



Assessing the Factors Affecting Cesarean Section Selection in Iranian Women Using Multilevel Count Models with Excess Zeros

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Abstract

Background: Iran has ranked second in the frequency of cesarean delivery (CD) and this rate in 2014 has increased by 56 percent. The CD has multiple complications for the woman and newborn, and due to the women's readmission after surgery impose additional costs to the countries. Although CD has many complications and is not recommended by obstetrician and midwives; some factors affect the choice of this method of delivery.

Methods: We used data from the Iranian Institute for Health Sciences Research (IIHSR) in 2015. We studied the effects of factors such as socioeconomic and demographic factors and supplemental insurance status in the choice of CD. We used multilevel Zero-Inflated models for the modeling of data.

Results: The employed women resident in urban areas with the high-income and age greater than 34-yr old and supplemental insurance more likely chose CD. On the other hand, women with high education level, women who use at least one media (e.g. Radio, television, etc.) and women that use contraceptive methods have chosen the less CD.

Conclusion: Our findings highlighted the importance of supplemental insurance and socio-economic status in choosing a CD by women. However, in some cases especially in the rich class of society, the high cost of this type of delivery does not affect the choice decrease of it, and governments should adopt rigorous policies in using this method.

Keywords: Cesarean delivery; Vaginal delivery; Multilevel models; Zero-inflated

Introduction

The WHO has recommended the optimal rate for CD to be between 10-15% (1). The usages of CD has increased in worldwide various countries

(2-5). According to the WHO, an average of 25.7% of births in the world between 2004 and 2008 was performed by CD, that the lowest rate



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(19%) of use of CD in European countries and the highest rates (29.2%) of use in Latin American countries (2, 3). In 2000, the rate of CD in Iran had been 35 percent that this rate in 2014 has increased 56 percent and according to the WHO, Iran has ranked second in the frequency of CD(6).According to official statistics, 40% of cesareans in Iran were unnecessary and selective (7).

Several studies have been performed to assess the complications of delivery cesarean. Complications including post-cesarean wound infection, pelvic and uterine infections, Urinary Tract Infection (UTI), Pulmonary Embolism (PE), venous thrombosis, complications of anesthesia, and Bleeding after a C-Section of CD have been reported more than vaginal delivery (VD)that, these complications are lead to increased mortality and morbidity of maternal and reduced fertility rates (1, 7-13). CD for infants also has complications such as respiratory problems, including Transient Tachypnea of the Newborn (TTN), child morbidity, neonatal respiratory distress syndrome (NRDS), the need for admission to the Neonatal Intensive Care Unit (NICU), premature baby's weight loss, and early neonatal injury and delay in breastfeeding of CD have been reported more than VD (14-17). On the other hand, the CD lead to re-admission of women and impose additional costs on the health system of the country and cause mental harm to the woman and it affects effective Breastfeeding to the infant (17). The CD also affects the outcomes of the next pregnancy, so that in the women with a history of CD, events like placenta accreta, placenta previa, placental abruption, and uterine rupture have been reported (18, 19).

Therefore, according to the above-mentioned studies, although CD has many complications and is not recommended by obstetrician and midwives except in certain cases, but factors such as fear of VD pain (20-23), lack of awareness the harmful consequences of this type of delivery (7), the socioeconomic status (24, 25) and cultural factors in some countries (26, 27) affect the choice of this method of delivery.

Considering that in Iran, one of the goals of the health promotion plan in midwifery is reducing the number of CD, and in order to achieve this, it is necessary to study the statistical societies in the country and determine the factors affecting the choice of CD in women. Therefore, our aim was to determine the factors affecting the choice of CD among Iranian women using the data of the Iranian Institute for Health Sciences Research (IIHSR).

Materials & Methods

We used data from National Institute for Health Research (NIH) in 2015. This study is a national survey and according to the regulations, it has an ethical code and the information collected is with the consent of the participants and the information will remain confidential.

