# Measuring the Caesarean Risk Factors in Bangladesh by Using Binary Logistic Regression Model

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## Abstract

Caesarean section (CS) has been on the rise worldwide and Bangladesh is no exception. In Bangladesh, the CS rate, which includes both institutional and community-based deliveries, has increased from about 3% in 2000 to about 24% in 2014. Rather than numerous impediments, cesarean conveyances are most basic among woman's however it is not clinically advocated. For enhancing the maternal wellbeing status, it is basic to decide the risk components of cesarean conveyance. The primary focal point of this examination is to research and recognize the cesarean risk factors in the entire territory of Bangladesh. For this investigation, we have gathered auxiliary information from the Bangladesh Demographic and Health Survey (BDHS) 2014. This dataset has one record for every eligible woman as defined by the household schedule. It contains 17864 data which is collected in the woman's questionnaire plus some variables from the household. For the examination, a chi-square test was performed to identify the significant association between conveyance type (cesarean/non-cesarean) and socio-demographic and

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financial factor's individual. A binary logistic regression was completed to recognize the most effective factors on cesarean conveyance. We found that 5 factors (i.e respondent age, respondent highest education level, husband's occupation, type of place of residence, wealth index) were measurably connected with conveyance type out of 13 chance elements. From this investigation, it is obvious to us that the above powerful factors may influences the mother's wellbeing status in Bangladesh.

# 1 Background of the Study

## 1.1 Introduction

Caesarean section (CS) is the most commonly performed surgical operation in the world. This surgery is lifesaving when performed in time to overcome certain types of dystocia and other complications. Over the last few years, caesarean delivery rates in South-Asian country increase annually for Bangladesh (1.19%), India (1.09%), Nepal (1.15%) and Pakistan (1.08%), Asia is 15.9%. China, Malaysia (15.7%).In Asia, Hong Kong and Lebanon present the highest rate, with estimates of 40.5%, 27.4% and 23.3%, respectively. Nepal and Cambodia's are lowest (1%), followed by Yemen (1.5%) [1,2,3].

The caesarean delivery rate is increasing day by day in most developing countries like Bangladesh. The World Health Organization recommends that a country should keep births through caesarean section below 15%, as it is a major operation that carries risks and takes a lot longer for a patient recover compared to a normal delivery [4,1]. Instead of some advantages of caesarean delivery, most of mothers and baby are sufferings from various health problems such as infection, haemorrhage, injury to organs, adhesions, reactions to medicine, maternal mortality rate, effects of future pregnancies, remove the uterus (hysterectomy) and premature birth, fetal injury, breathing problems respectively [5]. So, increasing C-section rate is one of the main concern in most of the countries in the world and now, it is identified as an emerging "global epidemic" [6,7].

Many studies were conducted about on this topic and many factors have been identified which are related to caesarean delivery but some factor was not included in the previous study. This study presents the most recent estimate of caesarean delivery in Bangladesh and identified some new factors which effect on the motivation of caesarean delivery by using data.

## 1.2 Literature review

Caesarean birth is influenced by a various factor such as maternal, socio-demographic, socio-economic and other relevant factors [4].

In the North region of Bangladesh, the most independent risk factors for caesarean deliveries are mother age, age at marriage and order of birth etc [8].

The increase in caesarean deliveries has been attributed to multiple factors ranging from maternal, socio-demographic, socio-economic and institutional factors. There are some common factors which are related to caesarean delivery such as maternal age at birth, the order of birth, baby birth weight, socioeconomic status, high levels of maternal education [9,10,11]. Age at marriage is also a significant cause of caesarean birth rates in the developing countries [8]. In the previous study maternal, socio-demographic, socio-economic factors, mother age, age at marriage and order of birth etc are the most influential factors are caesarean deliveries on the other hand in our study we try to find out some new most important caesarean risk factors in Bangladesh which are not conducted by the researcher in the past.

