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Research article

Dietary vitamin A intake and its major food sources among rural pregnant women of South-West Bangladesh

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ABSTRACT

The study aimed to estimate the dietary intake of vitamin A and its major food sources among rural pregnant women from the southwest region of Bangladesh. A multi-stage random cluster sampling method was used to select the respondents (N = 1012). A semi-structured questionnaire was used to collect the data, and statistical analysis was conducted using IBM SPSS 20.0. The mean age of the respondents was 23.27 ± 5.23 years, and the majority were in their second (48%) and third trimester (49%). The mean dietary intake of vitamin A was 392 ± 566 μg Retinol Activity Equivalent (RAE)/day (51% of Recommended Dietary Allowance). The contribution of β-carotene (plant source) and retinol (animal source) in vitamin A intake was about 60% and 40%, respectively. The major β-carotene contributing food groups were vegetables (dark and light) and tubers, and food items were colocasia, potato, beans, brinjal, and ripe tomatoes. On the other hand, the major retinol-contributing food groups were fish, eggs, and milk, and food items were small fish, Rui (carp) fish, and cow's milk. It was also observed that the consumption of food items from β-carotene and retinol-contributing food groups did not differ significantly among the three groups of respondents, but the variations in the amount of the different food items consumed were significant. Dietary vitamin A intake is low among pregnant women in the South-West region of Bangladesh. Hence, they are at a greater risk of adverse materno-fetal health outcomes associated with vitamin A deficiency.

1. Introduction

Vitamin A is essential for maintaining eyesight, cell differentiation, immune responses, reproduction, and gene expression [1,2]. Its deficiency has been a major public health issue worldwide, particularly in Africa and South-East Asia, including Bangladesh [3]. It has

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also been found that pregnant and lactating women from low-income countries are one of the main vulnerable groups to vitamin A deficiency [4,5]. In Bangladesh, almost 18.5% and 53% of pregnant women were reported to have vitamin A deficiency (VAD) and vitamin A intake less than RDA, respectively [6]. Low dietary intake of vitamin A paves the way to the depletion of body stores of vitamin A, weakening pertinent physiological functions [7]. Earlier reports have shown that VAD not only increases the risk of maternal morbidity and mortality [8,9] but also contributes to adverse pregnancy outcomes [10] and precipitates anemia [11–13]. Other well-known health consequences of vitamin A deficiency included increased mortality in the first months of life [14–16], xerophthalmia [17,18], night blindness [19], abnormalities in iron metabolism [20,21], risk of both infectious [22] and non-infectious diseases [23,24], inflammation [25], impaired fetal islet development [26], and disruption of normal lung physiology [27].

Preformed vitamin A (retinol) is found in animal-origin foods. Colored and green leafy vegetables (GLV), on the other hand, are the sources of provitamin A carotenoids (α-carotene, β-carotene, β-cryptoxanthin) [2]. However, information regarding the dietary intake of vitamin A and its major food sources among pregnant women is scarce in Bangladesh. A study conducted in 2008 showed that the median daily intake of vitamin A in pregnant women was 732.5 μg Retinol Activity Equivalent (RAE) [6]. The study also found that the major portion of the dietary vitamin A came from plant sources (515 μg RAE/day) compared to animal sources (112.5 μg RAE/day). Hasan et al. reported a very low (35% of RDA)mean intake of vitamin A in pregnant women in Bangladesh [28]. However, to our knowledge, no study has been conducted to date to identify the major food items contributing most to the vitamin A requirement of Bangladeshi rural pregnant women. Henceforth, the purpose of the current study was to estimate the recent dietary intake of vitamin A among pregnant women as well as the contribution of beta carotene and retinol to dietary vitamin A intake with the exploration of the major food sources of vitamin A intake. This information will help policymakers and public health practitioners to promote these foods to ensure vitamin A adequacy among pregnant women.

