Serum vitamin A content among malnourished and healthy children in Kisangani City, DRC

Summary: Vitamin A is an essential micronutrient needed by the body for various physiological functions. Its deficiency is associated with several functional disorders. The objective of this study is to determine blood vitamin A levels in malnourished and healthy children.

Methods: It is a cross-sectional analytical study, consisting of determining the vitamin A content in the blood of children suffering from malnutrition and those in good nutritional status. Our sampling was casual and 59 children aged 6 to 59 months were retained. Among them 30 healthy children chosen from those attending preschool consultation at U HC and 29 malnourished children from those followed at M TNU for the management of malnutrition. The serum vitamin A assay was performed according to the method described by Tietz. Children with serum vitamin A level below 30µg / 100ml had vitamin A deficiency and those with a serum level greater than or equal to 30µg / 100ml had good vitamin A status. Percent, average and standard deviation calculations were performed. The Chi square statistical test was used to compare serum vitamin A content in healthy and malnourished children, as well as other maternal parameters for a significance level of 0.05.

Results: from 59 children examined, 30 or 50.8% were 6-17 months old, the average age was 21.9 ± 13 months. 45.7% had a serum retinol level between 50-59 µg/100ml; the average value was 46.84 µg ± 14.27. The prevalence of VAD was 20.3% and this deficit was more marked in children aged 6-17 months that is 50% (P<0.14). Among 12 children with VAD, 10 or 83.3% were the wealthy and two were the malnourished, the difference was statically significant (P< 0.011).

Conclusion: Vitamin A deficiency remains a major health problem in the DRC. This affect all children regardless of their current nutritional status. Supplementation with this vitamin remains one of the palliative solutions.

Key words: Serum vitamin A, Malnourished and healthy children, Kisangani-DRC.

Abbreviations

U HC: Umoja Health Center; M TNU: Mwana Mpendwa Therapeutic Nutritional Unit
DRC: Democratic Republic of Congo; VAD: Vitamin A Deficiency; UNIKIS: University of Kisangani; ACF: Action contre la faim.

Introduction

Vitamin A is an essential micronutrient that the body needs to provide the various physiological functions. Its deficiency is associated with several functional disorders [1].

Malnutrition remains a major public health problem in sub-Saharan Africa [2]. It occurs in children under five, pregnant women and even in adults and is often accompanied with vitamin A deficiency (VAD) [3]. According to WHO estimates, severe acute malnutrition affects 19 million children under 5 years of age and causes approximately 400,000 child deaths each year [4]. About 190 million preschool children, most of whom live in Africa and South-East Asia, are deficient in vitamin A (low plasma retinol levels) and may be considered clinically or sub-clinically deficient in vitamin A. [5] In sub-Saharan Africa, more than 38.5% (> 56 million) of children suffer from chronic malnutrition,

nearly 80% have a martial anemia; the risk of blindness due to vitamin A deficiency is 50% and more than 4 million children are born annually with low weight [6].

VAD is more common between 6 to 36 months of weaning. [7] Agne and al [8], found a prevalence of 15.2% among children aged 6-23 months. This prevalence was 6.2% in pregnant women (serum retinol level <35 µg / dl or <0.7 µmol / L) [9]

In Democratic Republic of Congo (DRC) a national survey among children aged 6 to 36 months on the serum vitamin A content showed that 61.1% of children had a retinolemia rate of less than 0.7µmol / L [10]. This rate indicated a serious situation and had placed the DRC among the countries most affected by vitamin A deficiency in Africa [11].

Vitamin A plays several roles in human body: it is involved in growth, in the renewal of epithelial tissues, in the reproductive system, in vision and in the strengthening of immunity; it is an antioxidant [12,13]. The deficiency of this vitamin causes blindness and xerophthalmia, it is an aggravating factor of certain diseases such as respiratory infections, measles, diarrhea, protein-calorie malnutrition and various dermatological lesions [14].

Vitamin A supplementation has been shown to reduce malnutrition by 23-30% [14] and infectious diseases in children [15,16]. Since 2000, the DRC Ministry of Health has integrated vitamin A supplementation into routine primary health care activities within the Health Zones by organizing mass activities as well.

