to the child's caregiver to obtain information regarding parental education levels, occupation, marital status, number of children, family size, water and sanitation and child feeding practices. The questionnaire also covered topics such as livestock ownership and income source.

Anthropometric Measurements

Anthropometric assessments adhered to World Health Organization guidelines [18]. Recumbent length or height for children, aged 6 to 23 months and 24 to 59 months, respectively, was measured using a portable stadiometer (UNICEF), with precision to 0.1 cm, per WHO/UNICEF [19] recommendations. Birthdates were derived from vaccination records and calendars, with ages in months noted. Weight was measured using a standard electronic scale (seca GmbH & Co. KG, Hamburg, Germany), accurate to 100 g, with children lightly dressed and shoeless. For non-standing children, a mother/baby weight recording method was applied. Each measurement was taken twice for accuracy, with averages recorded, and the scale routinely calibrated with known weights.

Child Dietary Diversity Assessment

The caregiver was probed only once on the different foods consumed by the index child 24 hours preceding the interview time. A list of usual complementary foods in the study area was populated with support from Key Informants familiar with local dietary choices. The foods were clustered into 7 major food groups as recommended by the WHO and FAO [2, 20] on Infant and young child feeding guidelines for individual dietary diversity score (IDDS). The food groups included (1) Cereals, roots, and tubers; (2) legumes and nuts; (3) flesh foods (meat, fish,

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poultry and liver/organ meats); (4) eggs; (5) vitamin A-rich fruits and vegetables; (6) dairy products (milk, yogurt, cheese); and (7) other fruits and vegetables. A group was assigned a value of one (1) if a child consumed at least one food item from a food group 24 hours preceding the interview time. Likewise, the group was assigned a value of zero (0) if a food item in a group was not consumed during the same period. The group scores were then summed to obtain the IDDS, ranging from 0-7, whereby zero represents non consumption of any of the food items in the food groups, and 7 represents higher dietary diversity. The MDD was attained if a child had consumed four or more food groups (≥ 4) out of the seven food groups over the previous 24 hours preceding the interview time. Based on IDDS, children's dietary diversity was then categorized as low (1-3 food groups consumed), medium (4-5 food groups consumed) and high (6-7 food groups consumed) [20].

Data Analysis

Data obtained were precoded and entered into the computer using the statistical package for social science version 25 (IBM Statistics, Chicago, IL, USA) for analysis. Nutritional status indices were derived from anthropometric data via WHO Anthro Software, defining stunting and underweight as HAZ and WAZ scores below -2SD, respectively, while scores between -2SD and +2SD indicated normal nutritional status. Categorical variables were presented as proportions, while continuous variables are presented as the means and standard errors (means ± standard errors). Analysis of Variance (ANOVA) was used for continuous variables where means were separated using Tukey's HN test, while Chi-square and Bonferroni tests were used in categorical variables. A linear regression model was used to determine population factors influencing the dietary diversity score. Bivariate and multivariate logistic regression models were used to analyse the effect of the intake of different food groups on child stunting and underweight respectively. The results were considered significant if $p \leq 0.05$.

Ethical Standards Disclosure:

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Egerton University Review and Ethics Committee (approval No. EUREC/APP/088/2019). A research permit was acquired from the National Commission of Science, Technology and Innovations (NACOSTI) in Nairobi (License No: NACOSTI/P/20/2972). Written/verbal consent was obtained from the child caregiver/mother before nutrition data was obtained. To ensure adherence to COVID-19 protocols, data was collected with support from trained Ministry of Health officers distributed in the health facilities in each ward.

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RESULTS AND DISCUSSION

Population Characteristics

Population characteristics are summarized in table 1. A total of 394 households comprising children aged 6-59 months were sampled in the Karare (13.5%), Laisamis, (17.5%), Logologo, (10.9%), Central, (15.7%), Sagante/Jaldesa, (29.9%) and Turbi (12.4%) wards, respectively. Overall, 86.8% of households were headed by males, aged 36.8 years. Overall, 13% of female-headed households occasioned by divorce, loss of husband or early pregnancies. Highest cases were observed in the Central and Sagante wards which are closer to Marsabit town. In the current study, 99.5% of caregivers were mainly mothers while less than 1% were either aunt or step mother to the child with higher illiteracy levels (66%) than male household heads (53.3%). Iliteracy among mothers was significantly high in the Logologo, Karare, and Bubisa wards compared to central, sagante and Laisamis wards, respectively ($p<0.001$).

Approximately 32% of caregivers relied on livestock keeping as the main source of livelihood with a majority of households indicating monthly income of less than KES5000.00 or approximately USD33.0 across the wards (Table 1). Approximately, 99.5% of caregivers/mothers practiced breastfeeding, with insignificant differences across wards. In terms of age categories, 49.0% of the children fell within the age bracket of 6-23 months, 30.2% in the age bracket of 24-35 months, 16% in the bracket of 36-47 months, and 4.8% in the bracket of 48-59 months, respectively (Table 1).

Nutritional Status of Children

Figure 2 presents a summary of undernutrition of children in all the six wards. The overall, significant disparities were observed in stunting (37%; $p = 0.039$) and underweight (27.4%; $p = 0.010$). Wasting among children was 16% with no significant ($p=0.267$) differences observed. This may be attributed to food insecurity among settled pastoral households also observed by Mayanja *et al*. [26] among agro pastoralists in Uganda. Stunting and underweight were significantly higher in Laisamis, Karare, Marsabit central and Sagante compared to Bubisa and Logologo. As shown in figure 2, the prevalence of undernutrition among children in all the six wards was higher than the WHO recommended cut off values for stunting (<20%), underweight (<10%) and wasting (<5%) [18] and also higher than Kenya Demographic and Health surveys [9, 10].