# 2 Methodology

## 2.1 Data collection system

For this study, collected secondary data from the Bangladesh Demographic and Health Survey (BDHS) 2014 for the whole of Bangladesh. After collecting data, information was arranged in tables and analyzed. The secondary data of this paper, the BDHS women's questionnaires were pretested and the men's questionnaire was pretested. For the pretest, male and female interviewers trained at the office of mitral and associates. Recruitment criteria include educational attainment, maturity, ability to spend one month in training and at least four months in the field, and experience in other surveys. Trainees whose performance was considered superior were selected as supervisors and field editors. Fieldwork for the BDHS was carried out by 12 interviewing teams. Each consisted of one male supervisor, one female field editor, five female interviewers, two male interviewers, and one logistics staff person, for a total of 120 field staff for the survey.

This study used computer package named R-3.2.5 Programming and SPSS 16.0 for data analysis purpose. Beside the other well-known package, MS Excel and MS Word were also used for analysis and writing the report.

## 2.2 Statistical equipment

After collecting data, information was organized in a table and analyzed using some statistical tools. In the beginning, some percentage distribution and graphical representation were presented to realize the scenario of caesarean delivery and its related factors. Categorical or nominal variables were analyzed by the Chi-square test or Fisher's exact test according to their suitability. Finally, binary logistic regression analysis was conducted to separate factors which are connected to caesarean delivery. Here, tolerable 5% level of significance was considered for each of the tests.

### 2.2.1 Chi-square Test

Chi-square test is a statistical test commonly used for testing independence and goodness of fit [12]. The independent test is applied when you have two categorical variables from a single population. Independence test is used to determine whether there is a significant association between the two variables and Goodness of fit test is used to determine whether observed frequency distribution matches the theoretical frequency distribution.

### 2.2.2 Binary logistic regression model

The logistic regression model is useful to find out the best fitting, reasonable model to establish the relationship between dependent variable or response variable (dichotomous) and set of explanatory or independent variable (dummy or categorical) [13]. Binary logistic regression estimates the probability that a characteristic is present (e.g. estimate probability of "success") given the values of explanatory variables. Probability of success will depend on levels of the risk factor.

For single variable the model can be defined as

$$prob(event) = \frac{1}{1+e^{-(\beta_0+\beta_1 x)}} \tag{1}$$

Where $\beta_0$ and $\beta_1$ are regression coefficients estimated from the data and $x$ is the independent variable. For more than one independent variable the model is

$$prob(event) = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2 \cdots\cdots\cdots \beta_p x_p)}} \tag{2}$$

The log-odds and odds ratio can be defined as

$$\ln\left(\frac{prob(event)}{prob(nonevent)}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \dots\dots\dots \beta_p x_p \tag{3}$$

$$Odds\ ratio = \frac{prob(event)}{prob(nonevent)} = e^{\beta_0} e^{\beta_1 x_1} \dots\dots\dots e^{\beta_p x_p} \tag{4}$$

Odds Ratio changes when the $i^{th}$ independent variable increases by one unit. If $\beta_i$ is positive then the Odds Ratio is increased which indicates that the probability of occurring an event is greater than the probability of occurring non-event. If $\beta_i$ is negative then odds Ratio are decreased.

## 3 Results and Discussion

### 3.1 Distribution of respondent's age in 5 years group

From the Table 1, we observe that the percentage of non-caesarean in the age interval "15-19" is higher among all other age interval and the percentage of caesarean delivery in the age interval "25-29" is higher among all another age interval. Here, we get generally ( $p = 0.003$ ) <0.05, so the variable (respondent age) is statistically associated with the delivery type and also get in categorically all of the p- values are statistically associated with the delivery type. That means respondent age effects on delivery type. The possibility of caesarean delivery of age group "15-19" is more than the age group "20-24" and the possibility of caesarean delivery of age group "15-19" is less than the age group "25-29". The others are interpreted in a similar way.

