Factors Influencing Vitamin A Status of Lactating Mothers in Manyara and Shinyanga Regions of Tanzania

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Abstract

Vitamin A Deficiency (VAD) is a major public health problem that the world is facing today. It is more prevalent in low income countries including Tanzania. This study was conducted to determine factors influencing Vitamin A status of lactating mothers in selected regions of Manyara and Shinyanga, Tanzania. Purposive and random sampling were used to obtain a sample of 569 lactating mothers categorized in age groups - young age (15-19 years) middle age (20-34 years) and elderly (35-49 years). Results showed that, majority of households (98%) were headed by males. Prevalence of VAD was of public health significance (prevalence >50%) among the lactating mothers in all the districts studied. Prevalence of VAD among the lactating mothers was 88.5% for young mothers, 84.6% for middle age mothers and 86.3% for elderly mothers. Vitamin A status of the lactating mothers was significantly ($P<0.05$) associated with residence. Majority of lactating mothers (68%) lacked knowledge about vitamin A and fortified oil (98.2%). Most of the lactating mothers (87%) had positive attitude towards consumption of vitamin A, however, consumption of vitamin A rich foods and fortified foods was generally low. Only 40% of the lactating mothers consumed animal products, 30% consumed yellow/orange fruits while 20% consumed yellow/orange root foods including orange fleshed sweet potatoes. It was concluded from this study that, prevalence of VAD among lactating women was high. Residence was the major factor that significantly influenced vitamin A status. Therefore it was recommended based on this study that, to address the vitamin A deficiency problem, nutrition and healthy planners should put more efforts on food fortification especially of edible oil and promote consumption of diverse diets household level. Also they should educate lactating mothers and the community as a whole on the importance of consuming fortified oil and selection of foods rich in vitamin A. The community should further be educated on how to identify the fortified oil in the market by recognizing the fortification logo on the packages and/or reading the label before buying the oil or other fortified foods.

Keywords: Vitamin A status, lactating mothers, socio-economic factors, Tanzania

Introduction

Vitamin A Deficiency (VAD) is a major problem that the world is facing today and highly prevalent in low income countries including Tanzania (Tariku *et al.,* 2016). It is the leading cause of morbidity and mortality in nutritionally vulnerable groups including lactating mothers (FAO and WHO, 2013). Vitamin A is normally found in animal-source foods in preformed form (retinol) (Mbah *et al.,* 2013), and in plant-source foods as pro-vitamin A (Souganidis *et al.,* 2013). The widespread

consumption of primarily plant-based diets exacerbate vitamin A deficiency because of the poor bioavailability of pro-vitamin A carotenoids (Mbah *et al.,* 2013). Vitamin A deficiency is mainly caused by consumption of a diet which is persistently insufficient in vitamin A (Aktar *et al.,* 2013). Lactating mothers are the most susceptible demographic group to vitamin A deficiency, because of the increased requirements for energy and micronutrients during lactation (Henjum *et al.,* 2015). They require enough stores of vitamin A to satisfy their own physiological needs and those of their infants, since infants are born with low vitamin A stores and are dependent on external sources mostly breast milk (WHO, 2011). When lactating mothers become vitamin A deficient the breast-fed infants are also affected by that deficiency (Agne-Djigo *et al.,* 2012).

