Influence of Vitamin A Status on the Anthropometric Attributes of Children aged 6-36 months in Tanzania

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Abstract

Vitamin A deficiency remains one of the health challenge causing morbidity and mortality among under-five children in Tanzania. This study was conducted to determine the influence of vitamin A status on the anthropometric attributes of the children aged 6 - 36 months living in Manyara and Shinyanga regions, Tanzania. Purposive and random sampling techniques were used to obtain a sample of 462 children aged 6 - 36 months. Data were analyzed using SPSS program version 20 and ENA for SMART. Results showed that, the average prevalence of vitamin A deficiency among 6-36 months old children was 69.5% (n=321). Prevalence of vitamin A deficiency among children aged 6 - 36 months by regions was 69.3% (n=303) in Manyara and 69.8% (n=159) in Shinyanga. Prevalence of VAD among non-breastfed children was 75% (n=117) while among breastfed children was 66.0% (n=203). VAD was therefore significantly higher ($p<0.05$) among the non-breastfed children than their breastfed peers. Prevalence of wasting (weight-for-height z-score) among the children aged 6 - 36 months was 6.9% (n = 32), stunting (height-for-age z-score) was 51% (n=236) and underweight (weight for age z-score) was 25.5% (n=118). Vitamin A status has influence on the anthropometric attributes; however statistical significance ($p<0.05$) was observed only on age and stunting. It is concluded from this study that, prevalence of vitamin A deficiency among 6 - 36 months old children was higher than the national average. It was significantly higher in the non-breastfed children than their breastfed peers. Also, children with VAD suffered from one or more forms of under-nutrition (wasting, stunting and underweight). Stunting and age of the children were the strong predictors of vitamin A status. These findings call for coordinated and sustainable intervention programs to reduce vitamin A deficiency and under-nutrition to optimize growth among children aged 6 – 36 months.

Keywords: Vitamin A Deficiency, anthropometric attributes under-five children, growth and development

Introduction

Vitamin A Deficiency (VAD) continues to be foremost serious public health problem in many parts of the world today (Jemberu *et al.,* 2017). It is more prevalent in low and middle income countries including Tanzania (Laillou *et al.,* 2013). Vitamin A makes significant contribution to childhood morbidity and mortality (FAO and WHO, 2013). In Tanzania for instance, more than 33% of children aged 6 – 59 months suffer from vitamin A deficiency (NBS, 2011). More 27,000 infant deaths per annum in Tanzania are due to micronutrients deficiencies including vitamin A (Noor *et al.,* 2017). Demographic and Healthy Survey (2010) report showed that a third of children in Tanzania aged 6 – 59 months suffer from vitamin A deficiency (NBS, 2011). Causes of VAD are multi-factorial; however, the main underlying cause is poor diet, which is chronically supplies insufficient amount of vitamin A (Ndau *et al.,* 2016). VAD is not clinically identifiable until late stages, which lasts for a long period of time leading to many physiological consequences (WHO, 2009). Deficiency of vitamin A during childhood affects growth, immune competence,

physical and cognitive development (Marasinghe *et al.,* 2015).

Before 1996, prevalence rate of stunting, underweight and wasting among under-five children in Tanzania was very high (NBS, 2016). However, from 1996 – 2005 prevalence rates of stunting, underweight and wasting dropped from 50 to 44%, 27 to 17% and 9 to 3.5%, respectively. Between 2005 and 2015 prevalence rates of stunting and underweight continued to drop to 34 and 14%, respectively, however the prevalence rate of wasting has increased from 3.5 to 5% (NBS, 2016). From 1996, to date there has been a great improvement in the anthropometric status of children under the age of five years; however, some children are still suffering from one or more forms of under-nutrition namely stunting, underweight, wasting or specific nutrient deficiencies e.g. iron, iodine and vitamin A deficiencies (FACT, 2016).