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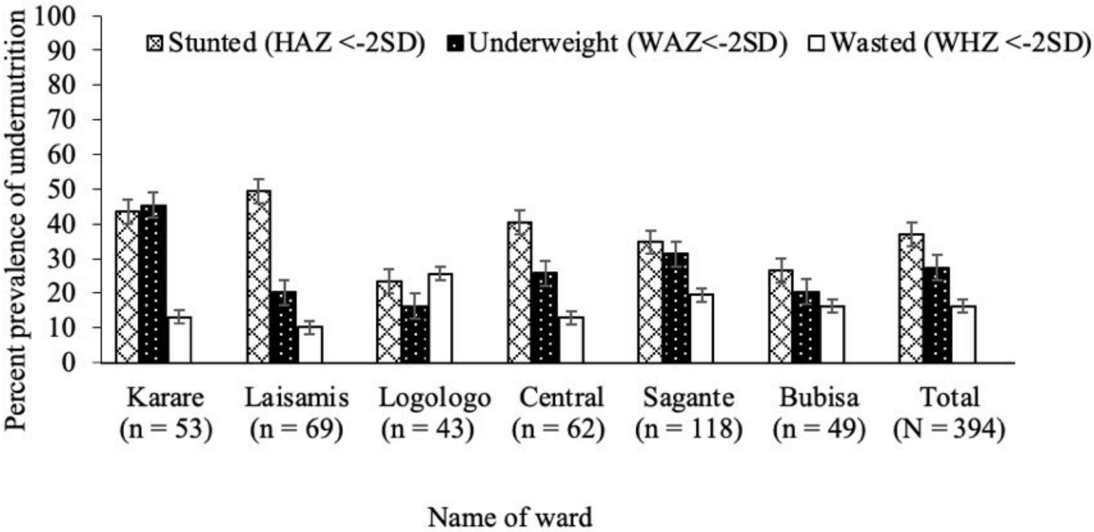

Figure 2: Prevalence of undernutrition among children aged 6-59 months in Marsabit

Food groups consumed by children in Marsabit County

Table 3 shows the proportion of the seven food groups consumed by children in the six wards. The results of this study indicate that 97.6% of children in the six wards consumed cereal foods constituting the main staple diet of children. The main cereals were maize, wheat and teff. These, were consumed in the form of porridge, ugali and *githeri* for older children. The frequency of consumption of cereals, roots and tubers reported here is higher compared to previous studies on DDS in children under five reported in Lebanon, which had a frequency of 91.1% [21], Dodoma Tanzania at 90.1% [22] but lower compared to the consumption frequency of similar food groups in eastern Morogoro, Tanzania [23]. The results of this study confirm that, as in other developing countries in sub-Saharan Africa, cereals, roots, and tubers are the main staple foods for settled pastoral households. Overall, 62% of the children consumed legumes and pulses which was mainly beans. Significantly (p <0.001) higher consumption of beans was observed in Bubisa (100%) followed by Logologo, Laisamis, Central, Karare and Sagante wards, respectively (Table 2). A study by Yesuf *et al*. [24] in Addis Zemen town, Ethiopia, showed that children under five consume more beans and nuts (84.5%) than children in the current study. This suggests that there may be some differences in dietary patterns between pastoralist children in Ethiopia and Kenya. Increased intake of cereals and plant proteins as opposed to animal source protein may be attributed to effect of sendenterisation —living in a group permanently in one place, occasioned by loss of livestock to frequent drought in ASALs [25]. Also, settled pastoral households heavily rely on purchased food stuff from local markets. Moreover, food aid agencies encourage supply of non-perishable food commodities such as maize and beans supplemented by food aid.

Daily intake of flesh foods mainly red meat was generally low (31.0%) (Table 2). Consumption of meat was significantly high in Bubisa (91.8%; p<0.001) than in Marsabit Central (41.2%), Logologo (37.2%), Laisamis (23.1%), Sagante/Jaldesa (21.6%) and Karare wards, respectively (p <0.001). Consumption of meat in this study is higher than that reported among pastoralists in the rangeland ecosystem in Uganda where only 10% of pastoralists children consumed flesh foods [26]. Egg consumption recorded the lowest frequency (19%) of intake at nearly all the study sites. Egg consumption was relatively higher in urban wards of Marsabit central (41.2%) but lower in peri urban and rural areas of Sagante/Jaldesa wards (24.3%), Laisamis (17.2%), Logologo (14.0%), Bubisa (6.1%) and Karare (5.8%) (Table 3). This may be attributed to sociocultural reasons that prevent rural settled pastoralists from consuming eggs, particularly among the traditional Rendille and Gabra communities. The proportion of children consuming eggs in this study was low compared to the findings in Burkina Faso [27].

Overall, consumption of dairy products was low (61%; $p < 0.001$). The consumption of dairy products was significantly higher in Bubisa (57.1%) and Logologo (51.2%). The low frequency of dairy products intake by pastoralist children can be explained by the fact that this study was conducted at the end of the drought season when most lactating animals are driven to far-off areas in search of water and pasture. The results in this study were higher than among preschool children in the north western province, South Africa [28], yet lower than milk intake (71%) observed among pastoralist children in Afar, Ethiopia [29]. Overall, daily intake of vitamin A-rich fruits and vegetables was 19%, with significant differences across the wards (p<0.001) while 58% of children consumed other fruits and vegetables. In Marsabit, access to vitamin A-rich fruits and vegetables like mangoes and kales are restricted mainly to Marsabit Mountain, where agro pastoralism is practiced. Fruits are obtained from neighbouring countries like Isiolo and Meru. Consequently, these fruits are often prohibitively expensive for most households. Low fruit consumption has also been reported among Maasai children in Kajiado [30].

