Understanding the Three Delays among Postpartum Women at Health Facilities in Nepal

Further Analysis of the Nepal Health Facility Survey 2021

Sara Riese
Rabina Dhakal

Government of Nepal
Ministry of Health

Understanding the Three Delays among Postpartum Women at Health Facilities in Nepal

Further Analysis of the Nepal Health Facility Survey 2021

Sara Riese[1]
Rabina Dhakal[2]

ICF
Rockville, Maryland, USA

June 2023

[1] ICF, The DHS Program
[2] CARE Nepal

Corresponding author: Sara Riese, The DHS Program, ICF, 530 Gaither Road, Suite 500, Rockville, MD 20850, USA; phone: +1 301-407-6500; fax: +1 301-407-6501; email: sara.riese@icf.com

Recommended citation:

Riese, Sara, and Rabina Dhakal. 2023. *Understanding the Three Delays among Postpartum Women in Nepal*. DHS Further Analysis Report No. 144. Rockville, Maryland, USA: ICF.

CONTENTS

TABLES

FIGURES

ABSTRACT

This report examines the levels and determinants of the three delays model among postpartum women at health facilities in Nepal. Measures of each delay—the delay in deciding to come to a health facility (delay 1), the delay in getting to a health facility (delay 2), and the delay in seeing a health care worker after arriving at a health facility (delay 3)—were estimated from the postpartum exit interview in the 2021 Nepal Health Facility Survey (NHFS). Sociodemographic characteristics of the women and facility characteristics were included in logistic regression models to identify determinants of each delay. The most common delay was delay 2, which occurred among 47% of women. Delay 1 occurred among 11% of women, while delay 3 occurred among 6% of women. The levels of delays 1 and 2 were similar to levels in 2017, although there was a reduction in delay 3 since the 2017 NHFS. Women with basic education had higher odds of delay 1, while those with higher education had lower odds of experiencing delay 3 compared to women with no education. Women who experienced any danger signs before arriving at the health facility had higher odds of experiencing delays 1 and 2. Being accompanied to the facility by a non-husband, parent, relative, or friend was associated with lower odds of experiencing delay 2 than when being accompanied by a husband. Women who delivered at a facility with a higher level of physical resources—drugs, equipment, and commodities—had lower odds of experiencing delay 3. There were also some geographic differences, with women delivering at facilities in Lumbini Province having higher odds of delay 1, and women in Madhesh and Lumbini Province having lower odds of delay 2 compared to women delivering in facilities in Koshi Province. Characteristics associated with delays were similar for women delivering at any facility compared to women delivering only at hospitals. These findings demonstrate that nearly half of postpartum women who delivered at a health facility in Nepal experience one of the three delays, and the result can begin to shed light on which programs and policies may contribute to reductions in these delays.

Keywords: Maternal health, maternal mortality, Nepal

1 INTRODUCTION

Nepal's maternal mortality ratio (MMR) has been decreasing, although the rate of decrease has slowed in recent years. In 1996, the MMR was estimated at 543 women per 100,000.[1] Over the next ten years, this decreased to 281 per 100,000 in 2006, and in the next 10 years, to 239 per 100,000 in 2016.[2]

The three delays model was developed in 1994 as a way to understand and quantify the factors that contribute to maternal mortality by delaying prompt, adequate treatment for a pregnant woman.[3] Thaddeus and Maine classified these factors into three categories:

- Delay in the decision to seek care
- Delay in the arrival at a health facility
- Delay of the provision of adequate care after she reaches a health facility

This model has been used extensively in the maternal health literature to better understand factors in maternal mortality.[4–11] Most previous studies that used the three delays model have been qualitative[12] and/or retrospective (maternal death or near miss audit).[13–15] A limited number of studies have assessed the three delays quantitatively, either among a sample of postpartum women[11] or among pregnant women with a high risk of maternal mortality.[16]

Previous research has identified reasons for the stagnation in the maternal mortality rates in Nepal. These include supply side challenges such as inadequate human resources, poor infrastructure, inaccessible health facilities, and negative provider attitudes, as well as demand side issues such as lack of perceived need and lower utilization by poorer families.[13] These challenges can also be linked to the three delays. Lack of perceived need can contribute to the first delay, inaccessible health facilities to the second delay, and inadequate human resources caused by poor allocation of human resources, absenteeism, or low motivation to serve in remote areas to the third delay. Within one tertiary care center in Eastern Nepal, a retrospective study among women who died during their care at the facility showed that over 40% of the deaths were associated with the first delay, 24% with the second delay, and 21% with the third delay.[17]

Given that 15% of all pregnant women will experience acute severe intrapartum complications[18–20] and that these complications are difficult to predict in advance,[21] it is important to understand the prevalence of these delays among all pregnant women and not only among those women who experienced a maternal death or a near miss. Despite the stagnating MMR and identification of these contributing factors, we were unable to identify any previous research that quantified the levels of each delay among the general population of pregnant women in Nepal or explore the client or facility characteristics associated with the delays.

Therefore, this study used the 2021 Nepal Health Facility Study to answer the following research questions:

- What are the levels of each of the three delays in Nepal?
- What are the client and/or facility characteristics associated with each delay?

The report provides valuable information on where interventions can be targeted to reduce the three delays and the MMR in Nepal.

2   DATA AND METHODS

2.1   Data

This study uses data from the postpartum client exit interview of the Nepal Health Facility Survey 2021 (NHFS 2021). The client exit interview is conducted with women who delivered their children in one of the health facilities in the survey. Women who gave birth at one of the surveyed facilities but were referred from other health facilities were excluded from the analysis because the survey did not have a mechanism for identifying if those women had experienced delay in reaching the original health facility. We did not have information about the referring facilities to include in the analysis. Likewise, women who died or had experienced serious injury during delivery were excluded. In total, 306 postpartum women from 65 health facilities were included in this analysis. Table 1 shows the weighted sample size used for this study.

Table 1   **Sample size of facilities and clients observed, 2021 Nepal Health Facility Survey**

	Hospitals	Health Centers	Total
Number of labor and delivery facilities[1]	103	701	804
Number of labor and delivery facilities with postpartum (PP) clients interviewed[2]	43	22	65
Number of PP clients interviewed[2]	283	23	306

[1]Excludes HIV testing and counseling (HTC) stand-alone labor and delivery facilities
[2]Excludes 13 PP women who had been referred from other facilities

2.2   Measures

2.2.1   Delay variables

There is no standard approach for calculating each delay. In quantitative studies, delays are typically measured by the amount of time elapsed, such as between the recognition of a complication or the need to go to a health facility and the decision to go to the facility for delay 1.[11,16] In this study, we had time measurements for the second and third delay, but not the first.

Measurement of the first delay, delay in the decision to seek care, was taken from the responses to two questions in the client exit interview. The first question was "*Do you think the decision to come or to send you to this facility for the delivery was taken at the right time?*" The responses "yes" and "no" were categorized as "no delay" and the response "wanted to come earlier" was categorized as "delay." In addition, a woman who did not respond that she wanted to come earlier, but answered the question *"At what stage did you (or someone else) decide you would come/be sent to this facility?"* with either "after 12 hours of complication" and "following postpartum complications," was also categorized as having had the first delay, while other responses in the questions were categorized as "no delay."

The variables for second delay, delay in the arrival at health facility, were obtained from two questions with the first, *"If you come to this facility directly from your home, how long does it take to get here?"* A woman who reported that it takes longer than an hour to reach the facility was categorized as having the

second delay, while less than an hour was categorized as "no delay." One hour of travel time has been used as the cutoff for previous research that estimated delay 2.[11]

For the third delay, the delay of the provision of adequate care after a woman reaches a health facility, we used the question, *"How long did you have to wait from when you first arrived until you were first assessed by a provider?"* A woman who reported that she waited an hour or more to be assessed by a provider was categorized as having delay 3. If she waited less than an hour, the woman was categorized as not having delay 3. One hour of waiting time has been used as the cutoff for previous work that estimated delay 3.[11]

2.2.2 Client variables

Sociodemographics can affect decisions to seek health care, a woman's ability to identify transportation to reach a health facility, and her treatment after arriving at the health facility. Hence, different socio-demographic variables that were associated with delays were included in the analysis. These variables are:

Age: Clients' age was categorized into "less than 20," "age 20–24," "age 25–29," and "age 30 and older."

Education: The education of client was categorized as "none or did not pass grade 1," "basic level," "secondary level," and "bachelor or above."

Caste: Different castes reported by respondents were categorized as "Brahman/Chhetri," "Terai/Madhesi," "Dalits," "Janajati," and "other." The categorization of caste was done using the NDHS categories.

First delivery: Categorized as "first delivery" and "not first delivery."

Decision maker: The person who made the decision for the woman to come to the facility was categorized as "self," "husband," "parents/parents-in-law," and "other relatives or health workers." This question allowed for multiple responses. If a woman indicated that she made the decision, that response took precedence; those women who did not make the decision themselves and indicated that their husband decided were then categorized as having the husband make the decision. The women who indicated that their parents or parents-in-law made the decision were categorized as such. The remaining women who stated that neither they, their husbands, nor their parents or parents-in-law made the decision to come to the health facility were grouped together as "other relatives or health workers."

Mode of transportation: Different modes of transportation used by clients to reach to the health facility were categorized as "auto-vehicle and ambulance," "rickshaw/bicycle," "on foot," and "others." "Others" included stretcher, doko, hand cart or wheelbarrow, animal driven cart/tanga, or any other mode.

Person accompanying women to the facility: The responses were categorized into "husband," "mother/father/in-laws," and "other relatives or friends." This question allowed for multiple responses, so that if a woman indicated that her husband accompanied her to the facility, that took precedence; and if the woman indicated that their mother, father, or in-laws accompanied them, they were categorized as such. The remaining women who were not accompanied by their husband or mother/father/in-laws were grouped together as "other relatives or friends."