**Table 1. Distribution of the respondent's age in 5 years group**

| Variable | Delivery type | | | | P-value | | Odds ratio | 95% Confidence interval |
|---|---|---|---|---|---|---|---|---|
| | Non-caesarean Delivery | | Caesarean delivery | | Generally | Categorically | | |
| Age in 5-years group | n | % | N | % | | | | |
| "15-19" | 1496 | 73.94 | 527 | 26.05 | | | 1.00 | |
| "20-24" | 2333 | 73.80 | 828 | 26.19 | | 0.027* | 0.994 | [0.875,1.129] |
| "25-29" | 2340 | 69.99 | 1003 | 30.00 | | 0.002* | 1.221 | [1.078,1.384] |
| "30-34" | 2142 | 71.12 | 870 | 28.88 | 0.003* | 0.007* | 1.195 | [1.051,1.360] |
| "35-39" | 1665 | 71.15 | 675 | 28.84 | | 0.003* | 1.234 | [1.076,1.416] |
| "40-44" | 1525 | 70.28 | 645 | 29.72 | | 0.000* | 1.313 | [1.140,1.513] |
| "45-49" | 1234 | 71.03 | 580 | 28.97 | | 0.000* | 1.484 | [1.283,1.718] |

From the Fig. 1, we observe that those women whose age is between 15 to 19 years old, the percentage of non-caesarean are 73.94% and caesarean are 26.05%. Similarly, in aged 20 to 24 years old, non-caesarean are 73.80% and caesarean is 26.19%, age between 25 to 29 years old the percentage of non-caesarean is 69.99% and caesarean are 30.00%, Between 30 to 34 years and also 35 to 39 years old women are the same percentage of non-caesarean are 71.15% and caesarean is 28.84%, age between 40 to 44 years old the percentage of non-caesarean are 70.28% and Caesarean is 29.72%. At last the age between 45 to 49 years old, the percentage of non-caesarean are 71.03% and caesarean are 28.97%.
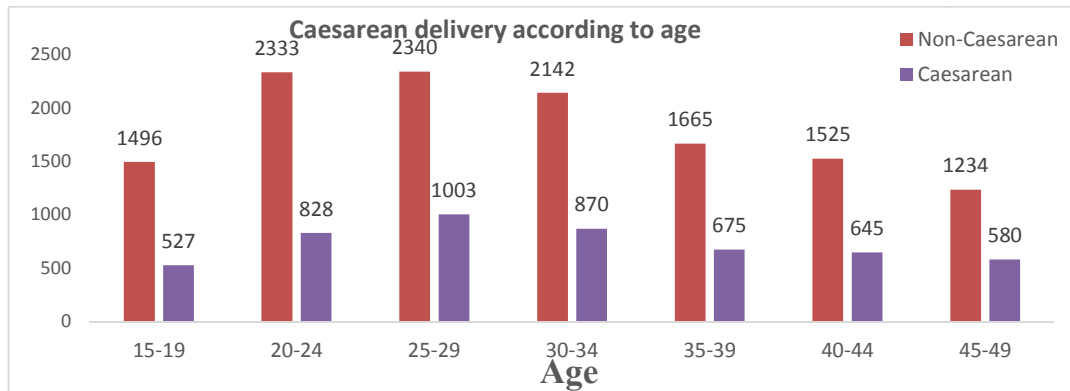
**Fig. 1. Bar diagram of caesarean delivery according to age**

**Table 2. Distribution of respondent's place of residence**

| Variable | Delivery type | | | | P-value | | Odds ratio | 95% Confidence interval |
|---|---|---|---|---|---|---|---|---|
| | Non-caesarean delivery | | Caesarean delivery | | Generally | Categorically | | |
| Type of place of residence | n | % | n | % | | | | |
| "Urban" | 4154 | 67.35 | 2013 | 32.64 | | | 1.00 | |
| "Rural" | 8581 | 73.37 | 3115 | 26.63 | 0.000* | 0.000* | 0.808* | [0.754,0.866] |

