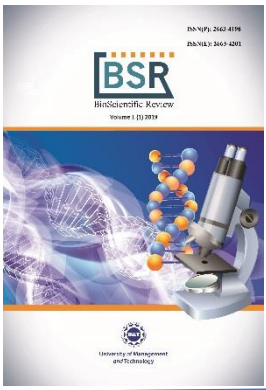

BioScientific Review (BSR)

Volume 2 Issue 3, 2020

$ISSN_{(P)}$: 2663-4198 $ISSN_{(E)}$: 2663-4201

Journal DOI: https://doi.org/10.32350/BSR

Issue DOI: https://doi.org/10.32350/BSR.0203

Homepage: https://journals.umt.edu.pk/index.php/BSR

Journal QR Code:

Article: **A Cross-Sectional Survey of Vitamin A Deficiency and the Associated Risk Factors among the Children of District Gujrat, Punjab, Pakistan**

Author(s): Aadil Hussain, Safa Rafique, Sana Batool, Saman Hina, Malik Siddique Mahmood

Article DOI: https://doi.org/10.32350/BSR.0203.05

Article QR Code:

Aadil Hussain

To cite this article: Hussain A, Rafique S, Batool S, et al. A cross-sectional survey of vitamin A deficiency and the associated risk factors among the children of District Gujrat, Punjab, Pakistan. *BioSci Rev.* 2020;2(3):46–59.

Crossref

Estd. 1990

A publication of the
Department of Life Sciences, School of Science
University of Management and Technology, Lahore, Pakistan

A Cross-Sectional Survey of Vitamin A Deficiency and the Associated Risk Factors among the Children of District Gujrat, Punjab, Pakistan

Aadil Hussain[1], Safa Rafique[2], Sana Batool[3], Saman Hina[4], Malik Siddique Mahmood[2,4*]

[1]Department of Biology, Beaconhouse College Programme, Gujrat, Pakistan
[2]Institute of Biochemistry and Biotechnology, University of the Punjab, Pakistan
[3]School of Biological Sciences, University of the Punjab, Pakistan
[4]Department of Biochemistry, NUR International University, Lahore, Pakistan

*Corresponding author: siddique.mahmood@niu.edu.pk

Abstract

Vitamin A deficiency (VAD) is a very common problem in developing countries and in extreme situations, it is responsible for vision impairment as well as death. To conduct a comprehensive cross-sectional evaluation of the deficiency of vitamin A and the associated risk factors responsible for its deficiency, a questionnaire based survey was conducted in District Gujrat, Punjab, Pakistan. In order to evaluate the data related to VAD and its relationship with different variables, a cross-sectional survey was conducted of 400 female students from three different schools in District Gujrat. The schools were situated in both rural and urban areas. A questionnaire eliciting personal information, family status and diet related information was used to collect the required data for the survey. The results did not pertain with the participants' gender. The results were based on the summer season routine of diet and physical activity. All information was sorted and the results were analyzed using the Microsoft Excel 2010 update and SPSS version 20. It was found that 39% girls (156 out of 400) were deficient in vitamin A. The main source of VAD was found to be inadequate dietary consumption. It was also found that children with poor socioeconomic standing, low fluid consumption, and from urban areas have more VAD than others. Moreover, the age group of 8-11 years carried a higher percentage of VAD, while physical activity had no impact on VAD. A large number of girls were reported as the victims of VAD due to poverty and related socioeconomic constraints prevailing among the school going children in District Gujrat. A crucial approach towards reducing VAD is to learn about the preventive measures to control VAD. In low-income countries, the use of vitamin A supplements with daily diet is required to reduce the impact of VAD.

Keywords: vitamin A deficiency, diet plan, health measures, socioeconomic status

1. Introduction

Vitamins are important micronutrients that perform hundreds of functions in the body. They make it possible to grow and build the body [1]. They act as co-factors in different bodily functions such as digestion, immunity, bones' formation, metabolism, repair of wounds and cellular damage [2]. Many vitamin forms are used in various bodily processes, such as vitamin D strengthens the bones, vitamin K helps to clot the blood, and vitamin E prevents skin ageing. Vitamin A shows its own characteristics in the same manner [3]. Vitamin A exists in mammals in the form of retinol. It is a fat soluble vitamin consumed in two main

forms by the human body. These are pre-formed and pro-vitamin A, abstained from animals and plants, respectively [4]. The nutritional compounds included in this group are retinal, retinol and retinyl esters. [5, 6]. It is considered useful in vision as it constitutes a portion of the protein rhodopsin required by the retina receptors to absorb light [3]. Besides, this vitamin plays a role in enhancing immune function, cellular contact, reproduction, and development along with differentiation. Vitamin A also facilitates the function and preservation of various organs such as the lungs, heart, and kidneys. [7]