In Tanzania, micronutrient deficiencies including vitamin A, cost the country over US$ 518 million, which is approximately 2.65% of the country's GDP (World Bank, 2012). Beyond the economic losses, micronutrient deficiencies significantly contribute to infant and maternal mortality, with over 27,000 infant and 1600 maternal deaths annually (World Bank, 2012). Despite the government efforts to eliminate vitamin A deficiency through various interventions for example; nutrition education and supplementation, prevalence of vitamin A deficiency is still high (Tanzania National Nutrition Survey, 2014). According to Tanzania Demographic Health Survey 2010, 39% of pregnant women and 35% of lactating mothers were vitamin A deficient (NBS, 2011). To deal with these challenges, the Government of Tanzania launched a nationwide food fortification program in 2013 as one of the measures to prevent micronutrients undernutrition (URT, 2013). This is because fortification of staple foods including sunflower oil with Vitamin A can reduce the prevalence of vitamin A deficiency. Edible oil (fortified with vitamin A) is used as a suitable vehicle for carrying vitamin A since it is commonly used in food preparation, thus making foods at the household contain high concentration of vitamin A (Andarwulan *et al.,* 2014). Evaluation of public intervention using large scale fortification of sunflower oil has not been conducted in Tanzania. As part of the efforts to evaluate the effectiveness of public intervention with fortified oil, this study was conducted to determine factors influencing vitamin A status of lactating mothers in Manyara and Shinyanga regions of Tanzania, which are areas with high prevalence of vitamin A deficiency among women and children under the age of five years.

Methodology

Description of Study Area

This study was conducted in two regions of Tanzania namely Manyanra and Shinyanga. The two regions were selected due to high prevalence of vitamin A deficiency among lactating women (NBS, 2011). These regions were also used as pilot areas to determine effectiveness of public intervention of vitamin A deficiency using fortified sunflower oil.

Study Design, Sampling frame, Sampling Technique and Sample size

The study was a longitudinal intervention design with intention to treat vitamin A deficiency. The study population involved all lactating mothers living in the selected districts of Manyara and Shinyanga regions of Tanzania. These regions were purposely selected based on the prevalence of vitamin A deficiency (NBS, 2011) and infrastructure to access remote villages. The sampling frame comprised of lactating mothers of different age groups, i.e., young mothers <20 years, middle age mothers 20-34 years and elder mothers at 35-49 years. Inclusion criteria were lactating mothers who had stayed in the study areas for more than three months at the time of the study and mothers who consented to participate in the study. Exclusion criteria were lactating mothers who refused to participate in the study and those who had stayed in the study areas for less than three months at the time of the study. Subjects were randomly selected by assigning random numbers and drawing them at random from each age group. Sample size was determined by statistical power analysis using a formula $N = t^2 \times (p \times q)/d^2$, whereby N= was sample size t was the risk of error, p was expected prevalence, q was expected non

prevalence and d was level of precision (WHO, 1991). A total number of 569 lactating mothers were selected for the study. Baseline data were collected from 17th June to 30th July 2015.

Data Collection

Construction of a questionnaire

A questionnaire was used to collect information on factors influencing vitamin A status of lactating mothers. The questionnaire was divided into three sections. Section one established socio-economic and demographic factors e.g. education level, household head, access to water and the main source of energy for light. Section two solicited information about maternal dietary diversity e.g. numbers of meals/food groups consumed for the past 24hrs and section three solicited information regarding knowledge, attitude and practices (KAP) about vitamin A rich foods and fortified oil.

Training of enumerators

Ten enumerators were trained on how to administer the questionnaire. They were also trained on how to collect blood samples between themselves, which finger to be used for collecting blood sample, how to massage the finger and insert lancet on it, how to use of micropipette to collect blood and dispense on protein saver cards and leave it for a while (five to ten minutes) to allow drying to take place, then packaging into airtight aluminum bags, adding three desiccants in the aluminum bags and seal it.

Pre-testing of questionnaire

The questionnaire was pretested among ten lactating mothers in Morogoro urban and rural districts of Tanzania. The villages in which the questionnaires were pre-tested were Bigwa, Kichangani and Mazimbu in Morogoro town and Mgeta and Mlali in Morogoro rural districts. Necessary adjustments were made on the questionnaire.

Administration of the questionnaire: The questionnaire was administered by home visits in which ten enumerators conducted face to face interviews with the lactating mothers in the early hours of the day.

Samples collected: Household cooking oils: A sample of cooking oil (capacity 5 ml) was also collected from the household after the interview. The oil samples were used to determine concentration of vitamin A in the oil that was consumed by the household.