Households in all Iran cities were randomly enrolled and then the health status of the residents has been investigated. From these households, questions asked in a variety of areas including social and economic characteristics of the household, mortality, fertility, coverage of children and women's health services, and people's knowledge of important diseases. In this study, the variables of woman's age (<20(reference category); 21-24; 25-29; 30-34 ;> 34), use of contraceptive methods (the pill, IUD etc.) (No 0; Yes 1), use of media (least one media such as newspapers, TV, Internet, etc. 1; No 0), monthly household income (Low (Less than 5 million Rials); Medium (Between 5 million Rials to 10 million Rials); High (More than 10 million Rials)), woman's occupation status (Housewife 0; Employee 1), father's occupation status (Unemployed 0; Employee 1), parent's education level (under the high school(reference category); high school; academic level), living area (Rural 0; Urban 1), insurance status (No 0; Yes 1), supplemental insurance status (No 0; Yes 1) are used as predictor variables. The outcome variable used for this study was the number of women cesarean deliveries. Considering that a high percentage of observations are zero (67% had VD), therefore we used zero-

inflated for modeling data. On the other hand, considering that samples from all Iran cities have been selected and clusters with unequal size are considered within the provinces, so data have been collected hierarchically and there is a kind of correlation and unexplained variability in the data. The unexplained variability in the model might lead to some clusters or provinces to have a higher or lower than average risk of having a CD. The multilevel models have been proposed to solve this problem so that such models could estimate the variation these latent factors (28, 29). Therefore, we use multilevel Zero-Inflated Negative Binomial (ZINB) and multilevel Zero-Inflated Poisson (ZIP) models for the modeling of data. The zero-inflated models belong to the finite mixture models family with two components. The first component of the logistic and the second component belong to count distributions such as Poisson, negative binomial, etc. In the multi-level ZI models, π_{ijk} ($i = 1, 2, \dots, m, j = 1, 2, \dots, n_i, k = 1, 2, \dots, n_{ij}$) represents the probability of the k th women of the j th cluster within the i th province that are not susceptible to cesarean delivery and $1 - \pi_{ijk}$ of the selected sample is susceptible to cesarean delivery. Therefore, the probability of ZI in the sample equal to

$$\pi_{ijk} = \frac{\exp(\alpha \times a_{ijk} + u_i + s_{ij})}{1 + \exp(\alpha \times a_{ijk} + u_i + s_{ij})}$$

The mean cesarean delivery count of women at risk equal to

$$\mu_{ijk} = \exp(\beta \times b_{ijk} + v_i + \omega_{ij})$$

Where, a_{ijk} and b_{ijk} are covariates vector for the logistic and the NB/Poisson components, and α and β are the corresponding vectors of regression coefficients, respectively. The random effects have been considered at cluster and province level to account for unexplained variability or unobserved factors in the model. The assumption is that observations are not independent at cluster and province level. The criterion for choosing the proper model is the Akaike Information Criterion (AIC) and model with lower AIC is proper. Multilevel ZI models have been employed using R programming language (Version 3.5.1).

Results

In this study, of the 17284 Iranian women with a mean age of 34.86 ± 9.98 years, 11588 (67%) of VD and 5696 (33%) used CD (Table 1).

Table 1: Frequency distribution of cesarean delivery

Value	Frequency	Percent	Cumulative Percent
0	11588	67	67
1	3301	19.1	86.14
2	1824	10.5	96.69
3	463	2.7	99.37
4	94	0.5	99.92
5	11	0.06	99.98
6	3	0.02	1

The demographic and socioeconomic status of the women is shown in Table 2. The about half (46.6%) of women were upper 35 year of age, about one third (32.4%) of women did not use media, over three fourth (76.4%) of women did not use contraceptive methods, lower one third

(30.5%) of the women were living in rural regions, nearly two-thirds (66.3%) of women had an education level below than high school, over half (54%) of the fathers had an education level below than high school, the majority of the fathers (84.7%) were employed, over three fourth

(76.2%) had a monthly household income of lower than Rials 5000000, a large proportion of women (90.9%) were the housewife, a large proportion (99.7%) had insurance and only (18.4%) had supplemental insurance.

The outcome variable used for this study was the number of women cesarean deliveries, considering that a high percentage of observations was zero (VD). The random effects were significant in three out of four of the cases (in the ZIP model) and in all cases (in the ZINB model), therefore it confirmed that the assumption of independence between observations at the cluster and the province level may be inappropriate. The results clearly highlighted the importance of latent factors in determining CD outcomes (Table 2). Therefore, multilevel models were suitable for considering these variations and multilevel ZIP and multi-level ZINB models have been employed using R (Version 3.5.1).

According to AIC, the Multilevel ZINB model has a more suitable fit (Table 2). In the logistic component of multilevel ZINB, variables such as women's education level, use of contraceptive, living area and women aged over than 34 year old at the level of 0.001 ($P<0.001$) were significant. In addition father's occupation status, use of me-

dia and women aged 20 to 24 year old at the level of 0.01 ($P<0.01$) were significant and insurance status and father's education level at the level of 0.05 ($P<0.05$) were significant.

