Heliyon 10 (2024) e25005

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Do community-level predictors have more impact than individual/family-level predictors on receiving the desired number of ANC services in Bangladesh?

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ARTICLE INFO

Keywords:
Maternal health
Community clinic
ANC services
Predictors
Bangladesh

ABSTRACT

Background: Bangladesh has improved maternal and child health, but healthcare indicators and access still need enhancement. Factors that contribute to increased antenatal care (ANC) need to be explored to inform healthcare policies. The study examined whether community-level (supply-side) predictors outperform individual/family-level (demand-side) predictors for the desired number of ANC services.

Methods: This cross-sectional study collected primary data from 630 pregnant and lactating women (PLW) in seven upazilas in Rangpur and Nilphamari districts of Bangladesh in 2022. The individual/family and community-level factors as predictors of desired antenatal care services were investigated using a semi-structured questionnaire. Various statistical techniques including the Student t-test, z-test, Chi-square test, and logistic regression model were employed in analyzing the data.

Results: Out of the total 630 participants, the majority were literate women who belong to higher pregnancy order and received benefits from SSNPs. In addition to this, these women did not earn and neither were the empowered. The outcome variable was the receiving status of 4+ ANC services by PLWs, which varied by different covariates. The desired 4+ ANC service received by 73 % PLWs. The significant ($p < 0.05$) predictors of receiving 4+ ANC services were secondary-level education (95 % CI:0.97–7.55), knowledge on danger signs (95 % CI:1.02–1.48), empowered women (95 % CI:0.99–2.69), community clinics as place of services (95 % CI:1.52–3.49), sources of information through SMS (95 % CI:2.63–7.04) and fully functional community clinic (95 % CI:1.0–2.347). The statistical evidence through the values of pseudo R^2 of the reduced models of community level (0.09), individual level (0.03) and family level (0.01) revealed that the community level predictors are more influential than individual/family level predictors.

Conclusion: The findings indicate that community level predictors played a dominant role in receiving the 4+ ANC services in Bangladesh. In short, the well-functioning of community clinics

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https://doi.org/10.1016/j.heliyon.2024.e25005
Received 10 October 2023; Received in revised form 13 January 2024; Accepted 18 January 2024
Available online 23 January 2024

in tandem with government forums/bodies and awareness raising through SMS messages, are sufficient for ensuring the desired number of ANC services in rural areas of Bangladesh.

1. Introduction

Regular ANC visits, ideally at least 4, have been shown to significantly reduce maternal and infant deaths and lower the risk of malnutrition [1]. Bangladesh has been performing considerably well in terms of healthcare provision, especially in maternal and new-born healthcare and family planning services for the last three decades [1]. As a result, the percentage of pregnant women who went to four or more ANC appointments increased from 5.5 % to 47 % during 1994–2017 [2,3]. This probably contributes to improvement in key health indicators related to maternal and child health (e.g., neonatal and under-five children mortality rate, maternal morality ratio) in the last decade. Over the past 25 years (1990–2016), Bangladesh has shown reductions in the child mortality rate by more than 70 % [4]. It has been documented that neonatal death constitutes 67 % of all under five child deaths in Bangladesh [2]. To achieve the targets of maternal and neonatal mortality of the Sustainable Development Goal-3 (good health and wellbeing), a combined effort is essential for further reduction of child mortality with special emphasis on neonatal deaths despite an already notable reduction in infant and child mortality in Bangladesh [5]. However, it can be perceived that meeting of the targets for maternal and child healthcare indicators will become more difficult unless healthcare facilities improve their access and quality of services. Pregnancy and delivery complications appear to be the principal causes of death among women during delivery in Bangladesh [6]. Maternal mortality reduction in Bangladesh has been seen to move more slowly than other health indicators [7]. As a result, maternal healthcare during pregnancy continues to be a serious issue for Bangladesh's public health. Literature reviews suggests that maternal deaths can be brought down to a minimal level if appropriate antenatal care services are ensured [8–11].