Natural sources of vitamin A are carrots, apricots, cheese, tomato, milk, salmon, beans, pistachio nuts, eggs, green leafy vegetables and some vegetable oils [8, 9]. Liver and fish oil are also rich in this vitamin [9]. It is available as a standalone supplement and also in multivitamins. The amount of vitamin A varies in multivitamins. In standalone supplements, there is a high quantity of vitamin A. Multivitamin supplements can have both forms of the vitamin A that is, beta-carotene and retinol. According to a source, it was found that 28% - 37% population of Pakistan takes the supplementary vitamin A [10]. There is a well-defined and unique prerequisite amount of each vitamin required to fulfil the body functions. This amount is mentioned by the Dietary Reference Intake (DRI) developed by the Institute of Medicine of the National Academies and Food and Nutrition Board (FNB). The Recommended Dietary Allowance (RDA) is 97% - 98% for all individuals enjoying good health. Adequate Intake (AI) ensures nutritional adequacy although RDA may or may not ensure it [11]. For adult women and men, the minimum RDA for retinol activity equivalent is 700 and 900 µg/day, respectively. The maximum intake amount that is tolerable for adults is 3000 µg/day. The higher and lower levels of these descriptive amounts may cause a negative impact on the body.

Although vitamin A deficiency (VAD) is rare in the USA, it is very common in developing countries [9]. The factors behind it are poverty and inadequate availability of the food containing this vitamin. Due to its deficiency the health of the individual can be affected adversely, particularly at times when there is a high demand of nutrition by the body such as childhood, various stages of pregnancy and lactation. World Health Organization (WHO) proposed that 190 million preschool children and 19.1 million pregnant women have lower concentrations of serum retinol. Indeed, 44% - 50% of the preschool children in South Asia suffer from VAD [12].

The main reason of VAD in infants is the inadequate supply of breast milk or colostrum [13]. Xerophthalmia is the disease that occurs most often. An early sign of this disease is night blindness and the person suffering from it cannot see in darkness or in low light [14]. Another critical illness caused by its deficiency is measles [15]. Vitamin A maintains the corneas and measles is correlated with its low concentration. People suffering from malnutrition can experience the problem of blindness [1]. A clinical investigation of 130 children from Africa suffering from measles was carried out. It was found that bilateral blindness and corneal ulcers occurred in these children due to VAD [16]. Premature infants, young children, pregnant women, lactating women and people suffering from cystic fibrosis bear the risk of VAD which causes one third of child deaths, worldwide. The largest proportion of infant mortality due

to malnutrition was observed in different areas of South Asia. Among South Asian countries, the highest prevalence of VAD is in India where 330,000 child deaths are caused due to it, annually. The expected mortality percentage is 31% - 57% [17]. This deficiency was also found to be more prevalent in the rural populace as compared to the urban [18]. It shows that poverty contributes to malnutrition and there is a small supply of diets rich in vitamin A. The extent of VAD prevalence in this country varies considerably, which means that the number of children with vision impairment varies from region to region [19]. Vitamin A supplements should be used to counteract it [20].

In Pakistan, healthcare services are very poor. Child growth and maternal health issues must also be resolved, ensuring the full protection and availability of nutritious food. The nutritionist data related to Pakistan reveals that this country has a severe problem of subclinical VAD [20]. In the Khyber Pakhtunkhwa (KPK) province of Pakistan, a large number of clinical cases of VAD among children under the age of 6 years were reported [21]. Moreover, it was observed that there is a greater risk of xerophthalmia that leads to systemic illness in many communities across different age groups. Low socioeconomic status is also considered as the primary reason behind the shortage of the essential nutrients [21, 22].

This research reports a questionnaire based study of VAD across various age groups of school going girls from various socioeconomic backgrounds. Diet, fitness, economic status and other physical activities were investigated during the summer season. The goal of this research is to understand the fundamental risk factors associated with VAD.

2. Material and Methods

The aim of the current research is to measure the prevalence of VAD and its related risk factors. A survey was conducted using a questionnaire based on VAD related systemic assessment and different factors leading to it. On the 13th, 14th, and 15th of May 2014,400 girls from three separate schools situated in District Gujrat, Pakistan were recruited for the survey. Oral and written consent was obtained from the participants. During the study visit, we registered the gender, age and self-reported race of each participant. Each participant was physically inspected to systemically check the deficiency of vitamin A, such as the presence of Bitot's spots in the eye, the risk of fatigue incidence and frequent infection. There is no clinical data available for this research. The knowledge about the influencing factors was also reported confidentially. It included topics related to the height, weight, BMI, socioeconomic background, lifestyle, family status, whole day eating habits, fluid consumption, substantial diet material, physical activities, and record of prior illnesses.

2.1. Statistical Analysis

Data was statistically analysed using Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistical analyzer was used to calculate the proportions and frequencies in order to summarize the variables of the study. To check the statistical effect of the place, age and family status on VAD, *t*-test was performed. It was also performed to validate the continuous effect of BMI on vitamin A in the body. One–way ANOVA was conducted to

check the relative influence of food, physical exercise, fluid consumption, worm presence and the incidence of disease on VAD. Variables with *p*-value ≤ 0.05 (significant) and ≤ 0.005 (more significant) were entered in order to control and analyze the potential influence of confounders.