According to the results of the negative binomial component of the ZINB model, women who used the media (Newspapers, TV, the Internet, etc.) , women age, parent's occupation status, living area, supplemental insurance status, parent's education level and monthly household income at the level of 0.001 ($P<0.001$) were significant (Table 2). On the other hand in the logistic component of multilevel ZIP, variables such as women's education level, use of contraceptive, living area at the level of 0.001 ($P<0.001$) were significant. Father's occupation status at the level of 0.01 ($P<0.01$) was significant and media at the level of 0.05 ($P<0.05$) was significant.

According to the results of the Poisson component of the ZIP model women aged over than 34 yr old, use of contraceptive and women's education level at the level of 0.001 ($P<0.001$) were significant. Women aged 20 to 24 yr old, father's occupation status and monthly household income at the level of 0.05 ($P<0.05$) were significant (Table 2).

Table 2: Estimation of parameters and S.E for multilevel ZIP and ZINB models

Variables	Type of delivery		Parameter Estimate (Standard Error)				
	CS n (%)	NVD n (%)	Multilevel ZINB		Multilevel ZIP		
			NB part	Logistic part	Poisson part	Logistic part	
Intercept	-	-	-1.61 (0.05)***	1.19 (0.09)***	-1.58 (0.41)***	1.26 (1.24)	
Fixed effect Women age (yr)	<20	49 (0.8)	644 (5.6)	-	-	-	-
	20-24	461 (8.1)	1811 (15.6)	0.72 (0.02)***	-1.32 (0.48)**	0.69 (0.32)*	-1.49 (0.97)
	25-29	1171 (20.6)	2018 (17.4)	1.55 (0.02)***	-0.22 (0.35)	1.53 (0.32)***	-0.27 (0.79)

30-34	1353 (23.8)	1726 (14.9)	2.04 (0.02)***	0.49 (0.34)	2.03 (0.32)***	0.47 (0.79)
>34	2662 (46.7)	5389 (46.5)	2.20 (0.02)***	1.26 (0.33)***	2.18 (0.32)***	1.24 (0.79)
use of media (women)						
No	1545 (27.1)	4056 (35)	-	-	-	-
Yes	4151 (72.9)	7532 (65)	-0.06 (0.01)***	-0.19 (0.06)**	-0.06 (0.03)	-0.18 (0.07)*
use of contraceptive						
No	4954 (87)	8252 (71.2)	-	-	-	-
Yes	742 (13)	3336 (28.8)	-0.47 (0.01)***	0.58 (0.08)***	-0.47 (0.05)***	0.58 (0.1)***
Monthly household income						
Low (< R5M)	4069 (71.4)	9094 (78.5)	-	-	-	-
Intermediate (R5M-R10M)	1336 (23.5)	2210 (19.1)	-0.02 (0.01)**	-0.06 (0.08)	-0.02 (0.04)	-0.06 (0.09)
High (>R10M)	291 (5.1)	284 (2.4)	0.17 (0.01)***	-0.11 (0.17)	0.16 (0.06)*	-0.12 (0.19)
Women's occupation status						
Housewife	5068 (89)	10642 (91.8)	-	-	-	-
Employee	628 (11)	946 (8.2)	0.05 (0.01)***	-0.09 (0.10)	0.05 (0.04)	-0.09 (0.12)
Father's occupation status						
Unemployed	670 (11.8)	1983 (17.1)	-	-	-	-
Employee	5026 (88.2)	9605 (82.9)	0.09 (0.01)***	-0.26 (0.08)**	0.09 (0.05)*	-0.26 (0.09)**
Women's Education level						
Under the high school	3303 (58)	8157 (70.4)	-	-	-	-
High school	1430 (25.1)	2118 (18.3)	0.04 (0.01)***	-0.45 (0.09)***	0.04 (0.03)	-0.46 (0.11)***
Academic	963 (16.9)	1313 (11.3)	-0.21 (0.01)***	-1.39 (0.21)***	-0.21 (0.05)***	-1.47 (0.28)***
Father's Education level						