Minimum Dietary Diversity Score by ward, age and sex

Figure 3 and 4 shows a summary of the mean ± S.E DDS and proportion of children falling in different categories of DDS. Overall, the mean DDS among children was 3.43 ± 0.89 with less than 50% of the children meeting the required MDD of ≥4.0.

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There was relatively higher dietary diversity among children in Bubisa ward (5.2), followed by Logologo (3.86), Central (3.26), Sagante (3.24), Laisamis (2.86) and Karare (2.79), respectively (Figure 3). In terms of sex, significantly (p<0.001) more girls (52.2%) than boys (50.8%) had MDD of <4.0. Additionally, Laisamis showed 74.4 % of male children had MDD <4.0 followed by Karare, Sagante, Logologo, Central and Bubisa wards respectively with significant (p<0.001) difference being observed (Table 3). In terms of age groups, significant differences in MDD were observed in age groups 6-11 (40.3%; *p* = 0.003), 12-23 (53.7%; *p*<001), 24-35 (*p*<0.001) and 35-47 (*p*=0.003). Approximately 42.1% of children aged 48-59 months had MDD <4.0, with no significant differences observed (*p* = 0.244). Proportion of children aged 6-12 months with low MDD were significantly (p=0.003) higher in Karare (100%) followed by Laisamis, Central, Sagante and Bubisa, respectively (Table 3). Laisamis ward also showed significantly (<0.001) high proportion of children with MDD <4.0 compared to Central (70%), Karare (64%), Logologo (60%) and Bubisa wards, respectively. Bubisa was the only ward with better MDD (≥4.0) in all categories. The mean DDS in the current study was lower than the FAO recommended cut off of ≥4 DDS [20]. The findings in this study was higher than average IDDS found in previous studies in Ethiopia, mean of 1.6 [31] and among 6-23 months old children in Busia in Kenya, 2.0±0.52 [31] but compared favourably with the findings of Adepoju *et al*. [32], among preschoolers in Ibadan, Nigeria.

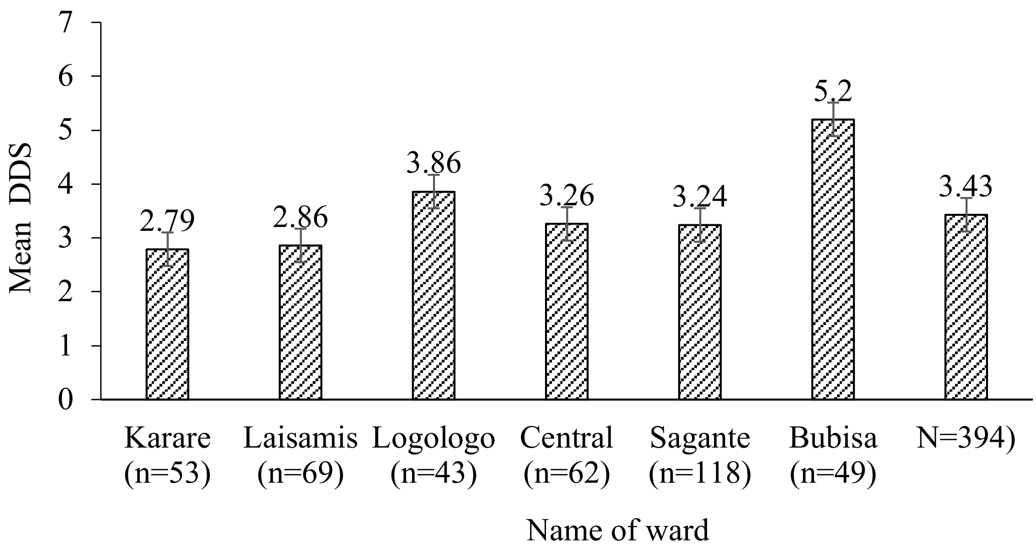

Figure 3: The mean ± SE of the dietary diversity score (ANOVA, F (5) = 16.288; p < 0.001)

The proportions of children classified as having low, medium and high dietary diversity were 51.5, 34.5 and 14.0%, respectively (figure 4). Low DDS (1-3) was more pronounced in the Laisamis, followed by Karare, Sagante/Jaldesa, Marsabit central, and Logologo, respectively. Nevertheless, Bubisa had a significantly ($p<0.001$) higher proportion of children consuming more than 6 food groups (43%) than Logologo (16.3%), Marsabit Central (14.5%), Laisamis (10.1%), Sagante/Jaldesa (7.6%) and Karare (3.8%) (Figure 4). This means that children who receive four or more food groups out of seven food groups, 24 hours preceding the interview day are more likely to have an adequate diet than children who consumed food items from less than four food groups. Moreover, the proportion of children who fell below MDD in this study was lower than that of Ethiopian children—87.5% [33] but higher than the findings of Wang *et al*. [34] among children in western China (44.5%). The indicator is based on the count of 7-food groups and therefore acts as a proxy indicator for nutrient adequacy for one's dietary intake status [35]. It has also been associated by probability of micronutrient adequacy in the diet. Additionally, MDDS can be used as an indicator of household food access. It has been postulated that 1% increase in DDS is associated with 0.7% increase in the per capita caloric availability for children [20]