Blood samples: Blood samples were drawn from the lactating mothers using safety lancets by finger prick method. About 50µL of blood was taken by a micropipette and dispensed into a protein saver paper (903 Protein Saver Card, Whatman International, UK) and allowed to dry in air for 5-10 minutes then packaged in airtight aluminum bags in which three pieces of desiccant were added to keep the blood sample dry. Retinol in the DBS was determined by enzyme-linked immunosorbent assay (ELISA) method. The cut-off point used to identify vitamin A deficiency for the lactating mothers was 26.04 µg/ml (NBS, 2011).

Maternal Dietary Diversity Score (MDDS)

24hr Dietary recall: Maternal dietary intake within the past 24 hours was collected from the lactating mothers. Mothers were requested to list all the foods consumed both at home and out of their home. Maternal Dietary diversity score was calculated based on the consumption of the following nine food groups: (1) starchy staples (2) legumes, nuts and seeds (3) milk and milk products (4) meat and fish (5) dark green leafy vegetables (6) other vitamin A rich fruits and vegetables (7) eggs (8) other fruits and vegetables (9) organ meat. Consumption of <3 food groups was classified as low dietary diversity, 3 food groups as moderate-low dietary diversity, 4 food groups as medium dietary diversity and ≥5 food groups as high dietary diversity

Data Analysis: Data from the questionnaire were coded, cleaned and analyzed using SPSS computer program version 21. Descriptive analysis was used to calculate frequencies and percentages in categorical variables such as age, sex and level of education. The relations between variables were determined through multiple linear regression analysis in which retinol status of lactating mothers was taken

as a dependent variable that was affected by independent variables.

Ethical Consideration: Ethical clearance was obtained from the Ethics Committee of the National Institute for Medical Research (NIMR). Subjects were required to fill in a consent form to affirm their willingness to participate in the study. Confidentiality of the data collected was ensured and no body outside the research team was allowed to access the information containing personal identifiers. All subjects were identified by numbers instead of their real names.

Results

Socio-economic and demographic characteristics of the lactating mothers

Table 1 presents socio-economic and demographic characteristics of the lactating mothers. Majority of lactating mothers 74.3% (95% CI: 70.14-78.45), had attained primary school education level. Only few had informal/ secondary education level 25.7% (95% CI: 18.61-32.79). Most of the lactating mothers 99.1% (95% CI: 98.32-99.88) were married. About 76.2% (95% CI: 72.05-80.35) of the lactating mothers came from families with more than 4 people in the household. Most of the lactating mothers 89.5% (95% CI: 86.84-92.16) were housewives while majority of households 98% (95% CI: 96.84-99.16) were headed by males.

Vitamin A deficiency by age groups and maternal education level

Vitamin A deficiency by age groups and maternal education level of the respondents are

Table 1: Socio-economic and demographic characteristics of the lactating mothers (n=569)

Parameter	N	%	95% CI
Age			
15- 19	25	4.4	3.64-12.440
20 – 34	383	67.3	62.60-72.00
35 - 49	161	28.3	28.00-28.65
Education level			
Primary education	423	74.3	70.14-78.45
Informal education	83	14.6	7.00-22.20
Secondary education	63	13.4	5.00-21.81
Marital status			
Married	564	99.1	98.32-99.88
Single	5	0.9	16.08-34.08
Household family size			
≤4	165	23.8	17.30-30.30
>4	404	76.2	72.05-80.35
Occupation			
Housewife	509	89.5	86.84-92.16
Petty business	25	4.4	3.64-12.44
Employed for wage	15	2.6	5.45-10.65
Self employed	20	3.5	4.55-11.55
Household head			
Male	558	98.0	96.84-99.16
Female	11	2.0	6.27-10.27

shown in table 2. Majority of lactating mothers 53.4% (95% CI: 47.79-59.01) who were vitamin A deficient were in middle age group (20-34 years). All groups had high deficiency of vitamin A, although the younger mothers group (15-19 years) was worse off. Prevalence of vitamin A deficiency among lactating mothers was high regardless of their education levels. The most affected group with vitamin A deficiency was primary school education mothers 64.3% (95% CI: 59.39-69.21).

