

RESEARCH ARTICLE

Utilization of institutional delivery services across successive births in India

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Abstract: As institutional delivery centers usually have much better modern facilities and hygienic conditions in India, utilization of institutional delivery services could improve maternal and child health. The objective of this paper is to address the issue of whether women were consistent in delivering births in an institutional care center over successive pregnancies in India and investigate the factors associated with consistent utilization of institutional delivery. We applied multivariate multilevel models that allow for a strong dependence between successive outcomes at the same unit to the third round of the National Family Health Survey in 2005-2006. Results show that region and place of residence, woman's education, wealth index, having experienced the loss of a child, ever having terminated a pregnancy, and birth order are significant predictors of place of delivery for all three recent births among ever-married women. Our results further show that previous utilization of institutional delivery was an important predictor of utilization for subsequent institutional deliveries. Policies aimed at improving the wide or persistent utilization of institutional delivery in India should focus on first-time mothers targeting disadvantaged women who are from rural areas, poor families, illiterate, Muslim, and scheduled castes.

Keywords: successive births, consistent utilization, National Family Health Survey, India, multivariate multilevel models

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1. Introduction

The government of India has been developing strategies and increased funding to improve maternal health and to achieve universal access to reproductive health in the past couple of decades. Despite these efforts (*e.g.*, per capita health spending rose from US\$21 in 2000 to US\$58 in 2012), India did not meet the Millennium Development Goal (MDG) for the reduction of the maternal mortality ratio (MMR) by 2015 (WHO *et al.*, 2015: Annex 19), which targeted 140 maternal deaths per 100,000 live births in 2015 from 556 in 1990, a three-fourth reduction in MMR required by Goal 5 of the MDGs (United Nations, 2015a). This rate of decline is considerably slower than what would be expected to reach India's Sustainable Development Goal (SDG) target in reducing MMR, which aims to reach 70 per 100,000 live births by 2030 (United Nations, 2015b).

One effective way to improve maternal and newborn health is for mothers to deliver in a health

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facility with adequate maternal care. Proper delivery care for all births is an important indicator for both maternal and child health. The benefits of delivering births in an institution is related to the life-saving equipment and hygienic conditions that help reduce the risk of complications that may result in death or illness to mother and/or child (Campbell, Graham and On behalf of The Lancet Maternal Survival Series steering group, 2006). The data of 15 major states of India confirmed the negative relationship between utilization of institutional delivery and maternal mortality. It is observed that states where mothers prefer to deliver births in an institution had a lower rate of maternal mortality (Dixit, 2013). For example, Southern states such as Kerala and Tamil Nadu had more than 95% of deliveries in health facilities and had maternal mortality ratios of only 66 and 90 maternal deaths per 100, 000 live births, respectively, in 2012. By contrast, Central and Northern regions had only 25% to 45% institutional deliveries. In Uttar Pradesh and Rajasthan, the maternal mortality ratios were 292 and 255 per 100, 000 live births, respectively, in 2012 (RGI, 2013).

In recent decades, several studies have attempted to determine the socioeconomic and demographic factors affecting the utilization of institutional delivery. However, these studies were either based on the most recent birth — ignoring information from previous births within five years of the survey — or overlooked the geographic variation in the utilization of institutional deliveries. Most studies in the literature documented a negative correlation between increased levels of fertility and the utilization of institutional deliveries based on the evidence that mothers at high parity were less enthusiastic and reluctant about the utilization of institutional delivery and had a preference for home delivery (Agha and Carton, 2011; Amponsah and Moses, 2009; Kebede, Gebeyehu, and Andargie, 2013; Magadi, Diamond, and Rodrigues, 2000; Sonneveldt, Plosky, and Stover, 2013). However, these studies overlooked the geographical variation in fertility across India and were typically at the state level. The total fertility rate (TFR) in India has declined from 3.39 in the years 1992–1993 (National family health survey-I (NFHS-I)) to 2.68 in 2005–2006 (NFHS-III). The rate of decline in the fertility rate in southern states was much faster than in the Northern part of the country where the TFR rate remains at approximately three (Dixit, 2009). These variations could have impacted the utilization of institutional delivery services. Some studies have further found that geographical access may have a greater effect on utilization of services than socioeconomic factors. For example, utilization of institutional delivery in Southern and western regions was higher than in Central and Northern parts of India because Southern and Western regions are expected to have better provision of services in the form of safe and affordable methods (Das, 1999). The overall development indicator in terms of per capita GDP indicates that development took place much faster in Southern and Western regions than other parts of India.