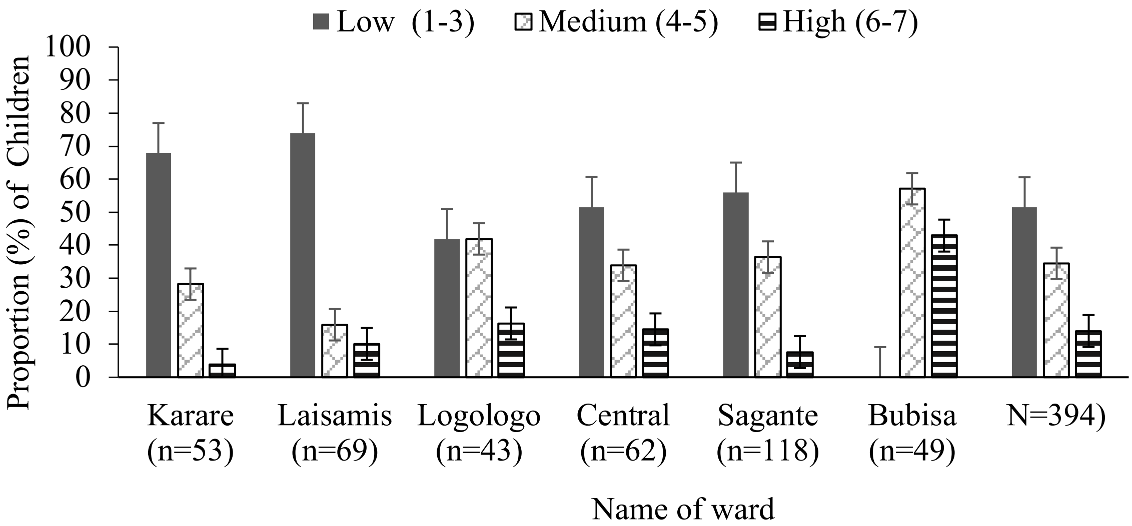

Figure 4: **Percentage of children falling into different dietary diversity categories**

Low dietary diversity observed in the current study may be attributed to endemic food insecurity in Arid and semi-arid lands [25], which is commonly addressed through intermittent food aid provided by development agencies. The mean DDS in this study was higher than those reported in Ethiopia at 1.6 [23] and Busia, Kenya at 2.0 [24]. Conversely, the current findings align with the findings of Adepoju and

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Ayodele [25] among pre-schoolers in Ibadan, Nigeria. The proportion of children who fell below MDD in this study was lower than that of Ethiopian children at 87.5% [26] but higher than 44.5% reported among children in western China [27].

Social and demographic factors influencing dietary diversity among children
Table 4 gives a summary of the significant social and demographic factors influencing DDS in the area. Significant predictors of DDS in Karare were; distance to nearest trading centre ($p = 0.034$), gender of household head ($p = 0.017$), household head marital status ($p = 0.029$), highest level of education ($p = 0.023$), livestock ownership ($p= 0.037$) and caregiver average monthly income ($p=0.004$). In Laisamis, age of child ($p = 0.042$), caregiver income (p=0.02), and distance to nearest market (p < 0.001) were the main predictors of DDS. The main predictors of DDS in the Logologo ward included household head level of education ($p < 0.001$) and main occupation ($p = 0.029$). Household head marital status ($p = 0.003$), gender ($p = 0.016$), main occupation (p = 0.034) and distance to nearest trading centre ($p = 0.054$) were the main predictors of DDS in Marsabit central ward. Furthermore, caregiver primary occupation ($p = 0.004$) and sex of the index child ($p = 0.042$) predicted DDS among children in Sagante/Jadesa while the household head's highest level of education ($p = 0.013$) and distance to nearest trading centre in ($p = 0.048$) explained the variations in DDS in Bubisa.

The study also found that distance to the nearest market had a significant negative effect on dietary diversity in all wards except in Karare (p=0.034), Laisamis (<0.001), Central (p=0.05) and Bubisa ward (p=0.05) (Table 4). Families in northern Kenya face challenges accessing diverse and safe complementary foods due to reliance on distant food markets. For example, in Karare, where the main market is 25 km away in Marsabit town, access is limited. This is worsened for semi-settled households off main roads and pastoralists living far from markets, leading to lower dietary diversity. The current findings are consistent with other studies done in rural Indonesia [36] and in Kenya [37]. Another study found that time taken to the market was associated with Household DDS in rural Ethiopia [38], suggesting that the time it takes to travel to the market can also be a factor in dietary diversity.

Gender of household heads showed a significant and positive influence on DDS in Karare (p = 0.017) but was negatively associated with DDS in the central ward (p = 0.02), an observation made in Ethiopia where female gender had a negative but significant association with DDS [38]. Approximately 19% of households in the central ward were female-headed, and 22.6% were unemployed single mothers. Moreover, the education of the household head was also positively associated with DDS in Karare (p = 0.016), Logologo (p < 0.001) and Bubisa (p = 0.048). The results reported in this study are consistent with previous studies where household heads with college level education were positively associated with individual dietary diversity among children 6-23 months in southern Ethiopia [39] and rural slum areas in Bangladesh [40].

