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Enhancing Dietary Vitamin A Intake Among Preschool Children: Socio-Demographic And Caregiver-Related Factors In A Deficiency High-Risk Context

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Abstract

Background: *Poor dietary Vitamin A (VA) intake is a risk factor for VAD but there are lacunae in intake data among preschool children.*

Objectives: *To assess levels of dietary VA intake among preschool children 24-59 months in rural Eastern Uganda.*

Methods: *A cross-sectional study involving 256 caregiver-child pairs. The 24-hour recall methodology was used to collect dietary intake data from caregivers, and food composition tables and Nutri-survey software were used to compute the amounts of VA consumed.*

Results: *The mean dietary VA intake was 139.86 ± 84.11 (66%± 40.13 of the EAR and 46.1%± 28.1 of the RDA for VA). Only 25.2% of the children had normal VA intakes. The intake correlated positively with the VA-related practices of caregivers but negatively with the age of the children.*

Conclusions: *The preschool children 24-59 months had insufficient dietary VA intake. indicating a high risk of VAD among them. Only 25% had intake levels equal to or greater than the Estimated Average Requirement (EAR). The intakes were significantly associated with the children's age and caregiver's VA-related practices. Increasing the milk quantities consumed and including other animal-based VA-rich foods and orange vegetables could raise the intakes.*

Keywords: *Vitamin A, dietary intake, caregivers, preschool children, 24-59 months, Deficiency, Vitamin A-rich foods*

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I. Introduction

Vitamin A Deficiency (VAD) continues to be a major nutritional as well as economic problem in countries and regions around the world.[1] Several studies including Stevens et al.2 do point out the magnitude, spread and impact of VAD in early to mid-1990s. In Uganda, there is a high prevalence of VAD (>15% among children under five), with the Eastern region having the highest rates (between 15% and 30% in most areas).[3] A socio-economically pervasive problem, VAD is one of the key factors that continue to derail the economies of low-income countries.[4] It is responsible for a significant portion of the mortality, morbidity and eye problems particularly among children and pregnant and lactating women and therefore a burden to national health systems.[5, 6] Alone, VAD accounts for 2-6% of under-five mortality.[7] Economically, up to 5% of GDP of most low-income countries is lost to a combination of VAD, iron and iodine deficiency.[8]

The main risk factor for VAD is inadequate VA intake.[4] The levels of inadequate intake vary greatly (1-100%) among countries in sub-Saharan Africa as established by Harika et al.[9] in a systematic review of intake studies from four African countries (Ethiopia, Kenya, Nigeria, and South Africa). However, various efforts such as food fortification have been undertaken in many countries to raise intakes among vulnerable populations alongside the high dose VA supplementation (VAS), with the aim to achieve sustainable control through dietary intake.1 But, according to different studies, realization of this target requires periodic analysis of both VA dietary intake and VAD prevalence data, both of which are scanty in many countries.[2, 7, 10] Studies also indicate that intake-raising interventions have a strong potential to resolve the persistent VAD problem.[7][8] There have been such efforts in Uganda since the problem was first reported, circa 1996. But, in spite of them, VAD levels have remained high. Nevertheless, there is lack of sufficient data to demonstrate levels of intake among under-five children who are largely out of the breastfeeding age-bracket and seem to bear the biggest brunt of VAD.[3]

The aim of this study was to assess the dietary VA intake among preschool children 24-59 months in Eastern Uganda. The objectives were: 1) to establish the levels of dietary VA intake among the children, 2) to investigate the relationship between the VA intake levels and, household socio-demographic factors and caregiver Vitamin A-related knowledge, attitudes and practices (VA-KAP). A cross-sectional design employing mainly quantitative methods was used to collect and analyze dietary intake data from 256 caregiver-child pairs for children 24-59 months in a selected rural district of Eastern Uganda. The participants and study area were both chosen using mainly random and purposive sampling methods. The study was designed to estimate the level of VA intake, data needed by governmental and non-governmental organizations to bolster initiatives in fighting VAD.

The study also strengthens the evidence-base for broader multi-sectoral efforts to enhance micronutrient (VA) nutrition in Uganda and the region, and contributes to the growing literature on VA-related nutrition among preschool children in low-income countries.

II. Materials And Methods

This study was cross-sectional and was part of a larger study. Quantitative methods were used to collect and analyze data on VA intake among preschool-age children 24–59 months. The sample size was determined by the formula $n = N/(1+N(e)^2$ adapted from Israel[12] where N represented the approximated population of preschool-age children in Eastern Uganda and e was 5%. Adjustment for cluster randomization using strategies described by Killip et al.[13] assuming an inter-cluster correlation coefficient (ICC, ρ) of 0.03 and a final cluster size of eight resulting in 256 children. The adjustment catered for a prospective cluster randomized trial where data would serve for baseline.