2. Materials and methods

2.1. Study design and participants

This cross-sectional study was conducted as a part of the post-implementation impact evaluation of a large-scale social behavior change communication (SBCC) project aimed at improving dietary diversity among pregnant women. The project was implemented by the international nonprofit organization FHI 360 (former Family Health International) and supported by the US Agency for International Development (USAID). The SBCC intervention is described previously [29]. In the present study, 1012 pregnant women from 4 sub-districts located near the intervention sub-districts in the South-West region of Bangladesh with socioeconomic similarities to the intervention areas were selected to serve as "controls" where no intervention was delivered. Data were collected from the control area between December 2015 and April 2016. A two-stage cluster random sampling procedure was applied. In the first stage, 32 to 33 villages were randomly selected from each sub-district, totaling 130 villages. A village was considered as a cluster because, in the rural area, it was the smallest social and administrative unit and contained permanent human settlements [30]. A team consisting of 4 data collectors and 1 supervisor visited all the households of the selected villages to prepare a complete list of pregnant women residing in those villages. In the second stage, from each village, on average, 8 pregnant women were randomly selected from the list of all pregnant women.

2.2. Data collection tools and techniques

Data were collected electronically using tablets and Qualtrics Survey Software was used to design the questionnaire. As most pregnant women feel comfortable providing data to female interviewers in Bangladesh, only female interviewers were recruited for data collection and trained by the investigators before the data collection. A team of 4 data collectors and 1 supervisor collected data from all the selected villages.

2.3. Assessment of dietary vitamin A intake, retinol, and β-carotene

Dietary information was collected using a 24-h recall of the food items consumed in the past 24 h on the previous day of the survey. The trained interviewers collected detailed information on all foods and beverages consumed at home and away from home by each individual. Household oil, salt, and onion consumption were also recorded along with the total number of members who ate in the household during the previous day of the survey.

Dietary intakes of retinol, β-carotene, and RAE were calculated by using three food composition databases: Food Composition Tables for Bangladesh (FCTB) [31], Indian Food composition table [32], and Nutritive Value of Foods [33]. Since data regarding retinol, β-carotene, RAE and conversion factors of all foods were not available in only FCTB, the other two databases mentioned above were used to estimate the dietary vitamin A intake of the respondents by dietary analysis for the current study. It was found in a meta-analysis that β- carotene accounts for about 86% of provitamin A carotenoid intake in developed countries [34]. However, this 86% factor has also been used in a recent study to estimate the dietary vitamin A intake among Chinese adults [35]. Since such a factor is yet to be established for developing countries like Bangladesh, 86% contribution of β- carotene in provitamin A carotenoids intake was used in this study. Also, due to the paucity of analytical data on other carotenoids like α-carotene and β-cryptoxanthin in FCTB, only the β-carotene conversion factor was used during RAE calculation procedures.

Vitamin A intake (RAE) was calculated by using the following formula:

μg RAE = (μg retinol) + (μg β-carotene/12)

Individual food items were grouped into different food groups according to the classification of FCT for Bangladesh [31] and vegetables were classified as dark vegetables and light vegetables according to their carotene content [35] as follows:

Dark vegetables (DV): ≥500 μg β-carotene/100 g

Light vegetables (LV): <500 μg β-carotene/100 g

In this study, vegetables that were regarded as DV were carrot, pumpkin, green banana, onion stem (green), red amaranth, and other green leafy vegetables. Vegetables that were regarded as LV were beans, cucumber, green tomato, ripe tomato, cabbage, cauliflower, and green papaya.

2.4. *Sociodemographic variables*

Sociodemographic variables used in this analysis and their categorization is described in an earlier paper [36]. In summary, age, family size, pregnant women's (PW) educational status, PW's occupation, religion, trimester, husband's educational status, husband's occupation, food security status, dietary diversity category, and income level were used.

