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Assessing and Determining Potential Factors Associated with Vitamin A Supplementation in Bangladesh

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Abstract

Objective: Vitamin A deficiency (VAD) is a major public health problem in Bangladesh. The main objective of this study is to assess and determine the potential factors of vitamin A supplementation among children.

Methods: Chi-square test is used to measuring the association between Vitamin A supplementation and socio-demographic characteristics of Bangladesh health and demographic survey, 2014 data. Logistic regression is used to determining the important factors of vitamin A consumptions.

Results: Only 63.5% of the children consumed vitamin A capsule in Bangladesh. Children age, region, religion, mother's education, father's education, wealth index, mass media and breast feeding status has been found significantly associated with vitamin A supplementation. Mid age children (OR: 1.804; CI: 1.523-2.136), others religion children (OR: 1.262; CI: 1.036-1.536), and children of higher educated mothers (OR: 1.390; CI: 1.058-1.828) were significantly more likely to consume vitamin A than others. Children in Rajshahi division (OR: 0.676; CI: 0.552-0.828) only significantly less likely to consume vitamin A as their counterparts.

Conclusion: This finding indicates that consume of vitamin A does not cover the target of sustainable or millennium development goal. So to achieve the target, government should take initiative to increase the consume status of vitamin A in Bangladesh.

Keywords: Children; Odds ratio; Vitamin A; Vitamin A deficiency

Abbreviations: VAD: Vitamin A deficiency; IAPB: International Agency For The Prevention Of Blindness; GAP: Global Action Plan; MDGs: The Millennium Development Goals; SDG: Sustainable Development Goal; WHO: World Health Organization; GAP: A Global Action Plan; BDHS: Bangladesh Demographic and Health Survey; EAs: Enumeration Areas; OR: Odds Ratio; Cis: Confidence Intervals; SPSS: Statistical Package for Social Sciences

Introduction

Vitamin A is a fat soluble vitamin that is a powerful antioxidant. Vitamin A plays a critical role in maintaining healthy vision, neurological function, healthy skin, and more. Vitamin A also responsible for building strong bones, regulating gene regulation, maintaining healthy clear skin, facilitating cell differentiation, and supporting immune function [1]. Vitamin A deficiency (VAD) is a leading cause of morbidity, mortality, and blindness among preschool children. VAD has been more seriously addressed in Bangladesh compared to the adjoining countries, such as India, Pakistan, Afghanistan, and Nepal [2]. VAD can result in more severe infections and greater mortality due to diarrhoea and measles, especially in preschool children. A child cannot always consume vitamin A needs from dietary sources. Vitamin A capsule supplementation among the children (age 6-59 months) is an important strategy to overcoming the VAD problem in Bangladesh. Children under six months are excluded due to having breast milk [3]. Children consume supplementation once in every six months during the national immunization days or vitamin A campaigns. Since February 2011, children age 9-11 months are no longer provided vitamin A supplementation at the time they receive the measles vaccination [4].

A global initiative for the elimination of avoidable childhood blindness by world health organization (WHO) and the international agency for the prevention of blindness (IAPB) named after VISION 2020: the Right to Sight [5]. A global action plan (GAP) 2014-2019 sets itself a global target of a 25% reduction in prevalence of avoidable visual impairment by 2019 from the baseline of 2010 [6]. 90% of the world's visually impaired people live in developing countries and it is believed that 60-80% of the children's are died within 1-2 years due to blindness [7]. Vitamin A supplementation helps maintain strong immune systems and it reduces the incidence of diarrhea, measles, blindness and hearing loss. Most importantly, Vitamin A supplementation in Guinea-Bissau is estimated to reduce all causes mortality by 24% [8]. Many developing countries have been established different programs to provide the periodic supplementation of high dose vitamin A to increase child survival and reduce the incidence of nutritional blindness. Vitamin A supplementation is one of the most cost effective interventions for child health, blindness and is known to reduce mortality of under five children by nearly one quarter [1,9].