3. Results and Discussion

All the respondents participated in the survey willingly. They came from both rural and urban areas. The oldest participant was 15 years of age and the youngest was 4 years of age which reflects the age range of the school going children. The overall results showed that 39% (n=156) of participants were VAD candidates. They suffered from different symptoms related to VAD such as Bitot's spots and corneal xerosis, as well as a poor immune response to sickness. Bitot's spots represent an accumulation of drying, keratinized, epithelial squamous cells that denote conjunctiva keratinizing metaplasia [23].

3.1. Prevalence in Different Age Groups

Vitamin A deficient children were found in all three age groups with varying ratios. Out of 156 children, 13.5% (21) were in the age group of 4 to 7 years, 48.7% (76) were in the age group of 8 to 11 years, while other 37.8% (59) were in the age group of 12 to 15 years. The age group of 8-11 years was found to have the highest deficiency ratio, that is, 48.7% (76) as compared to the lower and upper age groups. A comparison of the deficient and normal children is shown in Figure 1.

Table 1. Demonstration of the Data of Normal and Vitamin A Deficient Individuals of Three Different Age Groups

Age Groups	n	Normal %(n)	Deficient %(n)
4-7	42	50 (21)	50 (21)
8-11	202	62.6 (127)	37 (76)
12-15	155	61.9 (96)	38.1 (59)
Total	400	61 (244)	39 (156)

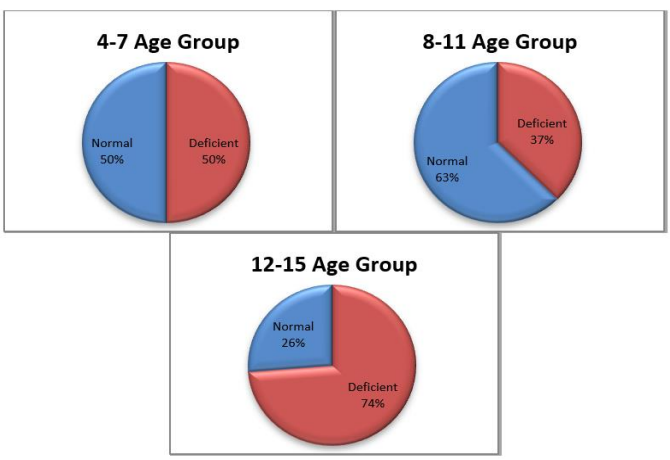

Figure 1. Prevalence of vitamin A deficiency in three age groups

3.2. Impact of Location and Socio-economic Status

The participants were classified into two main groups, that is, rural and urban. Around half of the participants, 53% (212) were urban and less than half of them, 47% were rural (212). It was observed that 61.1% (96) participants belonging to the urban areas showed more inclination towards VAD as compared to 37.8% (59) participants from the rural areas. Hence, there was a statistically strong and significant difference between the two classes (p-<0.005). Our results are in line with Rahman et al., who found that the urban population in Bangladesh is three times more at risk of VAD relative to the rural population [24]. Basically, rural communities are closer to nature relative to those living in the urban areas. They use fresh vegetables and a balanced diet that lowers the risk of VAD [25]. These groups were further divided into four distinct categories based on their socioeconomic standing (lower, middle, upper middle and elite class). It was found that in the rural areas most residents belonged to the lower- and middle-income classes. However, most residents in the urban areas had a middle and upper middle class status.

VAD mostly occurs in a poor environment marked with financial deprivation and relatively few clinical assessments [12]. Collective statistics showed that lower and middle classes are more vulnerable to VAD, since there were found among them 37.1% (23.7+13.4) and 59.5% (35.2+24.3) VAD cases, respectively (Table 2). When assessed individually for each class, the middle class in the urban areas was found to be more affected by VAD. As far as the elite class is concerned, there was insufficient data available about this class. Only one participant belonged to the elite class who did not suffer from VAD.

Table 2. The Effect of Location and Class on Vitamin A Deficiency

Location	**Family Status**	**Population size N=400**	**No. of deficient children N=156**		***P*-value**
			n	**%**	
Urban**	Lower	74	37	23.7	
	Middle	121	55	35.2	0.001
	Upper middle	16	4	0.64	
	Elite	1	-	-	
	Total	212 (57%)	96	61.53	
Rural**	Lower	57	21	13.4	0.001
	Middle	107	38	24.3	
	Upper middle	24	-	-	
	Elite	-	-	-	
	Total	188 (47%)	59	37.8	

Independent *t*-test revealed a strong effect of location on vitamin A deficiency status having a *t*-test value of 12.2 at *p*-value **≤0.005