Danger signs: Women were categorized as "having danger signs" if they responded "Yes" to the question, *"Did you experience any danger signs/have complications before arriving at the facility?"*

Aware of transport incentive: The women who stated that they were aware of a transport incentive were categorized as "aware of transport incentive" and those who were not aware were categorized as "not aware of transport incentive."

Aware that delivery is free at health facility: The women who were aware that delivery is free at health facilities were categorized as "aware that delivery is free" and those who were not aware were categorized as "not aware that delivery is free."

Difficulties in decision making: We were also interested in other non-sociodemographic variables that might have been related to the delays. The question, *"What difficulties did you face at home/in the community while taking decision to this facility for delivery?"* had the following response categories: "difficulty obtaining permission from household members," "difficult to find money to cover costs," "no one available to accompany," "no one for child care," "other difficulty," or "no difficulties." The question *"What difficulties did you face on the way to the facility?"* had the following response categories: "travel time too long," "difficult to travel," "difficult to find transport means," "difficult to find money to cover costs/transportation cost expensive," and "no one available to accompany," "other difficulty," or "no difficulty."

Reason for delivering at a health facility: The reason a woman decided to deliver at a health facility may contribute to her experience of any delays. We used the following response categories for the question *"Why did you decide to deliver in a health facility?":* "free care," "transportation incentives," "safer than home delivery," "to have a skilled birth attendant or because of female staff," "health worker advised me," "had complications/experienced danger signs," "clients are well treated," "nearby facility," "good reputation," and "other reason."

2.2.3 Facility variables

In addition to sociodemographic variables, facility characteristics have been shown to influence the experience of delays. Thus, we included different facility variables in the analysis:

Location of facility: Location of the health facility was categorized as "rural" and "urban."

Province: The categorization was based on the "seven provinces of Nepal" as identified in the NDHS. Since Province 1 has been named Koshi, this name was applied to Province 1 in this report, although it does not appear in the NDHS.

Ecoregion: Facilities were categorized by location in a specific ecological region of Nepal, which included "mountain," "hill," and "terai."

Facility type: All Federal/provincial, local, and private hospitals were grouped together as "hospitals," while primary health care centers and basic health centers were grouped together as "health center."

Managing authority: All NGO/private not-for-profit facilities, private for-profit facilities, and mission/faith-based hospitals were grouped together as "private." Government/public facilities were classified as "public."

Availability of provider for 24 hours: Facilities that provide 24-hour maternity services were categorized as "yes," and those not having 24-hour maternity services as "no."

Terciles of dedicated maternity beds: The number of beds available in the health facility was divided into terciles based on the number of dedicated maternity beds in labor and delivery facilities.

Facility structural quality: We constructed two measures of a facility's structural quality. The first includes the availability of physical resources, such as equipment, medicines, and commodities necessary for delivery. The second measure includes human resources, including the availability of qualified and trained staff. These measures were used in previous studies that measured structural quality for labor and delivery using SPA data.[22] Details on the specific items included in each of these measures are included in Appendix Table 1.

2.3   Statistical analysis

In this study, we described women who experienced delay in deciding to seek delivery care, delay in reaching health facility, and delay in receiving care from the health facility. We first compared the levels of each delay from the NHFS 2021 with the NHFS 2015. We then identified the client and facility factors associated with the three delays, first by using crosstabulations, and then by estimating multivariable logistic regression models. Covariates were checked for multicollinearity before inclusion in the model. The multivariable logistic regression models were also estimated for the subsample of women who delivered at hospitals to ascertain if the factors associated with each delay were different among these women compared to women who delivered at any facility. Variables on specific difficulties the women experienced while attempting to seek care were not included in the multivariable models because of small cell sample size and unstable estimates. Instead, we looked at associations with delays for these variables using separate crosstabulations. We used Stata 17 for all calculations. For all tests, statistical significance was set at $p < .05$. All data are weighted and the *svyset* commands in Stata were applied to account for the complex, clustered sampling design of the survey.

3   RESULTS

Nearly a third of postpartum women interviewed were between age 25 and 29, and nearly 40% had a secondary level of education. There was a relatively even number of nulliparous women and women who had previously given birth. Appendix Table 2 shows the distribution of client characteristics in the analytic sample.

The analysis found that 14% of women had experienced a danger sign before arriving at the health facility. Over 90% of women went to a hospital for delivery or postpartum care, and just under 80% went to a public facility. The most cited reason for delivering at a facility was that it was safer than a home delivery (70%), while the next most cited reason was the free care (28%).

3.1   Delays over time

3.1.1   Delay 1—Delay in deciding to go to a health facility

Overall, 11% of postpartum women interviewed in 2021 experienced a delay in the decision to go to a health facility. Figure 1 and Appendix Table 3 show that this is statistically equal to the 9.4% (95% CI [6.0, 14.5%]) of postpartum women interviewed in 2015 who experienced a delay in the decision to go to a health facility.

Figure 1   **Trends in the prevalence of each delay among postpartum women delivering in health facilities, 2015 NHFS and 2021 NHFS**
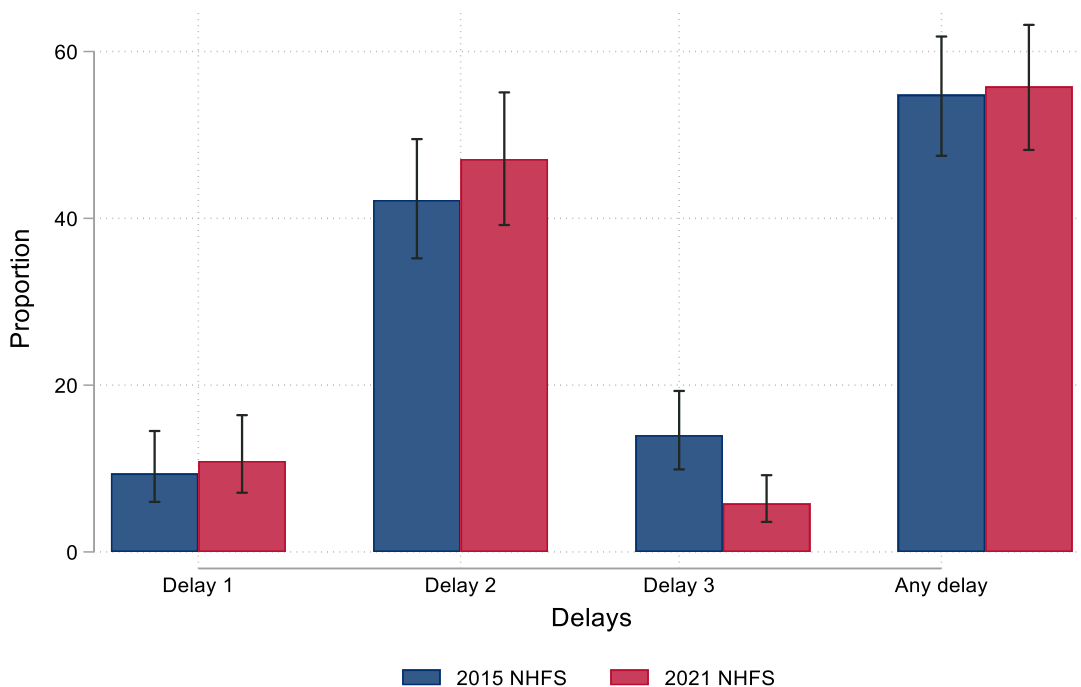
3.1.2 Delay 2—Getting to a health facility

Over forty-seven percent (47.1%) of all postpartum women interviewed in 2021 experienced a delay in getting to a health facility. There is statistically no difference between this result and the 2015 finding of 42.2% (95% CI [35.2, 49.5%] of women experiencing delay 2. The average time to reach the facility was just over 2 hours (2.05 hrs (95% CI [1.3, 2.8])).

3.1.3 Delay 3—Being seen by a health care worker after arriving at a facility

Just under six percent (5.8%) of women interviewed in 2021 experienced a delay of at least one hour to be seen by a health care worker after arriving at a health facility. This is a decrease from 2015 when 14.0% of postpartum women interviewed experienced delay 3. The average time that a woman waited to be seen by a health care worker after reaching the facility was 29 minutes (28.9 minutes (95% CI [11.0, 46.8]).

3.2 Crosstabulations

3.2.1 Delay 1—Delay in deciding to go to a health facility

Most client characteristics were not significantly associated with a delay in the decision to go to a health facility (Table 2). Just over a quarter of women (27%) who experienced any danger signs before arriving at a health facility experienced a delay in deciding to go to a health facility compared with 8% of women who did not experience any danger signs.

