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# Role of Agriculture for Choline Intake by Pregnant Women in Bangladesh

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**Abstract**

This study was conducted to draw linkage between intake pattern of Choline and nutritional status of pregnant women in 3rd trimester and assess the contribution of agriculture retrospectively to increase its intake. Retrospective data was therefore, collected from United States Development Agency (USDA) data base on Choline content of common vegetable products of Bangladesh. Recommended Choline intake for the pregnant women in 3rd trimester is 450mg/day. The present study conducted using 24 hours recall method revealed that average Choline intake among the study respondents was 317 mg/day which meet 71 percent of the requirement. Majority (72.7%) of the women took Choline below the recommended level (450 mg/day). It is remarkable that 56.7, 55.3 and 52.0% of the pregnant women were deficient in calorie, protein and fat intake respectively. This study found that 54% respondents' mothers were within normal Body Mass Index (BMI) while 33% were overweight, 5.3% were underweight and 8.0% were obese. Choline intake status was poor among the pregnant women commencing delivery complication and indicating high prevalence of mental retardation for newborn.

***Keywords:*** Choline intake, Pregnancy, 3rd trimester, choline in vegetable, pregnant women.

## 1. Introduction

Choline is a water-soluble essential nutrient (Blusztain *et al*., 2012). It is usually grouped within the vitamin B-complex and must be consumed through diet to remain healthy (Hollenbeck, 2012). Choline plays a significant role during pregnancy to reduce the negative effect of mother's stress on child health promoting fetal growth (Zeisel, 2013), proper brain (Craciunescu *et al*., 2003; Zeisel, 2004) and memory function (Wong-Goodrich *et al.*, 2008) and learning capabilities (Coreyann *et al*., 2011) with a guard for future health of child. Choline deficient diet during pregnancy adversely affects immunity, growth, cognitive development and causes apathy. Its deficiency also responsible for increased risk of complications during delivery, including prolonged labor, preterm delivery, preeclampsia, prematurity, neural tube defects (Gary *et al*., 2004), very low birth weight (Vollset *et al*., 2000)and maternal and neonatal death. Benefits to improve the Choline status through regular diet include increased immunity and lower morbidity from infectious diseases, improved physical work capacity, improved memory and cognitive development, (Boeke *et al*., 2013) and better educational achievement.

Animal products generally contain more choline per unit weight than plants. Eggs, beef, chicken, fish, and milk as well as selected plant foods like cruciferous vegetables and certain beans are particularly good sources of choline providing at least 10 percent of the daily requirement per servings, (Coreyann *et al*., 2011).Malnutrition among the rural Bangladeshi women of reproductive age is still very high (Abul *et al*. 2010). The report further states that a total of 34% of the reproductive aged rural women suffer from malnutrition. For the interest of healthy fetus and to avoid any complication during delivery it is important to take sufficient amount of choline during pregnancy. Therefore pregnant mothers should be advised to take more choline rich food those are produced locally. A large number of choline rich vegetables are available in local market of Bangladesh and are comparatively inexpensive.

The purpose of this report is to develop a linkage between dietary choline intake patterns among women at their 3rd trimester of pregnancy and identify common cost effective vegetable and vegetable products of Bangladesh to improve dietary intake of choline.

## 2. Materials and Methods

A cross-sectional study was conducted at Sir Salimullah Medical College and Hospital, Dhaka during 1st January to 30th April 2014. A total of 150 pregnant women at their 3rd trimester those received Ante Natal Care (ANC) at Sir Salimullah Medical College and Hospital were selected purposively for determining their dietary intake pattern and nutritional status by using anthropometric indicators.

### *2.1 Data a collection instruments*

Structured questionnaires were designed for collection of data on (i) the socio-demographic condition (ii) the dietary intake and (iii) anthropometric measurement. The questionnaires were pretested, modified as needed and standardized prior to conducting the field work. Age, level of education and stage of pregnancy were recorded. For assessing dietary pattern of the pregnant women, 24 hours recall method was used. For measuring anthropometric parameters standardized height, weight scales and Measuring Arm Circumference (MAC) tape were used.