Over the past two decades there has been an increasing interest in the field to examine how the utilization of maternal and child health (MCH) care services influence subsequent utilization of MCH services in developing countries, including India (Agha and Carton 2011; Dixit, Dwivedi, and Ram, 2013a; 2013b; Kesterton, Cleland, Slogett *et al.* 2010; Sugathan, Mishra and Retherford, 2001). That is, during pregnancy, whether a mother receives antenatal care, then delivers a birth in an institution, and receives postnatal care and immunization services for the same child at a proper age. This can be considered as a type of consistency in which utilization of previous health services affects utilization of subsequent health service for a particular birth. In the literature, the consistency in the utilization of same services across all births is normally defined as a woman utilizing the same types of health services for all of her births (i.e., across births). Limited evidence from other developing countries suggests that the likelihood of utilization of particular maternity care services is strongly related to whether a woman receives the same services for the immediately preceding birth (Adekunle, Filippi, Graham *et al.*, 1990; Govendasamy, Stewart, Rutsein *et al.*, 1993; Mekonnen, 2003).

Another shortcoming of the existing literature is that most studies do not take into account factors determining the utilization of services as a hierarchical structure and the analysis for each child was statistically independent. Because regional variations in socioeconomic conditions and health systems in India do not correspond to established models from other developing countries, no cohe-

rent picture of the consistency in utilization of institutional delivery across successive births and its determinants has been provided. Therefore, the objectives of this paper are: (i) to address the issue of whether women were consistent in delivering births in an institution over successive pregnancies, and (ii) to examine the factors associated with the consistent utilization of institutional delivery in India.

2. Data and Methods

2.1 Data Sources

Data for this study come from the third round of the cross sectional National Family Health Survey (NFHS) in 2005–2006 (hereafter NFHS-III). The NFHS samples are nationally representative and are designed to produce estimates at the national and state levels in India. Information related to maternal and child health care is available in each successive round of the NFHS. The NFHS surveys utilize a hierarchical (systematic multistage stratified) random sample design from area-based sampling frames to select clusters (the primary sampling units). Clusters are single-stage, equal probability samples of segments of equal size. Once clusters are selected, households within clusters are selected in order to obtain a nationally representative probability sample of individuals (Pamuk, Fuchs, and Lutz, 2011). Overall, the NFHS adopted a two-stage sample design in rural areas and three-stage sample design in urban areas (see IIPS and ORC Macro, 2007 for further details regarding sampling). The NFHS has designed a weight to account for the differential non-response rates of household interviews in the domains. The details of the sampling weights are given in the NFHS reports of various rounds. To date, four waves of the NFHS have been conducted.

2.2 Measurements

In NFHS-III, mothers who gave birth during the five years preceding the survey were asked about the place of delivery. Information regarding place of delivery is available for all of the successive births during the five years preceding the survey. Births delivered at health facilities — such as public institutions, NGO trusts, and private hospitals — are termed ‘institutional delivery,’ whereas births delivered at own homes, parents’ homes, and other homes are termed ‘home delivery’ (Dixit, Dwivedi, and Ram, 2013a).

It is difficult to identify the factors that are most influential in the decision to utilize institutional delivery services across three recent successive births. Based on previous literature (Babalola and Fatusi, 2009; Baru *et al.*, 2010; Stephenson *et al.*, 2006; Thind *et al.*, 2008), this study included the following socioeconomic and demographic factors: region (central, north, east, northeast, west, or south), place of residence (rural or urban), religion of the head of the household (Hindu, Muslim, or others), caste of the head of the household (scheduled tribe, scheduled caste, or others), wealth index for the household (poorest, poor, middle, rich or richest), educational status of women and their partners (illiterate, literate but below primary school, primary school completed but below middle school, middle school completed but below high school, or high school or above), loss of a child (no child lost or at least one child lost), sex composition of children (no son and no daughter, number of sons greater than daughters, number of sons less than daughters, or equal sons and daughters), ever having pregnancy terminated (no or yes), child’s age in months (0–23, 24–35, 36–47, or 48–59), and birth order (second order birth, first order, third order, or 3+ order). The first category of each of these independent variables is considered as the reference category in the multivariate analyses.

2.3 Analytical Strategy

The main focus of the study is to assess the consistency of institutional deliveries over successive pregnancies. However, the consistent utilization of services can be influenced by community-level (Primary Sampling Unit (PSU), or village) factors, beyond individual level factors. Due to this nested structure, conventional single-level logistic regression models may not be appropriate. Alter-

natively, multilevel logistic regression analyses account for variations due to the hierarchical structure of the data — allowing the simultaneous examination of the effects of village-level and individual-level variables while accounting for the non-independence of observations within groups.