Table 2   Percentages of clients who had a delay, by client and facility characteristics

	Delay 1			Delay 2			Delay 3		
	%	95% CI	*p* value	%	95% CI	*p* value	%	95% CI	*p* value
Overall	10.9	7.1–16.4		47.1	39.2–55.1		5.8	3.6–9.2	
Client									
Age									
<20	10.0	3.0–28.2		67.2	42.6–85.0		3.1	0.4–20.7	
20–24	8.0	4.7–13.5		51.1	41.5–60.7		6.9	3.7–12.4	
25–29	10.0	4.7–20.0		44.5	31.1–58.9		5.7	2.4–12.8	
30+	19.1	9.9–33.6		32.9	21.4–46.9		4.6	1.6–12.6	
Education						**			*
None or did not pass grade 1	10.3	4.0–24.3		38.9	24.9–54.9		14.1	6.3–28.5	
Basic level	13.0	7.2–22.4		63.5	51.1–74.3		5.1	2.3–10.7	
Secondary level	8.7	4.1–17.6		43.2	32.0–55.1		2.5	0.8–7.5	
Bachelor or above	12.6	5.0–28.4		25.4	13.6–42.3		7.0	1.6–26.0	
Caste									
Brahman/Chhetri	13.1	7.3–22.5		47.4	31.7–63.7		7.4	3.6–14.7	
Terai/Madhesi	9.7	4.7–19.2		45.7	33.7–58.3		4.4	1.6–11.1	
Dalits	12.1	5.6–24.2		60.3	39.0–78.3		5.6	1.4–19.6	
Janajati	8.4	3.8–17.7		47.0	33.2–61.4		4.8	1.8–11.9	
Other	15.4	5.6–35.8		27.9	12.0–52.5		10.9	3.3–30.2	
First delivery									
No	14.1	7.7–24.4		41.6	32.0–51.9		5.2	2.7–9.7	
Yes	7.8	4.4–13.5		52.2	42.0–62.3		6.4	3.4–11.7	
Experienced any danger signs before arriving at facility			***						
No	8.3	5.2–13.0		45.9	37.1–54.8		6.3	3.9–10.3	
Yes	26.7	14.4–44.0		54.5	39.3–68.9		2.5	0.6–10.2	
Decision maker									
Self	10.0	5.9–16.3		45.9	35.5–56.6				
Husband	13.7	6.3–27.4		46.4	32.9–60.4				
Parents/parents-in-law	11.8	3.8–31.1		55.8	37.6–72.6				
Other relatives or health worker	7.2	0.7–46.0		49.8	19.4–80.3				
Mode of transportation									
Auto-vehicle and ambulance	11.4	7.2–17.6		48.6	40.1–57.3				
Rickshaw/bicycle	15.9	4.5–43.5		33.2	16.4–55.8				
Others	0.0	0.0–0.0		48.5	18.9–79.2				
Who accompanied woman to facility									
Husband				49.0	40.1–58.0		4.8	2.6–8.6	
Parents/parents-in-law				45.0	31.6–59.2		7.3	2.8–17.7	
Other relatives or friend				30.1	11.9–57.8		12.8	3.4–37.7	
Facility									
Location of facility									
Urban	0.0	0.0–0.0		45.9	38.1–53.9		5.8	3.6–9.4	
Rural	11.3	7.4–17.0		75.5	17.6–97.8		5.0	0.2–62.9	
Province						*			
Koshi (Province 1)	2.4	0.3–18.9		67.2	47.4–82.3		5.1	1.7–14.5	
Madhesh (Province 2)	11	4.7–23.6		34.4	21.8–49.6		3.8	1–13.1	
Bagmati (Province 3)	9.5	3.6–23.1		38.7	22.0–58.4		3.4	0.4–24.7	
Gandaki (Province 4)	8.8	0.9–50.5		59.9	28.1–85.1		0.0	0.0–0.0	
Lumbini (Province 5)	20.5	12.4–31.9		36.4	25.1–49.4		9.2	4.3–18.8	
Karnali (Province 6)	0.0	0.0–0.0		80.0	66.5–89.0		5.0	1.8–13.2	
Sudurpashchim (Province 7)	9.9	1.8–39		50.9	24.2–77.1		7.8	1.8–28.3	
Ecoregion									
Mountain	15.1	4.4–40.4		55.3	26.2–81.2		13.7	0.9–73.7	
Hill	8.5	3.8–17.8		56.7	41.4–70.9		5.8	2.5–13.1	
Terai	11.7	6.9–19.2		42.7	33.7–52.2		5.5	3.0–9.8	
Facility type									
Hospitals	11.8	7.7–17.7		47.2	39.2–55.3		5.9	3.5–9.5	
Health centers	0.0	0.0–0.0		45.5	15.5–79.2		5.2	1.2–19.8	
Managing authority									
Private	9.1	4.0–19.7		49.1	28.7–69.8		3.8	1.2–11.3	
Public	11.3	6.9–18.1		46.5	38.4–54.8		6.4	3.8–10.6	

Continued…

9

Table 2—_Continued_

	Delay 1			Delay 2			Delay 3		
	%	95% CI	_p_ value	%	95% CI	_p_ value	%	95% CI	_p_ value
Tertiles of maternity beds									
1							6.2	2.8–13.1	
2							5.1	1.8–13.5	
3							6.0	2.5–14.1	
Facility structural quality (mean)							0.9	0.8–0.9	
Facility human resource quality (mean)							0.4	0.2–0.5	

$*p < .05, **p < .01, ***p < .001$

Table 3 shows disparities in the occurrence of delay 1 by experience of difficulties deciding to come to the facility, difficulties getting to the facility, and other factors. There were significant differences by having difficulties finding money for travel costs ($p < .01$) and finding travel difficult ($p < .05$).

Table 3   Crosstabulation of women experiencing each delay by explanatory variables

	Delay 1			Delay 2			Delay 3		
	Delay			Delay			Delay		
	%	95% CI	_p_ value	%	95% CI	_p_ value	%	95% CI	_p_ value
Experienced at least one of the below difficulties in deciding to come to facility	8.2	0.5–61.3		100.0		**			
Difficulties in getting permission to come to facility	100.0			100.0					
Difficulties in obtaining money to come to facility	10.0	0.4–76.0		100.0		**			
Difficulties in finding someone to accompany to facility	100.0			100.0					
Experienced at least one of the below difficulties in traveling to facility	20.9	8.1–44.1		93.7	73.0–98.8	***			
Finding travel means	100.0			100.0		*			
Finding money/travel costs	29.8	14.4–51.6	**	100.0					
Time was too long	11.4	2.0–44.9		94.0	49.0–99.6	***			
Difficult to travel	30.4	7.9–68.8	*	95.4	57.0–99.7	***			
Reasons for deciding to deliver at facility									
Free care	10.2	4.6–20.9		44.9	30.9–59.8		8.6	4.1–17.3	
Transportation incentives	17.3	4.6–47.8		40.5	19.8–65.2		15.6	3.9–45.7	
Safer than home delivery	10.2	6.4–16.0		47.7	38.4–57.1		6.8	3.8–11.7	
To have a skilled birth attendant or because of female staff	10.7	5.9–18.7		37.7	25.3–52.0		6.6	2.8–14.7	
Health worker advised me	9.2	3.8–20.6		65.2	50.0–77.8	*	4.6	1.3–14.8	
Had complications	27.0	3.4–79.5		62.1	16.5–93.1		11.3	0.7–70.1	
Clients are well treated	17.2	4.0–50.8		28.9	8.5–64.0		100.0		
Nearby facility	16.1	7.7–17.7		19.9	8.8–39.0	**	6.1	1.7–19.6	
Good reputation	2.6	0.3–19.1		57.6	32.6–79.2		1.3	0.2–10.2	
Aware of free delivery care	10.6	6.2–17.6		43.6	34.2–53.4				
Aware of transportation incentive payments	77.1	57.9–89.1		60.4	46.6–72.8				

$*p < .05, **p < .01, ***p < .001$

3.2.2   Delay 2—Getting to a health facility

Table 2 also shows the crosstabulation of women's characteristics with the experience of delay 2. Women with a bachelor's degree or above had the lowest percentage of delays in getting to a health facility

(25%), while women with a basic level of education had more than double that percentage (64%). Over three quarters (80%) of women in Karnali Province experienced delays in getting to a health facility for delivery compared with 34% in Madhesh Province.

There were disparities in the occurrence of delay 2 by other contextual factors (see Table 3). There were significant differences by finding it difficult to travel ($p < .001$). Women who experienced any difficulties in deciding to come to the facility were more likely to have delay 2 ($p < .01$) and specifically, those who had difficulties in obtaining money to come to the facility ($p < .01$). Nearly all postpartum women (94%) who had at least one difficulty getting to the health facility experienced delay 2, a significant difference compared to women who did not ($p < .001$). Among the specific difficulties, there were significant differences in the experience of delay 2 by difficulties finding the means to travel ($p < .05$), feeling that the travel time was too long ($p < .001$), and finding it difficult to travel ($p < .001$). There were also differences in the experience of delay 2 by reasons that a woman decided to deliver at a health facility. Over half of women (65.2%) who cited advice of a health care worker as a reason for deciding to deliver at a facility experienced delay 2 ($p < .05$). In addition, only 20% of women who said that the facility was nearby was the reason for deciding to deliver at the facility, a significant difference from those who did not give this reason ($p < .01$).

3.2.3 Delay 3—Being seen by a health care worker after arriving at a facility

Crosstabulation of the client's sociodemographic characteristics, and the facility and provider level variables with delay in being seen by a health care worker after arriving at a facility is also shown in Table 2. The variables were not significantly associated with delay 3 except for education. The women who had no education or had not passed grade one had the highest percentages of delay of being seen by a health care worker after arriving at a facility (14.1%), while women with a bachelor's degree or above had half of that (7%). The lowest percentages of experiencing delay in being seen by health care worker were women with a secondary level education (2.5%). Women who had experienced any danger sign before arriving at facility had a higher percentage of experiencing delay (6.3%) compared with those who had not experienced the danger signs before arriving to health facility (2.5%). However, this finding was not statistically significant.

There was no significant difference by other contextual factors for women who experienced delay in being seen by a health care worker after arriving at a health facility (see Table 3).

3.3 Multivariable regression analysis

3.3.1 Delay 1—Delay in deciding to go to a health facility

In the multivariate regression results (see Figure 2 and Appendix Table 3), very few covariates are statistically significantly associated with a delay in deciding to go to a health facility. Having a basic level of education increases the odds of this delay by 4.5 times when compared with having no education. Experiencing any danger signs increases the odds of delay 1 by over 5 times compared to women who experienced no danger signs. In addition, when compared with women who delivered at facilities in Koshi Province, women who delivered in facilities in Lumbini Province had higher odds of delay 1 (*aOR* = 13.6). Small sample sizes in some provinces led to very large confidence intervals. The same pattern of regression results is seen among women who delivered in hospitals (see Appendix Table 4). The figures

with the regression results show only statistically significant findings. The results for the non-significant variables are shown in Appendix Table 3.