## 3.2 Distribution of respondent's place of residence

From the above Table 2, we observe that, the percentage of non-caesarean in the rural area is higher than the urban area and the percentage of caesarean delivery in rural area is lower than the urban area. Here, generally ( $p = 0.000$ ) <0.05, so the variable (place of residence) is statistically associated with the delivery type and also get in categorically all of the p- values are statistically associated with the delivery type. That means the place of residence effects on the delivery type. The possibility of caesarean delivery in an urban area is more than the rural area.
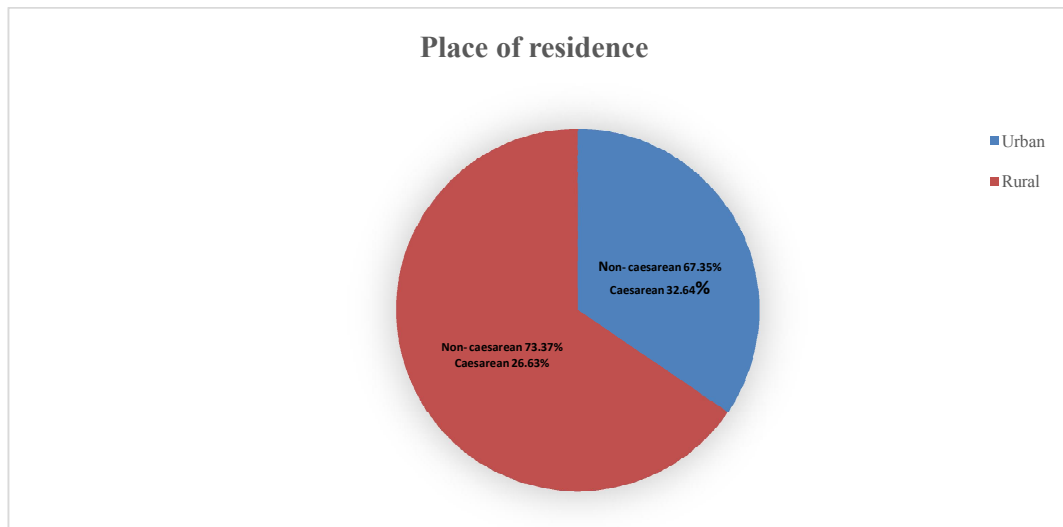


**Fig. 2. Pie chart of place of residence**

From the Fig. 2, we observe that in the rural area the percentage of non-caesarean are 73.37% and caesarean are 26.63%. In the urban area, the percentage of non-caesarean is 67.35% and caesarean are 32.64%.

### 3.3 Distribution of respondent's husband's occupation

From the Table 3, we observe that the percentage of non-caesarean which have farmer partners is higher among all others. Here, generally ($p = 0.000$) <0.05, so the variable (husband occupation) is statistically associated with the delivery type and also get in categorically all of the p- values are statistically associated with the delivery type. That means, respondent husband occupation effects on delivery type. The possibility of caesarean delivery of land owner's wife is more than the farmer's wife and the possibility of caesarean delivery of land owner's wife is less than the Doctor, lawyer, accountant, teacher, high-level service holder's wife. The others are interpreted in a similar way.

**Table 3. Distribution of respondent's husband's occupation**

| Variable | Delivery type | | | | P-value | | Odds ratio | 95% confidence Interval |
|---|---|---|---|---|---|---|---|---|
| | Non-caesarean delivery | | Caesarean delivery | | Generally | Categorically | | |
| **Husband occupation** | **n** | **%** | **n** | **%** | | | | |
| "Land owner" | 45 | 77.58 | 13 | 22.41 | | | 1.00 | |
| "Farmer" | 1965 | 72.53 | 744 | 27.46 | | 0.002* | 0.903* | [0.828,2.925] |
| "Agricultural worker" | 1252 | 74.39 | 431 | 25.60 | | 0.043* | 1.455 | [1.797,2.845] |
| "Fisherman" | 234 | 80.68 | 56 | 19.31 | | 0.045* | 1.024* | [0.527,2.103] |
| "Poultry raising, cattle raising" | 24 | 70.58 | 10 | 29.41 | | 0.049* | 1.571* | [0.589,4.125] |
| "Home-based manufacturing" | 29 | 59.37 | 13 | 30.95 | | 0.018* | 1.851* | [0.748,4.662] |
| "Rickshaw driver, brick breaking, construction worker" | 1456 | 76.91 | 437 | 23.08 | | 0.015* | 1.21* | [0.664,2.365] |
| "Domestic servant" | 13 | 68.42 | 6 | 31.57 | | 0.017* | 1.800* | [0.543,5.596] |
| "Factory worker, non-agricultural worker" | 1040 | 72.67 | 391 | 27.32 | | 0.028* | 1.406* | [0.469,2.746] |
| "Tailor, armed services, police man" | 2716 | 70.65 | 1128 | 29.34 | 0.000* | 0.037* | 1.457* | [0.805,2.828] |
| "Doctor, lawyer, accountant, teacher, nurse, high-level services" | 754 | 60.90 | 484 | 39.09 | | 0.032* | 1.755* | [0.985,3.439] |
| "Big businessman" | 360 | 67.28 | 175 | 32.71 | | 0.023* | 1.494* | [0.805,2.958] |
| "Small business/trader" | 2393 | 69.48 | 1051 | 30.51 | | 0.014* | 1.557* | [0.859,3.024] |
| "Unemployed/student" | 88 | 74.57 | 30 | 25.42 | | 0.009* | 1.215* | [0.858,2.627] |
| "Retired" | 30 | 73.17 | 11 | 26.82 | | 0.025* | 1.286* | [0.501,3.268] |
| "Others" | 288 | 70.58 | 120 | 29.41 | | 0.042* | 1.479* | [0.789,2.958] |
| "Don't know" | 14 | 66.66 | 7 | 33.33 | | 0.026* | 1.738* | [0.558,5.185] |