The units of analysis are births occurring within five years of the survey date, which are nested within mothers, and are further nested within communities (PSU). First, we applied a three-level model considering children at the lowest level. The estimation was based on the first-order predictive quasi-likelihood procedure (the second-order approximation methods did not converge). Second, because births of the same woman are correlated, the binomial assumption (over-dispersion of data) was assessed. For the purpose of model diagnostics, we included additional binomial multilevel models and tested the assumption of independent Bernoulli trials by keeping σ_e^2 as unconstrained. Finally, we used multivariate (two or more dependent variables) multilevel models to allow for the strong dependence between successive outcomes in the same unit — but do not require long series of repeated measures — as suggested by Cox (1972) for handling data with dependent binary responses. In this case, the assumption is that for a mother the response y_{ijk} for each individual pregnancy is one component of a multivariate binary response at the mother level j (Griffiths, Brown, and Smith, 2004). This model does not assume conditional independence of the individual responses and specifies the correlation structure between pregnancies to the same mother. We modified the general model by Yang *et al.* (2000) and considered a maximum of three consecutive births per woman. The number of women having four and five births during the five-year study period was 102 and 3, respectively, and therefore excluded from the analysis due to limited sample size.

Response y_{ijk} has two categories: 1 indicates institutional delivery for birth i nested within women j of PSU k , and 0 indicates home delivery.

$$y_{ijk} \sim \text{binomial}(\pi_{ijk}, 1) \text{ where } i = 1, 2, 3 \quad (1)$$

$$\text{var}(y_{ijk} / \pi_{ijk}) = \pi_{ijk} (1 - \pi_{ijk}) \quad (2)$$

$$\ln\left(\frac{\pi_{ijk}}{1 - \pi_{ijk}}\right) = b_0 + b_1 x_{1ijk} + b_2 x_{2ijk} + \dots + b_m x_{mijk} + \mathcal{G}_{0k} \quad (3)$$

where there is one constant item and m explanatory variables.

\mathcal{G}_{0k} is a PSU random effect.

The extension of equation (2) in the case of three births per women gives

$$y_{ijk} = \pi_{ijk} + e_{ijk} z_{ijk} \quad (4)$$

$$\text{var} \begin{pmatrix} e_{1jk} \\ e_{2jk} \\ e_{3jk} \end{pmatrix} = \begin{pmatrix} \sigma_{e1}^2 & & \\ \sigma_{21} & \sigma_{e2}^2 & \\ \sigma_{21} & \sigma_{e32} & \sigma_{e3}^2 \end{pmatrix} \quad (5)$$

Unlike independent univariate distributions, the multivariate distribution gives a complex form of the variance of e_{ijk} . In this model, to assess the binomial assumption, the variance parameter σ_{ei}^2 ($i=1, 2$, and 3) is unconstrained (not fixed at 1) and estimated to compare the value from 1. In the unconstrained model, if the value of σ_{ei}^2 is close to 1, it indicates that the model follows the binomial assumption. If we consider the variance parameter σ_{ei}^2 equal to 1, it gives the required binomial variation for each pregnancy outcome to mothers. From the data we can also estimate the covariance, which identifies whether the women's behavior is independent or not, across different births in relation to the institutional delivery. Finally, we calibrated a three-level multivariate multilevel regression model that had a structure of pregnancies (three for each woman) at Level 1 nested within women at Level 2 and finally nested within PSU at Level 3.

All models used a logit link function to obtain estimates of fixed and random effects and are estimated with MLwiN software (version 2.15, <http://www.bristol.ac.uk/cmm/software/mlwin/>). For interpretive ease, fixed coefficients were converted to odds ratios and the significance level of $p < 0.05$ was used.

3 Results

3.1 Percentage Using Institutional Delivery Care

Table 1 presents the percent distribution of ever-married women according to the utilization of institutional delivery for up to three of the most recent (successive) births in India in the five years prior to the NFHS-III in 2005-2006. The distributions show that the prevalence of utilization of institutional delivery among women who had one, two, and three births in the five years prior to the survey was 47.4%, 26.2%, and 15.6%, respectively. Among women who had three births, 63.1% of them delivered all three births at home and 5% delivered their third birth in a hospital while the previous two births were at home.

3.2 Validation of Assumption of Independent Bernoulli Trials

We first applied a three-level model to examine the consistent use of institutional delivery (presented in Table S1 in the Appendix). In the three-level model keeping σ_e^2 as unconstrained, we validated the assumption of independent Bernoulli trials. Our estimated σ_e^2 value is 0.16 (see Table S2), which was far below 1 and highlights the problem of under-dispersion in the model. This clearly shows that pregnancies within mothers are not conditionally independent of each other — note:

Table 1. Percent distribution of ever-married women according to the consistent utilization of institutional delivery for successive births in India.

Observed births in sequence of increasing birth order	Consistent utilization of institutional delivery	
	%	N
Women With One Birth		
Home	52.56	10956
Institute	47.44	13080
Total	100	24036
Women With Two Births		
Home, Home	59.73	6007
Home, Institution	5.87	686
Institution, Home	8.21	890
Institution, Institution	26.19	3448
Total	100	11031
Women With Three Births		
Home, Home, Home	63.05	1006
Institution, Home, Home	5.98	95
Institution, Institution, Home	2.98	48
Institution, Institution, Institution	15.55	301
Home, Institution, Institution	2.60	58
Home, Home, Institution	5.08	96
Home, Institution, Home	2.24	31
Institution, Home, Institution	2.51	43
Total	100	1678

Note: Successive births begin with the first birth for which information is available in the 5-year period before the NFHS-III.