Household head occupation was found to be positively associated with DDS in the central Marsabit ward (p = 0.030) but negatively associated with DDS in the Logologo ward (0.034). Household heads had better access to alternative income sources that could impact on better purchasing power compared to Logologo where most households primarily relied on livestock production. The present findings were consistent with those of Kundu *et al*. [40]. This study shows a negative but significant association between livestock ownership and child DDS in Karare (p= 0.037) compared with other wards. Karare is the main source of milk for Marsabit town. Similar results were observed in Luangwa Valley, Zambia [41]. Furthermore, among the Maasai in Kenya, the pastoral herding system denies women and children the opportunity to access dairy products, hence conferring a negative association between livestock ownership among pastoral communities and nutritional wellbeing [30]. Caregiver occupation had significant (p = 0.004) but negative association with child dietary diversity in Sagante/Jaldesa ward, but no effect on other wards (Table 4). Caregiver income was positively associated with DDS in Karare (p=0.004) and Laisamis (p=0.020). This could be explained by the increasing involvement of women, who are the primary caregivers, in the commercialization of livestock and livestock products near market centres as settlements expand [42]. A study by Ali *et al*. [43] found a significant association between caregiver employment and dietary diversity with reference to those who were housewives. More girls than boys had MDD of <4.0, indicating disproportionate feeding preference among pastoralists towards male children. The results of this study align with those reported by Harvey *et al*. [44], who found an association between the age of children (12-23 months) and DDS in Southeast Asia.

Association between food groups and nutritional status

Table 5 shows the results of univariate and multivariate regression analyses of the association between food groups consumed by children and nutritional status. The study shows that the consumption of legumes and pulses had significantly lower odds of children being stunted (OR = 0.63, 95% C.I. 0.41 - 0.97; *p* = 0.038). The results also indicate that the consumption of vitamin A rich fruits and vegetables significantly reduced the risk of stunting among children (OR= 0.50, 95% C. I. 0.30 - 0.85; *p* =0.010). Legumes and eggs are better sources of bioavailable protein, macro and microelements important for growth. A study conducted among children in East Java, Indonesia, showed that the consumption of animal protein such as fish (p=0.03) and meat/poultry (p=0.04) predicted a lower likelihood of a child becoming stunted [37]. Furthermore, consumption of milk, meat and eggs has been found to be associated with reduced stunting among children in Tanzania [12]. The consumption of dairy products by children had a significant reducing effect on underweight [OR= 0.58, 95% C. I. (0.34 - 0.98); p = 0.042]. This can be explained by the fact that consumption of dairy products confers increased linear growth at an early stage in life especially in low income countries such as Kenya [40]. Overall, there was no association between food groups consumed by children and wasting (thinness) among children (Table 5).

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

In the current study, the mean dietary diversity score among children was generally low. Furthermore, more than half the population of children did not meet the FAO and Kenya national recommended guidelines on minimum dietary diversity (MDD) of >4 food groups. Cereal- and tuber-based diets were the main staple complementary food among children. The majority of pastoral children do not consume eggs, fruits and vegetables compared to other food groups. Distance to food markets, caregiver/mother's occupation and average monthly income were some of the main predictors of DDS. Consumption of legumes, vitamin A fruits and vegetables, had a reducing effect on stunting, while children consuming flesh foods were less likely to be underweight. It is recommended that existing policies aimed at nutrition education on complementary feeding guidelines be implemented among settled pastoral caregivers in northern Kenya.

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CONFLICT OF INTEREST

[None]

AUTHORSHIP

A.O.A. was the lead scientist for the present research; J.W.M. and E.M. were university supervisors during thesis work at Egerton University. All authors have seen and approved the submitted manuscript.

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Table 1: **Population Characteristics**

	Name of Wards							
	Karare (n=53)	Laisamis (n=69)	Logologo (n=43)	Marsabit Central (n=62)	Sagante/ Jaldesa (n=118)	Bubisa (n=49)	Total (N=394)	*F* - test
	Mean (S.E)	Mean (S.E)	Mean (S.E)	Mean S.E)	Mean (S.E)	Mean (S.E)	Mean (S.E)	*p* value
Household head characteristics								
Family size	4.9 (2.4) [b]	3.4 (1.3)[a]	4.6 (1.7)[b]	4.5 (2.3) [b]	4.3(1.9) [b]	4.0 (1.7)[ab]	4.2 (1.9)	<0.001
Household head age	37.1 (11.0)	34.9 (8.5)	38.3 (11.0)	36.4 (8.7)	36.5 (7.6)	39 (9.4)	36.8 (9.1)	0.194
Household head Education [n (%)]								χ^2
None	38 (71.7)	42 (60.9)	34 (79.1)	15 (24.2)	50 (42.4)	31 (63.3)	210 (53.3)	<0.001
Primary	6 (11.3)	11 (15.9)	2 (4.7)	26 (41.9)	42 (35.6)	8 (16.3)	95 (24.1)	
≥ Secondary	9 (17)	16 (23.2)	7 (16.3)	21 (33.9)	26 (22)	10 (20.4)	89 (22.6)	
Household head Gender [n (%)]								
Male	46 (86.8)	63 (91.3)	37 (86)	50 (80.6)	100 (84.7)	46 (93.9)	342 (86.8)	0.319
Female	7 (13.2)	6 (8.7)	6 (14)	12 (19.4)	18 (15.3)	3 (6.1)	52 (13.2)	
Household head Marital status [n (%)]								
Married	48 (90.6)	62 (89.9)	37 (86.0)	48 (77.4)	102 (86.4)	46 (93.9)	343 (87.1)	0.163
Divorced	1 (1.9)	3 (4.3)	2 (4.7)	7 (11.3)	7 (5.9)	2 (4.1)	22 (5.6)	
Single	1 (1.9)	2 (2.9)	0 (0.0)	5 (8.1)	2 (1.7)	1 (2.0)	11 (2.8)	