Figure 2   Covariates significantly associated with delay 1
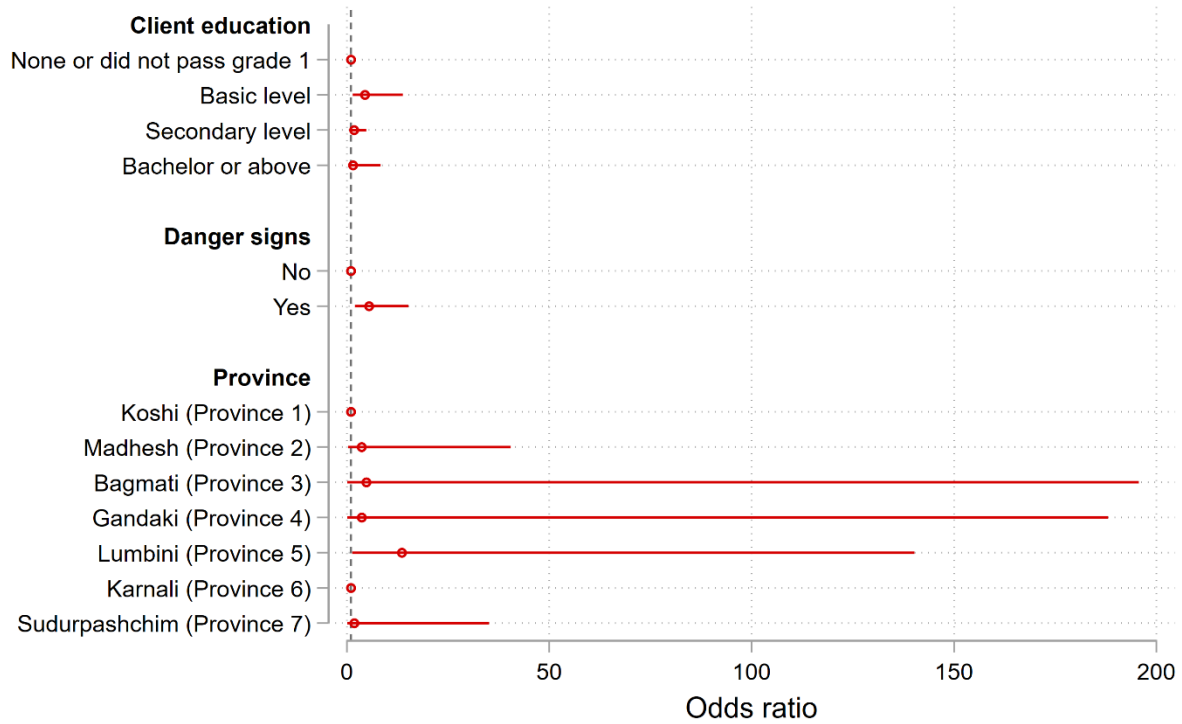
3.3.2   Delay 2—Getting to a health facility

Figure 3 and Appendix Table 3 show that very few client or facility variables were associated with the delay in getting to a health facility in multivariate regression analysis. Women who were accompanied to the health facility by a relative or friend had lower odds of experiencing this delay compared to women who were accompanied by their husband ($aOR = 0.20$). Women who experienced any danger signs before arriving at the facility had over 2.5 times the odds ($aOR = 2.51$) of experiencing a delay in getting to a health facility compared to those who did not. In addition, women who gave birth at facilities in Madhesh ($aOR = 0.26$) or Lumbini Province ($aOR = 0.26$) had lower odds of experiencing this delay compared to women who gave birth in Koshi Province. A similar pattern is seen among women who delivered in hospitals (see Appendix Table 4), with lower odds of experiencing delay 2 among those who were accompanied by another relative or friend rather than her husband and higher odds among those who experienced any danger signs before reaching the facility. Among women at hospitals, the mode of transportation was also significantly associated with the experience of a delay getting to a health facility. Women who traveled to the facility by foot, in an animal cart, hand cart or wheelbarrow, or on a stretcher had lower odds of experiencing a delay compared to women who traveled to the facility in a car or ambulance ($aOR = 0.09$). There were also no differences between the provinces among women who delivered in hospitals.

Figure 3   Covariates significantly associated with delay 2
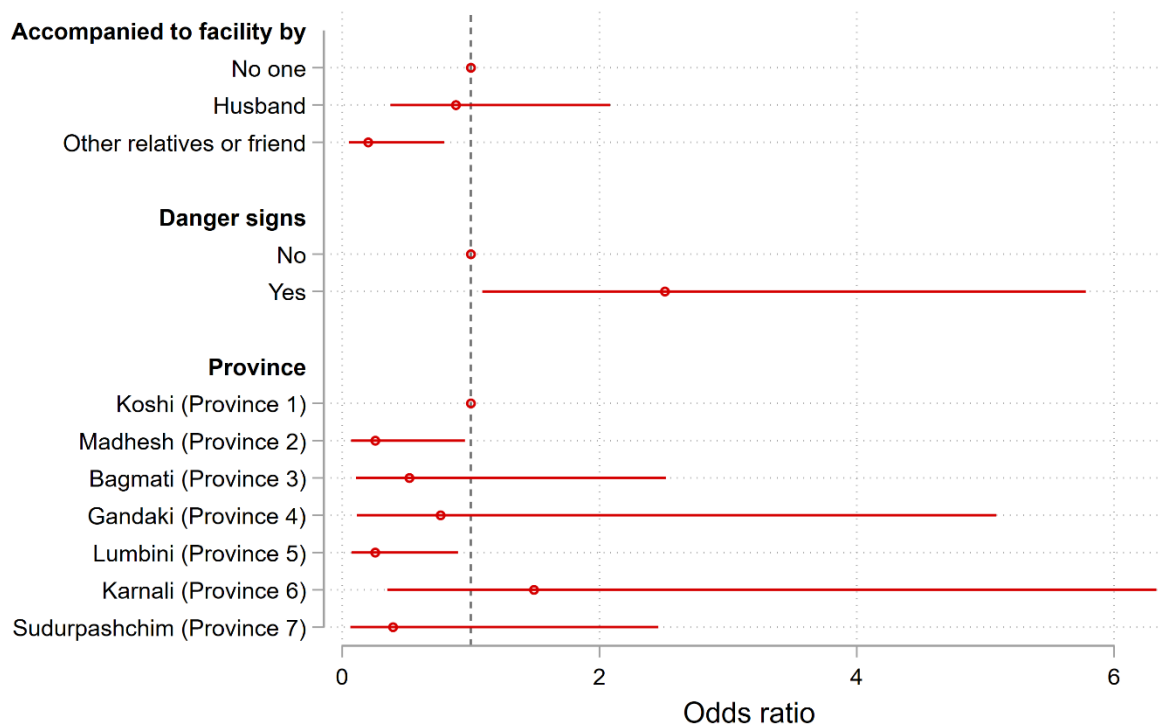
3.3.3   Delay 3—Being seen by a health care worker after arriving at a facility

In the multivariate regression analysis (see Figure 4 and Appendix Table 3), women with higher education had lower odds (basic level $aOR = 0.14$, secondary level $aOR = 0.06$) of experiencing a delay in being seen by a health care worker after arriving at a health facility as compared to women who had no education. In addition, the structural quality had an effect on experiencing delay, with women who delivered at a facility with better structural quality having lower odds of experiencing a delay in seeing a provider ($aOR = 0.0001$). For the women who delivered at a hospital, women giving birth for the first time had four times higher odds ($aOR = 3.62$) of experiencing delay in being seen by a health care worker after arriving at a health facility as compared to women who reported of having non-first delivery (see Appendix Table 4). The same pattern of decreasing odds of delay with increasing education was observed among women who delivered at hospitals. Women who delivered at hospitals in Bagmati Province had lower odds ($aOR = 0.06$) of experiencing a delay in being seen by a health care worker after arriving at a health facility compared to women who delivered at hospitals in Koshi Province.

Figure 4   Covariates significantly associated with delay 3
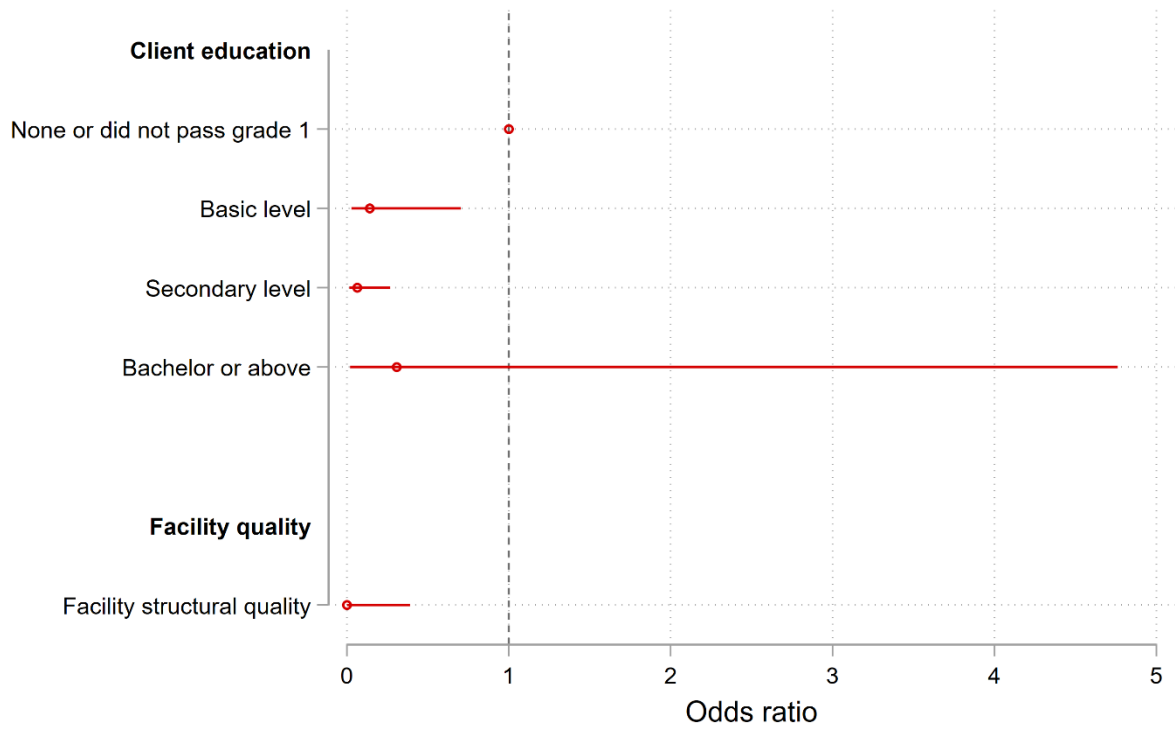
4   SUMMARY AND RECOMMENDATIONS

This analysis showed the levels and determinants of each delay among postpartum women who delivered at health facilities in Nepal. The findings indicate with whom and how interventions may be implemented that can reduce the occurrence of these delays as well as maternal morbidity and mortality. This section summarizes key findings and recommendations for potential interventions.