2.5. *Assessment of dietary diversity*

Women Dietary Diversity (WDD) was assessed based on Food and Agriculture Organization (FAO) where they considered nine major food groups: starchy staples, legumes and nuts, dairy, organ meat, eggs, flesh foods, vitamin A-rich dark green leafy vegetables (DGLVs), other vitamin A-rich fruits and vegetables, and other fruits and vegetables [37]. The detailed methodology of WDD assessment can be found in the study by Shamim et al. (2016) [36].

2.6. *Statistical analysis*

Statistical tools such as the Pearson chi-square test and other descriptive statistics like frequency, percentage, mean, standard

Table 1
Percent distribution of respondents by their Vitamin A intake category and sociodemographic characteristics.

Variables			Vitamin A intake (μg RAE/day)						*P*-value
			Below EAR (Less than 550 μg/day)		EAR to less than RDA (550 μg/day to less than 770 μg/day)		Above RDA (More than 770 μg/day)		
	N	%	N	%	N	%	N	%	
Total	1012	100.00	769	76	91	9	152	15	
Age (in years)									
Less than 19	206	20.4	161	20.90	18	19.80	27	17.90	.575
19 to 30	695	68.7	520	67.50	63	69.20	112	74.20	
31 to 50	111	11.0	89	11.60	10	11.00	12	7.90	
Family size									
3	340	33.6	269	34.90	23	25.30	48	31.80	.365
4 to 6	564	55.7	419	54.40	56	61.50	89	58.90	
7 to 8	108	10.7	82	10.60	12	13.20	14	9.30	
Trimester									
1^{st}	34	3.4	23	3.00	4	4.40	7	4.60	.781
2^{nd}	483	47.7	365	47.40	45	49.50	73	48.30	
3^{rd}	495	48.9	382	49.60	42	46.20	71	47.00	
Educational status									
Functionally illiterate	288	28.5	219	28.4	27	29.7	42	27.8	.982
Secondary incomplete	546	54	418	54.3	48	52.7	80	53.0	
Secondary complete	178	17.6	133	17.3	16	17.6	29	19.2	
Husband's occupation									
Daily wage earner	306	30.2	243	31.6	26	28.6	37	24.5	.154
Service holder or business	384	37.9	276	35.8	39	42.9	69	45.7	
Agriculture or other	322	31.8	251	32.6	26	28.6	45	29.8	
Food Security status									
Food secured	966	95.5	740	96.1	84	92.3	142	94.0	.172
Mild/moderately insecure	46	4.5	30	3.9	7	7.7	9	6.0	
Dietary Diversity									
Lower WDD (less than 5)	671	66.3	538	69.9	54	59.3	79	52.3	.000*
Higher WDD (equal or more than 5)	341	33.7	232	30.1	37	40.7	72	47.7	

N.B. RAE = Retinol Activity Equivalent, EAR = Estimated Average Requirement, RDA = Recommended Dietary Allowances, WDD= Women Dietary Diversity, *P*-value was obtained from Chi-square test, * significant association was found.

deviation (SD), and median were used for data analysis. A P-value less than 0.05 was considered indicating statistical significance at a 95% confidence interval. All statistical analysis was conducted using SPSS (version 20.0).

2.7. Ethical approval

Ethical approval for the study was obtained from the ethical review committee of the Center for Injury Prevention, Health Development and Research, Bangladesh (Memo No: CIPRB/ERC/2014/007). The respondents were interviewed only after they provided written informed consent. Participation was voluntary.