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Widowed	3 (5.7)	2 (2.9)	4 (9.3)	2 (3.2)	7 (5.9)	0 (0.0)	18 (4.6)	
Household head main occupation [n (%)]								
Livestock	31 (58.5)	39 (56.5)	30 (69.8)	0 (0.0)	21 (17.8)	31(63.3)	152 (38.6)	
Labour/herder	10 (18.9)	7 (10.1)	6 (14.0)	17 (27.4)	39 (33.1)	5 (10.2)	84 (21.4)	
Employed	4 (7.5)	9 (13.0)	2 (4.7)	11 (17.7)	16 (13.6)	4 (8.2)	46 (11.7)	<0.001
Self employed	2 (3.8)	8 (11.6)	1 (2.3)	27 (43.5)	24 (20.3)	4 (8.2)	66 (16.8)	
Pensioner	0 (0.0)	0 (0.0)	2 (4.7)	0 (0.0)	1 (0.8)	1 (2.0)	4 (1.0)	
Unemployed	6 (11.3)	6 (8.7)	2 (4.7)	7 (11.3)	17 (14.4)	4 (8.2)	42 (10.7)	
Caregiver characteristics								
Caregiver age	29.8 (1.0)	27.2 (0.7)	29.3 (1.0)	28.8 (0.9)	29.2 (0.6)	29.6 (1.23)	28.9 (0.3)	0.256
Caregiver Marital status [n (%)]								
Married	48 (90.6)	62 (89.9)	37 (86)	48 (77.4)	102 (86.4)	46 (93.9)	343 (87.1)	
Single	1 (1.9)	2 (2.9)	0 (0.0)	5 (8.1)	2 (1.7)	1 (2.0)	11 (2.8)	0.163
Divorced	1 (1.9)	3 (4.3)	2 (4.7)	7 (11.3)	7 (5.9)	2 (4.1)	22 (5.6)	
Widowed	3 (5.7)	2 (2.9)	4 (9.3)	2 (3.2)	7 (5.9)	0 (0.0)	18 (4.6)	
Caregiver Education level [n (%)]								
None	40 (75.5)	47 (68.1)	37 (86)	21 (33.9)	79 (66.9)	36 (73.5)	260 (66)	
Primary	8 (15.1)	13 (18.8)	3 (7.0)	25 (40.3)	30 (25.4)	10 (20.4)	89 (22.6)	<0.001
>Secondary	5 (9.4)	9 (13.0)	3 (7.0)	16 (25.8)	9 (7.6)	3 (6.1)	45 (11.4)	
Caregiver main occupation [n (%)]								
Livestock	8 (15.1)	25 (36.2)	26 (60.5)	0(0)	8 (6.8)	6 (12.2)	73 (18.5)	
Labour/herder	8 (15.1)	5 (7.2)	5 (11.6)	5 (8.1)	15 (12.7)	1 (2.0)	39 (9.9)	<0.001
Sale milk	0 (0.0)	6 (8.7)	2 (4.6)	0 (0.0)	3 (2.5)	0 (0.0	11 (2.8)	

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Employment	1 (1.9)	2 (2.9)	1 (2.3)	8 (12.9)	3 (2.5)	2 (4.1)	17 (4.3)	
Self employed	10 (18.9)	6 (8.7)	3 (7.0)	13 (21.0)	16 (13.6)	2 (4.1)	50 (12.7)	
unemployed	26 (49.1)	25 (36.2)	6 (14.0)	36 (58.1)	73 (61.9)	38 (77.5)	204 (51.8)	
Caregiver Estimated Monthly income (KES*) [n (%)]								
< 5,000	39 (73.6)	32 (46.4)	25 (58.1)	45 (72.6)	103 (87.3)	23 (46.9)	267 (67.8)	<0.001
5,001-10,000	12 (22.6)	22 (31.9)	13 (30.2)	8 (12.9)	9 (7.6)	14 (28.6)	78 (19.8)	
10,000-15,000	1 (1.9)	13 (18.8)	5 (11.6)	3 (4.8)	2 (1.7)	5 (10.2)	29 (7.4)	
15,001-20,000	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.2)	4 (3.4)	3 (6.1)	9 (2.3)	
>20,000	1 (1.9)	2 (2.9)	0 (0.0)	4 (6.5)	0 (0.0)	4 (8.2)	11 (2.8)	
Child Breastfeeding [n (%)]								
Yes	53 (100)	69 (100)	42 (97.7)	62 (100)	117 (100)	49 (100)	392 (99.5)	0.511
No	0 (0.0)	0 (0.0)	1 (2.3)	0 (0.0)	1 (0.8)	0 (0.0)	2 (0.5)	
Grow crops								
Yes	19 (35.8)	0 (0.0)	3 (7.0)	19 (30.6)	53 (44.9)	0 (0.0)	94 (23.9)	<0.001
No	34 (64.2)	69 (100)	40 (93.0)	43 (69.4)	65 (55.1)	49 (100)	300 (76.1)	
Child Characteristics								
Anthropometry (Mean (S.E)								
Weight (kg)	10.4 (0.2)	10.1 (0.2)	9.5 (0.3)	9.8 (0.3)	10.1 (0.2)	9.6 (0.3)	10-0 (0.1)	0.07
Height (cm)	83.7 (1.01)[b]	81.54 (0.8)[ab]	80.0 (1.0)[ab]	80.5 (1.1)[ab]	82.3 (0.8)[ab]	78.8 (1.2)[a]	81.4(0.4)	0.017
Child age	30.4 (1.55)[b]	24.7 (1.4)[ab]	21.0 (1.5)[a]	24.2 (1.6)[a]	26.9 (1.2)[ab]	21.4 (1.61)[a]	25.2 (0.6)	<0.001
Child Sex [n (%)]								**χ^2, *p*- value**
Male	24 (45.3)	43 (62.3)	19 (44.2)	29 (46.8)	68 (57.6)	33 (67.3)	216 (54.8)	0.06
Female	29 (54.7)	26 (37.7)	24 (55.8)	33 (53.2)	50 (42.4)	16 (32.7)	178 (45.2)	0.355