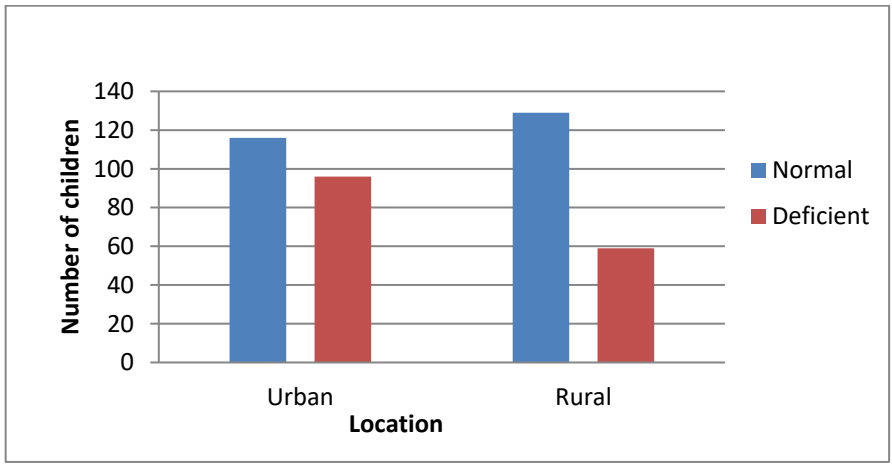

Figure 2. Vitamin A status in urban and rural areas

3.3. Impact of BMI on VAD

We measured the weight and height of all participants and also calculated their BMI (body mass index). The lowest BMI was 9 and the highest was 37, with an average of 17.5 ± (5.77). To find out the relationship between BMI and VAD, we categorized the data into four groups including underweight (UW), normal (N), overweight (OW) and obese (OB) girls. Approximately, 73% (292) of girls were categorized as UW. This indicates that the majority of residents in District Gujrat suffer from malnutrition [26]. The deep study of the data showed that the VAD level was high in the UW (63%) and OB (23%) groups (Table 3). Indeed, individuals carrying a normal weight enjoy a healthy life and face less chances of VAD as compared to the UW and OB individuals. Figure 2 clearly shows the effect of BMI on VAD. Cordeiro et al. compared the relationship between the inadequacy of vitamin A and weight in normal and obese women. The latter were found to have a lower level of serum-retinoid and β-carotene, which demonstrates that a high level of body fat leads to a lower level of vitamin A in the body [27].

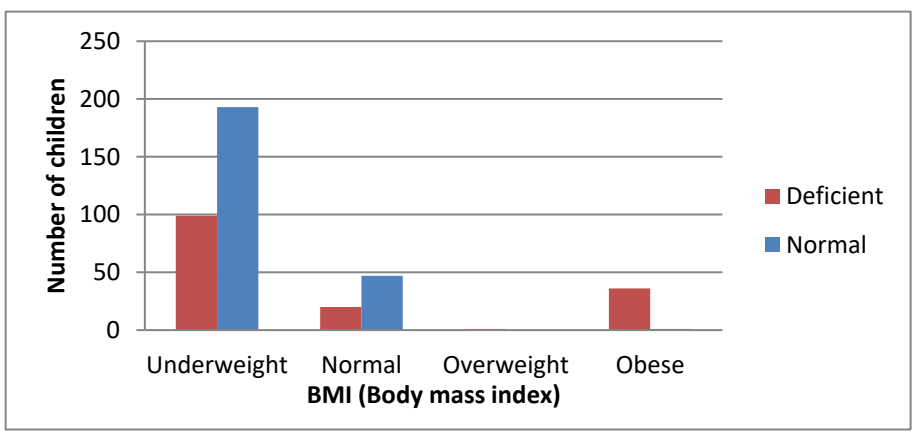

Figure 3. Graph shows the relationship between BMI and VAD

Table 3. Data Representing the Percentage of Vitamin A Deficiency in Different Groups Based on BMI

	Minimum	**Maximum**	**Mean**		**Standard deviation (SE)**
BMI*	**9**	**37**	**17.7**		**5.7**
	Groups	**Population size (N=400)**	**Deficient N=156**		***P*-value**
			n	**%**	
	Underweight (UW) (<18.5)	292	99	63.4	
	Normal (N) (18.5-24.9)	67	20	12.8	≤0.01
	Overweight (OW) (25-29.9)	1	1	0.64	
	Obese (OB) (>30)	37	36	23	

Mean, standard deviation, and *t*-test were used to measure the relationship between BMI and VAD. A statistically strong relationship between them was estimated having the *t*-test value of 62.05 *(p value ≤0.05).

3.4. Impact of Diet on VAD

According to WHO, VAD is predominantly associated with malnutrition and remains a leading cause of blindness in school going children [28]. Selective dietary patterns, climate and sociocultural factors are other variables leading to VAD [29]. Statistical data showed that girls having carbohydrates and lipids as primary diet were more exposed to VAD, comprising 79.4% and 12.17%, respectively (Table 4). However, girls with protein as a major part of their diet were less likely to suffer from VAD (2.5 %). This is due to the fact that protein rich diet, such as egg yolk, dairy products, and animal liver act as a major vitamin A source. Most of the people in developing countries depend on a low quality, energy-dense diet that is highly restricted to the dietary proteins, thus contributing to greater chances of the occurrence of VAD [30].