Potential interventions to combat under-nutrition and micronutrient deficiencies among children under the age of five years in Tanzania include supplementation, dietary diversity, nutrition education, vaccination, fortification and scaling up of breast feeding (TFNC, 2014). Combination of the various interventions against micronutrient deficiencies would accelerate survival, well-being, growth and development of the under-five children (FAO and WHO, 2013). It has been reported that improving micronutrient status such as reducing vitamin A deficiency among under-five children would significantly reduce the risk of mortality by 25–35% (Gaurav *et al.,* 2014). The prevalence rate of VAD in Manyara region ranged between 31 – 39% while in Shinyanga region the prevalence ranged between 39 – 50% (NBS, 2011; TFNC, 2014). Therefore, as part of the effort to combat VAD in Tanzania, this study was designed to evaluate the influence of vitamin A status on the anthropometric attributes of children aged 6 – 36 months in Manyara and Shinyanga regions, Tanzania.

Materials and Methods

Study design and area

A cross sectional baseline survey with intention to treat vitamin A deficiency, was conducted in Babati urban, Babati rural, Hanang and Mbulu districts of Manyara region and Shinyanga urban, Shinyanga rural, Kahama and Kishapu districts of Shinyanga region in 2016. These regions were selected due to high prevalence of vitamin A deficiency among children under the age of five years and lactating mothers (NBS, 2011). Shinyanga region is located in North-west of Tanzanian at latitude 3.36950 S and longitude 34.15320 E. According to the 2012 National Population Census (NBS, 2012), Shinyanga region had a population of 1,534,808 people of whom 750,841 were males while 783,967 were females. This region covers an area of 50,781 km^2. Manyara region is located in Northern part of Tanzania at latitude 4.31500 S and longitude 36.95410 E. According to the 2012 National Population Census (NBS, 2012) Manyara region had a population of 1,425,131 people out of whom 717,085 were males while 708,046 were females. Manyara region covers an area of 46,359 km^2 (NBS, 2012).

Study population, sampling technique and sample size

The study population involved children (both males and females) aged 6-36 months old were selected from low, middle and high income families. The children were receiving post-natal monthly health care at Maternal and Reproductive Health clinics (RHC). Respondents were mothers/caregivers who consented to participate in this study. Children whose parents/caregivers refused to participate in the study and children with chronic diseases such as type 1 diabetes mellitus, HIV, inborn errors of metabolism, e.g. phenylketonuria (PKU) and the children who were sick during the study were excluded from the study. Subjects were selected randomly by using tables of random numbers assigned to mothers/caregivers attending the monthly growth monitoring clinics. Sample size was determined by calculation of statistical power using a WHO (1991) formula $N=t^2 *(p\times q)/d^2$ whereby N – was the sample size, p - the expected prevalence rate of VAD among children aged 6 – 36 months in the study areas (0.37.8), t - the margin of error (1.96), q - 1- p (0.9); d - level of precision

(0.05). Using this equation, a sample size of 462 children (225 from Shinyanga and 237 from Manyara region) were recruited for the study. Out of these, 249 (53.9%) were males while 213 (46.1%) were females. The sample size was distributed according to the population in the study areas.

Data collection

A questionnaire used in the National Demographic and Health Survey (2014) was adopted for use in this study to obtain socio-economic and demographic information of mothers/caregivers of the studied children. The questionnaire was pre-tested among 10 lactating mothers/caregivers in Morogoro urban and rural districts, Tanzania. Villages used for pre-testing the questionnaires were Bigwa, Kichangani and Mazimbu in Morogoro Urban and Mgeta and Mlali in Morogoro rural districts. Necessary adjustments were made on the questionnaire after pre-testing. Ten enumerators were trained before administration of the questionnaire. They were taught on how to ask questions, expected answers, probing to reaffirm the responses, how to record the answers and also how to take anthropometric measurements and conducting finger prick to collect blood samples and preparation of dry blood samples (DBS). Administration of the question was done by home visit during the morning hours of the day. The questionnaire was administered to the respondents through face-to-face interviews and the enumerators recorded the responses.

Method of collecting blood sample

Determination of serum retinol

Blood samples were drawn from the under-five children by finger prick method using safety lancets. About 25µL of blood were taken by a micropipette and dispensed into a protein saver papers (903 Protein Saver Card, Whatman International, UK). After drying, the protein saver papers with blood samples were packaged in airtight aluminium bags in which three pieces of desiccators were added to keep the blood sample dry (DBS). DBS were stored under ambient conditions before transportation to Tanzania Food and Nutrition Center (TFNC) laboratory for analysis. Retinol in the DBS was determined by enzyme-linked immunosorbent assay (ELISA) method (WHO, 2011). In children, Retinol Binding Protein (RBP) the cut off points of 17.325 µg/kg or 0.825 µmol/L was considered normal (WHO, 2011). (2011) was considered as normal.