	Under the high school	2564 (45)	6768 (58.4)	-	-	-	-
	High school	1793 (31.5)	3147 (27.2)	0.06 (0.01)***	-0.16 (0.07)*	0.06 (0.04)	-0.17 (0.09)
	Academic	1339 (23.5)	1673 (14.4)	0.08 (0.01)***	-0.22 (0.10)*	0.09 (0.05)	-0.21 (0.12)
	Residential area						
	Rural	1335 (23.4)	3929 (33.9)	-	-	-	-
	Urban	4361 (76.6)	7659 (66.1)	0.02 (0.01)***	-0.47 (0.07)***	0.02 (0.04)	-0.47 (0.08)***
	Insurance status						
	No	19 (0.3)	25 (0.2)	-	-	-	-
	Yes	5677 (99.7)	11563 (99.8)	0.05 (0.04)	0.78 (0.3)*	0.04 (0.25)	0.77 (0.95)
	Supplemental Insurance status						
	No	4395 (77.2)	9710 (83.8)	-	-	-	-
	Yes	1301 (22.8)	1878 (16.2)	0.07 (0.01)***	0.08 (0.08)	0.07 (0.04)	0.08 (0.09)
	1/r			0.01 (0.00)***			
Random effect	σ^2 (Province)			0 (0.00)*	0.10 (0.04)*	0.001 (0.002)	0.09 (0.03)**
	σ^2 (Cluster)			0 (0.00)*	0.18 (0.06)**	0.03 (0.01)**	0.27 (0.07)***
AIC				14879.24		16765.82	

NB: Negative Binomial, ZINB: Zero Inflated Negative Binomial, ZIP: Zero Inflated Poisson, CS: Cesarean Section, NVD: Normal Vaginal Delivery, AIC: Akaike Information Criterion, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Discussion

The effects of non-clinical factors such as socio-economic status, demographic factors, and insurance and supplemental insurance status on the choice of CD were studied. There was a significant relationship between selection CD and factors the age of women, supplemental insurance, parent education levels, parent's occupations, living area, monthly household income, and use of contraceptive and media. So that, employed women with high-income more likely chose CD.

Furthermore, the lowest rates of CD were found in women less than 20-yr old (0.8%) and highest rates of CD were found in maternal age greater than 34-yr old (46.7%) that the rate increased with maternal age. Women living in urban areas tended to prefer cesarean to women in rural areas. Women with supplemental insurance had a higher preference for CD than those did not have it. In addition, women with high education level, women who used at least one media (e.g. Radio, television, etc.) and women that used contraceptive methods have chosen the less CD. On the

other hand, women with employed spouses were more likely to choose CD.

These results clearly highlighted the importance of demographic and socioeconomic factors in choosing the type of delivery (Table 2).

Some of our findings were consistent with previous studies in Iran and other countries. The association between socioeconomic level and CD selection has been observed by many authors. Studies conducted out by Cai (32) and Lamaz (33) showed that CD was associated with income level. In a study carried out by Elizabeth (4) demonstrated that there was a relationship between socioeconomic status and CD. In addition, there was the association between CD and woman job (9). There was a relationship between social class and CD (7). Our study showed that husband education level presented an associated with choosing a cesarean. The prevalence rate of the CD had associated with the father's education level (34). Women resident in urban areas was more likely to choose a CD. There was a relationship between living region and CD selection so that, women resident in the urban areas more likely selected CD (35). Our study shows that older women were more likely to choose a CD. There was a relationship between age at least 35 yr and the choice of CD so that women with of at least 35 yr chosen CD (36). In addition, Ecker (37) demonstrated that the rate of CD increased with advanced age and older women were more likely to have the CD. Women over 34 yr old had more request CD than women from 25 to 34 yr of age (reference group) (38). A number of factors affecting the increase in request for delivery by CD in this group of women, including at risk of this group of women for delivery in a natural way (39), physiological factors include the reduced uterine function and pelvic compliance among older women (40). Our study showed that supplemental insurance has a significant effect on the increase in the rate of CD selection. There was a strong association between CD and insurance status, so that Medicaid recipients' women or self-paying had the lowest rates of CD and women with privately insured had the highest rate (41). Perhaps the reason for the requested

increase for CD among this group of women is due to the insurance mistake policies.

Some studies do not confirm our results, for example, Alimohammadian et al. (42) showed that with the increasing education level, more women prefer CD, but, in this study, women with higher education had a less CD.

Conclusion

Our findings highlighted the importance of supplemental insurance and socioeconomic status in choosing a CD by women. Therefore, in some cases, the high cost of this type of delivery does not affect the choice decrease of it. Decision makers should adopt a strategy to reduce unnecessary CD. Of course, it should be noted that CD should be used in situations where woman and infant's life is at risk.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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