Among postpartum women at health facilities in Nepal, delay 2 is most common, followed by delay 1 and delay 3

The below Sankey diagram (Figure 5) presents the experience of each delay among the overall sample of postpartum women. There are smaller proportions of women who experienced delays 1 and 3, and a larger proportion who experienced delay 2. Nearly half of women who experienced delay 1 also experienced delay 2, and only a small fraction of women who experienced delay 2 also experienced delay 3.

Figure 5   Sankey diagram of three delays among postpartum women in health facilities in Nepal

Previous studies in Nepal have shown varying levels and patterns of delay—most showed delays 1 and 3 most frequently,[13] or delay 1 that was higher than the others (Sitaula et al. 2021), or similar levels with each delay.[24] These differences are likely due to different study populations or different definitions of each delay.

Study populations have varied in many studies that attempted to quantify delays. Maharjan and colleagues[24] assessed delays among women who were categorized as a near miss, while Karkee et al[13] and Situala et al.[17] examined delays among women who had pregnancy-related mortality. In these populations, it was expected that there would be higher levels of delays compared to the overall population of women who delivered at a health facility, since experiencing delays can lead to complications and potential maternal death.[3] In this analysis, assessing delays among all postpartum women at facilities might have led to lower estimates. This is especially true for delay 1 because we used a woman's recollection that she wanted to come to the facility earlier. Women who did not experience any danger signs may not recall a sense of urgency to decide to go to the facility. This difference was seen in the significantly higher proportion of women who experienced danger signs and then experienced delay 1.

The data collection method and definitions of the delay have often depended on the type of research study. For example, Situala and colleagues[17] relied upon case notes and the maternal death review tool to retrospectively assess delays among women who had pregnancy-related mortality. It is not surprising to see that in the Situala 2021 study, delay 1 had the highest frequency, with delay 2 next, and delay 3 the lowest. Health care workers may be less likely to document the experience of the third delay due to a fear of being blamed for the maternal death.[25,28] Relying on health facility staff to describe delays can be a barrier to true understanding of the delays, because many staff find it difficult to externalize the problem to women's families and communities.[26] In our analysis, we rely on women's self-report for all measures. For delay 2, we used estimates of the average time needed to travel to the facility where they were interviewed, although the question does not ask about the specific travel from home to the facility for the delivery. Therefore, our estimate does not capture cases where women experienced a longer than average travel to the facility prior to delivery, and it also does not capture cases where women traveled to or near to a facility in advance of her delivery.

Recommendation: Although all delays may contribute to maternal mortality and morbidity, our results indicate that a large proportion of pregnant women experience delays in getting to a health facility. Although a transportation incentive program is in place, women who were aware of the program did not have different levels of delay 2. Other policy and program interventions such as maternity waiting homes,[7] where the pregnant women can reside close to the facility during the final weeks of their pregnancy, have been suggested as an appropriate solution for Nepal.[23]

Effect of client education on experience of delays

No education or lower levels of education have been shown to be associated with lower rates of facility delivery[27] and higher risk of maternal mortality overall.[29] In this analysis, we also found an association between a woman's level of education and her experience of delays. For delay 1, we found that women with a basic level of education had higher odds of experiencing delay 1 compared to women with the lowest level of education. For delay 3, we can see the same pattern of delay that has been observed in facility delivery and maternal mortality, wherein women with higher levels of education have lower odds of experiencing delays.

Recommendation: Women with lower levels of education may need to be targeted with information about Nepal's Free Delivery Care Program as well as the transportation incentive program, and they may need to receive additional counseling about birth preparedness and preparations for any potential obstetric complications.

Effect of structural quality on delay 3

The availability of medicines and equipment at the facility may be facilitating delay 3 through the inability of providers to attend to the obstetric patients in a timely manner. Prior research has shown that providers believe that the lack of an adequate enabling environment is one of the main reasons that women experience delay 3 in Nepal.[26] In the original three delays framework, Thaddeus and Maine[3] discussed how shortages of essential drugs, supplies, and other quality of care issues contributed to delay.

Although many studies have identified human resource shortages as the most frequently cited factor associated with delays in receiving appropriate care in health facilities,[30] our measure of the human resources aspect of structural quality was not significantly associated with delay 3. The average human resource score of all facilities with the postpartum women interviewed was 0.35 (95% CI [0.27, 0.42]; min 0 max 1), while the average structural quality physical resources score was 0.90 (95% CI [0.88, 0.92]; min 0 max 1). This could be due to our measurement approach, which combined different aspects of human resource readiness, such as training and supervision, into one measure.

Recommendation: Facilities with low levels of structural quality can be targeted for quality improvement programs in order to reduce the third delay. Human resource quality should also be targeted due to the overall low levels at facilities that offer labor and delivery services.

Experience of danger signs before arriving at the facility had an effect on delay 1 and 2, but not on delay 3

In this analysis, experiencing danger signs before arriving at the health facility was associated with delay 1 and 2, but did not have any effect on the experience of delay 3. Since we do not know when the danger signs occurred relative to the decision to go to a health facility, it may be that experiencing delay 1 or delay 2 leads to higher odds of experiencing danger signs before arriving at the health facility. We also hoped to see that the experience of danger signs before arriving at the health facility would be negatively associated with delay 3, in that women who were experiencing danger signs would have lower odds of waiting an hour or more to see a provider after they arrive at the facility, especially due to the high levels of delay 3 observed in previous research in Nepal among women who died during or after childbirth.[13]

Recommendation: Implementation of strategies such as obstetric triage,[31] which trains health care workers to rapidly identify and prioritize pregnant women with danger signs or other urgent needs for care, have been shown to reduce delay 3 in certain settings.[32]

Difficulties in deciding to come to the facility and difficulties getting to the facility were associated with delays 1 and 2

Problems accessing health care are common in Nepal, with 83.2% of women reporting at least one problem in the last Nepal DHS.[33] Despite the Free Delivery Care policy, which provides cash incentives to women who attend antenatal care and deliver at a health facility, evidence has shown that not all individuals and geographic areas in Nepal have benefited equally.[34] Women are still experiencing difficulties in deciding to come to the health facility as well as getting to the health facility. Programs that incorporate community and health systems approaches, such as improving communication and transportation systems between facilities and communities, supporting community-based savings groups,

and building maternity waiting homes have been successful in increasing access to delivery services in other settings.[7,8]

Although women in the NHFS were asked to distinguish between difficulties they faced while deciding to come to the facility, which would be expected to be associated with delay 1, and difficulties that they faced on the way to the facility, which would be expected to be associated with delay 2, it seems that some of these difficulties may have cross-cutting influence. While there was no difference in the proportion of women who experienced delay 1 by experiencing difficulties in deciding to come to the facility, there was a difference in the proportion of women who experienced delay 2 (see Table 4). Similarly, although there was no difference in the proportion of women who experienced delay 2 by experiencing difficulties in obtaining money to cover costs due to travel, there was a difference in the proportion of women who experienced delay 1. However, this could be because all women who experienced these difficulties had a delay. Our findings suggest that many of the reasons that women experience delays 1 and 2 may be overlapping and intersecting.

Recommendation: Programs designed to reduce delays should consider all delays, but especially delays 1 and 2 with a systems approach, and with context-specific interventions that engage communities, the health system, and individuals, which have been shown to reduce delays 1 and 2 in other settings.[7,8]

Consistency in effect of determinants overall versus at hospitals

Of the 516 women interviewed, 481 delivered at hospitals, while 35 delivered at health centers. The client and facility characteristics associated with each delay were very similar in the overall sample, compared to the results when we limited the analysis to a subsample of women who gave birth in hospitals (see Appendix Table 4). In the NHFS, the postpartum women interviewed represent a convenience sample of women at the facility, and larger facilities like hospitals are more likely to have postpartum women to be interviewed. This is evident in that 45% of hospitals with labor and delivery services had postpartum women interviewed, while only 5% of health centers with labor and delivery facilities had postpartum women who were interviewed.

Recommendation: While all facilities that offer labor and delivery services should provide high quality care, prioritizing hospitals, which have larger volume of deliveries, will reach the most women who deliver. Given the limited resources, programs and policies could focus on hospitals to maximize their impact.

This analysis has limitations. First, due to the cross-sectional nature of the data, we are unable to determine causality. In addition, the measures of each delay were based on questions available in the NHFS and were therefore a proxy for the occurrence of each delay. Self-report of delays 1 and 2 in particular may have been inaccurate since a woman in labor or experiencing a labor complication may not be aware of discussions or arrangements that are happening during this time. In addition, the woman's self-assessment that she wanted to come to the facility earlier also depends on her own experience and knowledge of danger signs. Finally, women who died or had severe health problems during delivery were not interviewed as a part of the postpartum NHFS interview. Therefore, this analysis may underestimate the level of the delays due to these missing women, although this bias would be small given the rarity of these events.