Bangladesh has set the target for number of ANC visits taking into consideration the "Focused Antenatal Care (FANC) Model" of the World Health Organization [12,13]. The FANC Model states that, under normal circumstances, a pregnant woman should receive at least four antenatal care visits [13]. The Government had set a target of achieving 50 % of women attending four or more ANC services by 2020 [12,14]. In July 2019, the Government has revised the target of 4+ ANC services, which was set at 80 % by the year 2025 and 100 % by the year 2030 [14]. Meanwhile, the World Health Organization issued "WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience" in 2016, which advised at least eight ANC visits under normal pregnancy circumstances to ensure safe motherhood [15]. However, Bangladesh has not yet updated its goal for ANC visits in accordance with the current WHO recommendations of 8+ ANC visits.

In Bangladesh, the proportion of women with at least one ANC service rose from 64 % to 82 % during 2014–2017 [4]. Alternately, the proportion of women who obtained the recommended 4+ ANC services is reported at 36.9 % by MICS-2019 [16] and 47 % by BDHS 2017/18 [4], which indicates that Bangladesh is again slow in achieving the national target of 50 % women with 4+ ANC services during pregnancy by the year 2020 [14,17]. Several studies conducted in Bangladesh have identified that many socio-economic and demographic variables are associated with ANC visits and delivery care [5,18–22]. Examples include place of residence, economic status, religion, and education as important predictors of the quantity of ANC services [19,22,23]. It was also reported that access to mass media and birth order had significant effects on receiving ANC services [22]. Another study found that a woman's age at her first birth has a significant impact on the frequency of ANC visits [24]. It is reported that women with a moderate level of education, living in urban areas, belonging to rich families and having access to mass-media were more likely to attend the ANC visits compared to their counterparts [9].

The review of the literature explored that several social, economic, and demographic variables are the significant determinants of receiving ANC services in Bangladesh [3,5,9,13,18–22,25]. The review indicates that most of the studies have two main limitations: (i) determinants have not been identified for the receiving the recommended 4+ ANC services; and (ii) the community level variables (like place of ANC services and sources of information for ANC services) and potential related variables (knowledge on danger signs, women's empowerment, access to safety nets) have not been considered. Considering these limitations, an in-depth study is essential to explore the determinants of desired number of ANC services for PLWs.

The Joint Action for Nutrition Outcomes (JANO) project has been implemented in seven upazilas (sub-district administrative units) of Rangpur and Nilphamari districts of Bangladesh since 2018, to support the Government for successful execution of the 2nd National Plan of Action for Nutrition (NPAN-2) with the vision to improve the nutritional status of PLWs, children under the age of five years, and adolescent girls/boys by means of a multi-sectoral approach. The project has been working on capacity building at multiple levels of government bodies in terms of developing nutrition plans, budgeting, and effective supervision, as well as raising awareness among PLWs, adolescents and farmers/producers about receiving both nutrition-specific and nutrition-sensitive services. In a fourth-year evaluation of the progress of the JANO project, it was found that 72.7 % pregnant and lactating women (PLW) received 4+ ANC services, which is remarkably higher than the national level target (50 % by the year 2020) [26]. The factors influencing such radical improvement in receiving 4+ ANC services require exploration due to their potential to inform healthcare initiatives and policies. In addition, it is necessary to know which level (individual, family, or community level) of predictors played the dominant role for the radical improvement of ANC services. Thus, the investigation concentrates on two research questions: What are predictors of radical improvement of the ANC services in the selected rural areas of Bangladesh and whether community level (associated with supply side) predictors were more influential than individual/family level (associated with demand side) predictors in achieving the targets? Consequently, the purpose of this study was to discover the answers to these research questions.

2. Methods

2.1. Study design, setting and period

The study used data from a cross-sectional household survey conducted as part of the fourth-year annual evaluation of the JANO project. The household survey was conducted in 30 clusters (villages) located in JANO project intervention areas, namely seven upazilas within Rangpur and Nilphamari districts. Study subjects included pregnant women in their first trimester at or above 3 months from diagnosis of pregnancy and breastfeeding mother and child pairs (children aged 0–23 months). Study participants/respondents were recruited before the interview took place. The face-to-face interviewing took place with study participants to collect retrospective data on ANC services they had received. Data were collected during the months of August–October 2022. The PI and concerned Field Investigator had access to information that could identify individual participants at the interviewing phase only. When data was released for analysis the identity of respondents was completely anonymous.