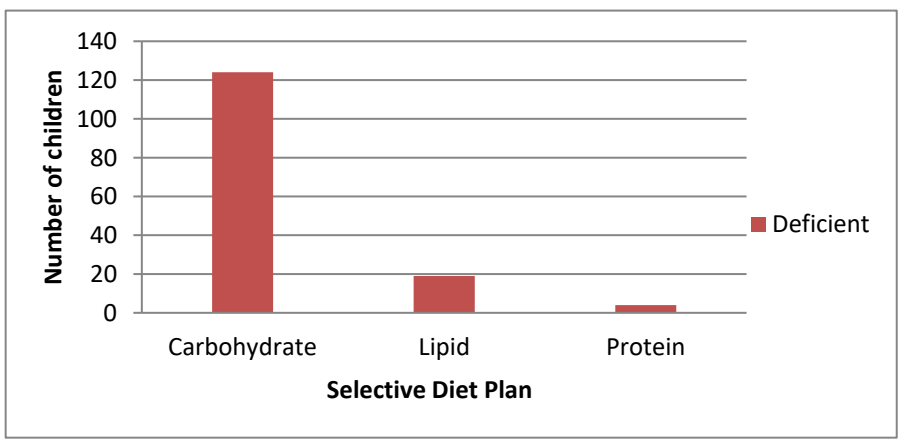

Figure 4. Relationship between selective diet types with VAD

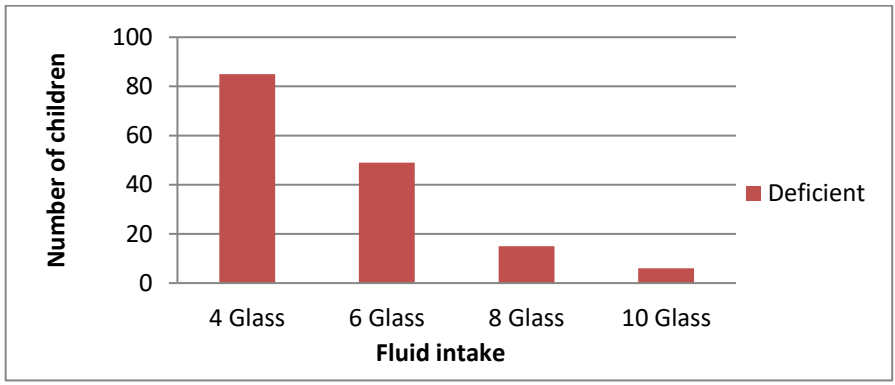

Figure 5. Relationship of vitamin A deficiency with fluid intake level per day

3.5. Impact of Fluid Intake Level per Day on VAD

We analyzed the data related to the daily fluid intake including water and milk. Mostly, vitamin A deficient children were found to have less fluid intake per day. The majority of girls, that is, 54.5% (85) had an intake of 4 glasses of fluids per day during the summer season. Moreover, 31.4% (49) of girls had an intake of 6 glasses of fluids per day, while 9.6% (25) of girls had an intake of 8 glasses of fluids per day. Only 4.5% (7) of girls had an intake of 10 glasses of fluids per day, which is the lowest ratio among the vitamin A deficient children (Table 4). The bar chart in Figure 5 shows the division of vitamin A deficient children on the basis of fluid intake per day. The figure represents an inverse relation of vitamin A deficiency with fluid intake. Since vitamin A is a fat soluble vitamin, hence a higher intake of water is ineffective, although milk consumption affects the vitamin A storage in the body [31].

3.6. Relationship with Physical Activity

The majority of children, that is, 60.9% (95) performed a moderate amount of physical activity, while 30.7% (48) did minimal physical activity throughout the course of the day. Only 2.5% (4) of children did extensive physical activity, while the remaining 5.8% (9) did no physical activity. Figure 6 shows the bar chart depicting the relationship of vitamin A deficiency with physical