5   CONCLUSION

Understanding the driving forces behind the slow reduction in the MMR in Nepal is key to reinvigorating reductions in maternal mortality. This study assessed the levels of women experiencing delay in deciding to seek delivery care, delay in reaching a health facility, and delay in receiving care from the health facility after she reached the health facility, and the association of these delays with client and/or facility characteristics, using data from the 2021 NHFS. Although most previous studies on delays focus on women who died or experienced near-miss at facilities, this study included all women who delivered their child in the surveyed health facility, with only a few exceptions. Women who were referred from other health facilities were excluded due to lack of information about the referring facility and women who died or experienced serious injury during delivery were excluded as they would not have been available to be interviewed.

Our study found that nearly 6 in ten postpartum women who delivered in a health facility experienced at least one of the three delays during their delivery. Just over 10% of women interviewed experienced delay 1, a delay in deciding to go to the health facility, and there was no significant change in this delay from 2015. Among the three delays assessed, delay 2, the delay in reaching health facility was the most common with 47% of women experiencing the delay. There was no significant difference with the 2015 NHFS. The study noted that in 2021, the average time to reach the facility was slightly over 2 hours for all postpartum women interviewed. The least experience of delay by the postpartum women was delay 3, with almost 6% of women experiencing a delay of at least one hour to be seen by a health care worker after arriving at a health facility. This is a significant decrease from 2015 when 14.0% of postpartum women interviewed experienced delay 3. Postpartum women waited an average 29 minutes to be seen by a health care worker after reaching the facility.

In the bivariate analysis, most client characteristics were not significantly associated with the delay in decision to go to a health facility. The delays in the decision to go to health facility were significantly different among those having difficulties in obtaining money for travel costs and those finding it difficult to travel. For delay 2, there were significant differences with reasons for finding it difficult to travel, with some women experiencing any difficulties in deciding to go to the facility and those who had difficulties with obtaining money to come to the facility. The knowledge of the transportation incentive payment program did not have an effect on delay 2. Moreover, nearly all postpartum women (94%) who had at least one difficulty getting to the health facility experienced delay 2. There were significant differences in the experience of delay 2 by feeling that the time was too long to reach health facility, finding it difficult to travel, and other reasons that a woman decided to deliver at a health facility such as the advice of a health care worker as a reason for deciding to deliver at a facility, and the facility being nearby. For delay 3, there was no significant difference by other contextual factors for women in experiencing delay in being seen by a health care worker after arriving at a health facility.

In the multivariate analysis, some client characteristics were significantly associated with the experience of a delay. Level of education was associated with delay 1 and delay 3, although the odds of experiencing delay 1 among women with a basic level of education was 4.5 times higher when compared with having no education. On the contrary, women with higher education had lower odds of experiencing a delay in seeing a provider after reaching the facility as compared to women with no education. Likewise, client

19

characteristics such as who accompanies the woman to the health facility and whether or not she experienced any danger signs before arriving at the health facility, and the means of transportation for reaching to health facility were all related to experience of a delay 2. Women who experienced danger signs before arriving at the facility had higher odds of experiencing delays 1 and 2. Geography had an influence on the experience of delays, with women delivering in facilities in Lumbini (Province 5) having higher odds of delay 1, and lower odds of delay 2 as compared to Koshi (Province 1), and women in Madhesh (Province 2) having lower odds of delay 2 compared to Koshi (Province 1). Women who were accompanied to the health facility by a relative or friend had lower odds of experiencing delay 2 compared to women who were accompanied by their husband (*aOR* = 0.20). Better quality of facility structure was associated with lower odds of delay 3.

This study found that women are experiencing delays in Nepal, especially delay 2. While there are no consistent determinants of all three types of delay, there were some common determinants of two of the three delays—specifically, education and experience of danger signs. Previous research has shown that these delays are associated with maternal death or morbidity. In the context of the slowed decrease in the maternal mortality ratio in Nepal, future work should focus on identifying, developing, and testing programs and policies such as maternity waiting homes and routine obstetric triage procedures that could reduce of the prevalence of these delays in Nepal.

REFERENCES

[1] Pradhan A, Aryal RH, Regmi G, Ban B, Govindasamy P. *Nepal Family Health Survey 1996*. Kathmandu, Nepal: Ministry of Health/Nepal, New ERA/Nepal, and Macro International; 1997. http://dhsprogram.com/pubs/pdf/FR78/FR78.pdf

[2] Ministry of Health - MOH/Nepal, New ERA/Nepal, and ICF. *Nepal Demographic and Health Survey 2016*. Kathmandu, Nepal: MOH/Nepal, New ERA, and ICF; 2017. http://dhsprogram.com/pubs/pdf/FR336/FR336.pdf

[3] Thaddeus S, Maine, D. Too far to walk: Maternal mortality in context. *Social Science Medicine.* 1994;38(8):1091–110. https://doi.org/10.1016/0277-9536(94)90226-7

[4] Barnes-Josiah D, Myntti C, Augustin A. The "three delays" as a framework for examining maternal mortality in Haiti. *Social Science Medicine*. 1998;46(8):981–93. https://doi.org/10.1016/S0277-9536(97)10018-1

[5] Goodman DM, Srofenyoh EK, Olufolabi AJ, Kim SM, Owen MD. The third delay: Understanding waiting time for obstetric referrals at a large regional hospital in Ghana. *BMC Pregnancy and Childbirth. 2017;*17 (1): 216. https://doi.org/10.1186/s12884-017-1407-4

[6] Hirose A, Borchert M, Cox J, Alkozai AS, Filippi V. Determinants of delays in travelling to an emergency obstetric care facility in Herat, Afghanistan: An analysis of cross-sectional survey data and spatial modelling. *BMC Pregnancy and Childbirth.*2015;15(1):14. https://doi.org/10.1186/s12884-015-0435-1

[7] Ngoma T, Asiimwe AR, Mukasa J, et al. 2019. Addressing the second delay in saving mothers, giving life districts in Uganda and Zambia: Reaching appropriate maternal care in a timely manner. *Global Health: Science and Practice.* 2019;7(Supplement 1):S68-S84. https://doi.org/10.9745/GHSP-D-18-00367

[8] Serbanescu F, Goodwin MM, Binzen S, et al. 2019. Addressing the first delay in saving mothers, giving life districts in Uganda and Zambia: Approaches and results for increasing demand for facility delivery services *Global Health: Science and Practice. 2019;*7(Supplement 1):S48-S67. https://doi.org/10.9745/GHSP-D-18-00343

[9] Shah N, Hossain N, Shoaib R, Hussain A, Gillani R, Khan NH. Socio-demographic characteristics and the three delays of maternal mortality. *Journal of The College of Physicians and Surgeons Pakistan.* 2009;19(2):95–8. https://pubmed.ncbi.nlm.nih.gov/19208312/

[10] Upadhyay RP, Rai SK, Krishnan A. Using three delays model to understand the social factors responsible for neonatal deaths in Rural Haryana, India. *Journal of Tropical Pediatrics.* 2012;59(2):100–105. https://doi.org/10.1093/tropej/fms060

[11] Wanaka S, Hussen S, Alagaw A, Tolosie K, Boti N. Maternal delays for institutional delivery and associated factors among postnatal mothers at public health facilities of Gamo Zone, Southern Ethiopia. *International Journal of Women's Health.* 2020;12:127–138. https://doi.org/10.2147/IJWH.S240608

[12] Jackson R, Tesfay FH, Gebrehiwot TG, Godefay H. Factors That Hinder or Enable Maternal Health Strategies to Reduce Delays in Rural and Pastoralist Areas in Ethiopia. *Tropical Medicine & International Health.* 2017;22(2):148–160. https://doi.org/10.1111/tmi.12818

[13] Karkee R, Tumbahangphe KM, Maharjan N, Budhathoki B, Manandhar D. Who are dying and why? A case series study of maternal deaths in Nepal. *BMJ Open.* 2021;11(5):e042840. http://dx.doi.org/10.1136/bmjopen-2020-042840

[14] Mgawadere F, Unkels R, Kazembe A, van den Broek N. Factors associated with maternal mortality in Malawi: Application of the three delays model. *BMC Pregnancy and Childbirth.* 2017;17(1):219. https://doi.org/10.1186/s12884-017-1406-5

[15] Mohammed MM, El Gelany S, Eladwy AR, et al. 2020. A ten year analysis of maternal deaths in a tertiary hospital using the three delays model. *BMC Pregnancy and Childbirth.* 2020;20(1):585. https://doi.org/10.1186/s12884-020-03262-7

[16] Assefa EM, Berhane Y. Delays in emergency obstetric referrals in Addis Ababa Hospitals in Ethiopia: A facility-based, cross-sectional study. *BMJ Open.* 2020;10(6): e033771. https://bmjopen.bmj.com/content/bmjopen/10/6/e033771.full.pdf

[17] Sitaula S, Basnet T, Agrawal A, Manandhar T, Das D, Shrestha P. Prevalence and risk factors for maternal mortality at a tertiary care centre in Eastern Nepal - Retrospective cross sectional study. *BMC Pregnancy and Childbirth.* 2021;21(1):471. https://doi.org/10.1186/s12884-021-03920-4

[18] Hogan MC, Foreman KJ, Naghavi M, et al. Maternal mortality for 181 countries, 1980–2008: A systematic analysis of progress towards millennium development goal 5. *The Lancet.* 2010;375(9726):1609–23. https://doi.org/10.1016/S0140-6736(10)60518-1

[19] Say L, Chou D, Gemmill A, et al. Global causes of maternal death: A WHO systematic analysis. *The Lancet Global Health.* 2014;2(6):e323–33. https://doi.org/10.1016/S2214-109X(14)70227-X

[20] World Health Organization. *World Health Statistics 2010*: World Health Organization; 2010. https://www.who.int/publications/i/item/9789241563987