Bukwo District in the eastern slopes of Mt. Elgon, was selected purposively for its relative remoteness and “hard–to-reach” status due to poor terrain, distance from paved road and scarcity of communication infrastructure, factors that raise socioeconomic vulnerability. Parts of the district were about 80 km away from an all-weather road. Fig no 1 shows the methods used to select participants. The district was stratified into four geographical blocks and, one sub-county from each was selected using simple random sampling (SRS). Eight villages and subsequently, eight caregiver-child pairs (children 24-59 months) were selected from each sub-county by Probability Proportional to Size (PPS) and SRS respectively.

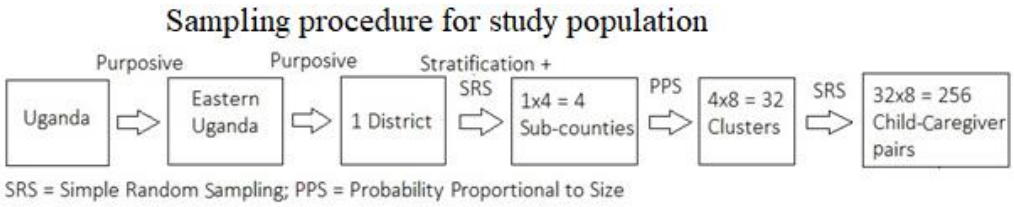

Fig no 1

Data collection

A questionnaire was used to collect different types of data (VA intake, socio-demographic, knowledge, attitudes and practices). It was pretested and adjusted prior to the data collection. The 24-hour recall methodology (24HDR) employing a multiple-pass protocol[14] was used to collect children’s dietary intake data from their caregivers. Face-to-face interviews were conducted for each child where the previous 24-hour diet was considered normal/usual. All the foods and drinks, their ingredients, types/varieties, methods of preparation and quantities consumed by the child during the period were recorded.

The socio-demographic data were captured using questions adapted from USAID’s Demographic and Health Survey (DHS) program. The VA-related knowledge, attitude and practices (KAP) were assessed using guidelines in FAO’s KAP model questionnaire.[15] There were 10 questions on knowledge (knowledge of VA, its food sources, deficiency, causes, signs/symptoms and prevention, eight on attitude and 12 on practices (VA-rich food selection, their preparation and use for feeding the children). For attitude, caregiver perceptions on VAD and VA-rich foods were assessed using the Health Belief Model constructs (susceptibility; severity; preparation of and feeding with VA-rich foods - benefit, difficulty, sensory appeal, feeding cues, confidence, barriers).

Statistical analysis

Each questionnaire was carefully scrutinized during data collection to ensure no avoidable gaps. The HarvestPlus’ Food Composition Table for Central and Eastern Uganda[16] and Nutri-survey databases provided the VA content of the different foods consumed according to the 24HDR. Intake data were first entered into MS Excel where total Retinol Activity Equivalents (RAE) for each child were calculated using the respective amounts of foods consumed and RAEs indicated. These data were finally imported and merged with socio-demographic and KAP data which were directly entered into SPSS (Version 24). The intakes (RAE) were compared with Estimated Average Requirement (EAR) and Recommended Dietary Allowance (RDA) for VA for preschool-age children as defined by the Institute of Medicine (IOM).[17] Nutrient Adequacy Ratios (NARs) were calculated by expressing intakes (RAE) as percentages of both EAR and RDA and the former used to categorize intakes as either *normal* (>=EAR), or *low* (<EAR). Mean RAE consumed and NARs were computed and used to describe overall intake, and frequencies of normal and low intakes were determined using SPSS.

A marking guide was used to assess Knowledge and Practice questions. Answers were scored and total scores obtained for each caregiver and converted into percentages. The scores were categorized into low (≤40%), medium (41-69%) and high (≥70%) for knowledge as in Kigaru et al.[18] and poor (<60%) and good (≥60%) for practices as in Liang et al.[19] Eight statements-questions were used to assess attitude (perceived: susceptibility to VAD, severity of VAD, importance of VA-rich foods, difficulty in preparing VA-rich foods, taste of VA plant foods, cues to feeding VA-rich foods, confidence in preparing VA-rich foods, barriers to using VA-rich foods). A five-point Likert scale was used where the response to each question/statement was ranked from 1 to 5 representing the poorest to the best attitude respectively. An aggregate attitude score was obtained for each caregiver by computing the mean score on all the eight aspects. Values 1 through 3 were categorized as poor while 4 and 5 good/positive. Relationships between variables were determined using Pearson's correlation and Chi-square, and linear and logistic regressions.