The millennium development goals (MDGs) include reducing child mortality by two thirds between 1990 and 2015, and the coverage of periodic supplementation of vitamin A is considered one of the most safe and cost effective strategies in reaching this goal [10]. Sustainable development goal (SDG) want to ensure healthy lives and promote physical and mental health and well-being for all at all ages [11]. SDG wants to reduce the preventable deaths of under-five year's children at least as low as 25 per 1000 live births within 2030 [12]. UNICEF and WHO recommend that children receive two high dose vitamin A supplements per year, spaced about 4 to 6 months apart, in places where under five mortality is high or deficiency is a public health problem. While universal coverage (100%) remains the ultimate goal, effective coverage (≥80%) is the threshold needed to improve child survival [13]. Supplementation programs have made notable progress towards the goal of effective two dose coverage with UNICEF's leadership and the support of partners including Helen Keller international with long term financing from the government of Canada. In 2000, only five countries in sub-Saharan Africa had effective two dose coverage, but by 2014, this number had more than tripled in that region [14].

Nearly 44-50% preschool children in South Asian regions were affected by severe VAD [15,16]. Moreover, significantly higher prevalence of VAD in South Asian developing countries may overwhelmingly disintegrate the health and economic infrastructure of these societies. It is imperative that immediate action be taken to meet the VAD challenge. The objectives of this study is to

i) Assess the coverage of the national vitamin A supplementation program in Bangladesh, and

ii) Determine a set of potential factors of vitamin A supplementation in Bangladesh and investigate their effects on vitamin A supplementation.

Materials and Methods

Source of data

This study used secondary data extracted from nationally representative 2014 Bangladesh Demographic and Health Survey (BDHS) and covers the entire population residing in no institutional dwelling units in the country. The survey used the list of enumeration areas (EAs) of the 2011 Population and Housing Census of the People's Republic of Bangladesh, provided by the Bangladesh Bureau of Statistics, as a sampling frame. The primary sampling unit for the survey is an EA created to have an average of about 120 households. The survey is based on a two stage stratified sample of households. In the first stage, 600 EAs were selected with probability proportional to the EA size, with 207 EAs in urban areas and 393 in rural areas. In the second stage of sampling, a systematic sample of 30 households on average was selected per EA to provide statistically reliable estimates of key demographic and health variables for the country as a whole. As a result 18,000 residential households were selected in four phases.

Data and Variable description

In this study we selected fourteen variables from 2014 BDHS child data (one dependent variable and thirteen explanatory variables) which are relevant to vitamin A supplementation. After cleaning the raw data we have only 6304 children's out of 7886 children's for our study.

Outcome variable

The motif of the study is measuring consumption status of vitamin A capsule. To assess consumption status of vitamin A capsule "Is your child consume vitamin A capsule within last six month?" was through to child's mother. The outcome variable is a dichotomous variable indicating whether a child has consumed vitamin A or not.

Explanatory variables

Mahajan et al. [17] has found that age group, sex, religion, mother's education, immunization status for vaccine preventable diseases are associated with Vitamin A supplementation [17]. Susan et al. [18] has been used the variables age of mothers, types of family, religion, education, occupation, income, age of child, source of information to find the awareness of vitamin A [18]. Agrawal also found that the greater maternal formal education, higher household wealth status and high social development status of their state of residence appears to be an important determinant for receipt of a vitamin A supplementation in India [19]. On the basis of above discussion the socioeconomic and demographic covariates included in the analysis are children's age (in month), children's sex, place of residence, region/division, religion, number of children, mother's age, mother's education, father's education, sex of household head, wealth index, mass media exposure, and breast feeding status. All the covariates are categorical and their categories are presented in Table 1 with their categories identification code.

Chi-square test

The chi-square is a valuable analysis tool that provides considerable information about the nature of research data [20].

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The Chi-square statistic is commonly used for testing relationships between categorical variables [21]. It is used very commonly in health research. The formula for computing the test statistic is as follows:

$$\chi^2 = \sum \frac{\left(O_{r,c} - E_{r,c}\right)^2}{E_{r,c}}$$

Where,

$O_{r,c}$ and $E_{r,c}$ are the observed and expected frequency count at level r of a variable and level c of another variable respectively.