However, several unknowns persist and provoke interrogations despite the attempts to respond: the proportion of children with an abnormal vitamin A serum level among the so-called "healthy" children, the age most affected by this deficiency, the family structure of these children and the socio-economic conditions of the children parents. The objective of this study is to determine vitamin A blood levels in malnourished and healthy children.

Material and methods

Our study took place in the city of Kisangani, Tshopo Province, located in the North-East of the DRC, precisely in Umoja Health Center (U HC) and Mwana Mpendwa Therapeutic Nutritional Unit (M TNU) in Kabondo urbano-rural health zone. The serum vitamin A assay was done at the Biochemistry Laboratory of the Faculty of Science, Kisangani University (UNIKIS).

Material

During our analyzes we used the spectrophotometer, the glass test tubes, the centrifuge (HETTICH brand), the precision balance (KERN EW brand), the syringes, the gloves, and some reagents, namely: the ethanol solution and the petroleum ether solution.

Our study population consisted of malnourished children being monitored in the Mwana Mpendwa Therapeutic Nutrition Center and healthy children continuing pre-school counseling sessions at the Umodja Health Center during the study period.

Methods

It was a cross-sectional analytical study, consisting of determining the vitamin A content in the blood of children suffering from malnutrition and those in good nutritional status during the period of our study which took place from 05 July to 25 September 2018.

Our sampling was casual. Healthy children were selected from those received at U HC for the preschool consultation and malnourished from those followed at M TNU for the management of malnutrition.

Was included in the study any child aged 6 to 59 months whose well informed mother has given the agreement for the child's blood test; excluded were any child aged 6-59 months whose mother had not given her consent. A total of 60 women accepted this deal. The sample consisted of 30 malnourished children and 30 healthy children. In the samples taken from the malnourished, one became insufficient after centrifugation to be analyzed (less than 1 ml of serum) and reduced our samples to 29 for malnourished children giving a total of 59 samples.

Data collection was done using a card containing the child's anthropometric parameters: age, sex, weight, height, nutritional status and socio-demographic parameters of the mother: Age, level of education, main occupation.

Serum dosage of vitamin A

After blood collection, approximately 3 ml were collected in a syringe and brought to the laboratory for direct analysis.

The serum vitamin A assay was done according to the method described by Tietz [17].

Put 1ml of serum in a centrifuge tube, add 2ml of 95% ethanol and 2ml of petroleum ether. Stir vigorously for 10 minutes then take 1 ml of the ether phase, that is to say supernatant liquid and put it in the spectrophotometer vat, then read the absorbance at 440 nm against the petroleum ether.

The carotenoid content in the serum was determined as follows:

$$\mu g \text{ of carotenoids / 100 ml} = \frac{\mu g \text{ carotenoid / vat} \times \text{dilution} \times 100}{\text{ml of serum}}$$

After the determination of carotenoids in the serum, evaporate the ether phase in the water bath between 40 to 45 ° C, dissolve the residue by adding 1 ml of a 20% solution of antimony trichloride. Read at 620 nm using antimony trichloride as blanch.

$$\text{The content of vitamin A in 100 ml of serum} = \frac{\mu g \text{ vitamin A / vat} \times \text{dilution} \times 100}{\text{ml of serum}}$$

$$\mu g \text{ vitamin A / 100 ml Serum} = \mu g \text{ vitamin A / vat} \times 200 - (0.075 \times \mu g \text{ carotenoid / 100 ml.})$$

The nutritional status assessment was based on nutritional software, ENA of SMART 2011 shared by ACF. The classification of nutritional status was made according to WHO 2006 standards which expresses the weight/ height ratio of children in standard deviation or z-score. If this report is:

- <-3 z-score or edema: the child suffers from severe acute malnutrition
- <-2 z-score and ≥ - 3: the child suffers from moderate acute malnutrition and
- ≥- 2 z-score: the child is in good nutritional condition

All children with serum vitamin A levels below 30µg / 100ml had vitamin A deficiency and those with a serum level greater than or equal to 30µg / 100ml had good vitamin A status Tietz [17].

