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## CLINICAL ARTICLE

## The relationship between facility delivery and infant immunization in Ethiopia

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## ABSTRACT

**Objective:** To determine whether facility delivery is related to compliance with recommended infant immunizations, particularly those that occur weeks or months after delivery. **Methods:** In a retrospective analysis, multivariate logistic regression was used to assess data from the 2011 Ethiopia Demographic and Health Survey (EDHS) to determine the strongest correlates of facility delivery. These correlates were then used, along with facility delivery itself, to determine the relationship between facility delivery and infant immunization. **Results:** In total, 3334 women delivered a newborn 12–24 months before the 2011 EDHS: 90.2% (3007) delivered at home, and 9.8% (327) delivered in a facility. Education, wealth status, urban residence, and number of children under 5 years living in the household were the factors most strongly associated with facility delivery. When facility delivery and its strongest correlates were entered into multivariate logistic regression models with infant immunizations as the outcome, facility delivery was significantly associated with increased likelihood of DPT-HepB-Hib, polio, and measles vaccination, and increased likelihood of being fully immunized (all  $P < 0.01$ ). Facility delivery was the strongest single factor associated with infants being immunized, doubling the odds of full immunization. **Conclusion:** The impact of facility delivery on health outcomes transcends the immediate delivery and postpartum period.

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## 1. Introduction

Encouraging women to deliver in a health facility is a key strategy to increasing childbirth with skilled attendants and thereby reduce both maternal and neonatal mortality rates in low-resource countries. Facility deliveries have been linked to lower rates of neonatal mortality [1–3] in addition to maternal mortality [4]. Despite challenges to the methodology of studies making such links [5,6], facility delivery remains a cornerstone of intervention strategies to address both Millennium Development Goal 4 (MDG4) and MDG5 in much of Sub-Saharan Africa.

One question that has not been asked is whether facility delivery has an impact on the subsequent health-seeking behavior of the mother, especially after controlling for factors such as education and wealth that might be associated with both facility delivery and health-seeking behaviors. Specifically, what is the impact of facility delivery on compliance with recommendations regarding infant immunizations, particularly those that occur weeks or months after delivery? Immunization coverage is one of the indicators used to monitor progress toward

the achievement of MDG4 and the reduction of child morbidity and mortality. Given that facility delivery and immunization coverage are both designed to address MDG4, the relationship between these 2 indicators is worth exploring.

The aim of the present study was to answer the following questions. Are mothers who deliver in facilities more likely to obtain immunizations for their infants in the weeks and months after delivery compared with women who deliver at home? If so, is that effect sufficiently robust to remain after controlling for factors such as education, wealth, and urban residence, which are known to be drivers of facility delivery that might also be related to infant care-seeking?

## 2. Materials and methods

The present study was a cross-sectional analysis of data from the 2011 Ethiopia Demographic and Health Survey (EDHS). All data were anonymous and available publically; thus, the study was not subjected to review by an institutional review board. All respondents in the survey participated in an informed consent process pursuant to DHS protocols [7].

The 2011 EDHS is a nationally representative survey of 16 515 women aged 15–49 years and 14 110 men aged 15–59 years. The

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2011 EDHS is the third comprehensive survey conducted in Ethiopia as part of the worldwide DHS project.

Data were obtained from the global DHS website [8], formatted for use in Stata IC version 11.0 (StataCorp, College Station, TX, USA). Data for this analysis were derived from the “births” data set, which includes all female respondents and variables such as demographics, birth history, childhood mortality, knowledge and use of family planning methods, fertility preferences, prenatal care, delivery care, postnatal care, vaccinations, and childhood illnesses.

Among the 16 515 women included in the 2011 survey, 8205 indicated that the interval between their last delivery and the time of the interview was between 12 and 24 months. This interval was chosen to ensure that the woman’s most recent delivery would match the DHS question pertaining to where the most recent delivery occurred, and that the infant would be old enough to have been eligible for all infant immunizations recommended for the first year of life. The sample of 3385 women with valid place of delivery data and whose last delivery was 12–24 months previously was weighted as per DHS analysis instructions [7] to account for the complex survey design of the DHS, yielding a weighted sample of 3334 women.