From the Fig. 3, we observe that those who are land owner the percentage of non-caesarean are 77.58% and caesarean are 22.41%. Similarly, for the farmer the percentage of non-caesarean are 72.53% and caesarean are 27.46% and the percentage of caesarean in other occupation calculated in similar way.
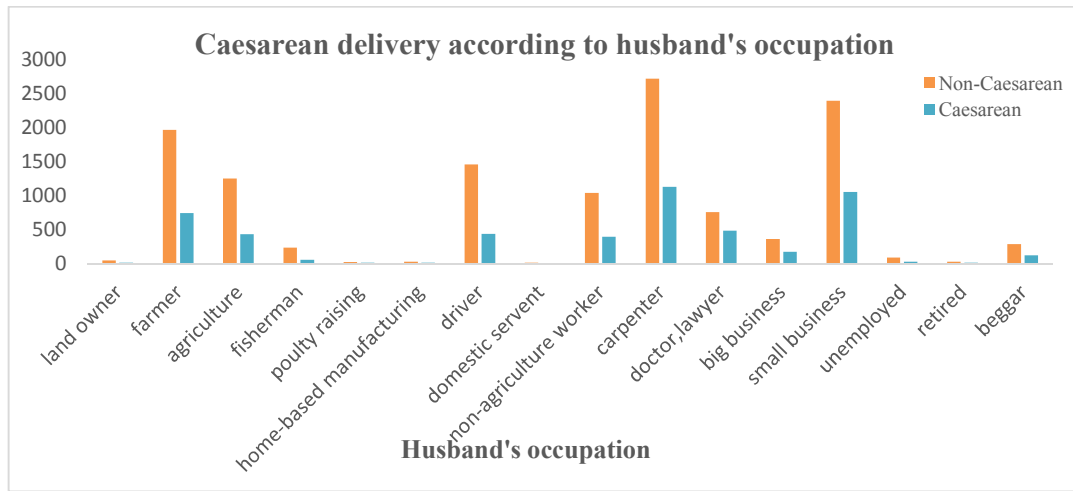
**Fig. 3. Bar diagram of respondent's husband occupation**

## 3.4 Distribution of respondent's highest education level

From the Table 4, we observe that the percentage of non-caesarean in the primary educational level is higher among all others. Here, generally ( $p = 0.000$ ) <0.05, so the variable (highest education level) is statistically associated with the delivery type and also get in categorically all of the p- values are statistically associated with the delivery type. That means, respondent highest education level effects on delivery type. The possibility of caesarean delivery in No education level is less than the primary education level. The others are interpreted in a similar way.