Statistical analysis:

The collected data were encoded into an Excel version7 workbook and imported into the SPSS 20 software. Percent, average and standard deviation were calculated. The Chi square statistical test was used to compare serum vitamin A content in healthy and malnourished children, as well as other maternal parameters such as main activity, level of education, the number of children under five in the household for a significance level of 0.05. The data were presented in the form of frequency tables.

Ethical consideration

The blood sample was taken from the child whose mother has given her agreement by signing or fingerprinting the consent form after being well informed.

Results

Age, sex and serum vitamin A content of children

Table I presents the children by age group, sex and serum vitamin A content according to the sampling center.

Table I. Distribution of cases by age, sex and serum vitamin A content

Sampling center	M TNU N=29		U HC N=30		Total		
	n	%	n	%	n	%	P-val
Age (months)							
6-17	15	50	15	50,	30	50,8	0.014*
18-29	7	58,3	5	41,7	12	20,3	
30-41	4	44,4	5	55,6	9	15,3	
42-53	1	33,3	2	66,7	3	5,1	
54-59	2	40	3	60,0	5	8,5	
sex							
Male	17	58,6	15	50	32	54,3	0,50*
Female	12	41,4	15	50	27	45,7	
Ratio	1,4		1,0		1.2		
Vitamin A content (µg / 100ml)							
20-29.9	2	6,9	10	33,3	12	20,3	0,001*
30-39.9	5	17,2	5	16,6	10	17	
40-49.9	0	0	2	6,6	2	3,3	
50-59.9	18	62,1	9	30	27	45,7	
60-69.9	4	13,7	4	13,3	8	13,6	

* = statistical test of Chi square

This table shows that 30 children or 50.8% were 6-17 months old, the average age was 21.9 ± 13 months; the sex ratio was 1.2; 27 children or 45.7% had a serum retinol level between 50-59 µg / 100ml, the average value was 46.84 µg ± 14.27.

137

138 3.2 Vitamin A status by age and sampling center

139 Table II shows the vitamin A status of children by age and sampling center

140 Table II. Vitamin A status by age and sampling center

Status vitamin A	<30µg/100ml N= 12		≥30 µg/100ml N=47		Total		
Age (months)	n	%	n	%	n	%	P-val
6-17	6	50	24	51,1	30	50,8	0,561*
18-29	3	25	9	19,1	12	20,3	
30-41	3	25	6	12,8	9	15,3	
42-53	0	0	3	6,4	3	5,1	
54-59	0	0	5	10,6	5	8,5	
Consultation Center							
M TNU	2	6,9	27	93,1	29	49,2	0,011*
U HC	10	33,3	20	66,7	30	50,8	

141 * = Statistical test of Chi square

142 It emerges from this table that, 12/59 children (20.3%) had vitamin A deficiency and this deficit was
143 more marked in children aged 6-17 months that is 50%;
144 Among 29 malnourished children, two (6.9%) were vitamin A deficient and among thirty healthy
145 children 10 that is 33.3% were vitamin A deficient. Ten of the 12 children with vitamin A deficiency
146 that is 83.3% were consulted at Umoja Health Center.

147

148 3.3 Mother's profile and vitamin A status

149 Table III presents the socio-demographic profile of the mother as well as the vitamin A status of the
150 children according to the two sampling centers.