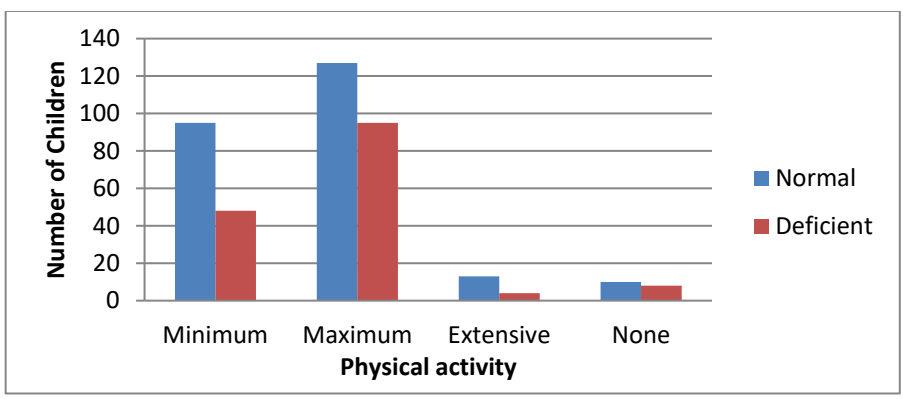

Figure 6. Vitamin A status according to the physical activity throughout the day

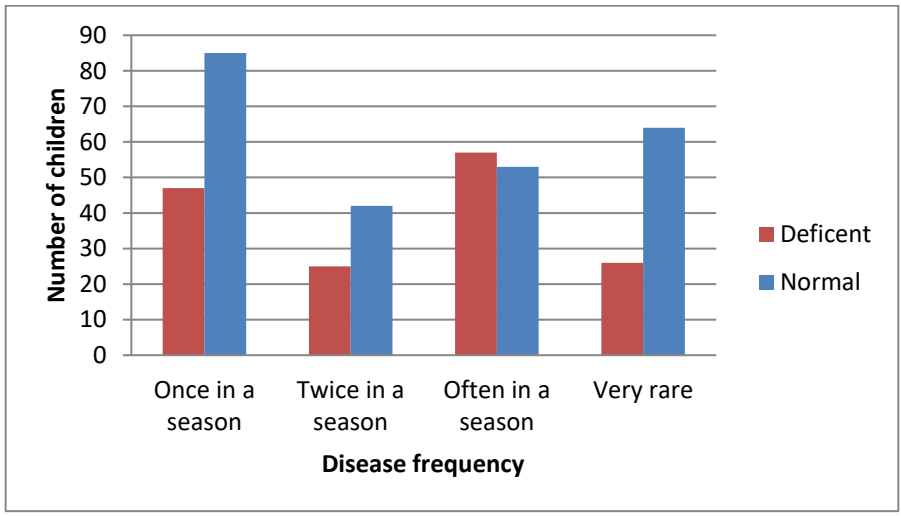

Figure 7. Relationship between the frequency of diseases in a season and vitamin A deficiency

activity. Statistics showed that there is no relationship of vitamin A deficiency with the daily physical activity because children doing no or extensive exercise showed minimum deficiency, while children doing moderate physical activity showed the maximum VAD. In another study seeking to measure the impact of vitamin A on the performance of athletes, data suggested that only a limited percentage of athletes preferred low vitamin A diets. However, the inadequacy of vitamin A affects the metabolism of the body although it does not influence physical activity [32].

3.7. Relationship with the Frequency of Diseases and VAD

It was observed that people with poor vitamin A levels are at a greater risk of contracting infections [33]. Infants who often suffer from different infections were found to have 51% (127) chances of VAD as compared to those who were infected only once or twice in a season. Similarly, those who were rarely prone to illnesses were found to be less vulnerable to VAD (16.7%) (see Table 4). These facts demonstrate that infection and VAD are interlinked in a vicious circle which can lead to an elevated mortality rate. Epidemiological findings confirm the fact that VAD is associated with multiple diseases such as respiratory illnesses, diarrhoea, HIV and measles [34].

3.8. Relationship between the Presence of Stool Worms and VAD

A causal association was found between vitamin A deficiency and the presence of worms in the stool. The coexistence of VAD and intestinal worms was noted in the pre-school children [35]. School going children are also at the risk of it. There were 4 children who had intestinal worms out of which 3 suffered VAD, showing that children with intestinal worms are more at risk of VAD (75%) as compared to the ones that do not have these worms. It was reported that vitamin A supplementation can be used as a treatment to effectively reduce the rate of reinfection with the intestinal *Ascaris* [20]

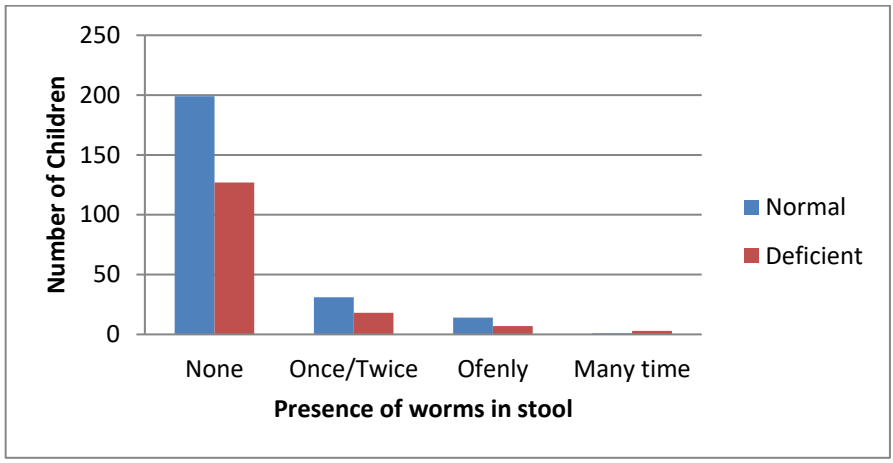

Figure 8. presence of worms in the stool and its relationship with vitamin A deficiency