3. Results and discussion

3.1. Sociodemographic variables by vitamin A intake

Table 1 shows the percent distribution of respondents by their Vitamin A intake and sociodemographic characteristics. It showed that 76% of the respondents' vitamin A intake was below the estimated average requirement (EAR), which is less than 550 μg/day, 9% of the respondents met EAR but did not meet RDA (550 μg/day to less than 770 μg/day), and only 15% of the respondents' vitamin A intake was greater than or equal to RDA that is ≥ 770 μg/day. Saiful et al. (2022) [38] found that 89% of the respondents had below EAR vitamin A intake which is in line with current findings. Although their study samples were lactating women, the findings might be compared due to the paucity of recent data regarding the dietary intake of pregnant women in Bangladesh. It is seen here that vitamin A adequacy is about 24% among the respondents. A similar result was found in a study by Phuong et al. (2013) [39], where vitamin A adequacy was found among 20% of respondents. A contrasting result was found in a study among pregnant women in Ghana, where vitamin A adequacy was very high (85%) [40]. However, respondents' vitamin A intake was found to be significantly associated with only dietary diversity and was not associated with other factors such as age (in years), family size, trimester, educational status of the respondents, husbands' occupation, and food security status. This study solely focused on presenting the association between dietary diversity and vitamin A intake of the respondents. Detailed expression of dietary diversity was reported in a previous study conducted among the same respondents [36]. About 70% of the respondents whose vitamin A intake was below EAR was observed to have lower Women Dietary Diversity (WDD), about 59% of the respondents whose vitamin A intake was EAR to less than RDA had lower WDD, and the percentage was about 52% in case of respondents with vitamin A intake ≥ RDA. It was observed from the present study that dietary diversity was associated with vitamin A adequacy which was also shown in another study conducted among pregnant women in Bangladesh [36]

3.2. Contribution of β-carotene and retinol to vitamin A intake

Fig. 1 depicts the contribution of β-carotene and Retinol to daily vitamin A intake (μg RAE/day). It showed that the mean daily vitamin A intake of all the respondents (N = 1012) was about 391.85 μg RAE/day, which stands for about 51% of RDA. The mean

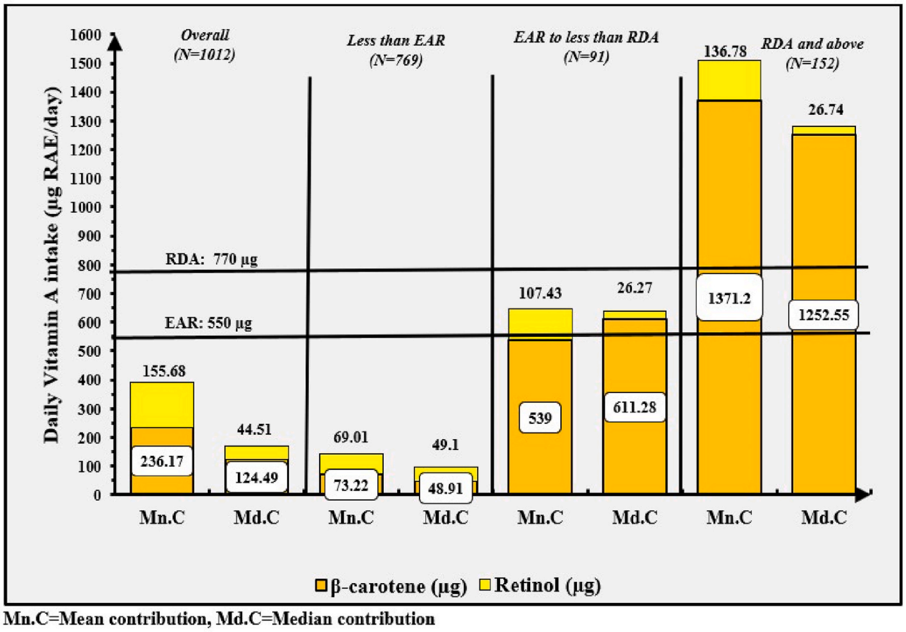

Fig. 1. Contribution of Beta-carotene and Retinol to daily Vitamin A intake (μg RAE/day) among pregnant women.