151

152 Table III. Socio-demographic profile of mother and vitamin A status of the child

	M TNU		U HC		Total		Statut Vit A (µg/100ml)		P-val
Age (year)	n	%	n	%	n	%	<30	≥30	
15-19	4	13,8	9	30	13	22	4	9	0,348*
20-29	13	44,8	14	46,7	27	45,8	4	23	
30-39	9	31,1	6	20	15	25,4	4	11	
40-49	3	10,3	1	3,3	4	6,8	0	4	
Level of study									
Illiterate	2	6,8	0	0	2	3,4	0	2	0,005*
primary	13	44,9	1	3,3	14	23,7	1	13	
secondary	14	48,3	27	90	41	69,5	11	30	
Sup / university	0	0	2	6,7	2	3,4	0	2	
principal activities									

Household	14	44,9	17	56,7	31	52,5	8	23	0,685*
Small business	7	24,1	3	10	10	17	2	8	
Farmer	8	27,5	3	10	11	18,6	0	11	
Teacher	0	0	4	13,3	4	6,8	1	3	
Other ©	0	0	3	10	3	5,1	1	0	
Number of children <5 years									
1-2	15	55,5	20	66,7	35	35	8	27	0,245*
3-5	14	45.5	10	33,3	24	24	4	20	

153 * = Statistical test of Chi square, © = cutter, maid.

154 This table shows that, 45.8% of mothers were 20-29 years old, the average age was 26.22 ± 7.4 years;
155 41 mothers or 69.5% had a secondary level of education, this distribution was statistically significant
156 with the vitamin A status of the child (P = 0.005); more than half of the mothers were housewives.

157 **Discussion**

158 Vitamin A status by age and consultation center

159 It is evident from our results that the majority of the children were 6 to 17 months old. This result may
160 be due to the fact that the mothers are active to bring their children to the consultation when they are
161 even small while this interest decreases as the child grows.

162 It emerges from this table that, 12 children or 20.3% had vitamin A deficiency (VAD) and that this
163 deficit was more marked in children aged 6-17 months or 50%. Retinolemia increases from birth to
164 adulthood, Agne and al [8] in their study conducted in Senegal found a prevalence of VAD of 15.2%
165 among children aged 6-23 months. Rongwang and al [18] found a prevalence of 3.08% among
166 pregnant women. Ajuluchukwa and al [22] found a prevalence of VAD of 65%. In view of these
167 different results we can say that vitamin A deficiency is widely prevalent among people at risk such as
168 children and pregnant women. Indeed, in a well-nourished breastfeeding woman, breast milk contains
169 the necessary amount of Vitamin A to cover the infant's needs, at six months, this quantity no longer
170 covers all needs and a complementary diet is the rule. In the case where this diet is not well conducted
171 it leads to micronutrient deficiency among which vitamin A deficiency.

172 The national survey conducted in 1998 in DRC among children aged 6 to 36 months established that
173 61.1% of the children examined had a retinolemia rate of less than 0.7 µmol / l [11]. In our study our
174 results are paradoxical; on 29 malnourished children; 2 that is 6.9% had VAD and on 30 healthy
175 children; 10 that is 33.3% had VAD out of the total of 12 children with VAD. Ten children(83.3 %)
176 on a total of twelve with VAD were consulted at Umoja Health Center so were in good health and 2
177 children that is16.7% (2/12) at Mwana Mpendwa Therapeutic Nutritional Unit therefore were
178 malnourished; the observed difference was statistically significant (p = 0.011). Our result would be
179 justified by vitamin A supplementation in all malnourished children who come to the nutritional
180 center. In addition, in ready-to-use therapeutic foods administered to malnourished the amount of
181 vitamin A is well represented.

The 33.3% of children with vitamin A deficiency observed in healthy children is consistent with the WHO estimate of more than 33.3% of preschool children who suffer from clinic deficiency in this vitamin [14].

Since 2000, the DRC Ministry of Health has integrated vitamin A supplementation into routine primary health care activities within health zones by also organizing mass activities in response to the outcome of the health survey. It is therefore important to insist on infant feeding by integrating foods rich in provitamin A such as: green leaves, orange fleshed sweet potato, carrots, meat, fish, eggs, and especially to improve culinary practice with palm oils that are naturally rich in this vitamin and whose impact on health is not visible. A study conducted by Lusamaki and al [23] showed that the quality of palm oil sold at the central market of Kisangani at an affordable price to all levels of the population had already lost more than 53% of provitamin A before its us in the household compared to the first quality oil which is rich in provitamin A but which is expensive and to which certain population has not access.