Table 2: Vitamin A deficiency by age groups and maternal education level (N = 569)

Parameter	With vitamin A deficiency (% , 95% CI)	Without vitamin A deficiency (% , 95% CI)	DBS not analyzed (% , 95% CI)	Total (% , 95% CI)
Age groups				
15-19	3.9 (4.12-11.99)	0.5 (7.48-8.48)	0.0 (0)	4.4 (3.64-12.44)
20-34	53.4(47.79-59.01)	9.8 (2.01-17.59)	4.0 (4.01-12.01)	67.3 (62.5-71.9)
35-49	23 (15.79-30.21)	3.2 (4.93-11.33)	2.2 (6.1-10.5)	28.3 (21.43-35.17
Education level				
Primary	64.3 (59.39-69.21)	10.0 (2.21-17.79)	0.0 (0)	74.3 (70.14-78.46)
Informal	6.5 (1.81-13.01)	1.9 (6.17-9.97)	6.2 (1.79-14.19)	14.6 (7.00-22.20)
Secondary	9.1 (1.43-16.77)	1.6 (6.60-9.80)	0.0 (0)	13.4 (5.0-21.81)

Vitamin A deficiency by district of residence

Table 3 shows vitamin deficiency by district of residence. Prevalence rate of vitamin A deficiency in rural districts was higher than that of urban districts. Prevalence of vitamin A deficiency in rural districts was 63.6% (95% CI: 58.64-68.56) while that in urban districts was 16.7% (95% CI: 9.2-24.2).

Table 3: Vitamin A deficiency by district of residence (N = 569)

Districts	With vitamin A deficiency (% , 95 CI)	Without vitamin A deficiency (% , 95 CI)	BDS not Analyzed (% , 95 CI)	Total (% , 95 CI)
Urban				
Babati urban	9.3 (1.48-17.12)	0.5 (7.48-8.48)	0.9 (7.38-9.18)	10.7 (2.94-18.46)
Shinyanga urban	7.4 (0.52-15.32)	1.1 (7.25-9.45)	0.2 (1.56-8.96)	8.6 (0.75-16.45
Total urban	16.7 (9.2-24.2)	1.6 (6.60-9.80)	1.1 (7.25-9.45)	19.3 (11.92-26.68)
Rural				
Babati rural	11.8 (4.08-19.52)	1.8 (6.44-10.04)	0.7 (7.47-8.87)	14.2 (6.6-21.80)
Hanang	10.0 (2.21-15.11)	1.4 (6.74-9.54)	2.1 (6.01-10.21)	13.5 (5.87-21.13)
Mbulu	20.7 (13.39-28.01)	4.9 (3.1-12.90)	1.1 (7.25-9.45)	26.7 (19.67-33.73)
Kishapu	7.2 (0.71-15.11)	1.4 (6.74-9.54)	0.2 (8.56-8.96)	8.9 (1.01-16.79)
Kahama	6.6 (1.63-14.83)	2.1 (6.01-10.21)	0.4 (8.35-9.15)	8.6 (0.75-16.45)
Total rural	**63.6 (58.64-68.56)**	**12.1 (4.40-19.80)**	**4.7 (3.14-12.54)**	**80.7 (77.09-84.31)**

Vitamin A deficiency by type of cooking oil and maternal dietary diversity

Vitamin A deficiency among the lactating mothers by type of cooking oil used in households and maternal dietary diversity are presented in table 4. According to the East African Standard EAS 299: 2013, the recommended levels of fortification of vitamin A in edible oil at factory level is 35±40 mg/kg, while the concentration of vitamin A at retail and household level (end

Table 4: Vitamin A deficiency by type of cooking oil used at the household and Maternal Dietary Diversity Score (MDDS) (N = 569)