contribution of β-carotene to daily vitamin A intake was 60.27% (236.17 μg RAE), and the mean contribution of retinol was 39.73% (155.68 μg RAE). The median daily vitamin A intake was 169 μg RAE/day. A similar result (median intake of Vitamin A was 191 μg RAE) was also found by Phuong et al. (2018) [39]. In a previous study by Joanne et al. (2013), the median vitamin A intake was reported to be 143 μg RAE/day [41]. However, the median vitamin A daily intake was also very low (32.4 μg RAE) in a study conducted in the neighboring country India, compared with the current study [42]. A recent study by Saiful et al. (2022) found the median daily vitamin A intake to be 93.69 μg RAE among Bangladeshi lactating women [38]. The overall mean and median Vitamin A intake was lower than EAR in the current study. Such findings were also observed in a study of Chines pregnant women by Fang-li et al. (2015) [43], although their median intake was higher (328 μg RAE) than our results. The median contribution of β-carotene to daily vitamin A intake was about 73.66% (124.49 μg RAE) and the median contribution of retinol was 26.34% (44.51 μg RAE). The mean intake of daily vitamin A among the respondents with below EAR was about 142.23 μg RAE/day.

The mean contribution of β-carotene to daily vitamin A intake among the below EAR respondents was about 51.48% and the mean contribution of retinol to daily vitamin A intake was 48.52%. About 9% of respondents met the EAR but not RDA. Among them, the mean vitamin A intake was about 646.44 μg RAE/day and the median intake was about 637.55 μg RAE/day. The mean contribution of β-carotene to daily vitamin A intake among the EAR to less than RDA respondents was about 83.38% and the mean contribution of retinol to daily vitamin A intake among them was 16.62%. About 15% of respondents were found to meet the RDA of vitamin A intake and their mean daily intake of vitamin A was 1508 μg RAE/day and their median daily vitamin A intake was 1279.29 μg RAE/day. The mean contribution of β-carotene to daily vitamin A intake among these respondents was about 90.93% and the mean contribution of retinol to daily vitamin A intake among them was about 9.07%.

3.3. Contribution of food groups to beta-carotene intake

Table 2 illustrates the contribution of different food groups to daily β-carotene intake. It shows that among all the respondents, the major contributing food groups were dark vegetables, light vegetables, and tubers. These three food groups were also observed as the major β-carotene contributing groups among the respondents whose vitamin A intake was below the EAR. In the case of the other two groups of respondents, the main contributing food group was dark vegetables. Similar to the current study, vitamin A-rich vegetable consumption was also found in another study conducted on Bangladeshi women [41].

3.4. Contribution of food groups to daily retinol intake

Table 3 shows the contribution of different food groups to daily retinol intake. The major retinol-contributing food groups were fish, eggs, and milk among all respondents. In the case of the three groups of respondents, the major retinol-contributing food groups were fish, eggs, and milk. The other food groups which were less retinol contributing among the respondents were poultry, meat, and other groups.

3.5. Key food items to vitamin A intake

Table 4 shows the key food items contributing to daily carotene and retinol intake by three groups of respondents. The key foods' consumption percentage, percent contribution, and amount (gram) eaten during the previous 24 h of study are shown in the table. Food items whose consumption percentage was below 5% were not included in the table as key foods. The table demonstrates that the frequently consumed tubers, vegetables, and fruits among all the respondents were potato (73%), colocasia (33%), brinjal (21%), ripe tomatoes (12%), beans (12%), ripe banana (12%), apple (9%), jujube (9%), bitter gourd (8%), and cabbage (8%). Common retinol-contributing food items were; rui (carp) fish (42%), small fish (34%), eggs (25%), cow's milk (18%), and chicken (11%) as retinol-contributing food items. The disaggregated analysis in terms of major contributing foods to Beta carotene and retinol reveals that the major carotene-contributing foods were colocasia (31%), potato (12%), beans (5%), brinjal (5%), and ripe tomatoes (4%) and major retinol contributing foods were small fish (23%), rui (carp) fish (18%), cow's milk (11%) and chicken (6%).