The present analysis relied on several dependent variables of interest. The first was “place of delivery,” to which there were 9 different response options recorded in the DHS, including respondent’s home, other home, government hospital or polyclinic, government health center, government health station, government health post, private hospital, private clinic, or non-governmental organization health facility. The 9 response options were collapsed into a dichotomous variable: deliveries reported to have occurred at the respondent’s home or at another’s home were combined to yield “facility-based delivery =no,”

and the remaining response options were combined to yield “facility-based delivery = yes.”

Place of delivery also served as an independent variable as a predictor of immunization status, along with the factors listed in Table 1. Demographic factors included age-related variables, education, marital status, wealth, religion, and ethnicity.

In Ethiopia, the vaccination policy calls for BCG vaccine (to prevent tuberculosis) to be given at birth or first clinical contact; 3 doses of DPT-HepB-Hib vaccine (the replacement for DPT vaccine that protects against diphtheria, pertussis, tetanus, hepatitis B, and *Haemophilus influenzae* type b) to be given at approximately 4, 8, and 12 weeks of age; 4 doses of oral polio vaccine given approximately at 0–2, 4, 8, and 12 weeks of age; and measles vaccine to be given at or soon after 9 months of age. The 2011 EDHS collected information on vaccination coverage in 2 ways: from vaccination cards shown to the interviewer, and from mothers’ verbal reports. If a vaccination card was available, the interviewer copied the vaccination dates directly onto the questionnaire. When there was no vaccination card for the child or if a vaccine had not been recorded on the card as being given, the respondent was asked to recall the vaccines given to her child.

The EDHS includes 624 census enumeration areas across Ethiopia, which require cluster weighting prior to analysis. In addition, sample weighting is required to adjust for the differential probability that some individuals are more likely to be sampled than others. Each analytical procedure was preceded with the appropriate weighting codes in Stata to ensure the ability to draw conclusions regarding the target population rather than the sample.

Univariate and bivariate statistics were calculated for demographic variables, and health and health system utilization variables, including

**Table 1**  
Demographic characteristics of EDHS respondents who delivered in the previous year stratified by facility delivery vs home delivery.<sup>a</sup>

Variable	Overall	Facility delivery	Home/non-facility delivery	P value
No. of women	3334	327 (9.8)	3007 (90.2)	
Maternal age, y	28.7 (28.3–29.1)	27.4 (26.3–28.5)	28.9 (28.4–29.3)	0.023
Age at first birth, y	18.9 (18.7–19.2)	20.5 (19.8–21.1)	18.8 (18.5–19.0)	<0.0001
Total no. of births	4.3 (4.1–4.5)	2.8 (2.3–3.3)	4.5 (4.5–4.6)	<0.0001
Education				
None	71.4	37.9	75.1	<0.0001
Primary	24.9	31.4	24.2	
Secondary	2.1	16.3	0.5	
Higher	1.6	14.4	0.2	
Literacy				
Unable to read	81.3	45.4	85.2	<0.0001
Able to read partial sentences	7.9	4.6	8.2	
Able to read full sentences	10.8	50.0	6.5	
Married	89.2	81.3	90.1	0.002
Children <5 y in household				
0	3.4	7.3	3.0	<0.0001
1	25.5	45.5	23.4	
2	55.2	41.8	56.7	
≥3	15.8	5.4	17.0	
Any prenatal care (n = 2066)	43.2	87.7	37.1	<0.0001
Start of PNC				
First trimester	25.3	37.9	21.2	0.009
Second trimester	56.8	51.0	58.7	
Third trimester	17.9	11.2	20.1	
Number of PNC visits				
0	57.0	12.3	63.2	<0.0001
1–3	24.7	23.7	31.6	
≥4	18.3	13.1	56.1	
Wealth index				
Poorest	24.6	4.1	26.8	<0.0001
Poorer	23.9	3.4	26.2	
Middle	18.5	6.8	19.8	
Richer	19.3	13.3	19.9	
Richest	13.7	72.4	7.4	
Covered by health insurance	0.2	1.1	0.1	0.023
Urban residence	12.1	70.4	5.7	<0.0001

Abbreviations: EDHS, Ethiopia Demographic and Health Survey; PNC, prenatal care.

<sup>a</sup> Values are given as number (percentage), mean (95% confidence intervals), or percentage unless stated otherwise.

immunizations. The results were reported overall, and by facility-based or home delivery.