* USD1.00 = KES 145

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Table 2: Proportion [n (%)] of each food group consumed 24 hours preceding interview time

Food group	Name of wards*								
	Karare (n=53)	Laisamis (n=69)	Logologo (n=43)	Central (n=62)	Sagante/ (n=118)	Bubisa (n=49)	Total (N= 394)	χ^2	*P* value
1	48 (92.3)[a]	63 (98.4)[a]	42 (97.7)[a]	51 (100)[1]	109 (98.2)[a]	48 (98.0)[a]	361 (97.6)	7.757	0.170
2	28 (53.8)[a,b]	39 (60.9)[a,b]	33 (76.7)[a]	29 (56.9)[a,b]	51 (45.9)[b]	49 (100)[1]	229 (61.9)	48.157	<0.001
3	7 (13.5)[a]	18 (28.1)[a,b]	22 (51.2)[b,c]	18 (35.3)[a,b,c]	22 (19.8)[a]	28 (57.1)[c]	115 (31.1)	38.424	<0.001
4	9 (17.3)[a]	15 (23.1)[a]	16 (37.2)[a]	21 (41.2)[a]	24 (21.6)[a]	45 (91.8)[b]	130 (35.0)	90.426	<0.001
5	3 (5.8)[a]	11 (17.2)[a,b]	6 (14.0)[a,b]	21 (41.2)[b]	27 (24.3)[a,b]	3 (6.1)[a]	71 (19.2)	30.147	<0.001
6	29 (55.8)[a]	29 (45.3)[a]	25 (58.1)[a]	30 (58.8)[a]	69 (62.2)[a]	45 (91.8)[b]	227 (61.4)	27.187	<0.001
7	22 (42.3)[a,b]	23 (35.9)[a]	23 (53.5)[a,b,c]	33 (64.7)[b,c]	79 (71.2)[c]	36 (73.5)[c,d]	216 (58.4)	32.124	<0.001

*Values in the same row with different subscripts are significantly different at p<05 in the two-sided test of equality for column proportions. Tests assume equal variances. Tests are adjusted for all pairwise comparisons within a row of each innermost suibtable using the Bonferroni correction.
¥(1) Cereal, roots, and tubers; (2) legumes and nuts; (3) flesh foods (meat, fish, poultry and liver/organ meats); (4) eggs; (5) vitamin A-rich fruits and vegetables; (6) dairy products (milk, yogurt, cheese); and (7) other fruits and vegetables

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Table 3: Minimum dietary diversity (MDD) distribution among children by age and sex

	MDD	Name of wards [(n (%)]						Total (N=394)	χ^2 (Sig)
		Karare (n=53)	Laisamis (n=69)	Logologo (n=43)	Central (n=62)	Sagante (n=118)	Bubisa (n=49)		
Overall	<4.0	36 (67.9)	51 (73.9)	18 (41.9)	32 (51.6)	66 (55.9)	0 (0.0	203 (51.5)	74.16
	≥4.0	17 (32.1)	18 (26.1)	25 (58.1)	30 (48.4)	52 (44.1)	49 (100)	191 (48.5)	(<0.001)
Sex									
Boys	<4.0	17 (70.8)	32 (74.4)	8 (42.1)	12 (41.4)	41 (60.3)	0 (0.0)	110 (50.8)	51.58 (<0.001)
	≥4.0	7 (29.2)	11 (25.6)	11 (57.9)	17 (58.6)	27 (39.7)	33 (100)	106 (49.2)	
Girls	<4.0	19 (65.5)	19 (73.1)	10 (41.7)	20 (60.6)	25 (50.0)	0 (0.0)	93 (52.2)	26.18 (<0.001)
	≥4.0	10 (34.5)	7 (26.9)	14 (58.3)	13 (39.4)	25 (50.0)	16 (100)	85 (47.8)	
Age category in Months									
6-12	<4.0	4 (100)	6 (60.0)	3 (30.0)	8 (53.3)	8(40.0)	0 (0.0)	29 (40.3)	17.82 (0.003)
	≥4.0	0 (0.0)	4 (40.0)	7 (70.0)	7 (46.7)	12 (60.0)	13 (100)	43 (59.7)	
13-23	<4.0	9 (64.3)	19 (73.1)	9 (60.0)	12 (70.6)	16 (50.0)	0 (0.0)	65 (53.7)	26.64 (<0.001)
	≥4.0	5 (35.7)	7 (26.9)	6 (40.0)	5 (29.4)	16 (50.0)	17 (100)	56 (46.3)	
24.35	<4.0	12 (70.6)	15 (71.4)	5 (35.7)	7 38.9)	23 (63.9)	0 (0.0)	62 (52.1)	24.38 (<0.001)
	≥4.0	5 (29.4)	6 (28.6)	9 (64.3)	11(61.1)	13 (36.1)	13 (100)	57 (47.9)	
35.47	<4.0	9 (64.3)	9 (90.0)	13 (33.3)	2 (22.2)	15 (68.2)	0 (0.0)	36 (57.1)	17.64 (0.003)
	≥4.0	5 (35.7)	1 (10.0)	2 (66.7)	7 (77.8)	7 (31.8)	5 100)	27 (42.9)	
48-59	<4.0	2 (50.0)	2 (100)	0 (0.0)	3 (100)	4 (50.0)	0 (0.0)	11 (57.9)	6.69 (0.244
	≥4.0	2 (50.0)	0 (0.0)	1 (100)	0 (0.0)	4 (50.0)	1 (100)	8 (42.1)	