In the case of respondents with below EAR vitamin A intake, the major carotene-contributing food items were brinjal (16%), potato (15%), beans (7%), colocasia (7%), and ripe tomatoes (6%); major retinol contributing food items were small fish (21%) rui (carp) fish (19%) cow's milk (12%). Major retinol-contributing food items were identical among the three groups of respondents (based on

Table 2
Contribution of food groups to daily beta-carotene intake.

Total (N = 1012)		Below EAR (N = 769)		EAR to less than RDA (N = 91)		Greater than or equal to RDA (N = 152)	
Food groups	Contribution (%)	Food groups	Contribution (%)	Food groups	Contribution (%)	Food groups	Contribution (%)
Dark vegetables	44	Light vegetables	30	Dark vegetables	95	Dark vegetables	97
Light vegetables	24	Dark vegetables	26	Light vegetables	2	Others	2
Tubers	12	Tubers	16	Fruits	2	Light vegetables	1
Others	8	Others	11	Others	1		
Fruits	6	Fruits	9				
Legumes	5	Legumes	7				
Cereals	1	Cereals	1				

Table 3
Contribution of food groups to daily Retinol intake.

Total (N = 1012)		Below EAR (N = 769)		EAR to less than RDA (N = 91)		Greater than or equal to RDA (N = 152)	
Food groups	Contribution (%)	Food groups	Contribution (%)	Food groups	Contribution (%)	Food groups	Contribution (%)
Fish	47	Fish	46	Fish	47	Fish	50
Eggs	23	Eggs	23	Eggs	22	Eggs	22
Milk	14	Milk	14	Milk	14	Milk	10
Poultry	9	Poultry	10	Others	11	Poultry	9
Others	5	Others	4	Poultry	5	Others	8
Meat	2	Meat	2	Meat	1	Meat	2

vitamin A intake). Concerning the upper two groups of respondents (meeting EAR but not RDA; RDA and above), the foremost carotene-contributing food items were colocasia and pumpkin. However, although the major retinol-contributing foods were all the same in the three groups of respondents, the amount of retinol-contributing food items consumed among the groups varied. The consumed amount of small fish was found higher in the top group (RDA and above), rui (carp) consumption (amount) was found higher in the medium group (EAR not RDA), whereas cow's milk consumption (amount) was higher among the lowest group (less than EAR).

On the other hand, the most commonly consumed carotene-contributing food was colocasia, and the amount of colocasia consumed also varied between the groups: about 7 gm in the lowest group, 75 gm in the medium group, and 181 gm in the top group. Though pumpkin was not a carotene-contributing commonly consumed food in the lowest group, the consumed amounts were higher in the top group (49 gm) than in the medium group (12 gm).

The present study explored the dietary intake and the sources of vitamin A among rural pregnant women from the South-West region of Bangladesh. Individual contribution of β-carotene and retinol to daily dietary intake of vitamin A was also analyzed. It was observed that vitamin A intake among the participants was 391.85 μg RAE/day, which was only 51% of the RDA. An earlier study in Bangladesh, however, reported the vitamin A intake of pregnant women as 35% of RDA [28]. On the contrary, pregnant women of all Latin American Countries (Mexico, the Caribbean, and South/Central America) were found with above EAR vitamin A dietary intake [44]. We also observed that the intake of vitamin A among rural pregnant women of Bangladesh differs significantly with their dietary diversity, as shown in Table 1. The contribution of β-carotene and retinol to their daily dietary vitamin A intake was analyzed. It was observed that vitamin A intake among all the rural pregnant women was very low in compliance with the RDA, only 391.85 μg RAE/day, and the contributions of β-carotene and retinol to the daily dietary intake of vitamin A were 61% and 39% respectively, which might be said to be expected for pregnant women of Bangladesh based on the findings of Sun Eun et al. (2012) where they concluded that plant-based diets were a common feature of the diet of pregnant women of developing countries [44]. However, a similar result was found in a recent study involving lactating women of Bangladesh conducted on a national survey data by Saiful et al. (2022) [38]. They also found that fruits and vegetables (rich in provitamin A β-carotene) contribute 55% of vitamin A intake, and meat, fish, eggs, and dairy (retinol rich) contribute about 39% of vitamin A intake among the respondents.