Anthropometric (weight and length/height) measurements

Body weights were measured by using SECA electronic scale (Model – SECA 874 Hamburg Germany). The scale was adjusted to zero before taking measurements. Children were weighed bare feet with only light clothes on. Children younger than 24 months were weighed after having the mother/caregiver stand on the scale, reset the scale to zero, then have the mother/caregiver hold the child and the child's weight was read. Measurement was taken three times and the average weight recorded to the nearest 0.1kg. Children aged 24 to 36 months were weighed while standing on the digital scale.

Heights were measured by using a length board (Manufactured by UNICEF). Children younger than 24 months were measured while lying down without shoes on. The child was placed on his/her back at the center of the length board such that the child was lying straight with shoulders and buttocks flat against the measuring surface and child's eyes looking straight up. Both legs were fully extended with the toes pointing upward and the feet kept flat against the foot-piece. Recumbent length of the child was measured three times and the average recorded to the nearest 0.1 cm. For children over 24 months, they were allowed to stand against the length board bare feet, with legs straight, eyes of the subjects looked straight ahead and the line of sight was in level with the surface, hands pointed vertically downwards against the body, while the head, shoulder blades and buttocks touched against the wall. Then the headpiece was slid down to touch the crown of the head. The body height was thereafter read parallel with the headpiece three times and the average height recorded to the nearest 0.1 cm. Z–Scores of weight for age, length for age and weight for length were calculated following WHO (2006) recommendation. Children with $-2 < SD < +2$

values were classified as normal (WHO, 2006).

Data analysis

Data were analyzed by STATA program and SPSS version 20. Means, frequencies and percentages were obtained using descriptive analysis. The mean values of Vitamin A of children in the two regions were compared by using t-tests. The strength of association between VAD and the anthropometric attributes was determined by multiple linear regression analysis in which VAD was taken as a dependent variable that was influenced by various anthropometric attributes (independent variables). Measures of anthropometric status (WAZ, HAZ and WHZ) were analyzed by using ENA for SMART program. Statistical significance was set at P-value of 0.05.

Ethical clearance and research permit

This study was approved by the National Institute for Medical Research (NIMR) (Tanzania) and the University of Waterloo (Canada) ethics committees for research on human subjects. Permission was also obtained from the regional and district health authorities to conduct the study in the selected districts. All mothers/caregivers who agreed to participate in this study signed an informed consent form to affirm their willingness to allow their children to participate in the study. Respondents had the liberty to decline participation in the study at any time.

Results

Table 1 summarizes the socio-economic and demographic characteristics of the mothers/caregivers of the studied children. Majority of the mothers/caregivers (82.3%, n = 380) were housewives while only small proportion of the mothers/caregivers (4.3%, n=20) were employed for wage. Majority of the mothers/caregivers had attained only primary school education level (84.2%, n=389) and only few mothers/caregivers had attained secondary school education level (4.3%, n=20). None of the mothers/caregivers had attained College/University or vocational training level and a handful of the mothers/caregivers (11.5%, n=53) had no formal education. Formal education is essential for mothers/caregivers not only in understanding nutrition information but also in opening up chances for employment and other entrepreneurial skills. Majority of the mothers/caregivers in the study were young (64%), between the ages of 20 – 34 years. About 24% of the mothers/caregivers were teenagers while few mothers/caregivers (12%) were above the age of 35 years. About 71% of mothers/caregivers in the study had a parity of 1 – 4 births, while 23% of them had a parity of 5 – 10 births.

Table 1: Socio-economic and demographic characteristics of the mothers/caregivers (n=462)

Parameter	No. of Respondents	%
Occupation		
Petty traders	62	13.40
Farmers	320	69.30
Employed for wage	20	4.30
Housewives	60	12.98
Education level		
Uneducated/Informal	53	11.50
Primary	389	84.20
Secondary	20	4.30
College/Vocation	0	0.00
Age (years)		
< 19	111	24.00
20 – 34	296	64.00
> 35	55	12.00
Maternal parity		
1 – 4	328	71.00
5 – 10	106	23.00
> 10	28	6.00
Marital Status		
Single	60	13.00
Married	356	77.10
Widowed	28	6.00
Divorced	18	3.90
Family size		
1 – 2	83	18.00
3 – 4	222	48.00
5 – 6	129	28.00
> 6	28	6.00

The high maternal parity was reflected in the family sizes, in which most households (48%) had family size of 3 – 4 people. These findings were in agreement with the data reported in the National 2012 Population and Housing census, in which the average family size in Manyara and Shinyanga regions was four (URT, 2012). Majority of the mothers/caregivers involved in the study (77.1%) were married and only a few were single (13%), widowed (6.0%) and divorced (3.9%).