Logistic regression

Logistic regression is one of the most widely used models to analyze the relation between one or more explanatory variables and a categorical response in the field of epidemiology, health and medicine [22]. The outcome in binary logistic regression analysis is coded as 0 or 1, where 1 indicates that the children consume vitamin A capsule, and 0 indicates that are not consume. If we define *p* as the probability that the outcome is 1, the multiple logistic regression models can be written as follows:

$$\hat{p} = \frac{\exp(X\beta)}{1+\exp(X\beta)};$$

Where,

$$X = \left(X_1, X_2, \ldots\ldots, X_{\beta}\right)'; \quad \beta = \left(\beta_0, \beta_1, \beta_2, \ldots\ldots, \beta_{\beta}\right)$$

$\hat{p}$ is the expected probability that the outcome is present; X_1 through X_{β} are distinct explanatory variables; and β_0 through β_{β} are the regression coefficients. The multiple logistic regression models is sometimes written as the log of odds form

$$\ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = X\beta$$

In logistic regression the coefficients (β_i) derived from the model indicate the change in the expected log odds relative to a one unit change in X_i holding all other predictors constant. Therefore, the antilog of an estimated regression coefficient $\exp(\beta_i)$ produces an odds ratio (OR). The OR is used to figure out if a particular exposure is a risk factor for a particular outcome, and to compare the various risk factors for that outcome [23].

The multicollinearity problem in logistic regression analysis is a big problem to perform statistical analysis and there is no exact method to detect this problem. In this study, the magnitude of SE was used to detect the multicollinearity problem. If the magnitude of SE lies between 0.001 and 0.500, it can be considered that there is no evidence of multicollinearity [18].

Statistical analysis

To examine the relationship between vitamin A capsule consumption status and socio-demographic characteristics of the respondents, both quantitative and qualitative statistics are applied in this study. Chi square test is used in order to measure the association between Vitamin A capsule consumption and its covariates. Binary logistic regression analysis is used to determine the comparative risk of the covariates to the response. The results are presented in the form of odds ratios (ORs), with 95% confidence intervals (95% CIs). All statistical analyses are performed by the Statistical Package for Social Sciences (SPSS) version 20 [24].

Results

Table 1: Frequency distribution of different categories and distribution of vitamin A supplementation status according to selected characteristics in Bangladesh.

Factors	Frequencies (%)	Vitamin A capsule consumption status		χ^2 values	*p*-values
		Yes (%)	No (%)		
Children's age					
06–12 months	877 (13.9%)	455 (52%)	422 (48%)	66.72	0.000*
13–24 months	1390 (22.1%)	890 (64%)	500 (36%)		
25–36 months	1399 (22.2%)	944 (67%)	455 (33%)		
37–48 months	1382 (21.9%)	921 (67%)	461 (33%)		
49–59 months	1256 (19.9%)	796 (63%)	460 (37%)		
Children's sex					
Male	3237 (51.3%)	2031 (63%)	1206 (37%)	1.85	0.170
Female	3067 (48.7%)	1975 (64%)	1092 (36%)		
Place of residence					
Rural	4296 (68.1%)	2684 (62%)	1612 (38%)	6.67	0.010*
Urban	2008 (31.9%)	1322 (66%)	686 (34%)		
Region/Division					