2.2. Sampling

The study used a stratified cluster sampling for intervention districts (Rangpur and Nilphamari in Bangladesh) as strata and intervention villages as clusters. The number of clusters from the strata were selected using proportional allocation. Sixteen clusters from Nilphamari district and 14 clusters from Rangpur district were randomly selected for administering the household survey. The study prepared a list of households in each of the selected 30 clusters to identify eligible PLWs to interview that may reduce potential bias. The household list identified that on average 5.74 households were required to be visited in order to get an eligible PLW.

2.3. Sample size determination

The study used the following formula to calculate the sample size for household survey:

$$n = \frac{p(1-p)Z^2}{d^2} \times Deff$$

where, p is the indicator percentage (% of women of reproductive age consuming a minimum dietary diversity), Z is the normal variate value at 95 % confidence interval, d is the error margin, and *Deff* is the assumed design effect for cluster sampling. Since '% of women of reproductive age expected to consume a minimum dietary diversity by 2023' was a fundamental indicator of the JANO project, hence this has been considered to determine the sample size for household survey. It is expected that the estimated sample size for this issue will obviously fulfill the sample requirements for other issues like receiving of ANC services. Reviewing the design effect of several nutrition and health outcomes from nine population-based cluster surveys, it is documented that the value of design effect in-between 1.5 and 2.0 produce a more efficient sample size for most of the cases while studying with malnutrition and mortality of children [27]. The Multiple Indicator Cluster Survey (MICS) 2019 of Bangladesh has considered the design effect as 1.5 to determine the sample size [11]. Taking into consideration of assumed design effect of similar nature of national and international surveys, this study has considered it as 1.65. Based on 46.9 % indicator percentage [26], 1.96 as Z-value (at 95 % confidence interval), 0.05 as error

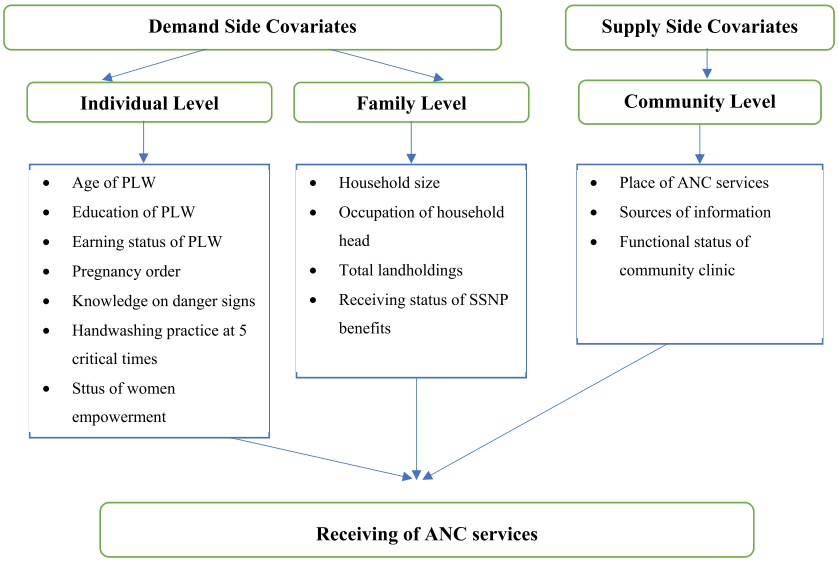

Fig. 1. Covariates at different levels covering both demand side and supply side attributes.

margin and 1.65 as design effect, the estimated sample size was at least 630 PLWs. Finally, the study covered 3614 households to interview 630 eligible PLWs. Because of incomplete data of one subject/respondent, 629 observations were used for final analysis.

2.4. Conceptual framework and study variables

The study's goal is to determine which levels of covariates are more influential in receiving the desired number of ANC services. More specifically, the study is designed to investigate whether community level predictors outperform individual/family level predictors for the desired number of ANC services. The literature reveals that the number of ANC visits by PLWs is influenced by multiple factors within the household and among women. It is assumed that individual/family level covariates, also known as demand-side variables, are not used solely to improve ANC services. There could be some supply-side factors. With this view in mind, the covariates from both the demand side and supply side were considered in this study.

The outcome variable of the study is considered as the receiving status of desired number (4 or more) of ANC services. The study has considered age, education, earning status, pregnancy order, knowledge on danger signs, handwashing practice at 5 critical times, status of women's empowerment, household size, occupation of household head, total landholdings, access to social safety nets, functional status of community clinics, sources of information for healthcare and nutrition services (SMS messages from JANO), and place of ANC services (community clinic) as covariates. The linking of the covariates associated with individual, family, and community levels, encompassing both demand side and supply side attributes is shown in Fig. 1.