Table 2 shows the characteristics of the studied children. The mean age of the children was 19.5±10.149 months, mean height-for-age Z-score was -0.65±1.26 Standard Deviation (SD), mean height for age was -1.41±1.71 SD, mean weight-for-height was 0.14±1.21 SD while mean serum retinol concentration was 14.87±5.40 µg/ml.

Table 2: Characteristics of the studied children (n=462)

Means of the children	Mean	Standard Deviation
Age (months)	19.5	10.15
WAZ Score	-0.65	1.26
HAZ Score	-1.41	1.71
WHZ Score	0.14	1.21
Serum retinol (µg/mL)	14.87	5.40

WAZ = weight for height Z-score; WAZ = weight for age Z-score; HAZ = height for age Z-score

Table 3 summarizes the prevalence of VAD among children aged 6 – 36 months in the study regions. The proportion of children with VAD (69.5%, n=321) was significantly higher (P=0.00) than children without VAD (30.5%, n=141). More than 69.5% (n=321) children had serum retinol binding protein less than the cut-off of 17.3256 µg/ml which implied that these children were vitamin A deficient. Very few children (30.5%, n=141) had adequate vitamin A levels of 17.3256 µg/ml and above. Out of the 321 (69.5%) children who were vitamin A deficient, 167 (n=34.1) were males while 154 (31.4%) were females.

The proportion of males with VAD in Morogoro region (71.5%, n=118) was significantly = higher (p=0.00) than that of their female counterparts (66.7%, n=92). Conversely, more females had VAD in Shinyanga region (76.0%, n=57) compared to their male counterparts (64.3%, n=54) (p > 0.05). Overall, more males (n = 249) had VAD compared to females (n=213). Prevalence of VAD in Manyara region was 69.3% (n=210) while in Shinyanga region the prevalence was 69.8% (n= 11).

Table 4 shows prevalence of VAD among breastfed and non-breastfed children involved in the study. Prevalence of VAD among breastfed children was 66.1% (n=203) while for the non-breastfed children the VAD prevalence was 75.5% (n=117). This implied that, VAD was significantly higher (p=0.00) among the non-breastfed children that than among their breastfed peers.

Table 5 shows the prevalence of wasting, underweight and stunting among the studied children. Prevalence of underweight among the 6 – 36 months old children was 25.5% (n=118), stunting was 51.1% (n=236) while prevalence of wasting was 6.9% (n=32). Prevalence of underweight was slightly higher (p>0.05) among males (26.5%, n = 66) than females (24.4%, n = 52). Conversely, slightly more females (p>0.05) were stunted (51.3%, n=110) compared to their male counterparts (50.6%, n=126). Likewise, slightly more females (p>0.05) were wasted (7.0%, n=15) compared to the males peers (6.8%, n=17).

Table 6 shows the prevalence of VAD among underweight, stunted and wasted children (n=462). Most of the children (both males and females) who were underweight, stunted and wasted were also deficient in vitamin A. The proportion of underweight and wasted males who had VAD were significantly higher (p=0.00) compared to that of females, however, the proportion of wasted males with VAD was similar (p>0.05) to that of the females.