**Table 4. Distribution of respondent's highest education level**

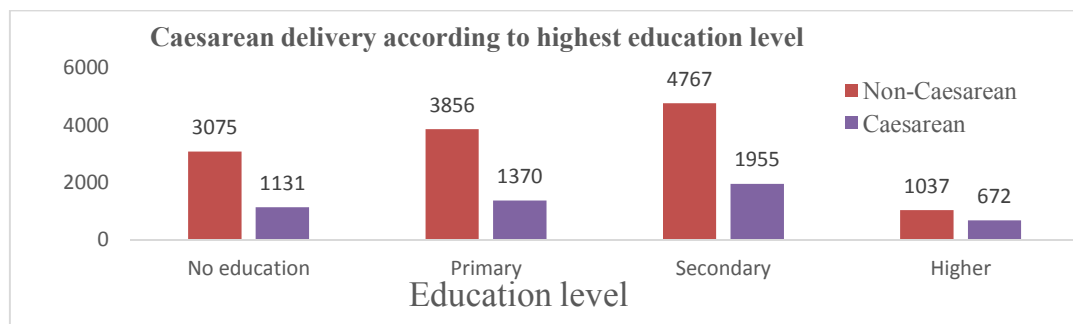| Variable | Delivery type | | | | P-value | | Odds ratio | 95% Confidence interval |
|---|---|---|---|---|---|---|---|---|
| | Non-Caesarean delivery | | Caesarean delivery | | Generally | Categorically | | |
| Highest education level | n | % | n | % | | | | |
| "No education" | 3075 | 73.10 | 1131 | 26.89 | | | 1.00 | |
| "Primary" | 3856 | 73.78 | 1370 | 26.21 | | 0.038* | 1.020* | [0.929,1.121] |
| "Secondary" | 4767 | 70.91 | 1955 | 29.08 | | 0.000* | 1.222* | [1.113,1.342] |
| "Higher" | 1037 | 60.67 | 672 | 39.32 | 0.000* | 0.000* | 1.809 | [1.596,0.052] |



**Fig. 4. Bar diagram of respondent's education level**

From the Fig. 4, we observe that those who are non-education, the percentage of non-caesarean are 73.10% and caesarean are 26.89%. Similarly, for primary education, the percentage of non-caesarean are 73.78% and caesarean are 26.21%. For secondary education, the percentage of non-caesarean is 70.91% and caesarean are 29.08%. Finally, for the higher education, the percentage of non-caesarean is 60.67% and the caesarean is 39.32%.

## 3.5 Distribution of respondent's religion

From the Table 5, we observe that the percentage of non-caesarean in Buddhism is higher among all other religion. Here, generally ( $p = 0.099$ ) >0.05, so the variable (religion) is not statistically associated with the delivery type and also get in categorically all of the p- values are not statistically associated with the delivery type. That means the respondent's religion doesn't effect on delivery type. The possibility of caesarean delivery of Muslim respondent is less than the Hinduism. The others are interpreted in a similar way.

**Table 5. Distribution of respondent's religion**

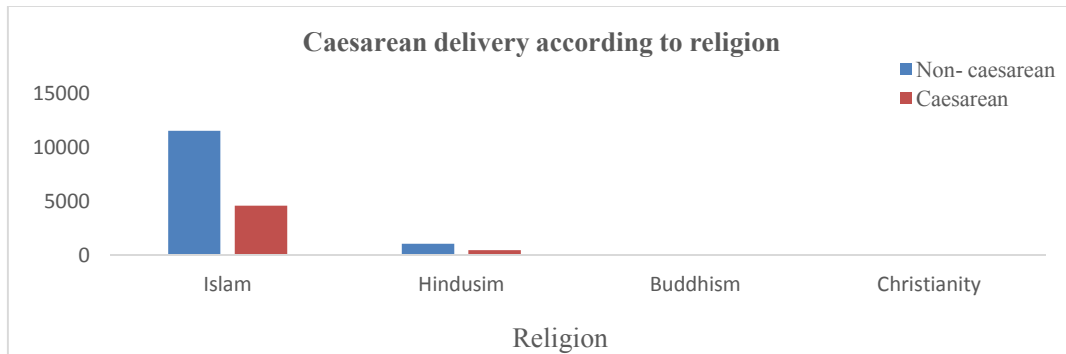| Variable | Delivery type | | | | P-value | | Odds ratio | 95% Confidence interval |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Non-caesarean delivery | | Caesarean delivery | | Generally | Categorically | | |
| Religion | n | % | n | % | | | | |
| "Islam" | 11532 | 71.47 | 4603 | 28.52 | | | 1.00 | |
| "Hinduism" | 1099 | 69.03 | 493 | 30.96 | | 0.154 | 1.129* | [1.008,1.262] |
| "Buddhism" | 7921 | 99.73 | 21 | 0.27 | | 0.117 | 6.871 | [0.413,1.0920] |
| "Christianity" | 3 | 21.42 | 11 | 78.57 | 0.099 | 0.864 | 1.254* | [0.528,2.558] |