Parameter	Cut-off point	With vitamin A deficiency (% , 95 CI)	Without vitamin A deficiency (% , 95 CI)	DBS not analyzed (% , 95 CI)	Total (% , 95 CI)
Household oil (mg/kg)					
	< 20	45.3 (39.23-51.37)	6.9 (1.05-14.85)	7.0 (1.88-3.28)	59.1(53.84-64.36)
	20-40	20.2 (12.86-27.54)	4.4 (3.64-12.44)	1.6 (6.60-9.80)	26.2(19.14-33.26)
	>40	11.2 (3.42-18.99)	1.4 (6.74-9.54)	1.6 (6.60-9.80)	14.7(6.94-22.46)
Maternal Dietary Diversity Score					
	Low (<3)	40.8 (34.48-47.12)	7.0 (0.9-14.91)	2.6 (5.45-10.65)	50.4 (44.62-56.18)
	Moderate low (=3)	29.3 (22.40-36.20)	5.4 (2.56-13.56)	1.4 (6.74-9.54)	36.2 (29.64-42.76)
	Medium (=4)	8.4 (0.55-16.26)	1.0 (7.0-9.0)	1.8 (6.44-10.04)	11.2 (3.47-18.93)
	High (≥5)	1.8 (6.44-10.04)	0.0 (0)	0.4 (8.35-9.15)	2.2 (6.10-10.50)

users) should be 20-40 mg/kg. The most popular oil in Manyara was sunflower oil which has some natural but low content of retinol while in Shinyanga was palm oil which is fortified. Prevalence of vitamin A deficiency among mothers indicated that, 45.3% (95% CI: 39.23-51.37) of the households had oil with retinol concentration of <20 mg/kg. Others with vitamin A deficiency had edible oil with retinol concentration in the range of 20-40 mg/kg and above 40 mg/kg of oil. Prevalence of vitamin A deficiency among lactating mothers was high in all groups, although deficiency was higher for mothers with the lowest dietary scores 40.8% (95% CI: 34.48-47.12). The mostly consumed food group 97% (95% CI: 96.99-97.01) was staples followed by other fruits and vegetables and dark green vegetables (Figure 1).

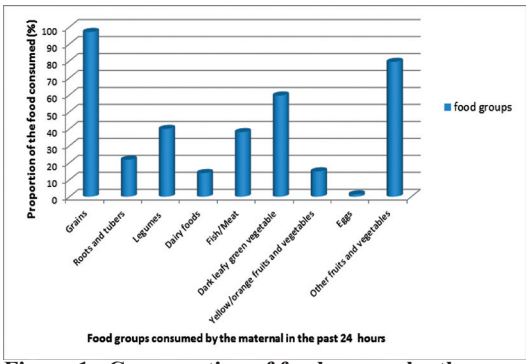

Figure 1: Consumption of food groups by the maternal within the past 24 hours

Knowledge about vitamin A

Table 5 indicates maternal knowledge about vitamin A, vitamin A rich foods and fortification of edible oil. Majority of the lactating mothers 74.5% (95% CI: 70.35-78.65) had heard about vitamin A from health centers and community health workers. Knowledge about implication of vitamin A deficiency was correctly mentioned by 23.7% (95% CI: 16.52-30.87) of the respondents. Only 2.1% (95% CI: 6.02-10.21) of the respondents knew about food fortification. Even the few who knew about fortification, only 1.2% (95% CI: 7.51-10.0) of the respondents were able to recognize fortified oil by the label. Four questions were asked on the role of vitamin A in human health. Score range of 3-4 was considered high knowledge while a score less than 3 was considered low. Only 43% (95% CI: 35.81-50.19) of the mothers correctly identified at least one benefit of vitamin A. When respondents were asked to mention vitamin A rich foods, only 44.2% (95% CI: 37.08-51.32) of the respondents identified correctly at least one food source, and 2.1% (95% CI: 6.02-10.21) respondents mentioned fortification of edible oil. When respondents were asked to

Table 5: Maternal knowledge about vitamin A, vitamin A rich foods and fortification of edible oils