Sociodemographic profile of mother and vitamin A status

According to the result of Table 3, it appears that, 45.8% of mothers were between the ages of 20-29, the average age was 26.22 ± 7.4 years; this average is lower than that found by Seck and al [24], who was 28 years old in a study of women's knowledge of malaria; on the other hand, it corroborates that of Lukuka and al, [25] who found the mean age of 26 in parturient. Ajuluchukwa [22] in his study of vitamin A deficiency in pregnant women found an average age of 23.67 ± 6.11 years. Our result would be explained by the fertility of women during this period.

Forty-one mothers or 69.5% had a secondary level of education, this distribution was statistically significant with the status of the child (P = 0.005); Chun Yang and al [26] found a significant difference between serum vitamin A levels in pregnant women with higher education level and those with low level of education. Breast milk is an ideal source of vitamin A, promotes rapid growth, plays the role of antioxidant and immune barrier, however, many factors modulate its composition such as diet, socioeconomic level, and nutritional status of mother [27]. It is well known that the education level of the mother allows her to comprehend and practice the counsels given at prenatal consultation and obtain information on the role of vitamin A in her body. Women who have studied often have a high socioeconomic level that allows them to provide good nutrition in their household.

Conclusion: At the end of our study, it appears that vitamin A deficiency remains a major health problem in the DRC and that supplementation with this vitamin remains one of the palliative solutions. This would affect all children regardless of their current nutritional status.

Recommendation: Given this result, we recommend mothers to feed their children well with foods rich in provitamin A, such as green leaves, oils, some tubers and colored cereals, as well as foods of animal origin.

References

1. Tariku A , Abel F, Ayanaw TF, Solomon M and Akilew A Vitamin-A defciency and its determinants among preschool children: a community based cross-sectional study in Ethiopia *BMC Res Notes (2016) 9:323* DOI 10.1186/13104-016-2134
2. Bain, L. E., Awah, P. K., Geraldine, N., Kindong, N. P., Sigal, Y., Bernard, N., & Tanjeko, A. T. 2013. Malnutrition in Sub-Saharan Africa: Burden, causes and prospects. *The Pan African Medical Journal*, *15*, 120.
3. Geoffrey Ss, James Ka, Gaston AT: Contribution of instant amaranth (Amaranthus hypochondriacus L.)-based vegetable soup to nourishment of boarding school adolescents Received: 7 September 2017 | Revised: 1 April 2018 | Accepted: 8 April 2018 *Food Sci N* www.foodscience-nutrition.com *utr.* 2018; 6:1402–1409.
4. Evaluation de l'importance de la malnutrition par carence en micronutriments en ligne sur www.who.int>nutr 2016. Consulté le 12/10/2018
5. Evaluation de l'importance de la malnutrition par carence en micronutriments www.who.int>nutr 2016 consulté le 06/12/2018
6. FAO/WHO. New Business Models to Help Eliminate Food and Nutrition Insecurity: Roadmap for Exploration. Rome: Food and Agriculture Organization of the United Nations (FAO); 2013.
7. Pière Aubry, Malnutrition protéino-énergétique et avitaminose, actualisés en 2003 et mise à jour le 07/01 /2004).
8. Agne-Djigo A, Idohou-Dossou N, Kwadjode KM, Tanumihardjo SA, Wade S. High prevalence of vitamin A deficiency is detected by the modified relative dose-response test in six-month-old Senegalese breast-fed infants. J Nutr 2012;142:1991–6.
9. Sabina B M, Maria F C, Suzana LS, Alex S RS, Camila C S, and Malaquias B F. The Prevalence of Vitamin A Deficiency and Associated Factors in Pregnant Women Receiving Prenatal Care at a Reference Maternity Hospital in Northeastern Brazil Nutrients 2018, 10, 1271; doi:10.3390/nu10091271 www.mdpi.com/journal/nutrients
10. PRONANUT, Programme National de Nutrition. L'intégration de la lutte contre la carence en vitamine A. Kinshasa, avril, 2002 Module de formation N° 3 RDC,2002
11. Ignace Balw'a kalonji kamuna Evaluation du statut de la vitamine A dans la ville de Kinshasa par la méthode HKI (Helen Keller International) 2007
12. Saari, J.C. Retinoids in photosensitive systems. In The Retinoids: Biology, Chemistry, and Medicine, 2nd ed.; Sporn, M.B., Roberts, A.B., Goodman, D.S., Eds.; Raven Press: New York, NY, USA, 1994; pp. 351–386. ISBN 0781700825 9780781700825.
13. D'Ambrosio, D.N.; Clugston, R.D.; Blaner, W.S. Vitamin A metabolism: An update. Nutrients 2011, 3, 63–103.
14. World Health Organization. Global Prevalence of Vitamin A Deficiency in Populations at Risk: WHO Global Database on Vitamin A Deficiency. Geneva: World Health Organization; 2009