III. Results

Socio-demographic/economic characteristics of the study population

The total number of caregiver-child pairs who participated in the study were 247; nine were unavailable. The caregivers were largely female (90%), married (94%) with a mean age of 30.88 years (SD = 7.54) and mostly spouses to the household heads (86%). Majority were at least primary-level educated (92%), subsistence crop farmers (39.3%), which occupation was also their biggest economic activity (71%). Others were stay-home mothers (33.6%), commercial business persons (18.6%), formally employed (5.2%) and others (3.2%). The average monthly household income varied widely from below UGX. 50,000) to above 500,000 (UGX. 1 ≈ USD. 1/3600) although a slight majority (24%) earned UGX. 50,000-100,000. The mean household size was 6.6 (SD = 2.4) and 37.2% of the households were small (1-4 persons), 55.5% medium (5-7 persons) and 7.3% large (≥8 persons). The children had a mean age of 36.47 months (SD = 8.67) and the males (52.6%) were slightly more than the females. Most of them (93%) were biological children of the caregivers.

Child-feeding practices

Almost all the children (98.4%) consumed *Posho* (maize meal) as the main dietary carbohydrate. Other dietary practices are shown in Table no 1.

Table no 1. Dietary practices among the children

Characteristic (N= 247)	n	%
Staple sauce		
Beans	36	14.6
Kale (Sukuma wiki)	141	57.1
Local green vegetables	66	26.7
Others (cabbage, fish, milk)	4	1.6
Sauce Preparation method		
Boiling	25	10.1
Frying	61	24.7
Boiling + Frying	158	64
Others	3	1.2
Green Vegetable preparation method		
Boiling	71	28.7
Frying	58	23.5
Boiling + Frying	115	46.6
Others	3	1.2
# meals daily		

Characteristic (N= 247)	n	%
Less than three	19	7.7
Three	217	87.9
More than three	11	4.4

Dietary VA intake levels

The children's dietary VA intake is shown in Table no 2. Their mean total VA (RAE) consumed was significantly lower than their EAR and much lower than their RDA. Similarly, 75% of the children had low VA intakes.

Table no 2. Levels of Dietary VA intake by children

Variable	n	Mean (SD)	Median (IQR)
RAE consumed (μg)	227	139.86(84.11)	139.25(142.44)
EAR consumed (%)	211**	65.96(40.13)	65.81(61.23)
RDA consumed (%)	211**	46.10(28.08)	46.07(42.86)

*Children with extreme values (RAE consumed [μg] >432) were excluded; **Children without proper age excluded; IQR, Interquartile range.

VA-rich foods consumed by the children

Milk was the most frequently consumed VA-rich food (81%) followed by the Dark Green Leafy Vegetables (DGLVs) including kales and other local green leaves (78%). Others (pumpkins, carrots, orange-fleshed sweetpotato mango fruits, and liver) were consumed but rarely. Cooking oil/fat was widely used in food/sauce preparation (96%), boiling-frying being the most common method (64%).

VA intake and socio-demographic characteristics and caregiver KAP

Children's VA intake (as percent of EAR) showed a negative correlation with the children's age, r(209) = -0.215, p = 0.002 and a positive correlation with the caregiver's VA-related practices, r(209) = 0.164, p = 0.017. None of the other relationships (Table no 3) were statistically significant.

Table no 3. Relationships between Dietary VA intake and Socio-demographic and Caregiver Characteristics (N = 247)

Socio-demographic and caregiver Characteristic	χ^2(df)	*p*
Sex of caregiver	2.930(1)	0.087
Is caregiver household head?	0.194(1)	0.660
Caregiver marital status	1.843(4)	0.765
Highest education level of caregiver	3.869(4)	0.408
Caregiver occupation	9.321(9)	0.682
Main household economic activity	6.239(7)	0.512
Household monthly Income	2.272(6)	0.893
Child-caregiver relationship	2.891(3)	0.409
Sex of child	0.007(1)	0.935
Household size	2.051(2)	0.359
Practices[a]	**9.496(1)***	**0.002**
Knowledge[a]	3.583(2)	0.167
Attitude[a]	2.701(1)	0.100

* Significant relationship (p<.05); [a] Caregiver's VA-related attribute

Both child's age and caregiver scores on VA-related practices were further examined in a linear regression model to estimate their contribution to variation in VA intake. The fitted model was: VA-intake level (%EAR) = 80.18 + 0.32 *(caregiver practice aggregate score) – 0.90*(child's age in months). The overall regression was statistically significant, R^2 = 0.07, F(2, 208) = 7.36, p = 0.001. It was found that both child's age and caregiver practices significantly predicted child's VA intake (β = -0.90, p = 0.003 and β = 0.32, p = 0.038 respectively).