[21] Vanneste AM, Ronsmans C, Chakraborty J, De Francisco A. Prenatal screening in rural Bangladesh: From prediction to care. *Health Policy and Planning.* 2000;15(1):1–10. https://doi.org/10.1093/heapol/15.1.1

[22] Wang W, Mallick L, Allen C, Pullum T. Effective coverage of facility delivery in Bangladesh, Haiti, Malawi, Nepal, Senegal, and Tanzania. *PLOS ONE.* 2019;14(6):e0217853. https://doi.org/10.1371/journal.pone.0217853

[23] Karkee R, Tumbahanghe KM, Morgan A, Maharjan N, Budhathoki B, Manandhar DS. Policies and actions to reduce maternal mortality in Nepal: Perspectives of key informants. *Sexual and Reproductive Health Matters.* 2021;29(2):1907026-1907026. https://doi.org/10.1080/26410397.2021.1907026

[24] Maharjan N, Tuladhar H, Malla K, et al. Maternal near miss analysis in three hospitals of Nepal: An assessment using three delays model. *Journal of Nepal Health Research Council.* 2021;19(2):264–269. https://pubmed.ncbi.nlm.nih.gov/34601514/

[25] Kongnyuy EJ, van den Broek N. The difficulties of conducting maternal death reviews in Malawi. *BMC Pregnancy Childbirth.* 2008;8:42. https://doi.org/10.1186/1471-2393-8-42

[26] Milne L, van Teijlingen E, Hundley V, Simkhada P, Ireland J. Staff perspectives of barriers to women accessing birthing services in Nepal: A qualitative study. *BMC Pregnancy and Childbirth.* 2015;15(1):142. https://doi.org/10.1186/s12884-015-0564-6

[27] Aryal KK, Sharma SK, Khanal MN, et al. *Maternal Health Care in Nepal: Trends and Determinants.* DHS Further Analysis Reports No. 118. Rockville, Maryland, USA: ICF; 2019. http://dhsprogram.com/pubs/pdf/FA118/FA118.pdf

[28] Tura AK, Fage SG, Ibrahim AM, et al. Beyond no blame: Practical challenges of conducting maternal and perinatal death reviews in eastern Ethiopia. *Global Health: Science and Practice.* 2020;8(2):150. https://doi.org/10.9745/GHSP-D-19-00366

[29] Bauserman M, Thorsten VR, Nolen TL, et al. Maternal mortality in six low and lower-middle income countries from 2010 to 2018: Risk factors and trends. *Reproductive Health.* 2020;17(3):173. https://doi.org/10.1186/s12978-020-00990-z

[30] Morof D, Serbanescu F, Goodwin MM, et al. Addressing the third delay in saving mothers, giving life districts in Uganda and Zambia: Ensuring adequate and appropriate facility-based maternal and perinatal health care. *Global Health: Science and Practice.* 2019;7(Suppl 1):S85-S103. https://doi.org/10.9745/GHSP-D-18-00272

[31] Goodman DM, Srofenyoh EK, Ramaswamy R, et al. Addressing the third delay: Implementing a novel obstetric triage system in Ghana. *BMJ Global Health.* 2018;3(2):e000623. http://dx.doi.org/10.1136/bmjgh-2017-000623

[32] Oduro F, Otchi EH, Coleman J, Dodoo J, Srofenyoh E. Improving 'needless' waits in an obstetric ER: Implementing an obstetric triage system in a tertiary hospital in Ghana. *IJQHC Communications.* 2022;2(1). https://doi.org/10.1093/ijcoms/lyac002

[33] Ministry of Health and Population - MOHP/Nepal, New ERA/Nepal, and Macro International. *Nepal Demographic and Health Survey 2006.* Kathmandu, Nepal: MOHP/Nepal, New ERA/Nepal, and Macro International; 2007. http://dhsprogram.com/pubs/pdf/FR191/FR191.pdf

[34] Ensor T, Bhatt H, Tiwari S. 2017. Incentivizing universal safe delivery in Nepal: 10 years of experience. *Health Policy and Planning.* 2017;32(8):1185–1192. https://doi.org/10.1093/heapol/czx070

APPENDIX

Appendix Table 1   Items included in composite structural quality measures

Equipment, medicine, and commodities	Sterilization equipment	Facility reports that some instruments are processed in the facility and the facility has a functioning electric dry heat sterilizer, a functioning electric autoclave, or a non-electric autoclave with a functioning heat source available somewhere in the facility.
	Delivery bed	At least one delivery bed available and observed in delivery area.
	Examination light	Examination light (flashlight okay) available, observed, and functioning in delivery area
	Delivery pack	Delivery pack OR cord clamp, episiotomy scissors, scissors/lade to cut cord, suture material with need, AND needle holder all available in delivery area
	Suction apparatus (mucus abstractor)	Suction apparatus (mucus abstractor) available, observed, and functioning in the delivery area
	Manual vacuum extractor	Manual vacuum extractor available, observed, and functioning in the delivery area
	Vacuum aspirator or D&C kit	Vacuum aspirator or D&C kit available, observed, and functioning, in the delivery area
	Partograph	Partograph available, observed, and functioning in delivery area
	Disposable latex gloves	Disposable latex gloves observed in delivery area
	Newborn bag and mask	Newborn bag and mask (AMBU bag and mask) available, observed, and functioning in the delivery area
	Infant scale	Infant scale observed and functioning in delivery area
	Blood pressure apparatus (digital or manual)	Manual or digital blood pressure apparatus observed and functioning in delivery area
	Hand-washing soap and running water or hand disinfectant	Hand-washing soap and running water or hand disinfectant available and observed in delivery area
	Injectable antibiotic	Injectable antibiotics observed in delivery area (at "service site") and at least 1 dose valid
	Hydrocortisone available at the facility	Hydrocortisone observed at the facility and at least one dose valid
	Injectable uterotonic	Oxytocin observed in delivery area with at least one valid dose
	Skin disinfectant	Skin disinfectant available for newborns in delivery area
	Magnesium sulfate	Magnesium sulphate available in delivery area with at least one dose valid
	IV solution with infusion set	IV solution with infusion set available in delivery area with at least one set valid
	Chlorhexidine for cord cleaning	Chlorhexidine solution (4%) for umbilical cord cleaning available in delivery area, with at least one dose valid
	Antibiotic eye ointment for newborn	Tetracycline eye ointment for newborn available in delivery area and at least one dose valid

Continued…

Appendix Table 1—*Continued*

Guidelines, staff training, and supervision	Guidelines: Nepal medical standard (NMS) volume III or reproductive health clinical guidelines available	Guidelines available in delivery area
	Training in IMPAC	At least one provider of delivery/newborn care in facility received training in IMPAC in the past 24 months
	Training in routine care during labor and delivery	At least one provider of delivery/newborn care in facility received training in routine care during labor and normal vaginal delivery in the past 24 months.
	Training in Active Management of Third Stage of Labor (AMTSL)	At least one provider of delivery/newborn care in facility received training in AMTSL in the past 24 months.
	Training in Emergency Obstetric Care (EmOC)/Life Saving Skills (LSS) in general	At least one provider of delivery/newborn care in facility received training in EmOC/LSS in the past 24 months.
	Supervision	At least half of interviewed providers reported being personally supervised at least once during the 6 months before the survey.

Appendix Table 2   Description of client and facility background variables in the analysis

Variable	Among PP clients	
	%	n (weighted)
Delay 1 – Deciding to go to facility		
No delay	89.1	272
Delay	10.9	33
Total	100.0	305
Delay 2 - Getting to facility		
No delay	52.9	162
Delay	47.1	144
Total	100.0	307
Delay 3 – Being seen at facility		
No delay	94.2	289
Delay	5.8	18
Total	100.0	307
Age		
<20	8.2	25
20–24	43.0	132
25–29	30.1	92
30+	18.7	57
Total	100.0	307
Education		
None or did not pass grade 1	16.8	51
Basic level	32.8	101
Secondary level	38.8	119
Bachelor or above	11.6	36
Total	100.0	307
Caste		
Brahman/Chhetri	24.7	76
Terai/Madhesi	29.6	91
Dalits	11.7	36
Janajati	27.5	84
Other	6.6	20
Total	100.0	307
First delivery		
No	48.6	149
Yes	51.4	158
Total	100.0	307
Decision maker		
Self	62.5	192
Husband	23.7	73
Parents/parents-in-law	8.7	27
Other relatives or health worker	5.1	16
Total	100.0	307
Who accompanied woman to facility		
Husband	71.6	220
Parents/parents-in-law	22.8	70
Other relatives or friend	5.6	17
Total	100.0	307
Mode of transportation		
Auto-vehicle and ambulance	81.0	248
Rickshaw/bicycle	10.2	31
Other	8.9	27
Total	100.0	307
Experienced any danger signs before arriving at facility		
No	86.2	264
Yes	13.8	42
Total	100.0	307

Continued…

Appendix Table 2—*Continued*

Variable	Among PP clients	
	%	n (weighted)
Facility		
Health facility type		
Hospital	92.4	283
Health centers	7.6	23
Total	100.0	307
Managing authority		
Private	21.2	65
Public	78.8	242
Total	100.0	307
Urban/rural municipality		
Urban	96.0	295
Rural	4.0	12
Total	100.0	307
Province		
Koshi (Province 1)	19.0	58
Madhesh (Province 2)	19.4	60
Bagmati (Province 3)	15.2	47
Gandaki (Province 4)	3.3	10
Lumbini (Province 5)	26.3	81
Karnali (Province 6)	5.7	18
Sudurpashchim (Province 7)	11.2	34
Total	100.0	307
Ecoregion		
Mountain	2.7	8
Hill	28.8	88
Terai	68.6	210
Total	100.0	307
Availability of provider 24 hours		
No	4.6	14
Yes	95.4	293
Total	100.0	307
Reasons for deciding to deliver at facility		
Free care	28.0	86
Transportation incentives	5.0	15
Safer than home delivery	70.1	215
To have a skilled birth attendant or because of female staff	29.9	92
Health worker advised me	19.1	59
Had complications	2.6	8
Clients are well treated	5.6	17
Nearby facility	13.5	41
Good reputation	11.0	34