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Table 4: Backwards Linear Regression of significant household head, caregiver and child characteristics influencing DDS

	Karare (n=53)			Laisamis (69)			Logologo (n=43)			Marsabit central (n=62)			Sagante/Jaldesa (n=118)			Bubisa (n=49)		
	β	95% C.I	Sig	β	95% C.I	Sig	β	95% C.I	Sig	β	95% C.I	Sig	β	95% C.I	Sig	B	95% C.I	Sig
Constant	1.86	0.15, 3.58	0.034	5.59	3.53, 7.65	0.000	1.1	0.17, -0.52	0.17	2.20	0.11, 4.29	0.04	3.9	2.51, 5.29	0.000	6.4	5.09, 7.71	0.000
Distance to Market	-0.04	-0.07, 0.00	0.034	0.38	-0.55, 0.21	0.000				-0.25	-0.51, 0.0	0.05				0.013	-0.09, -0.01	0.05
HHH gender	1.95	0.37, 3.52	0.017	-1.24	-2.61, 0.13	.075				2.04	0.40, 3.69	0.02						
HHH marital status	-0.80	1.52, 0.08	0.029							-1.34	-2.22, -0.46	0.003	-0.36	-0.731, 0.014	0.059			
HHH education	0.61	0.12, 1.10	0.016				1.7	0.93, 2.52	0.000				0.29	-049, 0.633	0.09	0.3	0.01, 0.567	.048
HHH main occupation							0.333	-0.63, -0.04	0.03	028	0.02, 0.53	.034	0.11	-0.228, 0.006	0.06			
Livestock ownership	-0.85	-1.64, -0.05	0.037															
Caregiver occupation													-0.17	-0.287, -0.055	0.004			
Caregiver income	0.0	0.0, 0.0	0.004	0.0	0.0, 0.0	0.020												
No of children							0.648	-0.1, 1.39	0.087									
Age in Months				-0.03	0.07, 0.00	0.042												
Sex of child													0.55	0.20, 1.081	0.042			
R^2	.456			.306			0.342			0.25			0.275			0.169		
S.E	1.160			1.570			1.31			1.86			1.39			0.783		
Durbin-Watson	1.710			1.29			1.52			1.51			1.692			1.977		
F test	6.29			7.17			6.75			3.62			6.43			4.686		
P value	0.000			0.000			0.000			0.011			<0.001			0.014		

*P < 0.05); **p < 0.01; ***p < 0.001: HHH- Household head; S. E means standard error; C. I means Confidence Interval

[a]Adjusted for Distance to nearest market, Household size excluding household head, Gender of household head, Marital status household head, Education level of household head, Main economic activity of household head, age of index child, Caregiver education level, Primary occupation of caregiver, Caregiver estimated average monthly income. *$p < 0.05$; †Numbers represent names of foods are reported under materials and methods

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Table 5*:* **Bivariate and multivariate logistic regression analysis of the association between food groups consumed and stunting, underweight**

Food Group§	Stunting (HAZ <-2 SD)				Underweight (WAZ <-2SD)			
	OR (95% C.I)	Sig	[a]AOR (95% C.I)	Sig	OR (95% C.I)	Sig.	AOR (95% C.I)	Sig
1	1.19 (0.26, 4.86)	.804	1.69 (0.33, 8.58	.529	1.30 (0.27, 6.39)	.743	1.27 (0.25, 6.55)	.775
2	0.63 (0.41, 0.97)*	.038	0.77 (0.46, 1.29)	.314	1.07 (0.66, 1.71)	.789	0.74 (0.43, 1.28)	.284
3	1.31 (0.82, 2.08)	0.256	1.37 (0.78, 2.40	.289	0.58 (0.34, 0.98)*	.042	2.09 (1.16, 3.79)*	.015
4	0.94 (0.60, 1.45)	0.771	0.81 (0.47, 0.41)	.109	1.04 (0.64, 1.67)	.882	1.16 (0.67, 2.01)	.595
5	0.50 (0.30, 0.85)*	.010	1.86 (0.98, 3.52)	.059	1.07 (0.60, 1.91)	.810	0.78 (0.40, 1.50)	.453
6	0.72 (0.47, 1.11)	.142	0.70 (0.41,1.18)	.179	0.93 (0.58,1.48)	.745	0.98 (0.58, 1.66)	.900
7	0.97 (0.64, 1.49)	.902	0.84 (0.51, 1.40)	.496	0.77 (0.48, 1.23)	.273	1.22 (0.73, 2.04)	.452

§(1) Cereal, roots, and tubers; (2) legumes and nuts; (3) flesh foods (meat, fish, poultry and liver/organ meats); (4) eggs; (5) vitamin A-rich fruits and vegetables; (6) dairy products (milk, yogurt, cheese); and (7) other fruits and vegetables
OR mean Odds Ratio; AOR means Adjusted Odds Ratio and C.I means Confidence Interv

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