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Barisal	712 (11.3%)	471 (66%)	241 (34%)	31.62	0.000*
Chittagong	1203 (19.1%)	787 (65%)	416 (35%)		
Dhaka	1107 (17.6%)	711 (64%)	396 (36%)		
Khulna	690 (10.9%)	444 (64%)	246 (36%)		
Rajshahi	762 (12.1%)	457 (60%)	305 (40%)		
Rangpur	770 (12.2%)	525 (68%)	245 (32%)		
Sylhet	1060 (16.8%)	611 (58%)	449 (42%)		
Religion					
Islam	5774 (91.6%)	3641 (63%)	2133 (37%)	7.07	0.008*
Others	530 (08.4%)	365 (69%)	165 (31%)		
Number of children					
1 child	1917 (30.4%)	1229 (64%)	688 (36%)	8.55	0.014**
2 child	2105 (33.4%)	1378 (65%)	727 (35%)		
3/3+ child	2282 (36.2%)	1399 (61%)	883 (39%)		
Mother's age					
<=20 years	1160 (18.4%)	699 (60%)	461 (40%)	8.46	0.070
21-25 years	2137 (33.9%)	1357 (64%)	780 (36%)		
26-30 years	1689 (26.8%)	1093 (65%)	596 (35%)		
31-35 years	862 (13.7%)	568 (66%)	294 (34%)		
35+ years	456 (07.2%)	289 (63%)	167 (37%)		
Mother's education					
No education	1036 (16.4%)	585 (56%)	451 (44%)	71.74	0.000*
Primary	1777 (28.2%)	1053 (59%)	724 (41%)		
Secondary	2873 (45.6%)	1919 (67%)	954 (33%)		
Higher	618 (09.8%)	449 (73%)	169 (27%)		
Father's education					
No education	1661 (26.4%)	981 (59%)	680 (41%)	72.87	0.000*
Primary	1914 (30.4%)	1135 (59%)	779 (41%)		
Secondary	1842 (29.2%)	1249 (68%)	593 (32%)		
Higher	887 (14.1%)	641 (72%)	246 (28%)		
Sex of household head					
Male	5713 (90.6%)	3635 (64%)	2078 (0.36%)	0.17	0.682
Female	591 (09.4%)	371 (63%)	220 (0.37%)		
Wealth index					
Poor	2599 (41.2%)	1524 (59%)	1075 (41%)	48.95	0.000*
Middle	1210 (19.2%)	787 (65%)	423 (35%)		
Rich	2495 (39.6%)	1695 (68%)	800 (32%)		
Mass media exposure					
No	2769 (43.9%)	2119 (60%)	1416 (40%)	45.11	0.000*
Yes	3535 (56.1%)	1887 (68%)	882 (32%)		
Breast feeding status					
No	2825 (44.8%)	1869 (66%)	956 (34%)	15.08	0.000*
Yes	3479 (55.2%)	2137 (61%)	1342(39%)		
* and ** indicates the significance at 1% and 5% level of significance respectively					

Out of 6304 children's 3998 (63.5%) children's had consumed and the rest 2296 (36.5%) children's were not consumed vitamin A capsule. This indicates poor coverage, so children's were unsecured and it is a big problem. Table 1 show that how much data comes from different categories with their percentages. Table 1 also gives the row percentage of the different categories under covariates with respect to vitamin A consumption status. Vitamin A consumption roughly increased with the increasing children's

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age, mother's age, mother's education, father's education and wealth index but children's sex, sex of household head and number of total child were approximately equally likely to consume vitamin A capsule. In the age group 6-12 months only 52% child were consumed vitamin A capsule and this dose was first dose. This study also found that, vitamin A capsule consuming rate of different region varying around 60-68% and rural people are less (62%) consume than urban (66%) people in Bangladesh. Breast feeder children and Muslims were also less consuming vitamin A capsule than its counterpart. Mass media also play an important role in consumption of vitamin A capsule.

The chi square test was used to performing whether the probabilities in different categories of covariates are equal or not. The comparisons based on the resulting probabilities for selected covariates along with p-value were obtained from chi square and it was presented in Table 1. Vitamin A supplementation was being associated with children's age, region, type of place of residence, religion, mother's education, father's education, wealth index, mass media and breast feeding status at 1%, and number of child at 5% level of significance. Children's sex and sex of household head were not found to have significant impact on the vitamin A supplementation in Bangladesh.

Table 2: Logistic regression estimates and odds ratio of different socioeconomic and demographic variables on vitamin A supplementation in Bangladesh.