The study evaluated women's empowerment by affirmative responses to three issues viz., freedom of movement to visit relatives/friends, participation in decision-making at households in financial affairs and accessing healthcare services from community clinics alone without being accompanied. The functional status of community clinics has been evaluated by considering 3 issues: provided at least 5 services, operated 6 days/week and respondents rated the services as very good. Though multiple sources for information about the importance of nutrition and healthcare for PLWs were available, the SMS messages from JANO is considered as a special source of information for ANC services in the study area and it is expected that this covariate may play a crucial role of receiving 4+ ANC services.

Table 1
Comparison of ANC services for selected covariates.

Covariates with categories		Total N (%)	Level of ANC services		P-value*	*P*-value**
			Group-I: ≤3 ANC visits	Group-II: 4+ ANC visits		
Education of PLW	Illiterate	21 (3.33)	10 (5.81)	11 (2.41)	0.01	0.18
	Primary	152 (24.17)	42 (24.42)	110 (24.07)	0.40	
	Secondary	276 (43.88)	70 (40.70)	206 (45.07)	0.12	
	Post-secondary	180 (28.62)	50 (29.07)	130 (28.45)	0.38	
Earning status of PLW	Not earner	569 (90.46)	160 (93.02)	409 (89.50)	0.04	0.22
	Earner	60 (9.54)	12 (6.98)	48 (10.50)	0.04	
Pregnancy order	First	235 (37.36)	74 (43.03)	161 (35.23)	0.01	0.04
	Higher order	394 (62.64)	98 (56.98)	296 (64.77)	0.01	
Handwashing at 5 critical times	No	441 (70.11)	131 (76.16)	310 (67.83)	0.01	0.03
	Yes	188 (29.88)	41 (23.83)	147 (32.17)	0.01	
Status of women empowerment	No	500 (79.49)	141 (81.98)	359 (78.59)	0.13	0.20
	Yes	129 (20.51)	31 (18.03)	98 (21.44)	0.13	
Occupation of household head	Agriculture	310 (49.28)	88 (51.16)	222 (48.58)	0.26	0.46
	Non-agricultural labor	216 (34.34)	61 (35.47)	155 (33.92)	0.33	
	Service/Job	103(16.38)	23 (13.37)	80 (17.51)	0.05	
Benefits from SSNPs	No	241 (38.32)	64 (37.21)	177 (38.73)	0.34	0.34
	Yes	388 (61.69)	108 (62.79)	280 (61.27)	0.34	
Sources of information for ANC services	Others	411 (65.34)	147 (85.47)	264 (57.77)	<0.01	<0.001
	SMS from JANO	218 (34.66)	25 (14.53)	193 (42.23)	<0.01	
Functional status of community clinic	Partially functional	393 (62.48)	128 (74.42)	265 (58.00)	<0.01	<0.001
	Fully functional	236 (37.52)	44 (25.58)	192 (42.01)	<0.01	
Place of ANC services	Other than community clinic	185 (29.41)	69 (40.12)	116 (25.38)	<0.01	<0.001
	Community clinic	444 (70.59)	103 (59.88)	341 (74.62)	<0.01	
		Average values (SD)				
Age of the PLW		24.84 (5.70)	24.19 (6.00)	25.09 (5.57)	0.08	
Knowledge on number of danger signs		3.24 (1.08)	3.08 (1.12)	3.30 (1.06)	0.02	
Household size		4.88 (1.65)	4.59 (1.65)	4.99 (1.65)	0.01	
Total landholdings of households		41.12 (56.03)	36.55 (51.85)	42.84 (57.49)	0.21	
Sample size (n)		629	172	457	–	

* P-values for testing the equality of two proportions (z-test) for categorical variables and testing the equality of two means (*t*-test) for continuous variables; **P-values for testing the association between level of ANC services and categorical covariates (χ^2 test).