Table 7 indicates the prevalence of VAD among breastfed and non-breastfed children who were

Table 3: Prevalence of VAD among children aged 6-36 months

Children in Region	Vit. A Cut-off (µg/mL)	Boys		Girls		Total		P -value
		n	%	n	%	n	%	
Manyara region								
With VAD	<17.325	118	71.52	92	66.67	210	69.3	0.00*
Without VAD	≥ 17.325	47	28.48	46	33.33	93	30.7	
Total		**165**	**100.0**	**138**	**100.0**	**303**	**100.0**	
Shinyanga region								
With VAD	<17.325	54	64.29	57	76	111	69.8	0.00*
Without VAD	≥ 17.325	30	35.71	18	24	48	30.2	
Total		**84**	**100.0**	**75**	**100.0**	**159**	**100.0**	
All regions								
With VAD	<17.325	167	67.07	154	72.3	321	69.5	0.00*
Without VAD	≥ 17.325	82	32.93	59	27.7	141	30.5	
Total		**249**	**100.0**	**213**	**100.0**	**462**	**100.0**	

*VAD - Vitamin A Deficiency; * Significant difference at p ≤ 0.05*

Table 4: Vitamin A deficiency among breastfed and non-breastfed children involved in the study (n=462)

Children	Vitamin A Cut-off (µg/mL)	Male		Female		All		P-value
		n	%	n	%	n	%	
BF-VAD	<17.325	103	63.19	100	69.44	203	66.12	0.61
BF- Normal	≥ 17.325	60	36.81	44	30.56	104	33.88	
All BF		163	100.0	144	100.0	307	100.0	
NBF - VAD	<17.325	63	73.26	54	78.26	117	75.48	0.00*
NBF-Normal	≥ 17.325	23	26.74	15	21.74	38	24.52	
All NBF		86	100.0	69	100.0	155	100.0	

*BF=breastfed; NBF = non-breastfed; BF-VAD= breastfed vitamin A deficiency; NBF – VAD = non-breastfed vitamin A deficiency, *Significant difference at p ≤ 0.05;*

Table 5: Prevalence of wasting, underweight and stunting among children aged 6-36 months (n=462)

Anthropometric attribute	Z-score (SD)	Male		Female		Total		P -value
		n	%	n	%	n	%	
Underweight (WAZ)	>-3 < SD < -2	66	26.50	52	24.41	118	25.54	0.00*
Normal (WAZ)	-2 < SD <+2	183	73.50	161	75.59	344	74.46	
Total		**249**	**100.0**	**213**	**100.0**	**462**	**100.0**	
Stunting (HAZ)	> -3 < SD < -2	126	50.60	110	51.37	236	51.08	0.00*
Normal (HAZ)	-2 < SD < + 2	123	49.40	103	48.63	226	48.92	
Total		**249**	**100.0**	**213**	**100.0**	**462**	**100.0**	
Wasting (WHZ)	>-3 < SD < -2	17	6.80	15	7.04	32	6.93	0.17
Normal (WHZ)	-2 < SD < + 2	232	93.20	198	92.96	430	93.07	
Total		**249**	**100.0**	**213**	**100.0**	**462**	**100.0**	

** Significant difference at p ≤ 0.05; WAZ = weight for height Z-score; WAZ = weight for age Z-score; HAZ = height for age Z-score; SD = Standard deviation*

Table 6: Prevalence of VAD among underweight, stunted and wasted children (n=462)

Anthropometric attributes	With VAD				Without VAD				Total		P-value
	Male		Female		Male		Female				
	n	%	n	%	n	%	n	%	n	%	
Underweight	47	18.88	37	17.37	19	7.63	15	7.04	118	25.54	0.00*
Normal	202	81.12	176	82.63	230	92.37	198	92.96	344	74.46	
Total	**249**	**100.0**	**213**	**100.0**	**249**	**100.0**	**213**	**100.0**	**462**	**100.0**	
Stunting	83	33.33	74	34.74	43	17.27	36	16.9	236	51.08	0.00*
Normal	166	66.67	139	65.26	206	82.73	177	80.1	226	48.92	
Total	**249**	**100.0**	**213**	**100.0**	**249**	**100.0**	**213**	**100.0**	**462**	**100.0**	
Wasting	11	4.42	11	5.16	6	2.41	4	1.88	32	6.93	0.19
Normal	238	95.58	202	94.84	343	97.59	209	98.12	430	93.07	
Total	**249**	**100.0**	**213**	**100.0**	**249**	**100.0**	**213**	**100.0**	**462**	**100.0**	

*VAD = vitamin A deficiency; * Significant difference at p ≤ 0.05*

Table 7: Prevalence of VAD among breastfed and non-breastfed children with wasting, stunting and underweight (n=307)