Questions about knowledge on vitamin A	Yes (% , 95 CI)	No (% , 95 CI)
Questions about vitamin A		
Heard about vitamin A	74.5 (70.35-78.65)	25.5 (18.41-32.59)
Health implications of vitamin A deficiency	23.7 (16.52-30.87)	76.3 (72.30-80.31)
Question about vitamin A rich foods		
Correctly identified at least one benefit of vitamin A	43.0 (35.81-50.19)	57.0 (52.07-61.93)
Correctly identified at least one food source of vitamin A	44.2 (37.08-51.32)	55.8 (50.82-60.78
Mentioned at least one way to avoid vitamin A deficiency	26.9 (18.76-35.04)	73.1 (69.03-77.17)
Question about fortification of oil		
Heard about fortification	2.1 (6.02-10.21)	97.9 (96.71-99.10)
Able to identify fortified oil by the logo/label	1.2 (7.51-10.0)	98.8 (97.90-99.70)

mention ways to avoid VAD, only 26.9% (95% CI: 18.76-35.04) of the respondents mentioned correctly at least one way to avoid vitamin A deficiency.

Attitude and practices toward consumption of fortified vitamin A rich foods

Table 6 summarizes the attitude and practices regarding vitamin A rich foods and fortified oil. Majority of mothers 87.0% (95% CI: 84.04-90.0) in this study had a positive attitude towards fortified oil but lacked good practices of consuming vitamin A rich foods.

Association between average vitamin A status and age, education level, household cooking oil, vitamin A rich foods, maternal dietary diversity (MDDS) and knowledge about Vitamin A and fortification and residence

Linear regression was run to compute the strength of association between maternal retinol status and the age, maternal education, household cooking oil, residence, knowledge about fortification and vitamin A rich foods and maternal dietary diversity is presented in table 7. There was a significant difference at $p<0.05$ between the maternal retinol status and residence.

Table 6: Attitude and practices towards consumption of vitamin A rich foods and fortified oil (N = 569)

Parameter	Yes (% , 95 CI)	No (% , 95 CI)
Positive Attitude toward fortified oil	87.0 (84.04-90.0)	13.0 (5.34-20.66)
Consumption of vitamin A rich foods		
Consumption of dark green vegetables	90.0 (87.40-92.60)	10.0 (2.21-17.79)
Yellow fruits or vegetables	30.0 (23.13-36.87)	70.0 (65.50-74.50)
Animal products	40.0 (33.00-47.00)	60.0 (55.08-64.92)
Yellow orange root foods	20.0 (12.66-27.34)	80.0 (76.32-83.68)
Didn't consume vitamin A rich foods	10.0 (2.21-17.79)	90.0 (87.40-92.60)
Reason for consuming vitamin A rich foods		
Availability and easy to accommodate	90.0 (87.40-92.60)	10.0 (2.21-17.79)
Don't know	10.0 (2.21-17.79)	90.0 (87.40-92.60)

Table 7: Association between the average vitamin A status and the age, education level, household cooking oil, vitamin A rich foods, maternal dietary diversity (MDDS) and knowledge about Vitamin A and fortification and residence

Parameters	Beta coefficients	P - values
Age	.014	0.450
Household family size	-.017	0.343
Education level	.004	0.811
Household oil	-.006	0.761
Knowledge about fortification of oil	-.106	0.070
Knowledge about vitamin A rich foods	-.026	0.171
Maternal Dietary diversity	-.060	0.524
Cereal	-.001	0.978
Roots and tubers	-.016	0.648
legumes	-.037	0.417
Dairy consumption	-.015	0.460
Fish/meat	-.037	0.424
Eggs	.009	0.804
Dark leafy vegetable	-.038	0.431
Yellow/orange fruits	-.037	0.299
Other vitamin A rich vegetables and fruits	-.036	0.327
Residence	.951	0.000*