2.5. Survey administration and data collection

The household survey of the fourth-year annual evaluation was conducted by 15 enumerators, who were selected and appointed by Data Management Aid, Dhaka (DMA). Three supervisors and a field coordinator were employed for smooth implementation of the fieldwork. A 5-day residential training was held at BRAC Learning Centre, Rangpur on technical aspects of study and survey tools for data collection. The tools were developed before the training had commenced and then finalized after piloting. The data collection activities were closely monitored by the research team. The pertinent officials of JANO project have also monitored the data collection activities. The necessary data and information pertaining to nutrition-specific and sensitive services as well as the background profile of respondents and households were collected from the PLWs of the selected households. The study used smart devices and an online platform known as SurveyCTO for collection and storage of the survey data electronically.

2.6. Data analysis

All data were summarized by level of ANC visits reported using means for continuous variable and proportions/percentages for categorical variable. Several statistical tests including χ^2 test, Z-test, *t*-test were performed for testing the association between the outcome variable and categorical covariates, equality of two proportions for categorical variables and equality of two means for continuous variables respectively.

Multiple logistic regression model was used to determine predictors of attending 4+ ANC visits, which was coded as a dichotomous variable (ANC visits 4+ = 1 and ≤ 3 visits = 0). The study has considered key characteristics of PLWs, key features of their families and related facilities of their communities as covariates to identify the predictors of radical improvement of ANC services. In order to assess whether community level covariates have more potential than individual/family level predictors, the study has estimated the pseudo R^2 for the three reduced models considering the individual level, family level and community level covariates [28]. All the statistical analyses were performed by using the Statistical Packages for Social Sciences (SPSS-26) software (SPSS Inc, Chicago, IL, USA). The p-values within 0.05 were considered as statistically significant.

3. Results

3.1. Characteristics of PLWs and level of ANC services

The distribution of 629 sample PLWs based on individual characteristics, household background and community profiles is presented in Table 1. The analysis was performed by categorizing the PLWs based on desired number of ANC services - ≤3 visits (Group-I) and 4 or more visits (Group-II). Most of the PLWs were found to have secondary or above level education and were from higher pregnancy order. However, a huge portion lacked earning status as well as empowerment (freedom of movement and participation in family decision-making) and handwashing practices in 5 critical times. The average age of the PLWs was 24.84 years with a standard deviation of 5.70 years. More than three-fifths of the households received benefits from social safety net programs. Nearly half of the household heads were involved in agriculture, about one-third involved as non-agricultural laborers and the rest were employed in jobs/services. About 35 % of PLWs got SMS messages to access ANC services. Community clinics are viewed as the main hub of medical facilities for rural people and 70.59 % PLWs had received ANC services from community clinics. However, 37.52 % of the community clinics in the study area were fully functional based on the predefined criteria.

Bivariate analysis indicated significant ($p < 0.05$) association between desired number of ANC services and pregnancy order, handwashing practices in 5 critical times, access to social safety net benefits, sources of information for ANC services, functional status of community clinic and place of ANC services (Table 1). As some of the selected covariates were found to have insignificant association with the level of ANC services, the study also performed tests of equality of the proportions between two groups and found

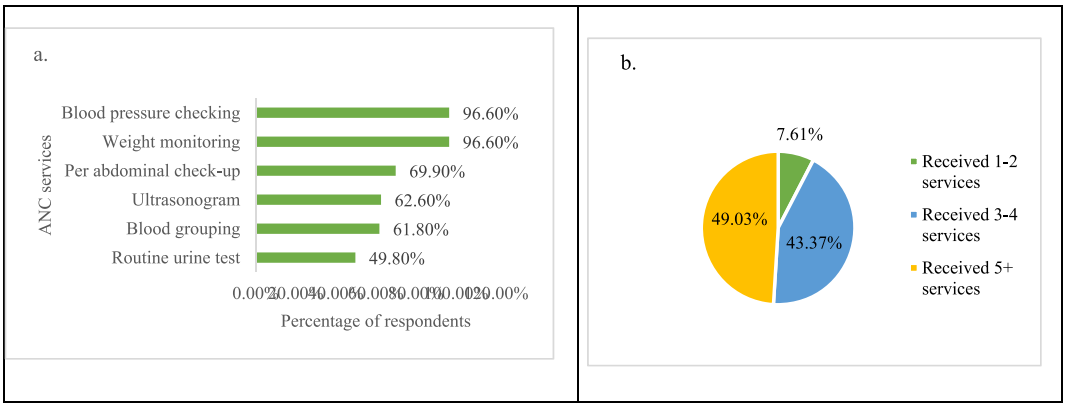

Fig. 2. Percentage of PLWs by a. The tests/services as part of ANC; b. Number of ANC services.