Table 4. Representation of Vitamin A Deficiency in Different Groups of Girls Based on Selective Diet, Fluid Intake, Physical Activity, Disease Frequency and the Presence of Worms in the Stool

	Qualities	N	Deficient Girls		F-factor	df	*p*-value
			n	%			
Major Diet*	Carbohydrates	307	124	79.4	464	1	0.013
	Protein	67	19	12.17			
	Lipid	10	4	2.5			
	Missing data	14	-	-			
Fluid Intake	4 glasses	186	85	54.5	6.389	1	0.496
	6 glasses	141	49	31.4			
	8 glasses	57	15	9.6			
	10 glasses	16	7	4.5			
Physical Activity	Minimum	143	48	30.7	0.938	1	0.333
	Moderate	222	95	60.8			
	Extensive	17	4	2.5			
Occurrence of Disease	None	18	9	5.8			
	Once in a season	132	47	30.12	0.003	1	0.956
	Twice in a season	67	25	16.02			
	Often in a season	110	57	36.5			
	Very rare	90	26	16.7			
Presence of worms in stool?	None	326	127	81.14	0.035	1	0.852
	Once / Twice	49	18	11.5			
	Often	21	7	4.4			
	Many times	4	3	1.9			

ANOVA: *P-value ≤ 0.05 shows the significant relation

4. Conclusion

It was found that all three age groups had vitamin A deficiency. The age group of 8-11 years had a higher percentage of vitamin A deficiency as compared to other age groups. Location, socioeconomic status, selective diet plan and the presence of worms in the stool impact the prevalence of vitamin A deficiency. Socioeconomic status and diet plan play a significant role in evaluating the prevailing health measures in Gujrat to overcome vitamin A deficiency. In order to maintain the health and well-being of the people living in developing countries, VAD is specifically described by the modern paradigms as the most critical problem to be tackled.

References

[1] van Stuijvenberg ME, Dhansay MA, et al. South African preschool children habitually consuming sheep liver and exposed to vitamin a supplementation and fortification have hypervitaminotic a liver stores: a cohort study. *Am J Cli Nutr*. 2019 Jul 1;110(1):91-101. https://doi.org/10.1093/ajcn/nqy382

[2] Zinder R, Cooley R, Vlad LG, et al. Vitamin A and wound healing. *Nutr Cli Practice*. 2019 Dec;34(6):839-49. https://doi.org/10.1002/ncp.10420

[3] Miller AP, Coronel J, Amengual J. The role of β-carotene and vitamin A in atherogenesis:evidences from preclinical and clinical studies. *Biochim Biophys Acta Bioenerg (BBA)-Mol Cell Biol Lipids*. 2020 Jan 21:158635. https://doi.org/10.1016/j.bbalip.2020.158635

[4] Dwyer JT, Coates PM, Smith MJ. Dietary supplements: regulatory challenges and research resources. *Nutrients*. 2018 Jan;10(1):1-41. https://doi.org/10.3390/nu10010041

[5] Coates PM, et al. *Encyclopedia of Dietary Supplements*. 2010: Informa Healthcare.

[6] Shils ME, Shike M. *Modern Nutrition in Health and Disease*. 2006:Lippincott Williams & Wilkins.

[7] Coates PM, Betz JM, Blackman MR, et al., *Encyclopedia of Dietary Supplements*. 2010:CRC Press.

[8] US Department of Agriculture. *USDA National Nutrient Database for Standard Reference.* 2013. https://www.ars.usda.gov/

[9] Coates PM, Paul MC, Blackman M, et al. Encyclopedia of Dietary Supplements (Online). 2004 Dec 29:CRC Press.

[10] Bailey RL, Gahche JJ, Lentino CV, et al. Dietary supplement use in the United States, 2003–2006. *J Nutr*. 2011 Feb 1;141(2):261-6. https://doi.org/10.3945/jn.110.133025

[11] Table M. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. National Academy Press: Washington, DC, USA; 2005.

[12] World Health Organization. Global Prevalence of Vitamin a Deficiency in Populations at Risk 1995-2005: WHO global database on vitamin A deficiency. 2009:1-86.

[13] Yang C, Chen J, Liu Z, et al. Prevalence and influence factors of vitamin A deficiency of Chinese

pregnant women. *Nutr J*. 2015 Dec;15(1):1-7.

[14] Alanazi SA, El-Hiti GA, Al-Baloud AA, et al. Effects of short-term oral vitamin A supplementation on the ocular tear film in patients with dry eye. *Clin Ophthalmol* (Auckland, NZ). 2019;13:599-604.