Forward stepwise multivariate logistic regression was conducted to identify the strongest predictors of facility-based delivery. The strongest predictors were then entered into separate regression models with the immunization of interest as the outcome variable and facility delivery as a predictor. In this way, it was hoped to determine the relative impact of delivering in a facility on obtaining immunizations, especially when controlling for variables known to be related to facility delivery that might also be associated with obtaining immunizations. For all analyses, a *P* value of less than 0.05 was considered statistically significant.

### 3. Results

Out of a total weighted sample of 3334 women who delivered a newborn 12–24 months before the 2011 EDHS and had valid place of delivery data, 90.2% delivered at home, whereas 9.8% delivered in a facility (Table 1). Women who delivered in facilities were slightly younger at the time of the survey, were older at their first birth, had fewer total births, had fewer children under 5 years living in their household, were more highly educated, were more likely to have had prenatal care, were more likely to be wealthier, and were more likely to live in an urban area than women who delivered at home.

In the multivariate analysis, the factors most strongly associated with facility-based delivery were level of education, wealth status, urban residence, and number of children under 5 years living in the household (Table 2). Having completed secondary school or being in the richest wealth category each increased the likelihood of facility delivery by approximately 10-fold, and living in an urban area increased the odds of a facility delivery by 7-fold (all *P* < 0.001). Having more than 1 child under the age of 5 years living at home decreased a woman's odds of facility delivery by 40%.

Table 3 illustrates the immunization status of the infants delivered within the previous year, as reported by mothers or determined from their immunization cards. Note that 93% of infants were still alive at the time of the survey, and there was no difference in mortality on the basis of facility or home delivery. The percentage of infants immunized with BCG, DPT-HepB-Hib, polio, and measles was higher among infants delivered in a health facility compared with those delivered at home (all *P* < 0.01).

Logistic regression was carried out with immunization status as the outcome variable, and facility delivery, educational attainment, household wealth, urban residence, and number of children under 5 years in the household as the predictor variables. Even after controlling for education, wealth, urban status, and number of children under 5 years in the household, facility delivery was associated with an increased likelihood of the second and third DPT-HepB-Hib immunizations, the first and third polio vaccines, the measles vaccination, and the likelihood of being fully immunized (all *P* < 0.01; Table 4). Facility delivery was the

**Table 2**  
Multivariate logistic regression model for strongest correlates of facility-based delivery.

Variable	Odds ratio (95% CI)	<i>P</i> value
Education		
None	Ref.	
Primary	1.3 (0.7–2.3)	0.45
Secondary	10.4 (3.3–33.4)	<0.001
Higher	17.0 (4.4–66.1)	<0.001
Wealth category		
Poorest	Ref.	
Poor	0.7 (0.2–2.7)	0.6
Medium	2.2 (0.8–5.7)	0.12
Rich	2.9 (1.1–7.7)	0.03
Richest	9.6 (3.9–23.7)	<0.001
Urban residence	7.3 (3.7–14.2)	<0.001
Children <5 y in household	0.59 (0.4–0.8)	<0.001

Abbreviation: CI, confidence interval.

**Table 3**  
Relationship between facility delivery and infant immunization.<sup>a</sup>

Variable	Percentage of respondents (n = 3334)	Facility delivery (n = 327)	Home/non-facility delivery (n = 3007)	<i>P</i> value
Child alive	93.2	94.6	93.1	0.478
Infant immunizations				
BCG	64.3	85.1	62.0	0.0007
DPT-HepB-Hib 1	60.7	82.2	58.3	0.0007
DPT-HepB-Hib 2	52.0	75.5	48.5	<0.0001
DPT-HepB-Hib 3	35.4	62.5	32.4	<0.0001
Polio 0	15.9	57.6	11.2	<0.0001
Polio 1	81.3	92.3	80.1	0.004
Polio 2	71.7	88.6	69.8	<0.0001
Polio 3	48.0	66.3	45.9	<0.0001
Measles	54.5	79.8	51.7	<0.0001
Fully vaccinated	25.9	55.0	22.6	<0.0001

<sup>a</sup> Values are given as a percentage unless stated otherwise.

strongest single factor associated with infants being fully immunized, doubling the odds of full immunization.

### 4. Discussion

The present results suggest that facility-based delivery is linked to increased infant immunization rates, even after controlling for education, wealth, urban status, and number of children under 5 years in the household, and even for immunizations that are given months after delivery.