Data processing was done by field editing, coding and data entry. Food consumption data at individual level were converted into raw weight of edible part by using conversion factors and were coded according to given food code. Software wire for Statistical Package for Social Services (SPSS), was used for data analysis. Frequency distribution for all the variables were worked out and produced in tabular form. Outputs of data were transferred into Epi Info, a public domain statistical software for epidemiology developed by Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia (USA). Currently Epi Info is available for Microsoft Windows. The program allows for electronic survey creation, data entry, and analysis. Analytic routines include t-tests, ANOVA, nonparametric statistics, cross tabulations and stratification with estimates of odds ratios, risk ratios, and risk differences, logistic regression, survival analysis and analysis of complex survey data (Wikipedia). We used Epi Info to calculate Chi-square value, Odds ratio and Relative risk. Difference between average Choline intake of the pregnant women by their educational level and difference between average intakes of Choline by their Body Mass Index (BMI) were also calculated.

### *2.2 Nutritional requirements for pregnant women*

The consumption pattern of the pregnant women was measured by 24 hours dietary recall methods. Original weight, dressed weight, boiled weight, cooked weight, fried weight and weight of edible part of the same food item were noted. Weighing scale, standard cup, pot and spoon were used for dietary survey. Weight of different states of food items were converted in gram. Weight of edible part of food items were estimated by using conversion factors. Nutrients value of food items were calculated by using standard conversion factors (Ali *et al.*, 1991,).

Chi-square test, odds ratio (OR), relative risk (RR) and correlation coefficient was done to find out the degree of relationship among groups and variables. Multiple rage tests and mean test were done to find out degree of significance and compare between groups.

According to USDA database cauliflower, peas, broccoli, corn, cabbage mushroom, beans, tomato, sweet potato, spinach, potato, radish, cucumber contains comparatively high contents of choline (Table 1). Some nut products like nuts almonds, seeds, sunflower seeds, pea nuts, hazel nuts also contain high percentage of choline contents.

## 3. Results and Discussion

Choline plays an important role in fetal and infant brain development improving the areas of the brain responsible for memory and life-long learning ability (Zeisel, 2000). High choline intake during pregnancy helps to decrease the baby's levels of cortisol, which is widely known as the "stress hormone." Thus high choline intake may help reduce the impact of a pregnant mother's stress on the baby's developing brain, nervous system, and metabolism (Zeisel, 2006). Therefore a balanced diet throughout the pregnancy could be effective to control nutrition & health related complications promising better delivery of a healthy newborn. Table 2 of this study demonstrates that only 27.3% respondents receive recommended amount of choline. Further analysis shows that (Figure 1) above 19% of the respondent could eat one third of the recommended amount of choline during their pregnancy. Table 2 further reveals that about half of the respondents could not meet recommended daily allowance of carbohydrate (48%), protein (55.3%), and fat (52%) through their daily food intake, whereas average carbohydrate, protein and fat intake was 102.%, 99.1% and 97.3% of the requirement respectively.

**Table 1.** USDA Database for the Choline Content of Common Bangladeshi vegetables. Adopted from USA database (Agriculture Research service, U.S. Department of Agriculture; 2010)

| Description of vegetables | Total Choline Value of vegetables (mg/100g) |
|---|---|
| Beans, snap, green, frozen, cooked, boiled, drained without salt | 14.0 |
| Beets, canned, drained solids | 7.5 |
| Broccoli raab, raw | 18.0 |
| Broccoli, cooked, boiled, drained, without salt | 40.0 |
| Broccoli, raab, cooked | 34.0 |
| Cabbage, cooked, boiled, drained, without salt | 20.0 |
| Carrots, cooked, boiled, drained, without salt | 8.8 |
| Cauliflower, cooked, boiled, drained without salt | 39.0 |
| Corn, sweet yellow, frozen, kernels cut of cob, boiled, drained, without salt | 22.0 |
| Cucumber, with peel, raw | 6.0 |
| Cucumber, peeled, raw | 5.7 |
| Mushrooms, raw | 17.0 |
| Onions, raw | 6.1 |
| Peas, green, frozen, cooked, boiled, drained without salt | 28 |
| Pickles, cucumber, dill or kosher dill | 3.4 |
| Potatoes, french fried, frozen, home prepared, heated in oven without salt | 24.0 |
| Radishes, raw | 6.5 |
| Spinach, frozen, chopped or leaf, cooked, boiled, drained, without salt | 25.0 |
| Sweet potato, cooked, without salt | 13.0 |
| Tomato products, canned, paste, | 39.0 |