Different caregiver VA-related practices were assessed and their performance by caregivers is shown in Table no 4. Feeding children with animal-source VA-rich foods or orange vegetables (OVs) were significantly associated with their VA intake levels.

Table no 4. Caregivers' VA-related food practices and relationships with levels of intake (N=247)

VA-related practice	n	Caregivers who practiced (%)	Relationship with VA intake	
			χ^2(df)	*p*
Fed child with VA animal foods[a]	177	71.7	**11.353(1)***	**0.001**
Fed child with OVs[b]	56	22.7	**10.926(1)***	**0.001**
Fed child with DGLVs[c]	219	88.7	2.926(1)	0.087
Fed child with yellow/orange fruits[d]	16	6.5	3.746(1)	0.053
Fed child with VA-fortified foods	223	90.3	3.84(1)	0.050
VA-related reasons for food selection	200	81	1.511	0.219
Food prepared with cooking oil/fat	236	95.5	2.720	0.099
Sight health in food selection	126	51	0.132	0.717
Skin health in food selection	171	69.2	0.285	0.594

[a]Milk eggs, liver; [b]Carrots, pumpkins; [c]Dark Green Leafy Vegetables; [d]Mangoes, pawpaw; *Significant Relationship (p < .05)

Children who were fed with VA-rich animal foods or OVs were more likely to have a normal VA intake than those who were not, ORs and 95% CIs: 8.678 [2.582, 29.170] and 2.576 [1.278, 5.195] for animal foods and OVs respectively.

Other selected socio-demographic factors (staple foods, meals per day, toilet and handwashing facilities, health care-source, land and home-garden possession, small animal/birds rearing, cooking fuel, sauce-preparation methods, water-sources/ treatment) had no significant relationship with VA intake save for treatment of drinking water, $\chi^2(1) = 6.459$, $p = 0.011$, for which, children from households which did so were more likely to have normal VA intakes than the others (OR = 2.36, 95% CI [1.177, 4.748]).

IV. Discussion

This study set out to establish the levels of VA intake among preschool-age children 24-59 months, a group vulnerable to VAD in Uganda, and investigate the associated factors. Eastern Uganda has a high prevalence of VAD.[3]

Intakes were estimated using the 24HDR, which allows for optimum recall of dietary practices including the foods consumed,[20] and evaluated against both EAR and RDA. Results showed that the daily intake fell far below the reference levels as defined by IOM (Table no 2). This study used EAR, a popular measure,[10, 21–23] to categorize levels of intake. Majority of the children (75%) had inadequate intakes (<EAR). Despite known limitations of the 24HDR in estimating actual quantities consumed[24] and incompleteness of food composition databases,[25, 26] the level of intake obtained corresponded to the type of VA-rich foods consumed. The pro-VA green leafy vegetables rather than preformed VA foods were mainly consumed. The bio-conversion of the pro-VA in plant-sources to VA is inefficient,[27] limiting their contribution. Although milk was widely consumed, its contribution was probably undermined by the meagre quantities used. These findings indicate low VA intake among under-five children.

The low intake suggested the presence of VAD or a high risk. However, in typical rural areas, VA intake varies with seasons depending on the more-accessible pro-VA foods.[7] The twice-yearly VAS (coverage ~60%[3]) also probably prevented likely chronic low bodily VA levels among the children. Additionally, widespread dietary use of VA-fortified vegetable oils possibly contributed to VA intake but it was not considered in this study owing to arbitrary measurements used by the caregivers which complicated the quantification of amounts consumed. These levels of intake are similar to those found by Arsenault et al.[22] and Hotz et al.[28] with the latter's being higher (188–204 μg/d) although equally below the recommended intakes. They also fall within the 38–947 μg/d range established from different studies reported in Harika et al.[9] Generally, these findings agree with others that preschool children in rural settings of low-income countries have insufficient intakes of VA.