[15] Sudfeld CR, Navar AM, Halsey NA. Effectiveness of measles vaccination and vitamin a treatment. *Int J Epidemiol*. 2010 Apr 1;39(suppl_1):48-55. https://doi.org/10.1093/ije/dyq021

[16] Foster A, Sommer A. Corneal ulceration, measles, and childhood blindness in Tanzania. *Brit J Ophthalmol*. 1987 May 1;71(5):331-43. http://dx.doi.org/10.1136/bjo.71.5.331

[17] West Jr KP. Extent of vitamin a deficiency among preschool children and women of reproductive age. *J Nutr*. 2002 Sep 1;132(9):2857S-66S. https://doi.org/10.1093/jn/132.9.2857S

[18] International Institute for Population Sciences. National family health survey (NFHS-3), 2005-06: India. International Institute for Population Sciences; 2007.

[19] Horton S. *Opportunities for investments in nutrition in low-income Asia.* Asian Development Bank; 1999. http://hdl.handle.net/11540/5393

[20] Akhtar S, Ahmed A, Randhawa MA, et al. Prevalence of vitamin A deficiency in South Asia: causes, outcomes, and possible remedies. *J Health Popul Nutr*. 2013 Dec;31(4):413-423.

[21] Khan MA, Gilbert C, Khan MD, et al. Incidence of blinding vitamin A deficiency in North West Frontier Province and its adjoining federally administered tribal areas, Pakistan. *Ophthalmic Epidemiol*. 2009 Jan 1;16(1):2-7. https://doi.org/10.1080/09286580802573185

[22] Rauf S, Sharif N, Hamid A. Serum vitamin A levels in children under five years old. *J Ayub Med College Abbottabad*. 2002;14(1):26-07.

[23] Sommer A. Vitamin A deficiency and clinical disease: an historical overview. *J Nutr*. 2008 Oct 1;138(10):1835-9. https://doi.org/10.1093/jn/138.10.1835

[24] Miandad M, Anwar MM, Ahmed S,et al. Assessment of risk factors associated with spread of tuberculosis in Gujrat city Pakistan. *Coğrafya Dergisi*. 2019(39):41-60. https://doi.org/10.26650/JGEOG2019-0023

[25] Cordeiro A, Bento C, de Matos AC, et al. Vitamin A deficiency is associated with body mass index and body adiposity in women with recommended intake of vitamin A. *Nutrición hospitalaria: Organo Oficial De La Sociedad Española De Nutrición Parenteral Y Enteral*. 2018;35(5):1072-8.

[26] Rahman S, Rahman AS, Alam N, et al. Vitamin A deficiency and determinants of vitamin A status in Bangladeshi children and women: findings of a national survey. *Public Health Nutr*. 2017 Apr;20(6):1114-25. https://doi.org/10.1017/S1368980016003049[Opens in a new window]

[27] Bloem MW, Hye A, Wijnroks M, et al. The role of universal distribution of vitamin A capsules in combatting vitamin A deficiency in Bangladesh. *Am J Epidemiol*. 1995 Oct 15;142(8):843-55. https://doi.org/10.1093/oxfordjournals.aje.a117724

[28] World Health Organization. *Xerophthalmia and night blindness for the assessment of clinical vitamin A deficiency in individuals and populations*. World Health Organization; 2014:1-6.

[29] Kersting M, Alexy U, Schürmann S. Critical dietary habits in early childhood: principles and practice. *Hidden Hunger*. 2016;115:24-35. https://doi.org/10.1159/000441885

[30] Martini S, Rizzello A, Corsini I, Romanin B, et al. Vitamin A deficiency due to selective eating as a cause of blindness in a high-income setting. *Pediatrics*. 2018 Apr 1;141(Supplement 5):S439-44.

[31] Shibata K, Hirose J, Fukuwatari T. Relationship between urinary concentrations of nine water-soluble vitamins and their vitamin intakes in Japanese adult males. *Nutr Metabolic Insights*. 2014 Jan;7:NMI-S17245. https://doi.org/10.4137/NMI.S17245

[32] Marriott BM. *The Effect of Exercise and Heat on Vitamin Requirements*, in *Nutritional Needs in Hot Environments: Applications for Military Personnel in Field Operations*. Washington, DC:National Academy Press;1993:187–214.

[33] Huang Z, Liu Y, Qi G, et al. Role of vitamin A in the immune system. *J Cli Med*. 2018 Sep;7(9):258-. https://doi.org/10.3390/jcm7090258

[34] Kaminstein D, Kuhn WT, Huang D, et al. Perspectives on Point-of-Care Ultrasound Use in Pediatric Tropical Infectious Disease. *Cli Pediatric Emerg Med*. 2019 Jun 1;20(2):128-40. https://doi.org/10.1016/j.cpem.2019.06.003

[35] Payne LG, Koski KG, Ortega-Barria E, et al. Benefit of vitamin A supplementation on Ascaris reinfection is less evident in stunted children. *J Nutr*. 2007 Jun 1;137(6):1455-9. https://doi.org/10.1093/jn/137.6.1455