By dividing the population into three groups based on their vitamin A intake, it was observed that the respondents with vitamin A intake less than EAR took only 144 μg RAE/day, and about 76% of respondents had inadequate vitamin A intake. Hence, vitamin A adequacy was seen among only 24% of the respondents (meeting EAR and Meeting RDA). β-carotene and retinol contributed almost equally to vitamin A intake in this group. In the case of the other two groups of respondents with higher vitamin A intake, the contribution of β-carotene was much higher than retinol. This finding demonstrated that the consumption of plant sources and their contribution towards vitamin A intake in pregnant women was higher than that of animal sources. A similar finding was reported by Faruk Ahmed et al. in 2008 that the major contribution to the vitamin A intake of pregnant women was from the plant sources (515 μg RAE) in comparison with animal sources (112.5 μg RAE) [6].

The major dietary contributors of β-carotene and retinol intake among the respondents were also identified. Dark vegetables, light vegetables, and tubers constituted the major food groups that contributed to the β-carotene intake. However, among the two groups (EAR to less than RDA; RDA and above), dark vegetables were the predominant contributors of β-carotene. The major retinol-contributing food groups were fish, eggs, and milk.

Since the respondents belonged to rural settings, it can be anticipated that their consumption of these food groups was sourced back to their domestic livestock production and accessibility to small fish at a low price. We observed that small fish contributed the most among all the retinol-contributing food items. This finding is supported by several earlier studies reporting small fish as a significant source of vitamin A in the diet of the rural Bangladeshi population [45,46]. Interestingly, despite not being a rich source (25 μg/100 g of β carotene) [31], the potato was identified in our study as a significant dietary contributor to vitamin A because of the higher proportion of respondents (72.5%) ate potato, and compared to other foods, had eaten it at a greater amount (92.6 g/day).

Strengths and limitations: Present research did not collect biochemical data to show the prevalence of vitamin A deficiency. However, research conducted in Bangladesh pointed to a higher prevalence of inadequate micronutrient status, including vitamin A, in pregnant women [47]. Nevertheless, the current study included a large number of pregnant women and reported their intake as well as food sources of this micronutrient.

4. Conclusion

The present study concludes that dietary vitamin A intake is insufficient among pregnant women in Bangladesh's southwest region. Hence, they are at a greater risk of adverse materno-fetal health implications of vitamin A deficiency. It was found that major carotene-

Table 4
Key food items to daily Vitamin A intake.