** Means significant at p<0.05*

Discussion

It was revealed in this study that, vitamin A status of lactating mothers with informal education was better as compared to their peers with primary school and secondary school education (Table 2). These findings are contrary to those of Rahman and Sapkota (2014) who reported that, vitamin A status of lactating mothers with primary and secondary education was better than those with informal education. The benefits of maternal education to nutrition and child health care have been demonstrated (Vikram *et al.,* 2012; Sabates, 2013; Wang *et al.,* 2013; Rawlings, 2014). According to Abuya *et al.* (2012) maternal education contributes to a decline in morbidity and mortality. Maternal education improves child nutrition through adopting better child-care practices such as good selection of healthy foods and health care services (Makoka, 2013), since mothers are good custodians of family health (Burchi, 2012; Bain *et al.,* 2013).

It was also noted in this study that, vitamin A deficiency rate was higher among lactating mothers in rural than urban areas (Table 3). These results are agreement with those of Wallace *et al.* (2014) who reported that, prevalence of VAD among lactating mothers was higher in rural areas in comparison to the urban locations. High prevalence of VAD in rural areas has also been documented by Mbah *et al.* (2013) and Abebe *et al.* (2014). This disparity could be due to the fact that, mothers in rural areas are less educated (Agarwal *et al.,* 2014; Wallace *et al.,* 2014) and therefore, they are less likely to participate in health programs or utilize available health services (Makoka, 2013). Also this disparity could be due to low income hindering dietary diversification consumption of fortified foods (Haileslassie *et al.,* 2016).

The results also showed that, most of the households in this study were using edible oil with retinol concentrations below the recommended levels (<20 mg/kg) while some other oil samples had retinol concentrations above the recommendation (>40 mg/kg) (Table 4). This is because fortification of edible oil in low income countries including Tanzania poorly managed (Akhtar *et al.,* 2013). This has been observed in this study whereby much of the oil which was sold in retail outlets was not fortified and even the little that was fortified contained either too little vitamin A concentration or excess amount of it. These findings are in line with those of Sandjaja *et al.* (2015) and Rohner *et al.* (2016). Poor fortification of oils with vitamin A might be due to poor quality control and monitoring at factory level (Soekirman *et al.,* 2012; Andarwulan *et al.,* 2014)

Vitamin A deficiency by maternal dietary diversity showed that mothers with low dietary diversity (scores less than 3) were worse off as

compared to their peers with medium (4 scores) and high (5 scores and above) dietary diversity (Table 4). Several studies have reported high prevalence of vitamin A deficiency among lactating mothers in low income countries with lowest dietary diversity score (Haileslassie *et al.,* 2016; Chagomoka *et al.,* 2016; Na *et al.,* 2016). This was attributed to low education and poverty which influence food choices and access. MDDS is important to both, mothers and their nursing children (Amugsi *et al.,* 2015). According to Weldehaweria *et al.* (2016), dietary diversity during lactation is essential because of increased nutritional needs especially minerals and vitamins. When a lactating mother gets sufficient vitamin A through the diet, the breastfed child also benefits since the concentration of vitamin A in the mother's milk also increases with the mother's diet (WHO, 2011). When lactating mothers do not get enough energy and micronutrients from their diets, they are at risk of getting micronutrient deficiencies (Henjum *et al.,* 2015). Some micronutrient deficiency negatively affects the quality of the breast milk as the mother's milk would also be deficient in those micronutrients. This in turn adversely affects the health of the breastfed baby (Weldehaweria *et al.,* 2016).

Food consumption by the maternal in this study was mostly based on the staples. Consumption of vitamin A rich foods such as animal foods e.g. meat, fish, eggs and dairy products especially in rural areas was very limited, despite the fact that, many households in the districts of Manyara and Shinyanga regions were animal keepers. Also, consumption of fruits and/or vegetables that were yellow/orange in color such as papaya, carrots and orange fleshed sweet potatoes was very low (figure 1). Findings of this study are in agreement with those reported by Haileslassie *et al.* (2016) who stated that, consumption of vitamin A rich foods including animal products, fruits and/or vegetables yellow/orange in color in rural communities was generally low but high consumption of staple foods. Low consumption of vitamin A rich foods among women in low income countries was mostly associated with factors such as low economic status (Amugsi *et al.,* 2015) and non-availability of vitamin A rich foods especially fortified foods (Haileslassie *et al.* 2016). Intakes of micronutrients less than the recommended levels increase the risks of micronutrient deficiencies and reduce lactation performance (Henjum *et al.,* 2015.) Adequate consumption of vitamin A rich foods among lactating mothers is beneficial for the health of both mothers and their nursing children (WHO, 2011).