significant ($p < 0.05$) differences for most of the categories of the selected covariates (Table 1). The analysis showed that the proportion of PLWs with their first pregnancy was significantly ($p < 0.01$) higher in Group-I than in Group-II. The PLWs with handwashing practice were found significantly ($p < 0.01$) higher in Group II compared to Group I. Empowerment, as measured by freedom of movement and decision-making spaces in family, was found considerably higher in Group-II in comparison to Group-I cohorts (Table 1). The average household size was found significantly ($p < 0.01$) higher in Group-II households in comparison to Group-I households. The average number of reported danger signs by PLWs was found 3.30 and 3.08 for Group-II and Group-I households respectively. Group-II households had a larger average landholding size compared to Group-I households. PLWs receiving SMS messages from JANO were significantly ($p < 0.01$) more in numbers in Group-II households (42.23 %) than in Group-I households (14.53 %). A significantly ($p < 0.01$) greater percentage of PLWs from Group-II households reported that the community clinics were fully operational compared to Group-I households. The percentage of PLWs utilizing community clinic services was significantly ($p < 0.01$) higher in Group-II households (74.62 %) than in Group-I households (59.88 %).

3.2. Content of ANC and frequency of visit

The effectiveness of antenatal care (ANC) services is contingent upon the content of care provided. Fig. 2 shows the types of tests/services received by the PLWs as part of ANC along with corresponding frequency of service utilization. The vast majority of the PLWs were found to receive weight measurements, followed by blood pressure check-ups, abdominal examination and ultrasonogram during pregnancy as part of ANC services (Fig. 2a). Fig. 2 b presents an overview of the number of tests and services received during pregnancy. Near half of the PLWs received 5 or more services during pregnancy. On average, PLWs received 4.1 services with standard deviation of 0.63 services.

Fig. 3a and 3b provided insights into the number of visits for antenatal care for lactating mothers and pregnant women (3+ months of pregnancy) respectively. Notably, 98.3 % of lactating mothers received at least one ANC service by medically trained service providers, surpassing the national figure of 81.9 % reported by the BDHS 2017-18 [2]. Following the WHO [13] recommendation for four ANC visits, the analysis indicates that 87.1 % of lactating mothers and 43.8 % of pregnant women attained the recommended visits (Fig. 3a and b). Combining both groups, it is found that 72.7 % of PLWs received 4 or more ANC services, markedly surpassing the national figures of 47 % reported in BDHS-2017/18 [2].

3.3. Predictors of desired ANC services

Table 2 presents the estimated regression coefficients along with the odds ratios against each category of the covariates. Based on different goodness of fit statistics including Hosmer and Lemeshow test criteria (p-value = 0.22), the logistic regression model demonstrated a good fit to the observed data. Individual-level covariates such as education of the PLW, knowledge on danger signs and women empowerment status showed significant positive associations with receiving of 4 or more ANC services. On the other hand, age of the PLW, earning status, pregnancy order, and handwashing practice did not reach statistical significance. Among the family level covariates, only household size exhibited a significant association with 4+ ANC visits during pregnancy, while other factors like occupation of the household head, household landholdings, access to social safety nets benefits were not statistically significant. All community level covariates viz., functional status of community clinic, sources of information for ANC services and place of ANC services were significantly associated with receiving 4+ ANC services.

Analysis revealed that education level of the PLW had a significant positive impact on receiving desired number of ANC services. The odds ratio indicates that women with primary level of education were nearly twice as likely to receive the desired number of ANC services compared to illiterate women. Women with secondary level education were 2.26 times more likely to receive 4+ ANC services than their illiterate counterparts. Knowledge on danger signs during pregnancy had a significantly positive impact on receiving 4 or more ANC services with the likelihood increasing by 1.23 times for each unit increase in knowledge. Empowered women were 1.63 times more likely to receive 4+ ANC services compared to those who were not empowered. Household size also had a significantly