Overall (N = 1012)				Not meeting EAR (N = 769)				Meeting EAR but not RDA (N = 91)				Meeting RDA (N = 152)			
								Carotene							
Name of foods (Percent consumed)	Percent contribution	Amount consumed in gram		Name of foods (Percent consumed)	Percent contribution	Amount consumed in gram		Name of foods (Percent consumed)	Percent contribution	Amount consumed in gram		Name of foods (Percent consumed)	Percent contribution	Amount consumed in gram	
		Mean	SD			Mean	SD			Mean	SD			Mean	SD
Potato (72.5)	11.56	92.64	121.43	**Potato** (76.5)	15.24	99.00	124.62	**Colocasia** (80.2)	74.90	74.51	41.11	**Colocasia** (83)	75.58	180.59	136.17
Colocasia (32.5)	30.87	38.87	84.01	**Brinjal** (22.9)	16.33	32.37	91.21	**Brinjal** (20.9)	0.21	27.77	76.40	**Potato** (57.2)	0.19	72.85	116.16
Brinjal (21.2)	4.68	30.82	90.91	**Colocasia** (16.8)	6.78	6.63	16.79	**Pumpkin** (13.2)	11.87	11.94	31.46	**Pumpkin** (22.4)	17.66	49.09	105.02
Ripe tomatoes (12.2)	4.25	11.89	46.88	**Ripe tomatoes** (13.4)	5.54	13.46	50.11	**Apple** (11.0)	0.03	6.45	23.71	**Brinjal** (12.5)	0.21	24.81	97.42
Bean (11.7)	5.31	6.99	30.51	**Bean** (13.4)	6.79	8.13	33.81	**Bean** (9.0)	0.45	4.46	16.99	**Ripe banana** (10.5)	0.02	12.03	37.04
Ripe banana (11.6)	0.85	13.92	44.00	**Ripe banana** (12.4)	1.17	14.87	46.01	**Cabbage** (9.0)	0.10	11.98	48.08	**Ripe tomatoes** (9.2)	0.11	6.81	29.13
Apple (9.1)	0.86	7.89	34.73	**Jujube** (9.6)	0.66	4.32	16.24	**Ladies' finger** (9.0)	0.39	16.46	63.49	**Bitter gourd** (8.6)	0.11	5.04	18.68
Jujube (8.7)	0.51	4.07	16.46	**Apple** (9.1)	1.13	8.38	36.11	**Bitter gourd** (8.80)	0.28	6.76	27.65	**Apple** (7.9)	0.02	6.26	33.24
Bitter gourd (8.4)	2.82	6.08	27.09	**Bitter gourd** (9.0)	3.66	6.20	28.42	**Ripe banana** (6.6)	0.03	8.95	36.66	**Jujube** (6.6)	0.01	3.86	19.99
Cabbage (7.7)	1.87	10.53	48.62	**Cabbage** (9.0)	2.45	11.21	49.51	**Ripe tomatoes** (6.6)	0.18	7.41	41.83	**Bean** (5.3)	0.37	2.76	14.83
								Retinol							
Rui (carp) (42)	17.52	30.28	43.08	**Rui** (carp) (44.4)	18.67	31.64	42.93	**Rui** (carp) (41.8)	16.54	33.62	50.81	**Smallfish** (41.4)	28.48	46.36	82.14
Smallfish (34.3)	22.54	33.71	76.09	**Smallfish** (33)	21.31	31.14	70.42	**Smallfish** (33)	22.98	34.31	105.26	**Rui** (carp) (32.2)	12.26	21.37	37.65
Hen's Egg (25.4)	0.74	16.31	31.63	**Hen's Egg** (26.4)	0.63	16.50	31.12	**Hen's Egg** (22)	1.91	13.41	28.16	**Hen's Egg** (22.4)	0.58	17.09	36.00
Cow's milk (18.4)	11.42	47.37	109.31	**Cow's milk** (19)	12.13	48.78	110.29	**Cow's milk** (18.7)	11.38	45.01	100.85	**Cow's milk** (15.4)	7.83	41.61	109.71
Chicken (10.7)	6.19	10.28	34.70	**Chicken** (11.6)	6.72	11.03	34.91	**Silver carp** (9.9)	0.0	7.41	23.60	**Silver carp** (11.25)	0.0	10.25	37.18

contributing food items were colocasia, potato, beans, brinjal, and ripe tomatoes, and major retinol-contributing foods were small fish, rui (carp) fish, cow's milk, and chicken. However, the study does not include a large enough sample size to represent the national picture. Further research is recommended with a large and nationally representative sample size to elucidate the association between vitamin A intake pattern and deficiency at clinical and sub-clinical levels among pregnant women of Bangladesh. In a previous trial from Bangladesh, it was reported that multiple micronutrient supplementation containing vitamin A failed to eliminate the vitamin A inadequacy of pregnant women [48], emphasizing the importance of undertaking multiple approaches such as dietary diversification and food fortification along with supplementation [49]. So, the program managers and policymakers should promote the foods contributing to vitamin A intake of the rural pregnant women of Bangladesh.

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Declaration of competing interest

The authors declare that there was no conflict of interest.

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