**Fig. 5. Bar chart of respondent's religion**

From the Fig. 5, we observe that those are the religion of Islam, the percentage of non-caesarean are 71.47% and caesarean are 28.52%. Similarly, those are the religion of Hinduism, the percentage of non-caesarean are 69.03% and caesarean are 30.96% and the percentage of other religion calculated in similar way.

## 3.6 Distribution of respondent's wealth index

From the Table 6, we observe that the percentage of non-caesarean in the poorest level is higher among all others. Here, generally ( $p = 0.000$ ) <0.05, so the variable (wealth index) is statistically associated with the delivery type and also get in categorically all of the p- values are statistically associated with the delivery type. That means respondent wealth index effects on delivery type. The possibility of caesarean delivery of poorest women is less than the richest women. The others are interpreted in a similar way.

**Table 6. Distribution of respondent's wealth index**

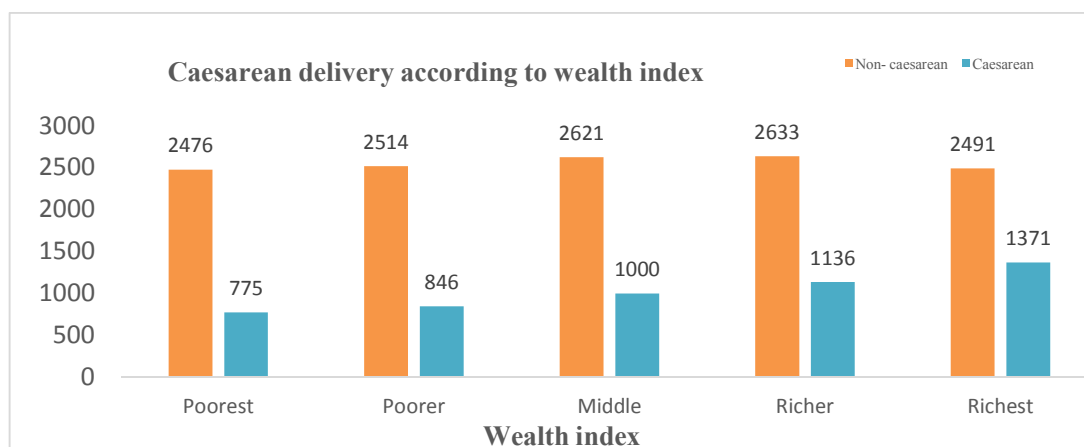| Variable | Delivery type | | | | P-value | | Odds ratio | 95% Confidence interval |
|---|---|---|---|---|---|---|---|---|
| | Non-caesarean delivery | | Caesarean delivery | | Generally | Categorically | | |
| Wealth index | n | % | n | % | | | | |
| "Poorest" | 2476 | 76.16 | 775 | 23.83 | | | 1.00 | |
| "Poorer" | 2514 | 74.82 | 846 | 25.17 | | 0.002* | 1.045* | [0.932,1.171] |
| "Middle" | 2621 | 72.38 | 1000 | 27.61 | | 0.015* | 1.152* | [1.029,1.291] |
| "Richer" | 2632 | 69.85 | 1136 | 30.14 | | 0.000* | 1.266* | [1.127,1.421] |
| "Richest" | 2491 | 64.50 | 1371 | 35.49 | 0.000* | 0.000* | 1.469* | [1.298,1.662] |



**Fig. 6. Bar diagram of respondent's wealth index**

From the Fig. 6, we observe that the poorest respondent's non-caesarean are 76.16% and caesarean are 23.83%. The poorer respondent's non-caesarean are 74.82% and caesarean is 25.17%. The middle respondent's non-caesarean are 72.38% and caesarean are 27.61%. Similarly, the richer respondent's non-caesarean are 69.84% and caesarean are 30.14% and the richest respondent's non-caesarean are 64.50% and caesarean are 35.49%.