Table S1. Parameter estimates for the three-level (child, mother, and PSU) regression model for the use of institutional delivery of recent births, NFHS-III, 2005–2006.

	Exp(B)	95% C.I. for EXP(B)	
		Lower	Upper
Background Characteristics			
Regions			
Central ^a			
North	1.57*	1.35	1.82
East	2.43*	2.08	2.83
Northeast	1.71*	1.46	2.00
West	5.85*	4.95	6.93
South	14.43*	12.31	16.91
Place of residence			
Rural ^a			
Urban	2.60*	2.36	2.88
Religion			
Hindu ^a			
Muslim	0.84*	0.76	0.94
Others	1.03	0.91	1.17
Caste of women			
Others ^a			
Scheduled caste	0.85*	0.78	0.92
Scheduled tribe	0.56*	0.50	0.63
Respondent education			
Illiterate ^a			
Literate but below primary	1.38*	1.24	1.53
Primary but below middle	1.57*	1.44	1.71
Middle but below high school	1.93*	1.76	2.13
High school and above	3.33*	3.00	3.69
Partner education			
Illiterate ^a			
Literate but below primary	1.13	1.00	1.27
Primary but below middle	1.19*	1.08	1.31
Middle but below high school	1.25*	1.14	1.37
High school and above	1.32*	1.20	1.45
Wealth index			
Poorest ^a			
Poor	1.45*	1.30	1.61
Middle	2.12*	1.90	2.37
Rich	3.27*	2.90	3.68
Richest	7.41*	6.42	8.55
Child loss			
None ^a			
At least one	1.15*	1.06	1.24
Sex composition of living children			
No son and no daughter ^a			

Continued

	Exp(B)	95% C.I. for EXP(B)	
		Lower	Upper
No. of sons greater than daughters	1.11	0.84	1.47
No. of sons less than daughters	1.09	0.83	1.44
Equal sons and daughters	1.06	0.80	1.40
Ever had terminated pregnancy			
No ^a			
Yes	1.34*	1.24	1.44
Child age (in months)			
0 - 23 ^a			
24 - 35	0.89*	0.83	0.96
36 - 47	0.73*	0.68	0.78
48 - 59	0.67*	0.63	0.72
Birth order			
2 nd order birth ^a			
1 st order birth	1.92*	1.79	2.05
3 rd order birth	0.74*	0.68	0.80
3+ order birth	0.67*	0.62	0.74
Constant	0.06*	0.04	0.08
Random Effects		Coefficient (Standard Error)	
Level 3 (PSU Level)		1.119 (0.045)	
Level 2 (Mother Level)		0.557 (0.043)	

Note:^a Reference category.*p<0.05**Table S2.** Random-parameter estimates for the three-level (child, mother, and PSU) univariate multilevel regression model for the utilization of institutional delivery, NFHS-III, 2005–2006.

Parameter	Parameter estimates in unconstrained model (S.E.)	Parameter estimates in constrained model (S.E.)
PSU level σ_g^2	3.43 (0.13)	1.12 (0.05)
Mother level σ_u^2	9.63 (0.14)	0.56 (0.04)
Pregnancy level σ_e^2	0.16 (0.002)	1.00

when we converted the constrained variance to unconstrained, the random effects at PSU and mother levels significantly increased. Therefore, a statistical model is needed that does not assume conditional independence between the pregnancies to the same mother. Thus a multivariate response model was used to address the problem of dependency. We developed a three-level multivariate regression model which includes the numbers of pregnancies during the last five years at Level 1, used as multiple outcomes nested within mothers at Level 2, who in turn are nested within their local communities (PSU) at Level 3. By treating multiple pregnancies (outcome) within the multivariate response model, we were able to estimate the covariance between three pregnancies nested within mothers, as well as the variance for each outcome in a simultaneous manner.

3.3 Results from Multivariate Multilevel Models

Table 2 presents the fixed estimates of the full model. There were similarities and differences in the socioeconomic patterning of the place of deliveries for all three births. For the most recent and second to last pregnancy, it was found that mothers in five regions were more likely to deliver

Table 2. Parameter estimates for the three-level (child, mother, and PSU) multivariate regression model for the use of institutional delivery among ever-married women who had at least one birth in the last five years before the NFHS-III survey.