**Table 2**. Distribution of respondents according to their recommended daily allowance of food intake

| Nutrients | Situation | Number of respondents | Percent |
|---|---|---|---|
| Carbohydrate (gm) | Could not meet RDA | 72 | 48.0 |
| | Could meet RDA | 78 | 52.0 |
| Protein (gm) | Could not meet RDA | 83 | 55.3 |
| | Could meet RDA | 67 | 44.7 |
| Fat (gm) | Could not meet RDA | 78 | 52.0 |
| | Could meet RDA | 72 | 48.0 |
| Choline (mg) | Could not meet RDA | 109 | 72.7 |
| | Could meet RDA | 41 | 27.3 |
| Calcium (mg) | Could not meet RDA | 57 | 38.0 |
| | Could meet RDA | 93 | 62.0 |
| Calorie (Kcal) | Could not meet RDA | 85 | 56.7 |
| | Could meet RDA | 65 | 43.3 |
| Iron (mg) | Could not meet RDA | 77 | 51.3 |
| | Could meet RDA | 73 | 48.7 |
| Vitamin A (I.U) | Could not meet RDA | 90 | 60.0 |
| | Could meet RDA | 60 | 40.0 |
| Thiamine (mg) | Could not meet RDA | 90 | 60.0 |
| | Could meet RDA | 60 | 40.0 |
| Riboflavin (mg) | Could not meet RDA | 94 | 62.7 |
| | Could meet RDA | 56 | 37.3 |
| Vitamin C (mg) | Could not meet RDA | 75 | 50.0 |
| | Could meet RDA | 75 | 50.0 |

Table 2 states that 60% of respondents could not meet recommended amount of vitamins, Vitamin – A (60%), Thiamin (60%), Riboflavin (62.7%), and Vitamin C (50%); whereas average vitamin intake was above 97% of requirement. The table 2 illustrates that 56.7% respondents could not meet required amount of calorie intake and above 72% could not meet recommended amount of Choline intake whereas average calorie and Choline intake were 92.99% and 71.05% of the requirement respectively. Sixty two percent (62%) of the respondents could meet the Recommended Daily Amount (RDA) of Calcium intake.

Average intake of Choline by pregnant women 118.14 mg/day, 256.65 mg/day, 397.32 mg/day and 529.18 were presented by the level of Body Mass Index (BMI) 16.00-18.49, 18.50-24.99, 25.00-29.99 and 30.00-34.99 respectively. Analysis of variance showed the average intake of Choline by BMI was not homogenous (F-value=34.85, P=0.000). Figure 2 shows linear relationship between choline intake and BMI of respondents and positively significant correlation (r=0.658, p=0.000) was found between average choline intake of the pregnant women and their Body Mass Index (BMI).In 1998, Choline was classified as an essential nutrient by the Food and Nutrition Board of the Institute of Medicine, (USA CholineInfo.org. Retrieved 6 January 2012). In 1975, scientists discovered that the administration of Choline increases the synthesis and release of acetylcholine by neurons. The study also observed that pregnancy is a time when the body's demand for Choline is the highest. Choline is particularly used to support the fetus's developing nervous system (Leslie *et al.*, 2010).