Appendix Table 3   Adjusted odds ratios (*aOR*) of each delay

	Delay 1			Delay 2			Delay 3		
	aOR	CI	*p* value	*aOR*	CI	*p* value	*aOR*	CI	*p* value
Client									
Age									
<20		*(ref)*			*(ref)*			*(ref)*	
20–24	0.56	0.12–2.64		0.72	0.22–2.32		5.69	0.51–63.09	
25–29	0.74	0.11–5.09		0.86	0.24–3.02		3.43	0.29–40.68	
30+	2.53	0.44–14.56		0.87	0.23–3.20		2.90	0.20–42.43	
Education									
None or did not pass grade 1		*(ref)*			*(ref)*			*(ref)*	
Basic level	**4.46**	**1.44–13.81**	**	1.25	0.44–3.50		**0.14**	**0.03–0.70**	*
Secondary level	1.78	0.67–4.77		0.40	0.14–1.11		**0.06**	**0.02–0.27**	***
Bachelor or above	1.51	0.27–8.32		0.29	0.06–1.33		0.31	0.02–4.76	
Caste									
Brahman/Chhetri		*(ref)*			*(ref)*			*(ref)*	
Terai/Madhesi	0.72	0.21–2.48		0.47	0.14–1.52		0.51	0.06–4.24	
Dalits	0.73	0.23–2.29		0.96	0.36–2.59		1.27	0.14–11.72	
Janajati	0.52	0.16–1.71		0.54	0.22–1.34		0.80	0.17–3.79	
Other	0.89	0.23–3.39		0.28	0.05–1.49		0.75	0.07–8.45	
First delivery									
No		*(ref)*			*(ref)*			*(ref)*	
Yes	0.64	0.23–1.81		1.54	0.76–3.12		2.38	0.86–6.60	
Decision maker									
Self		*(ref)*							
Husband	1.57	0.63–3.95							
Parents/parents-in-law	1.00	0.25–3.91							
Other relative/health worker	0.29	0.01–6.95							
Who accompanied woman to facility									
Husband					*(ref)*			*(ref)*	
Parents/parents-in-law				0.88	0.38–2.08		2.09	0.33–13.21	
Other relative/friend				**0.20**	**0.05–0.79**	*	1.94	0.27–14.06	
Experienced any danger signs before arriving at facility									
No		*(ref)*			*(ref)*			*(ref)*	
Yes	**5.48**	**1.97–15.25**	***	**2.51**	**1.09–5.78**	*	0.30	0.07–1.27	
Mode of transportation									
Auto-vehicle and ambulance					*(ref)*				
Rickshaw/bicycle				0.54	0.20–1.44				
Others				0.23	0.04–1.17				
Aware of transport incentive payments									
No					*(ref)*				
Yes				0.81	0.41–1.57				

Continued…

Appendix Table 3—*Continued*

	Delay 1			Delay 2			Delay 3		
	aOR	CI	*p* value	*aOR*	CI	*p* value	*aOR*	CI	*p* value
Facility									
Location of facility									
Urban	*No delay 1 among urban population			*(ref)*			*(ref)*		
Rural				5.34	0.77–36.91		0.59	0.02–17.44	
Level									
Hospital							*(ref)*		
Health center							0.72	0.04–12.68	
Managing authority									
Private							*(ref)*		
Public							2.60	0.41–16.39	
Province									
Koshi (Province 1)		*(ref)*			*(ref)*			*(ref)*	
Madhesh (Province 2)	3.65	0.33–40.46		**0.26**	**0.07–0.95**	*	1.01	0.11–9.34	
Bagmati (Province 3)	4.81	0.12–195.67		0.52	0.11–2.52		0.15	0.02–1.05	
Gandaki (Province 4)	3.66	0.07–188.08		0.76	0.11–5.09		-	-	
Lumbini (Province 5)	**13.59**	**1.32–140.23**	*	**0.26**	**0.07–0.90**	*	2.88	0.67–12.35	
Karnali (Province 6)	-	-		1.49	0.35–6.33		0.10	0.00–2.12	
Sudurpashchim (Province 7)	1.83	0.10–35.13		0.39	0.06–2.46		0.99	0.06–15.16	
Ecoregion									
Mountain		*(ref)*			*(ref)*			*(ref)*	
Hill	0.26	0.04–1.53		1.65	0.38–7.20		0.57	0.02–20.32	
Terai	0.24	0.02–2.98		1.14	0.18–7.29		0.10	0.00–8.18	
Tertiles of maternity beds									
1								*(ref)*	
2							1.76	0.28–10.90	
3							3.89	0.71–21.28	
Structural quality—physical resources							**0.0001**	**0.00–0.39**	*
Structural quality—human resources							1.00	0.10–9.49	

*p < .05, **p < .01, ***p < .001

Appendix Table 4   Adjusted odds ratios (*aOR*) of each delay among women delivering at hospitals

	Delay 1			Delay 2			Delay 3		
	aOR	CI	*p* value	*aOR*	CI	*p* value	*aOR*	CI	*p* value
Client									
Age									
<20		*(ref)*			*(ref)*			*(ref)*	
20–24	0.54	0.12 - 2.50		0.82	0.26 - 2.58		6.97	0.59 - 81.97	
25–29	0.70	0.10 - 4.87		0.68	0.19 - 2.46		6.73	0.57 - 80.14	
30+	2.26	0.39 - 13.24		0.75	0.18 - 3.13		4.56	0.30 - 69.63	
Education									
None or did not pass grade 1		*(ref)*			*(ref)*			*(ref)*	
Basic level	**3.72**	**1.21 - 11.48**	*	1.01	0.34 - 2.99		**0.11**	**0.02 - 0.76**	*
Secondary level	1.68	0.65 - 4.37		0.39	0.13 - 1.17		**0.07**	**0.01 - 0.36**	***
Bachelor or above	1.34	0.25 - 7.31		0.25	0.05 - 1.19		0.28	0.02 - 5.09	
Caste									
Brahman/Chhetri		*(ref)*			*(ref)*			*(ref)*	
Terai/Madhesi	0.79	0.23 - 2.64		0.53	0.16 - 1.74		0.50	0.07 - 3.42	
Dalits	0.85	0.26 - 2.70		1.63	0.66 - 4.04		1.75	0.20 - 15.63	
Janajati	0.54	0.16 - 1.83		0.59	0.25 - 1.41		0.83	0.19 - 3.56	
Other	0.94	0.25 - 3.52		0.29	0.05 - 1.57		0.71	0.09 - 5.44	
First delivery									
No		*(ref)*			*(ref)*			*(ref)*	
Yes	0.64	0.23 - 1.80		1.16	0.54 - 2.52		**3.62**	**1.15 - 11.41**	*
Decision maker									
Self		*(ref)*							
Husband	1.48	0.60 - 3.65							
Other relative	0.95	0.24 - 3.68							
FCHV/health worker	0.33	0.01 - 8.48							
Who accompanied woman to facility									
Husband					*(ref)*			*(ref)*	
Other relative				0.84	0.36 - 1.98		2.28	0.38 - 13.72	
Health worker				**0.22**	**0.06 - 0.83**	*	0.90	0.08 - 10.55	
Experienced any danger signs before arriving at facility									
No		*(ref)*			*(ref)*			*(ref)*	
Yes	**5.15**	**1.88 - 14.09**	***	**2.67**	**1.12 - 6.38**	*	0.17	0.01 - 2.27	
Mode of transportation									
Auto-vehicle and ambulance					*(ref)*				
Rickshaw/bicycle				0.49	0.16 - 1.47				
Others				**0.1**	**0.01 - 0.87**	*			
Aware of transport incentive payments									
No					*(ref)*				
Yes				0.65	0.35 - 1.20				

Continued…

Appendix Table 4—*Continued*

	Delay 1			Delay 2			Delay 3		
	aOR	CI	*p* value	*aOR*	CI	*p* value	*aOR*	CI	*p* value
Facility									
Location of facility (Urban/rural omitted)									
Managing authority									
Private								*(ref)*	
Public							3.68	0.50 - 26.92	
Province									
Koshi (Province 1)		*(ref)*			*(ref)*			*(ref)*	
Madhesh (Province 2)	3.75	0.34 - 41.86		0.30	0.08 - 1.08		0.20	0.01 - 5.90	
Bagmati (Province 3)	4.71	0.10 - 218.26		0.89	0.19 - 4.13		**0.06**	**0.00 - 0.77**	*
Gandaki (Province 4)	3.85	0.07 - 223.28		1.69	0.22 - 13.21		-	-	
Lumbini (Province 5)	**13.81**	**1.27 - 149.68**	*	0.41	0.12 - 1.45		1.85	0.56 - 6.05	
Karnali (Province 6)	-	-		1.90	0.44 - 8.14		0.05	0.00 - 1.68	
Sudurpashchim (Province 7)	2.05	0.10 - 42.64		0.65	0.09 - 4.65		0.42	0.02 - 6.91	
Ecoregion									
Mountain		*(ref)*			*(ref)*			*(ref)*	
Hill	0.25	0.04 - 1.49		1.48	0.32 - 6.74		0.63	0.01 - 27.03	
Terai	0.25	0.02 - 3.17		1.32	0.21 - 8.30		0.08	0.00 - 7.71	
Tertiles of maternity beds									
1								*(ref)*	
2							2.00	0.30 - 13.43	
3							4.78	0.68 - 33.38	
Structural quality—physical resources							0.004	0.00 - 16.58	
Structural quality—human resources							1.28	0.15 - 11.01	

p < .05, **p* < .01, ***p* < .001