Anthropometric attributes	Breastfed-with VAD				Non-Breastfed with VAD				Total		P -value
	Male		Female		Male		Female				
	n	%	n	%	n	%	n	%	n	%	
Underweight	28	8.14	26	5.80	7	17.18	4	18.06	65	14.07	0.00*
Normal	135	91.86	118	94.20	79	82.82	65	81.94	397	85.93	
Total	163	100.0	144	100.0	86	100.0	69	100.0	462	100.0	
Stunting	49	13.95	41	11.60	12	30.06	8	28.47	110	23.81	0.00*
Normal	114	86.05	103	88.40	74	69.94	61	71.53	352	76.19	
Total	163	100.0	144	100.0	86	100.0	69	100.0	462	100.0	
Wasting	9	2.33	9	2.90	2	5.52	2	5.52	22	4.76	0.16*
Normal	154	97.67	135	97.10	84	94.48	67	94.48	440	95.24	
Total	163	100.0	144	100.0	86	100.0	69	100.0	462	100.0	

*VAD = vitamin A deficiency; *Significant difference at p ≤ 0.05*

also underweight, stunted and wasted (n=462). The proportion of underweight males and females with VAD was significantly higher (p=0.00) among the non-breastfed than the breastfed children. Likewise, the proportion of stunted males and females with VAD was significantly higher (p=0.00) among the non-breastfed children than among the breastfed peers. A similar trend was also observed for the wasted children.

Table 8 data show the Standardized Beta-coefficients and level of significance of anthropometric attributes predicting VAD among children aged 6-36 months (N=462). Among the attributes, age and low height for age of the children were strong predictors of VAD (p=0.03 and p=0.00, respectively). The age of the child was strongly but negatively associated (p=0.03) the vitamin A status of the child accounting for 20.9% of the VAD occurrence. This implied that, as the child grew older from 6 to 36 months the risk for VAD increased. Likewise, stunting (low HAZ) was strongly

associated (p=0.01) with VAD, accounting for 25.2% of VAD occurrence. Age and height-for-age status of the child were therefore good anthropometric attributes for predicting vitamin A status of children aged 6 – 36 months. Other anthropometric attributes such as sex, under-nutrition (low WAZ) and wasting (low WHZ) did not show strong association with VAD and therefore they were weak predictors of VAD among children aged 6 – 36 months.

Table 8: Standardized Beta-coefficients and level of significance of anthropometric attributes predicting VAD among children aged 6-36 months (n=462)

Anthropometric attributes	Standardized Beta-coefficients	t-value	P - value
Constant		-2.29	0.026
Age	-0.10	-2.09	0.03*
Sex	-0.02	-0.35	0.72
W/A	0.27	1.90	0.06
H/A	0.09	2.52	0.01*
W/H	-0.11	-1.11	0.27

Dependent variable – Vitamin A deficiency
*Independent variables - anthropometric attributes - W/A = weight for age, H/A = height for age; W/H - weight for height; * Significant difference at p ≤ 0.05*

Discussion

The findings in this study revealed that, prevalence of vitamin A deficiency among children aged 6-36 months were very high in Manyara (69.3%) and Shinyanga (69.8%) regions (Table 2). These prevalence rates were higher than the national average of 47.6% in Manyara and 41.5% in Shinyanga region (NBS, 2011). One possible reason could be the declining coverage of vitamin A mega dose supplementation during the survey. According to NBS (2011) and TFNC (2014) coverage of vitamin A mega-dose supplementation was at times very low in remote districts. Coverage of vitamin A mega-dose supplementation in Manyara has been reported at 41.8% while in Shinyanga the coverage was 71.1%. The rate of vitamin A deficiency among children was higher among boys than among girls. The findings in this study are in line with the Tanzania Demographic and Health Survey (2010) in which high rate of vitamin A deficiency was observed among boys (NBS, 2011). Similar findings were reported by Tariku *et al.* (2016) whereby more boys were affected by vitamin A deficiency than girls. The high prevalence of VAD could be attributed to several factors such as low maternal intake of vitamin A rich foods during pregnancy and lactation (Ulak *et al.,* 2016), poverty (Makaka, 2016), inappropriate feeding behaviors and low dietary diversity (Zhao *et al.,* 2016), lifestyles and increase in age-associated physiological demands for vitamin A especially for boys (Schwinger *et al.,* 2016).