15. Kara A. Bresnahan and Sherry A. Tanumihardjo Undernutrition, the Acute Phase Response to Infection, and Its Effects on Micronutrient Status Indicators. 2014 American Society for Nutrition. Adv. Nutr. 5: 702–711, 2014; doi:10.3945/an.114.006361.
16. Tanumihardjo SA. Vitamin A: biomarkers of nutrition for development. Am J Clin Nutr 2011; 94 Suppl:658S–65S.
17. Tietz, Clinical Guide to Laboratory tests, 4e edition, 1995 Bioforma, Cahier de formation Biologie Médicale, Les vitamines, n°38, 2007 Edition: Janvier 2013
18. Rongwang Yang1, Rong Li1, Shujiong et al The survey of serum retinol of the children aged 0~4 years in Zhejiang Province, China, BMC Public Health 2007, 7:264 doi:10.1186/1471-2458-7-264)
19. OMS. *Concentrations sériques en rétinol pour déterminer la prévalence de la carence en vitamine A dans les populations.* Système d'information nutritionnelle sur les vitamines et les minéraux. Genève, Organisation mondiale de la Santé, 2011
20. Caminha MF, Batista FM, Fernade TF, Arruda Uk, Dinis AS. Vitamin A supplementation during puerperum; systematic review.Rev Saude Publica. 2009;43:28-38
21. Villamor E, Mbise R, Spiegelman D, Hertzmark E, Fataki M, Peterson KE, Ndossi G, Fawzi WW. Vitamin A supplements ameliorate the adverse effects of HIV-1, malaria, and diarrheal infections on growth. Pediatrics 2002;109:E6.
22. Ajuluchukwa U. Vitamin A and E deficiencies among pregnant women attending Antenatal care General hospital Dawakin KuDU, North-West Nigeria international journal of preventive Medecine Int J prev Med. 2015;6:65PMCID: PMC4521299
23. Lusamaki M F, Solomo E., Borive A., Posho I.,Kayembe T., Batina A., et al 2017, Nutritional Quality of Palm Oils Sold At The Central Market of Kisangani. Int J Recent Sci Res. 8(3), pp. 15982-15985.
24. Seck I, Fall IS, Faye A, Ba O, Tal-Dia. Connaissances attitudes et pratiques de femmes sur le paludisme dans la zone rurale de Sénégal Méd Trop (mars) 68, 629-33, 2008
25. Lukuka K A, Fumie O.S, Mulumbu M. R, Lokombe B. J, Muyembe T. J. J.: Prévalence du paludisme à l'accouchement dans quatre maternités de la ville de Kinshasa, République Démocratique du Congo, . "Santé publique". octobre 2005(5) 215-223
26. Chun Y, Jin C, Zhen L, Chunfeng Y, Jianhua P , Xiaoguang Y. Prevalence and influence factors of vitamin A deficiency of Chinese pregnant women. Nutrition journal(2016) 15:12 doi 10.1186/s12937-016-0131-7
27. Gurgel CS, Grilo EC, Lira LQ, Assuncao DG, Oliveira PG, Melo LR et al,. Vitamine A Nutritional status in high-and low-income postpartum women and its effect on colostrum and the requirements of the newborn. J pediatr (RioJ).2018; 94:207-215.