Background Characteristics	Institutional Delivery	Sample Size	Last Birth			Second to Last Birth			Third to Last Birth		
			EXP (B)	95% C.I. for EXP(B)		EXP (B)	95% C.I. for EXP(B)		EXP (B)	95% C.I. for EXP(B)	
				Lower	Upper		Lower	Upper		Lower	Upper
Regions											
Central ^a	41.03	5686									
North	23.17	8746	1.63*	1.38	1.92	1.56*	1.27	1.9	1.61*	1.11	2.32
East	30.38	5847	2.49*	2.10	2.96	2.70*	2.19	3.34	2.39*	1.60	3.57
Northeast	29.82	6965	1.82*	1.53	2.16	1.61*	1.29	2.02	1.00	0.60	1.66
West	63.83	4178	6.92*	5.73	8.35	5.77*	4.59	7.24	5.14*	3.30	8.01
South	75.31	5428	17.67*	14.79	21.12	15.20*	12.15	19.00	8.02*	5.25	12.25
Place of residence											
Rural ^a	30.87	22323									
Urban	70.47	14527	2.80*	2.51	3.14	2.70*	2.35	3.11	2.44*	1.85	3.24
Religion											
Hindu ^a	41.97	25806									
Muslim	35.3	5851	0.83*	0.74	0.93	0.88	0.75	1.03	0.96	0.69	1.32
Others	54.54	5193	1.06	0.92	1.21	0.97	0.79	1.19	1.24	0.77	1.98
Caste of women											
Others ^a	46.34	24786									
Scheduled caste	34.81	6331	0.83*	0.75	0.90	0.93	0.81	1.06	0.90	0.65	1.23
Scheduled tribe	19.33	5733	0.53*	0.47	0.61	0.58*	0.48	0.70	0.57*	0.37	0.88
Respondent education											
Illiterate ^a	19.54	14143									
Literate but below primary school	38.31	2770	1.41*	1.26	1.59	1.31*	1.09	1.57	0.84	0.51	1.39
Primary but below middle school	49.32	5546	1.54*	1.40	1.70	1.76*	1.53	2.03	2.30*	1.65	3.20
Middle but below high school	64.83	9053	1.95*	1.76	2.17	2.05*	1.75	2.40	2.65*	1.80	3.90
High school or above	87.87	5338	3.44*	3.06	3.87	3.81*	3.19	4.56	2.61*	1.65	4.14
Partner education											
Illiterate ^a	19.52	8726									
Literate but below primary school	32.72	2713	1.15*	1.01	1.31	1.04	0.85	1.28	1.43	0.90	2.27
Primary but below middle school	39.96	5509	1.24*	1.12	1.38	1.15	0.98	1.35	1.08	0.75	1.55
Middle but below high school	43.75	6575	1.27*	1.14	1.41	1.31*	1.12	1.54	1.20	0.82	1.75
High school or above	62.9	13327	1.36*	1.22	1.51	1.26*	1.07	1.48	1.38	0.94	2.03
Wealth index											
Poorest ^a	13.2	6154									
Poor	24.31	6468	1.46*	1.29	1.65	1.46*	1.22	1.75	1.09	0.85	1.38
Middle	41.14	7418	2.23*	1.97	2.52	1.97*	1.64	2.37	1.55*	1.02	2.35
Rich	60.18	8136	3.57*	3.12	4.08	2.82*	2.32	3.43	2.22*	1.42	3.47
Richest	85.57	8674	8.58*	7.30	10.07	5.87*	4.62	7.46	3.75*	2.10	6.68
Child loss											
None ^a	46.31	30161									
At least one	23.73	6689	1.22*	1.11	1.34	1.20*	1.06	1.37	1.46*	1.12	1.90
Ever had terminated pregnancy											
No ^a	48.34	30369									
Yes	26.25	6481	1.31*	1.21	1.42	1.38*	1.21	1.57	1.40	1.00	1.94
Birth order											
Second order birth ^a	55.24	10934									
1 st order birth	60.23	10394	2.09*	1.91	2.30	2.33*	2.06	2.65	1.88*	1.39	2.54
3 rd order birth	30.21	6297	0.71*	0.64	0.78	0.68*	0.58	0.81	0.63*	0.41	0.97
3+ order birth	15.45	9225	0.63*	0.57	0.7	0.59*	0.49	0.70	0.73	0.49	1.11

Note:^a Reference category, Sex composition of living children and child age have been controlled in the model *p<0.05

their births in an institution than those in the central region. For the third pregnancy, except for women in the northeastern region ($OR_{\text{northeastern}} = 1.00$; 95% CI: 0.60, 1.66) women in the other four regions had a significantly higher chance of delivering in a hospital compared with those in the central region. Living in urban areas was associated with a higher likelihood of delivering all three successive births in a hospital. Muslim women were 17% less likely ($OR_{\text{Muslim}} = 0.83$; 95% CI: 0.74, 0.93) to deliver their last birth in an institution compared with Hindu women. However, there was no association between religion and an institutional delivery for the second to last and the third to last births in this study.