Another study reported that higher dietary intake of choline shortly before and after conception was associated with a lower risk of neural tube defects (Gary et. al., 2004). Research shows that choline may help prevent neural tube defects. Gary et al., 2004 compared women who get sufficient choline in their diets with the women who had low choline in diets during pregnancy and stated that women with low choline intake have four times higher risk of having babies with neural tube defects such as spina bifida. Our study found direct correlation between Choline intake and trends of Body Mass Index (BMI). Table 3 shows that average intake of Choline 118.14 mg/day, 256.65 mg/day, 397.32 mg/day and 529.18 were associated with the level of respondents BMI 16.00-18.49, 18.50-24.99, 25.00-29.99 and 30.00-34.99 respectively. The study also demonstrated tendency towards an increase nutritional status in pregnancy with an increase in the level of education.

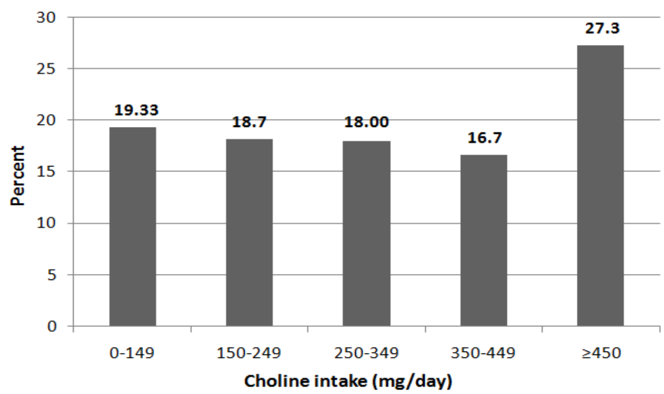


**Figure 1.** Distribution of respondents by choline intake

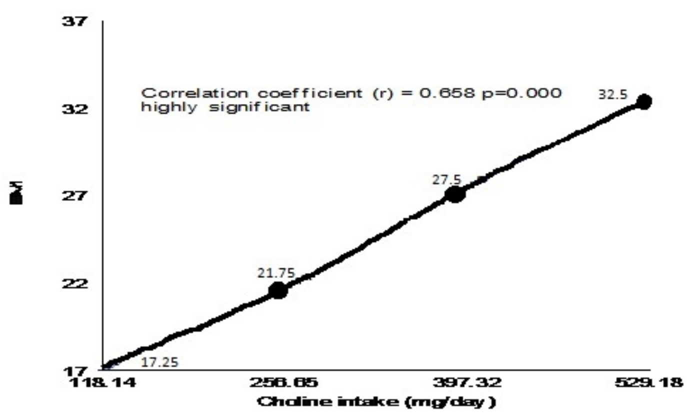


**Figure 2**. Linear relationship between choline intake and BMI

Table 4 shows that average choline intake increases with increased educational level of respondents. Analysis of variance showed the average intake of choline by educational level not homogenous (F-value = 22.997, P = 0.000). Table 5 further shows that Choline intake of pregnant mothers with secondary and graduate level of education was not significantly different. Choline intake of the respondents above graduate educational level were significantly higher when compared with the Choline intake by the respondents of educational level illiterate, primary, secondary and graduate, respectively.

The California Birth Defects Monitoring program identified an association between choline intake by pregnant mothers and Neural Tube Development (NTD) of their babies. The study found a significant lower risk of developing NTD among the mothers whose diets were in the 75$^{th}$ percentile of Choline, Betaine and Methionine compared to mothers, those diets were below the 25$^{th}$ percentile of recommended Choline intake (*Gary et al*., 2004).

The study suggested that getting at least 290 mg/day of Choline, as well as plenty of betaine and methionine, possibly reduces the risk of having a baby with a Neural Tube Development (NTD). In this connection it may be mentioned that based on study report of the University of North Carolina (UNC), Chape Hill (Zeisel *et al*., 1991), the Institute of Medicine (IOM) created an adequate intake of 550 mg/day Choline for men and 425 mg/day Choline for women (7mg/day/kg body weight).