The findings further revealed that, vitamin A deficiency in children was significantly higher among non-breastfed than among breastfed children (Table 4). Therefore, older non-breastfed children were at a higher risk of becoming vitamin A deficient compared to their younger breastfed peers. A study in Iran showed similar results in which prevalence of VAD among non-breastfed children was higher compared to the breastfed groups (Bahreynian *et al.,* 2017). High prevalence of vitamin A deficiency among non-breastfed children could be a result of limited intake of vitamin A from mothers' breast milk (Kuchenbecker *et al.,* 2015). Breastfed children usually get vitamin A from two sources, first from their mothers' milk and second from their normal diets. For this reason, breastfed children are likely to get sufficient amount of vitamin A since human milk is a good source of vitamin A unless the mother has low serum retinol concentration (Ulak *et al.,* 2016).

The prevalence rate of underweight and stunting

among the children aged 6-36 months was higher than wasting; however, males were more affected than females in all forms of under-nutrition (Table 5). This is probably due to the fact that, this age group is the turning point for increased energy and micronutrient requirements to support their rapid growth and development of males (WHO, 2011). These results are in agreement with the Tanzania National Nutrition Survey (2014) which reported low prevalence rate of wasting than stunting and underweight among children, yet more males were wasted compared to females. Also, the findings in this study are in agreement with Abdelaziz *et al.* (2015) who found high prevalence of stunting and underweight than wasting in children and more males were stunted and underweight compared to the female counterparts. Possible reason for predominant under-nutrition among males than among females could be due to the geographical differences, poverty (Zhao *et al.,* 2016), inappropriate feeding practices and low dietary diversity (Asfaw *et al.,* 2015).

Prevalence of VAD among children with under-nutrition (wasting, underweight and stunting) is shown in Table 5. Most of the children who had VAD also suffered from one or more forms of under-nutrition, however, children who were underweight and stunted were more susceptible to VAD. Prevalence of VAD among breastfed and non-breastfed children with wasting, stunting and underweight is shown in (Table 7). Stunting was significantly higher among the non-breastfed children with VAD. In this study, children with VAD had a higher risk of being stunted than being underweight or wasted. The findings in this study concurred with results of a study by Marasinghe *et al.* (2015) and Tariku *et al.* (2016) who found that VAD in children was associated with stunting because VAD adversely affects linear growth of children. This connotes that; vitamin A plays a great role in linear growth of children under the age of five years (Tariku *et al.,* 2016). Our findings are also comparable with those reported Mazola *et al.* (2009) who found that plasma retinol concentrations were negatively associated with child's age implying that as the child grows the physiological requirements for retinol also increase.

The strength of association between VAD and anthropometric attributes of 6 – 36 month old children was determined by multiple linear regression analysis in which VAD was taken as a dependent variable that was influenced by various anthropometric attributes (independent variables) (Table 8). Age and stunting were the main anthropometric attributes that influenced VAD strongly ($p = 0.03$ and $p = 0.01$, respectively). This indicates that, a stunted child was also very likely to be vitamin A deficient. Likewise, as the child grows, especially when other under-nutrition conditions (underweight, stunting and wasting) co-exist is also very likely to be vitamin A deficient. As children grow older they also stop breastfeeding and thus no longer receive vitamin A from their mothers. Findings of this study were in agreement with those reported by Marasinghe *et al.* (2015) in which VAD in children was strongly associated with stunting because VAD negatively affects change in height (linear growth). A study by Tariku *et al.* (2016) also observed positive association between VAD and stunting among children aged 6-36 months in Ethiopia. Age of the child and stunting are therefore strong anthropometric attributes for predicting presence of VAD among children aged 6 – 36 months.

Conclusion and Recommendations

In this study, prevalence of vitamin A deficiency among children was significantly higher than the national average. VAD was significantly higher among non-breastfed than among breastfed children, and also higher among males than among females. Most of the children with vitamin A deficiency also suffered from one or more forms of under-nutrition (underweight, stunting and/or wasting). Vitamin A status was strongly associated with age of the child and stunting condition. Age and height-for-age status of the child were therefore good anthropometric attributes for predicting vitamin A status of children aged 6 – 36 months. These findings call for coordinated and sustainable intervention programmes to reduce under-nutrition and micronutrient deficiencies such as vitamin A deficiency to optimize growth among children age 6 – 36 months.

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