Mothers from scheduled castes/tribes were less like to use institutional delivery for all three successive births. However, we found no significant association between scheduled castes/tribes and the use of institutional delivery for their recent second and third births. Mothers with higher education were more likely to deliver all three births ($OR_{\text{first birth}} = 3.44$; 95% CI: 3.06, 3.87), ($OR_{\text{second birth}} = 3.81$; 95% CI: 3.19, 4.56) ($OR_{\text{third birth}} = 2.61$; 95% CI: 1.65, 4.14) in an institution compared with illiterate women. Additionally, the likelihood of using institutional delivery increased with increasing levels of the respondent's education; with the exception of the third birth where there was no difference for illiterate women. A positive association between the use of institutional delivery and education among the partners of women was also found for the last and the second to last births. For example, women with partners with middle-school or above educational attainment had 26–31% greater odds of deliveries at a medical institution versus home for the last and the second to last children compared to women with illiterate partners. However, no educational difference was found for the third to last birth.

The difference in the use of institutional delivery by wealth quintile was more pronounced. Mothers in a higher wealth quintile were associated with significantly higher odds of delivering all three successive births in an institution. For example, mothers in the second (poor), third (middle), fourth (rich), and fifth quintiles (richest) of the wealth index were all more likely to use institutional delivery than the poorest. A possible reason why women from poor families had higher odds of using institutional delivery than those from the poorest families could be the introduction of different “free maternity benefit schemes,” which may attract women to utilize institutional delivery even if they were in the second quintile group (poor households).

Women who experienced the loss of a child during their reproductive period (not necessarily within the 5-year study period) were more likely to have all three successive births in an institution. Women who experienced a terminated pregnancy had higher odds of delivering their most recent and second to last birth in an institution; however, this variable was not significant for the third to last birth. Compared with second-order births, first-order births were more likely to be delivered in an institution, but third- and higher-order births had less of a chance to be delivered in an institution.

Table 3 shows the random parameter estimates for the three-level multivariate regression models for the utilization of institutional delivery in India from the 2005–2006 NFHS-III using the second-order approximation penalized quasi-likelihood. The results indicate that the covariance between place of birth of the most recent (last) and second to last birth was higher (0.46) than between the last and third to last births (0.28). These results indicate that utilization of institutional delivery for the two subsequent births was significantly related to each other. Using the second-order approximation and maximize quasi-likelihood method, we obtained random parameter estimates for the three-level multivariate regression models for institutional delivery in India (see Table 4). The unconstrained binomial variance parameter for the three pregnancy outcome was estimated to be $\sigma_{e11}^2 = 1.00$, $\sigma_{e22}^2 = 0.97$, and $\sigma_{e33}^2 = 0.95$, which was very close to one. This indicates that the data in the multivariate multilevel model supported the binomial assumption. The estimated covariates derived from the multivariate multilevel model were positive and highly significant. The interesting finding is that the correlation between successive pregnancies was high compared with the estimates from the non-successive pregnancies, suggesting that once the decision has been made for the place

Table 3. Random parameter estimates for the three-level (child, mother, and PSU) multivariate regression models for institutional delivery in India, NFHS-III, 2005–2006.

Parameter	Level 1 Variance Constrained (S.E.)
$\sigma_{e11}^2 = \sigma_{e22}^2 = \sigma_{e33}^2$	1.00
σ_{e21}^2	0.46 (0.01)
σ_{e31}^2	0.28 (0.02)
σ_{e32}^2	0.41 (0.02)

Table 4. Random parameter estimates for the three-level (child, mother, and PSU) multivariate regression models for institutional delivery in India, NFHS-III, 2005–2006.

Parameter	Level 1 Variance Unconstrained (S.E.)
σ_{e11}^2	1.00
σ_{e22}^2	0.97
σ_{e33}^2	0.95
σ_{e21}^2	0.42 (0.01)
σ_{e31}^2	0.25 (0.02)
σ_{e32}^2	0.40 (0.02)

of delivery of one birth, the behavior of the mother is unlikely to change for the next and, to a lesser extent, subsequent birth.

4. Discussion

Despite the availability of health institutions in India, a significant number of pregnant women still deliver at home. Data from the present study show that the percentages of women having a home delivery for all births were 53%, 60%, and 63% for those with one, two, and three births during the five-year study period in the 2005–2006 NFHS-III, respectively. The high proportion of women using home delivery instead of institutional delivery has prompted researchers and policymakers to investigate the factors that may influence such patterns. However, a limitation of the existing literature is that studies have not fully clarified the separate role of factors affecting the consistent utilization of institutional delivery services. Moreover, until now, no research has been conducted in contemporary India with an in-depth analysis of the consistent utilization of institutional delivery among different births. Using data from the 2005–2006 NFHS-III, the present study explored several factors associated with the consistent use of institutional delivery services.