**Table 3.** Average choline intake of the pregnant women by their BMI

| Level of BMI | N | Mean Choline intake | Std. Deviation | Anova | |
|---|---|---|---|---|---|
| | | | | F-test | Sig. |
| 16.00-18.49 | 8 | 118.14 | 32.33 | | |
| 18.50-24.99 | 81 | 256.65 | 119.44 | | |
| 25.00-29.99 | 49 | 397.32 | 132.59 | 34.85* | 0.000 |
| 30.00-34.99 | 12 | 529.18 | 78.03 | | |
| Total | 150 | 317.02 | 153.34 | | |

* Significant

Table 3 shows that average intake of Choline 118.14 mg/day, 256.65 mg/day, 397.32 mg/day and 529.18 were associated with the level of respondents BMI 16.00-18.49, 18.50-24.99, 25.00-29.99 and 30.00-34.99 respectively. Analysis of variance showed the average intake of Choline by BMI was not homogenous (F-value=34.85, P=0.000).

**Table 4.** Average Choline intake of the pregnant women by their educational level

| Level of education | N | Mean Choline intake (unit) | Std. Deviation | ANOVA | |
|---|---|---|---|---|---|
| | | | | F-test | Sig. |
| Illiterate | 17 | 175 | 84.71 | | |
| Primary | 58 | 258 | 114.56 | | |
| Secondary | 44 | 350 | 138.95 | 22.997 | 0.000 |
| Graduate | 23 | 411 | 137.21 | | |
| Above graduate | 8 | 584 | 79.55 | | |

**Table 5.** Multiple comparisons of choline intake of the pregnant women by their educational level

| (I) Group | (J) Group | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|
| Illiterate | Primary | -83.46* | 33.59 | 0.014 |
| | Secondary | -175.54* | 34.78 | 0.000 |
| | Graduate | -236.11* | 38.96 | 0.000 |
| | Above graduate | -409.00* | 52.22 | 0.000 |
| Primary | Secondary | -92.08* | 24.35 | 0.000 |
| | Graduate | -152.65* | 30.01 | 0.000 |
| | Above graduate | -325.54* | 45.94 | 0.000 |
| Secondary | Graduate | -60.57 | 31.34 | 0.055 |
| | Above graduate | -233.46* | 46.82 | 0.000 |
| | Above graduate | -172.88* | 50.00 | 0.001 |

* The mean difference is significant at the 0.05 level.

Vicki Contie reported in his article that pregnant women who are deficient in choline may have babies with reduced blood vessel growth in the brain. Author further stated that fewer than 15 percent of pregnant women consume enough choline in their diets (Vicki, 2010). The overall study results showed that, most of the pregnant women at their 3rd trimester did not fulfill the recommended level of Choline (450 mg/day), while Choline is an important micronutrient for proper development of baby and newborn. The study further reveals that Majority of the subjects could not meet the Recommended Daily Amount (RDA) of calorie, protein, fat, minerals and vitamins.

Every parent wishes a healthy newborn. Choline in the diet of the pregnant mother and the infant is directly related to permanent changes in brain function. Without enough choline during the critical time of brain growth and development, intelligence, memory, and possibly mood regulation damaged permanently (Zeisel, 2006). In Bangladesh pregnant women suffer from Choline and other nutrients deficiency due to ignorance of nutrient contents of locally available low cost foods. Therefore if pregnant women are aware about importance of Choline and its health benefit for newborn children; mothers would initiate to increase choline intake during pregnancy.

According to USDA database there are many vegetables like Beans, Broccoli, cabbage, carrots, Cauliflower, Corn, Cucumber, Mushrooms, Onions, raw Peas, Pickles, Potatoes, Radish, Tomato, those are produced locally in Bangladesh and rich in choline contents. These choline rich vegetables are comparatively inexpensive. Creating awareness among mothers regarding importance of choline intake during pregnancy may be helpful to increase demand of those vegetables at community level. Simultaneously department of agriculture may encourage the farmers for choline rich vegetable production.

## 4. Conclusions

An important micro-nutrient like choline is missed out in majority (73.3%) maternal diet because of lack of awareness and availability. It is hoped that the study would be useful for health planners and doctors taking care of pregnant women. It is also urged that the department of agriculture should come forward to encourage the farmers for producing choline rich vegetables.

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