Factors	Coefficient, (β)	SE (β)	*p*-values	Odds ratio, $\exp(\beta)$	95% CI for $\exp(\beta)$	
					Upper	Upper
Children's age						
06–12months (ref)				1.000		
13 – 24 months	0.445	0.085	0.000*	1.560	1.322	1.842
25 – 36 months	0.590	0.086	0.000*	1.804	1.523	2.136
37 – 48 months	0.517	0.097	0.000*	1.678	1.388	2.028
49 – 59 months	0.375	0.097	0.000*	1.454	1.203	1.758
Children's sex						
Male (ref)				1.000		
Female	0.076	0.053	0.154	1.079	0.972	1.197
Place of residence						
Rural (ref)				1.000		
Urban	-0.018	0.062	0.767	0.982	0.870	1.108
Region/Division						
Barisal (ref)				1.000		
Chittagong	-0.169	0.096	0.078	0.844	0.699	1.019
Dhaka	-0.235	0.097	0.016**	0.791	0.654	0.957
Khulna	-0.255	0.109	0.019**	0.775	0.627	0.959
Rajshahi	-0.391	0.104	0.000*	0.676	0.552	0.828
Rangpur	-0.004	0.106	0.970	0.996	0.810	1.226
Sylhet	-0.396	0.097	0.000*	0.673	0.556	0.814
Religion						
Islam(ref)				1.000		
Others	0.232	0.100	0.021**	1.262	1.036	1.536
Number of children						
1 child (ref)				1.000		
2 child	0.025	0.077	0.746	1.025	0.882	1.192
3/3+ child	-0.080	0.095	0.400	0.923	0.765	1.113
Mother's age						
<=20 years (ref)				1.000		
21-25 years	0.045	0.082	0.585	1.046	0.890	1.228

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26-30 years	0.129	0.099	0.192	1.138	0.937	1.382
31-35 years	0.240	0.120	0.046**	1.271	1.005	1.607
35+ years	0.198	0.140	0.157	1.219	0.926	1.605
Mother's education						
No education (ref)				1.000		
Primary	0.083	0.080	0.298	1.087	0.929	1.271
Secondary	0.277	0.087	0.002*	1.319	1.111	1.565
Higher	0.330	0.140	0.018**	1.390	1.058	1.828
Father's education						
No education (ref)				1.000		
Primary	-0.121	0.072	0.093	0.886	0.769	1.020
Secondary	0.122	0.084	0.149	1.130	0.957	1.333
Higher	0.197	0.119	0.097	1.218	0.965	1.537
Sex of household head						
Male (ref)				1.000		
Female	-0.115	0.093	0.214	0.891	0.744	1.069
Wealth index						
Poor (ref)				1.000		
Middle	0.112	0.080	0.162	1.119	0.956	1.310
Rich	0.077	0.092	0.401	1.080	0.902	1.293
Mass media exposure						
No (ref)				1.000		
Yes	0.131	0.074	0.078	1.140	0.985	1.319
Breast feeding status						
No (ref)				1.000		
Yes	-0.084	0.068	0.221	0.920	0.805	1.052

* and ** indicates that the significance at 1% and 5% level of significance respectively

Abbreviations: SE, standard error; CI, confidence interval; ref, reference category.

Table 2 presents the effects of different covariates on vitamin A supplementation among children's 6-59 months by using binary logistic regression. The most important objective in this paper was to examine the potential determinants of vitamin A supplementation in Bangladesh. The study utilizes well fitted logistic regression model and there was no multicollinearity problem based on the magnitudes of standard error to get valid results and adjusted effects of the covariates.

Children's age groups were significantly more likely to consume vitamin A in comparison to age group 6-12 months, whereas maximum receiving age group was 26-36 months (OR: 1.804, CI: 1.523-2.136). Female children were consuming vitamin A capsule 7.9% more than male (OR: 1.079, CI: 1.523-2.136). Regional effect was an important consideration and all children's residing different divisions were receiving vitamin A capsule less respect to Barisal division as the reference category. Another good feature was that others religious households were more aware than Islam (OR: 1.262, CI: 1.036-1.536). Families having three or more children were less likely to consume vitamin A supplementation than single children families (OR: 0.923, CI: 0.765-1.113).