Majority of the lactating mothers in this study lacked knowledge about the health implications of VAD, vitamin A rich foods and fortification of edible oils (Table 5). These results concurred with those reported by Aktar *et al.* (2013), who found that more than half of lactating mothers in Pakistan lacked knowledge about the health implications of Vitamin A deficiency and only few women in India had knowledge about vitamin A rich foods and fortified edible oil. Also, Damayanti *et al.* (2012) reported from their study that lactating mothers lacked the knowledge to identify fortified edible oil by reading the labels or recognize the logo on the packages. Knowledge about the beneficial effects of consuming vitamin A rich foods, such as green leafy vegetables, poultry, meat, cereal, and dairy products, may help to reduce the risk of VAD among lactating mothers (Aktar *et al.* 2013). According to Chagomoka *et al.* (2016), maternal knowledge about vitamin A is important to reduce vitamin A deficiency by achieving dietary diversification through consumption of locally produced vitamin A rich foods.

The findings in this study revealed further that, most of the lactating mothers had positive attitude towards oil fortification and vitamin A rich foods although consumption of these foods was very low (Table 6). Also, respondents appeared to be willing to buy and use the fortified oils but availability especially in rural settings was the limiting factor. These results are in agreement with those of Haileslassie *et al.* (2016) in their study who reported that, majority of maternal were willing to consume vitamin A rich foods and fortified foods but the availability and affordability of these foods was the main challenge. In the study by Wimalawansa,

(2013) it has been stated that, availability and affordability of the fortified foods in low income countries is still a problem. Also, positive attitude towards fortified foods and vitamin A rich foods is the main driver for consuming these foods (Jeżewska-Zychowicz and Królak, 2015), as it prompts people to search for them at the markets although in low income countries there is still shortage of fortified foods especially in rural communities (Dwyer *et al.,* 2015).

In this study there was also a strong relationship between the maternal vitamin A status and their residence (Table 7). The association observed suggested that, residence was an important factor that influenced the retinol status of the lactating mothers. The findings are in line with those of Samba *et al.* (2013) and Hanson *et al.* (2016), who in their studies reported that, retinol status among the lactating mothers was significantly influenced by residence. Residence is an important factor in determination of maternal retinol status because mothers in rural settings have low income and purchasing power in comparison to those from urban Samba *et al.* (2013). Thus, they are less likely to diversify diets and consume vitamin A rich foods including fortified foods (Sealey-Potts and Potts, 2014).

Conclusions and Recommendations

Generally vitamin A deficiency among lactating mothers was high. The major factor that influenced vitamin A deficiency in this socio group was residence. Other factors which had insignificant influence included fortification of cooking oil and consumption of animal-based foods such as eggs fish/meat and dairy foods, plant based foods such as cereal, roots and tubers, yellow or orange fruits, dark green vegetables, other fruits and vegetables, maternal knowledge about vitamin A rich foods and maternal dietary diversity. Starchy foods were commonly consumed by the respondents while animal-based foods were rarely consumed. It is recommended based on this study that, to address the problem of vitamin A deficiency, nutrition and healthy planners should put more efforts in food fortification especially of edible oil and promote consumption of diverse diets at the household level. Also lactating mothers and the community as a whole should be educated on the importance of consuming fortified oil and selection of foods rich in vitamin A. Furthermore, the community should to be educated on how to identify the fortified oil in the market by recognizing the fortification logo or reading the label before buying the oil or any other fortified food product.

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