# 4 Conclusion and Recommendation

## 4.1 Conclusion

Mothers in Bangladesh need to delay their first birth until their age is 24-29 years old. The rate of caesarean delivery in age 25-29 is higher and the lower rate belongs to age 15-19. The rate of caesarean delivery in the rural area is 26.63% and the urban area is 32.64%. In the family of a doctor, lawyer, accountant, the rate of caesarean delivery is 39.09%. The caesarean rate of higher education level is 39.32%. In the wealth index factor, the caesarean rate of the richest category is 35.49% which is high. Finally, we identified, the variables respondent age, respondent highest education level, husband's occupation, type of place of residence, wealth index are statistically associated with the delivery type. But the variable, respondent's religion is not statistically associated with the delivery type. In previous research, mother's age at birth, husband occupation, Pregnancy-induced swollen of the leg, mother's age, high blood pressure, the order of birth were the most influential factors of caesarean delivery. This evidence confirms our study and also we have found some new most influential factor's which were absent in the past study.

## 4.2 Recommendation

The following suggestions may be recommended in view of our observation:

- In this study, the rate of caesarean delivery is higher for the maternal whose age is (25 -29) years.
- Balanced and nutritional diet may be beneficial for pregnant women. For this purpose Govt. and non-Govt. organization should conduct healthcare programs.
- Increasing awareness of women on a suitable delivery type may influence the motive of caesarean delivery.
- Moreover, public awareness of harmful and long term effects of caesarean deliveries are needed to confirm a stable mother's health.

## Competing Interests

Authors have declared that no competing interests exist.

## References

[1]     Betran AP, Merialdi M, Lauer JA, Shun WB, Thamas J, Look PV, Wagner M. Rates of caesarean section: Analysis of global, regional and national estimates. Paediatric and Perinatal Epidemiology. 2007;21(2):98-113.

[2]     Ravindran J. Rising caesarean section rates in public hospitals in Malaysia 2006. Med J Malaysia. 2008;63(5):434–435.

[3]     BMMS. Bangladesh maternal mortality and health care survey 2010: Summary of key findings and implications, Dhaka, Bangladesh 1-12; 2010.

[4]     Gomes UA, Silva AA, Bettiol H, Barbieri MA. Risk factors for the increasing caesarean section rate in Southeast Brazil: A comparison of two birth cohorts, 1978–1979 and 1994. International Journal of Epidemiology. 1999;28(4):687-694.

[5]     Van Ham MA, Van Dongen PW, Mulder J. Maternal consequences of caesarean section. A retrospective study of intraoperative postoperative maternal complications of caesarean during a 10-year period. European Journal of Obstetrics & Gynecology and Reproductive Biology. 1997;74(1): 1-6.

[6]     Savage W. The caesarean section epidemic. Journal of Obstetrics & Gynecology. 2000;20:223-225.

[7]     World Health Organization. Appropriate technology for birth. Lancet. 1985;2:436-437.

[8]     Rahman M, Shariff AA, Saaid R, Shafie A. Age at marriage, maternal age and caesarean delivery of first birth in the northern region of Bangladesh: a study on curve estimation. Man in India. 2012; 92(1):93-113.

[9]     Kun H, Fangbiao T, Brian F, Joanna R, Rachel T, Shenglan T, et al. A mixed-method study of factors associated with differences in caesarean section rates at community level: The case of rural China. Midwifery. 2013;29(8):911-920.

[10]    Taffel SM. Caesarean delivery in the United States, 1990. Vital Health Statistics. 1994;51:1-24.

[11]    Tatar M, Gunalp S, Somunoglu S, Demirol A. Women's perceptions of caesarean section: Reflections from a Turkish teaching hospital. Social Science & Medicine. 2000;50:1227-1233.

[12] Jeremy A. Lauer, Ana P. Betrán. Determinants of caesarean section rates in developed countries: Supply, demand and opportunities for control; 2010.

[13] JP Souza, Betran AP. A global reference for caesarean section rates (C-Model): A multicountry cross-sectional study; 2015.