Two sociodemographic/economic characteristics: child's age and household drinking-water treatment practices, were found to have significant relationships with the children's VA intake. Intakes decreased with children's age, in spite of the need for the contrary so as to meet increasing physiological requirements. The EAR and RDA used for VA for children 1-3 years and 4-8 years were 210 and 275, and 300 and 400 μg RAE/d respectively[16] but majority did not meet these levels of intake and seemingly got farther from them with age. Dietary attention given to children 24-59 months possibly diminished as the children got older. The UDHS 2016[3] shows children 24-35 months at a particularly higher risk of VAD. However, this study seemed to show the older children at higher risk of inadequate intakes although Analysis of Variance (ANOVA) did not show significant differences between the age-groups 24-35, 36-47, 48-59 months, $F(2) = 2.178$, $p = 0.116$. The higher end of 24-59 months is a transition from dietary dependence on caregiver towards partial independence. Such children therefore, increasingly got part of their dietary intakes outside the caregiver's knowledge/control which possibly supplemented their needs. Conversely, reliance on caregiver's recall rather than actual weights of the foods likely under-estimated the quantities consumed by older children. In spite of these differences, children at transitional stages apparently need more attention from caregivers to ensure adequate consumption of VA-rich foods. The positive association between VA intake and treatment of drinking water in the household probably arises from the differences in general health-related attitude in households exemplified by the seemingly better VA-related attitude among caregivers of children with higher VA intakes.

The practices of feeding children with animal VA-rich foods (eggs, liver, milk) and OVs (carrots, pumpkins, OFSP), were significantly associated with VA intake, $\chi^2(1) = 18.967$, $p < 0.001$ and $\chi^2(1) = 11.450$, $p = 0.001$ respectively. Intake and practices are inherently synchronous events, partly explaining the observed relationship. Generally, various caregiver food practices, are directly linked to children's dietary nutrient intake, appetite being normal, and affect both child nutritional status[29] and dietary intake.[30] In this study, animal VA sources and the OVs significantly affected VA intake albeit being scantily consumed.

Animal foods provide preformed VA[31] whereas OVs have higher concentrations of β-carotene, the most important pro-VA carotenoid, than other types of vegetables.[32] Some OVs, including OFSP, have bio-fortified with β-carotene by which they are able to provide large amounts of VA which may suffice for the needs of populations in rural or poor settings if consumed in significant amounts.[33–36] The inadequate intake of preformed VA or the pro-VA carotenoids is the cause of primary VAD, a common problem of public health concern in many countries.[31] These foods ought to be incorporated in the children's diet to promote VA intake.

There was no significant relationship between level of VA intake and caregiver VA-related knowledge (Table no 3). Reviews by Spronk et al.[37] showed that nutritional knowledge correlated positively (though weakly) with dietary intake. Janiczak et al.[38] also showed a significant relationship among athletes. This study differed with the other studies owing to the more specific nature of the nutrition knowledge (NK) involved (VA-related) as opposed to the more general NK in other studies and also differences in the study populations (more highly educated for Spronk et al.[37] and athletes for Janiczak et al.[38]). In addition, this study examined intake of children against knowledge of their caregivers, unlike the other studies. NK is a key factor for nutritional status improvement[39] and although it requires other factors in order to translate into dietary intake, its role remains indispensable as "one must know before one can do".[37] Caregivers' NK is linked to children's nutrition through healthful diets.[40] However, this study found that, intake of VA among preschool children may not depend on the VA knowledge of the caregiver.

The VA-related attitude of caregivers was not significantly associated with the children's VA intake levels. Studies examining caregiver's attitude and children's intakes are rare, but, a few including Berra[41] and Liang et al.,[19] although looking at different populations and nutritional aspects (milk/colostrum in the former and Vitamin D in the latter), found positive attitude-intake/status associations. Therefore, despite the findings on knowledge and attitude, foods such as OFSP, carrots, pumpkins, should be promoted for their potential to raise VA intakes and value in preventing VAD among children.

V. Conclusion

The preschool children 24-59 months consumed inadequate VA in their diet, with only 25% achieving recommended intakes. The overall mean intake was over 30% and 50% below the children's EAR and RDA respectively. The diet consisted of very few VA-providing foods of which majority were the pro-VA-rich green vegetables and mainly milk as the preformed VA source but consumed in meagre quantities thus limiting the VA intake. The low intake predisposed the children to VAD and its disorders. The children's VA intake levels decreased with their age and were significantly associated with the caregiver's VA-related practices of feeding children with animal source vitamin A-rich foods (such as milk, eggs and liver), and feeding them with orange vegetables (carrots and pumpkins). This study recommends that efforts aimed at raising VA intake among preschool children be strengthened and preferably focused on promoting the VA-related practices among the caregivers. More attention from caregivers for children getting older within the preschool age-range is also called for. Further studies are needed to investigate the contribution of industrially fortified foods to VA intake among preschool children in rural areas of Uganda.

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