All mother's age groups were more likely to consume vitamin A in comparison to age less than or equal 20 years, whereas maximum receiving age group was 31-35 years (OR: 1.271, CI: 1.005-1.607). Children whose mothers has higher education were about one and half times more likely (OR: 1.390; CI: 1.058-1.828) to consume vitamin A supplementation than children whose mothers were no educated. Even children whose mothers had at least primary education were nearly equally (OR: 1.087; CI: 0.929-1.271) likely to consume vitamin A supplementation than those with illiterate mothers. Higher education of children's father was around one and quarter times more likely (OR: 1.218; CI: 0.965-1.537) but children whose father had primary education were less likely (OR: 0.886; CI: 0.769-1.020) to consume vitamin A supplementation than fathers were no educated. Female household head family's children were consuming 11% less vitamin A capsule than its counterparts. In case of wealth index,

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children with middle class family were receiving more (OR: 1.119; CI: 0.956-1.310) likely than poor people. Mass media had a good influence to increase the rate of receiving vitamin A capsule (OR: 1.140; CI: 0.985-1.319).

Discussion

This study demonstrated the association between socioeconomic and demographic factors, with vitamin A supplementation among under five children in Bangladesh. In this paper an endeavor has been made to examine the potential determinants of vitamin A supplementation in Bangladesh. Mother's education is the most important factor for receiving vitamin A capsule in Bangladesh. In this study we found that the rates of vitamin A capsule receiving are increased when mother's educational level are increased. Bishai Kumar, et al. [25] in a study found that children whose mothers had no education were less likely to consume vitamin A supplementation [25].

In this study we also found that vitamin A supplementation is more in those children whose father are higher and secondary educated than primary and no educated. Mother's age is also an important factor and age more than 20 years are more likely aware to intake vitamin A capsule than age group less than or equal 20 years. Higher vitamin A supplementation intake by rich and middle class family compared with poor households showed an increased health inequity. Specially, children of middle class family consume more vitamin A in compare with rich and poor family in Bangladesh but these scenarios is different in India [19].

We found an evidence of gender differentials in vitamin A supplementation coverage in Bangladesh; however Agrawal and Agrawal did not found any evidence of gender differentials in India [19]. Our results on the lack of evidence of gender equality are not similar to what was reported by Bishai Kumar, et al. [25]. Mass media exposure has a positive impact on taking vitamin A capsule. This finding is supported by Warnick et al. [26], who found that mass media led to intake vitamin A capsule.

Breastfeeding is another factor and this study clearly indicates it has a less impact on receiving vitamin A capsule in Bangladesh. While this is not supported by Agrawal and Agrawal, they noticed that breastfeeding had more impact on receiving vitamin A capsule in India and this is also not supported by Danneskiold-Samsoe, et al. [27] in Guinea-Bissau [19,27]. The intake of vitamin A capsule is almost equally likely which families has 1 and 2 children but less likely for 3 or more children. While this is partially supported by Agrawal and Agrawal, they noticed that more than 1 child were consumed less vitamin A supplementation [19].

Children age is also an important factor on receiving vitamin A capsule and in this study we found that the vitamin A capsule consumption in all age groups is more likely compared to age group 06-12 months. Janmohamed et al. [28] found that the all age groups are equally likely to consume vitamin A capsule in thirteen sub-Saharan African countries [28]. Agrawal and Agrawal also found that reverse scenario to our results [19]. Finally, in this study we found that vitamin A supplementation coverage only 63.5%, which does not meet the SDG target.

Conclusion

In this study, frequency and percentage distribution, chi-square test and logistic regression model, have been used to determining the potential determinants of vitamin A capsule supplementation in Bangladesh using BDHS, 2014 data. Findings of the study suggest that female education participation needs to be enhanced because it consequently brings an improvement in vitamin A capsule reception. Higher children age, mother's age, mother's education, household wealth and one or two children appears to be an important determinant for receiving vitamin A in Bangladesh. Children in urban area, primary education of father, female household head, and breastfeeding status may be more experienced to increase the vitamin A reception. Findings of the study show that the vitamin A supplementation does not cover the target of SDG or MDG. Now to ensure the vitamin A supplementation coverage is acceptable position we suggest immediately take necessary action to raise the coverage of vitamin A supplementation in Bangladesh.

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