These results are similar to previous research suggesting that missed opportunities for immunization are more common with home deliveries [9,10], place of delivery is linked to immunization coverage [11–13], and full immunization status is linked to close proximity to a health facility [14]. However, the present study differs in that we explicitly controlled for factors that might be associated with both facility delivery and increased health service utilization in exploring the relationship between facility delivery and infant immunizations, including maternal education, household wealth, urban status, and number of children under 5 years living in the household. In addition, the present study focused on data from the most recent wave of the EDHS, reflecting the most up-to-date information available on both facility delivery and national immunization rates.

Despite its strengths, the study has limitations. First, the EDHS data set does not facilitate nuanced exploration of the drivers of health-seeking behavior. Thus, the study was not able to investigate the reasons that mothers might have for seeking immunizations for their infants, beyond the associations with demographic variables such as education, wealth, and urban status. It is possible that infant immunizations are driven by a factor aside from facility delivery that is not captured in the EDHS. Second, fewer than 10% of women in the EDHS sample delivered in a facility. These observations might change as more women choose facility delivery. Last, the DHS relies on a combination of maternal recall and checking immunization cards to verify infant immunization status. Maternal recall is likely to be inaccurate, and the present findings should be interpreted with this possibility in mind.

The present study was conducted in 1 country in eastern Africa in a setting where very few women seek facility delivery. Thus, the generalizability of these findings is not clear, and further research is warranted to explore whether this association holds in countries that have a higher rate of facility delivery or better overall immunization coverage compared with Ethiopia.

The present findings have several implications. First, they suggest that encouraging facility delivery not only has the potential to decrease maternal mortality and early neonatal mortality associated with delivery-related events, but also might have a role in influencing new mothers to seek vaccinations for their infants in the weeks and months following delivery. Although the study data did not allow an exploration

**Table 4**  
Logistic regression analysis of predictors of obtaining infant and child immunizations.

Factor	Odds ratio for immunization									
	BCG	DPT-HepB- Hib 1	DPT-HepB- Hib 2	DPT-HepB- Hib 3	Polio 0	Polio 1	Polio 2	Polio 3	Measles	Fully immunized
Delivery in a facility	NS	NS	1.8 <sup>a</sup>	1.8 <sup>a</sup>	5.0 <sup>c</sup>	NS	2.1 <sup>a</sup>	NS	1.8 <sup>a</sup>	2.2 <sup>b</sup>
Educational attainment	1.76 <sup>b</sup>	1.8 <sup>c</sup>	1.7 <sup>c</sup>	1.3 <sup>b</sup>	1.3 <sup>b</sup>	1.5 <sup>c</sup>	1.6 <sup>b</sup>	NS	1.6 <sup>b</sup>	NS
No. of children <5 y in household	0.77 <sup>b</sup>	NS	NS	NS	NS	0.7 <sup>b</sup>	NS	NS	0.8 <sup>a</sup>	NS
Wealth	NS	1.13 <sup>a</sup>	1.16 <sup>a</sup>	1.2 <sup>b</sup>	NS	NS	NS	1.1 <sup>a</sup>	NS	NS
Urban status	NS	NS	NS	NS	NS	NS	NS	1.6 <sup>a</sup>	NS	NS

Abbreviation: NS, not significant.

<sup>a</sup>  $P < 0.05$ .

<sup>b</sup>  $P < 0.01$ .

<sup>c</sup>  $P < 0.001$ .

of the mechanism of action, it seems that women who deliver in facilities experience an interaction with the healthcare system that fosters future care-seeking for their infants. This additional care-seeking has enormous implications for overall infant and child mortality, because vaccinations are known to be one of the best strategies to prevent mortality among infants and children under 5 years.

Further research is needed on the sociocultural, ethnic, and regional factors affecting both facility delivery and infant immunization in Ethiopia and throughout Sub-Saharan Africa. Whereas many studies have documented the logistic and social factors that affect facility delivery [15–18], few have explored the relationship between facility delivery and immunization in a robust manner. The present study suggests that such an investigation is warranted to enhance our understanding of how interactions with providers in a healthcare setting may influence women to seek further care for their infants and perhaps themselves, long after their delivery is over.

### Conflict of interest

The authors have no conflicts of interest.

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