Our results show that consistency in institutional delivery was low in Central and Northern regions compared with other regions in India, especially Southern and Western regions. One of the possible reasons could be, compared with other regions, Southern states like Kerala, Karnataka, and Tamil Nadu, and Western states like Goa and Maharashtra have experienced demographic transitions before other states. Consequently, the Southern region is equipped with better health facilities. The significant difference between these regions (Southern and Central) was found to be due to a large gap in both health infrastructure and services (Joumard and Kumar, 2015). These results clearly illustrate the importance of region of residence in determining the use of maternal health-services.

Our results suggest that choosing the same place of delivery for all successive births varied according to their place of residence. Women from rural areas were no less consistent in utilizing institutional delivery services than urban women. Harsh geographic conditions, long distances between home and health centers, poor transportation services, and unavailability of maternal services might be important factors associated with the women's decision of not seeking modern health care services for all subsequent births (Bolam, Manandhar, Shrestha *et al.*, 1998). Furthermore, in rural India, traditional pregnancy is considered to be a natural state of being. These beliefs, coupled with mis-

conceptions and fears of medical institutions, have led women to continue to rely on home births in India (Stephenson, Baschieri, Clements *et al.*, 2006). As a result, rural women may continue to under-utilize health care facilities relative to urban women despite the introduction of free maternal care schemes.

The effect of religion and caste were found to vary in relation to all three births. Muslim and scheduled caste women were less likely to deliver their three most recent births in an institution. For the other two recent births, religion was not a significant predictor — a finding that is consistent with earlier studies (Mekonnen and Mekonnen, 2002; Saroha, Altarac, and Sibley, 2008). The observation that Muslim women sought less assistance from medical settings is likely to be attributed to their religious beliefs, cultural norms, and traditional practices (Ganle, 2015). Our finding that scheduled caste women had lower odds of institutional delivery even after adjusting for other covariates, suggests that there may be additional social and/or cultural reasons for the low uptake of delivery services among these groups.

Findings again conform to the positive correlation between level of education and the consistent utilization of institutional delivery. Women with some level of education were more likely to deliver all births at health facilities than those who were unable to read and write. However, for the third to the last birth, there was no significant difference between illiterate women and literate women with below primary level education. Studies conducted in different parts of India (Govindasamy and Ramesh, 1997; Kesterton, Cleland, Slogett *et al.*, 2010; Navaneetham and Dharmalingam, 2000; Varma, Khan, and Hazra, 2010; Vora, Koblinsky, and Koblinsky, 2015), and in other countries such as Bangladesh, Nepal, Nigeria, Malawi, and Afghanistan also found a similar association (see Palamuleni, 2011). These may be due to the fact that educated women had better awareness about the benefits of preventive health care services, have familiarity with modern medical culture, and have higher receptivity to health-related information. We also speculate that literate women are more likely to overcome some old stereotypes, norms, and beliefs, and know themselves better in terms of the physiological condition of pregnancy. They know that each and every birth needs medical attention and consequently they would deliver in an institution. Moreover, highly educated women are likely to be more confident about asking questions related to the health care needs of themselves and their children; and are more willing to be listened to by their health care providers, who may encourage institutional delivery (Bloom, Lippeveld, and Wypij, 1999). Partner's education showed a significant positive relation with institutional delivery for the most recent birth; however, the same was not significant in relation to older births. The possible reason may be that in the recent time period educated partners had become more aware about the health care of mothers and children, which has changed their attitudes and beliefs, and played a key role in overcoming the barriers to accessing maternal health care services. This argument is consistent with some recent studies conducted in Gujarat, India, and other developing countries (Daniel and Desalegn, 2014; Vora, Koblinsky, and Koblinsky, 2015).

Previous studies have shown a linear increase in institutional delivery with an increase in wealth quintiles (Chakraborty, Islam, Chowdhury *et al.*, 2003; Gabrysch and Campbell 2009; Goel, Roy, Rasania *et al.*, 2015; Kesterton, Cleland, Slogett *et al.*, 2010; Titaley, Dibley, and Roberts, 2010; Vora, Mavalankar, Ramani *et al.*, 2009), the present study also showed a similar finding in the case of consistent utilization of institutional delivery. Despite different government incentive programs, the high cost of delivery care is often blamed for the low rate of delivery service utilization, especially for poorer women. This finding may be explained by the fact that transportation costs and the loss of daily wages may be high; as a result, women from poorer households prefer to deliver every birth at home. A large inequality in the use of skilled birth attendants are found in developing countries, with the poor being at a stark disadvantage (Houweling, Ronsmans, Campbell *et al.*, 2007; Mayhew, Hansen, Peters *et al.*, 2008).

Our finding also shows that women who never had a terminated pregnancy or loss of a child in her lifetime were more likely to deliver at home. The possible reason for the inconsistent use of institutional delivery could be that these women have developed self-confidence and have become less

motivated to deliver in an institution if they experienced no problems in their previous deliveries. Contrary to this, if women experienced the termination of a previous pregnancy or lost a child, they would be more conscious about a safe delivery, and therefore, they would tend to deliver in an institution. However, this is not the case for the third to last birth. This may be because a woman who had a bad reproductive history has become more conscious for her subsequent births.

In this study the birth order of a child was one important predictor in determining institutional delivery in the three-level multivariate analysis. If the birth was the first birth, the mother was more likely to deliver in an institution compared with their second-order birth. These data are consistent with studies from developing and low income countries (Feyissa and Genemo, 2014; Kabakyenga, Östergren, Turyakira *et al.*, 2012; Shimazaki, Honda, Dulnuan *et al.*, 2013); they are also consistent with studies from different regions of India (Kesterton, Cleland, Slogett *et al.*, 2010; Sugathan, Mishra, and Retherford, 2001). The likely reason is that women with more children perceive delivery as a normal process and develop the confidence to give birth at home.

Women who had three births in the study period were also more likely to deliver at home compared with women who had two births. Among women who had two births, the likelihood of delivering the first birth in an institution was higher than that of delivering the second birth in an institution during the observation period. This may be due to concern about the successful delivery of a healthy first child, and therefore women maybe more likely to use a healthcare facility for delivery (Gabrysch and Campbell, 2009). However, in the absence of complications, women may forgo an institutionalized delivery (Stephenson and Tsui, 2002).

An advantage of the current study is the application of a three-level multivariate model. Over the years, researchers have identified individual and household characteristics that are associated with the institutional delivery of the most recent birth. However, by modeling the inter-dependence among successive births, the multivariate model provides additional information. Similar to previous studies, we tested a three-level model to examine how the effects of women's characteristics at different levels are associated with delivery in an institution (Yebyo, Alemayehu, and Kahsay, 2015). We found that the assumption of independent Bernoulli trials is violated in the multilevel model. A three-level multivariate multilevel model provides a solution to this problem and consists of more than one response variable. Although multivariate multilevel methods are popular in epidemiological studies (Oksanen, Kawachi, Subramanian *et al.*, 2013; Subramanian, Kim, and Kawachi, 2005), prior studies have not addressed the utilization of delivery care. Using this model, we considered the place of delivery for three births of a mother as the dependent variable(s). Taking advantage of the multivariate multilevel modeling approach, we were able to investigate the co-variation in socioeconomic correlates of place of delivery for all three births for a given mother.

Our models reveal that the variation in the utilization of institutional delivery at the level of the woman is smaller than that at the PSU level, indicating that even after controlling for household-level variables, the clustering of use of institutional delivery exists between birth orders for the same woman. In other words, the utilization of institutional delivery can be considered as a motivating factor for subsequent deliveries in an institution, and eventually, such repeated behaviors may elicit habitual behaviors.

Despite the strengths discussed above, the study has the following limitations. First, each woman did not have the same number of births during the five-year study period, which introduces some biases in the analyses. Second, the interactions between age, birth cohorts, and place of delivery were not included in the analyses because of the complexity of modeling. Therefore, this prohibits us from examining potential cohort and period effects in the use of institutional delivery. Third, the results could be more informative if data on the quality of health services were collected. Nevertheless, we encourage more research on this topic to further explore the factors associated with the use of institutional delivery services.

Our findings have important policy implications. Policies aimed at improving the consistent utilization of institutional delivery in India should focus on first-time mothers — particularly targeting

disadvantaged women in rural areas, from poor families, and who are illiterate, Muslim, and scheduled caste. Our findings also show that a large proportion of women delivered in an institution and subsequently deliver at home. These women may not have adequately benefited from their health care facilities during the delivery of their first child. Therefore, policies may seek to improve the cleanliness of facilities and the provision of mothers' friendly services to improve the consistency in utilization of delivery services.

5. Conclusion

By analyzing NFHS-III data of ever-married women in 2005–2006, this study has provided a new perspective on the consistent utilization of institutional delivery across successive births. This study has shown some significant socioeconomic predictors of place of delivery for all three births born within the five years prior to the NFHS-III, such as region and place of residence, educational level, wealth index, loss of a child, termination of a pregnancy, and birth order of the child. Multivariate multilevel models with multiple responses were used to identify whether the women's behaviors were independent across different births in relation to institutional delivery. Results show that the utilization of institutional delivery for subsequent births is significantly related to each other. The estimated covariates derived from the multivariate multilevel models are positive and highly significant, and the finding is that the correlation between successive pregnancies is higher relative to that between non-successive pregnancies.

Author Contributions

Both PD and LKD conceived of the study design and performed data analyses; PD drafted the manuscript and offered critical discussion.

Conflict of Interest and Funding

No conflict of interest has been declared by the authors.

Ethics Statement

The study is based on a publically available secondary data set with no identifiable information on the participants. This dataset is available in the public domain for research use and hence no formal approval from the institutional review board is required. Therefore, no ethics statement is required for this study.

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