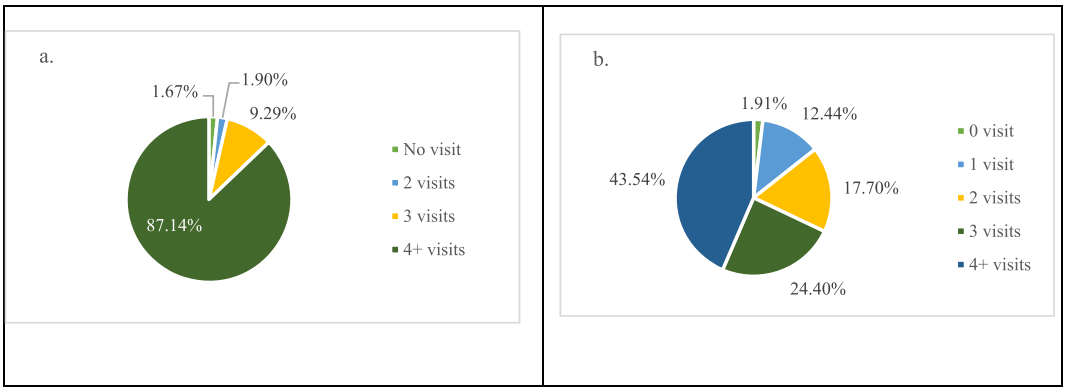

Fig. 3. Number of ANC Services received by a. The Lactating Women; b. The Pregnant Women.

Table 2
Estimated regression coefficients along with odds ratio of Multiple Logistic Regression Model.

Level	Covariates	Estimated regression coefficient (β)	S.E. (β)	*P*-value	Odds Ratio	95 % CI for Odds Ratio	
Individual level	**Age of PLW**	0.02	0.02	0.45	1.02	0.97	1.07
	Education of PLW						
	Illiterate	–	–	–	1.00		
	Primary	0.69	0.53	0.19	1.99	0.71	5.57
	Secondary	1.00	0.52	0.05	2.71	0.97	7.55
	Post-secondary	0.82	0.54	0.13	2.26	0.78	6.56
	Earning status of PLW						
	Not earner	–	–	–	1.00		
	Earner	0.35	0.37	0.34	1.42	0.67	2.95
	Pregnancy order						
	First	–	–	–	1.00		
	Higher order	0.36	0.27	0.19	1.43	0.84	2.44
	Knowledge on number of danger signs	0.21	0.09	0.03	1.23	1.02	1.48
	Handwashing practice at 5 critical times						
	No	–	–	–	1.00		
	Yes	0.25	0.23	0.27	1.29	0.82	2.01
	Status of women empowerment						
	Not empowered	–	–	–	1.00		
	Empowered	0.49	0.26	0.05	1.63	0.99	2.69
Family Level	**Household size**	0.12	0.07	0.08	1.13	0.98	1.28
	Occupation of household head						
	Agriculture	–	–	–	1.00		
	Nonagricultural labour	0.12	0.23	0.60	1.13	0.72	1.75
	Service/Job	0.18	0.30	0.55	1.20	0.66	2.15
	Total landholdings	0.002	0.002	0.40	1.00	1.00	1.01
	Households received benefits from SSNPs						
	No	–	–	–	1.00		
	Yes	−0.20	0.21	0.36	0.82	0.54	1.25
Community level	**Place of ANC services**						
	Other than community clinic	–			1.00		
	Community Clinic	0.83	0.21	0.00	2.30	1.52	3.49
	Sources of information						
	Others	–	–	–	1.00		
	SMS from JANO	1.46	0.25	0.00	4.30	2.63	7.04
	Functional status of Community Clinic						
	Partially functional	–	–	–	1.00		
	Fully functional	0.43	0.22	0.05	1.53	1.00	2.35

−2 Log likelihood = 642.18; Cox & Snell R^2 = 0.14; Nagelkerke R^2 = 0.21; Hosmer and Lemeshow Test: Chi-square = 10.77 (*P*-value = 0.22); Correctly classified cases: 76.30 %

positive impact with the likelihood of receiving desired number of visits increasing by 1.13 times for each unit increase in household size.

Since a community clinic is the nearest health facility for most of the households, the study intended to know whether the ANC services increased remarkably if the services were taken from the community clinic. The plausibility of receiving 4 or more ANC services was 2.30 times higher for the women who received services from a community clinic than the women who did not receive services from a community clinic. The sources of information have played a vital role in attaining desired number of ANC services and the likelihood was 4.3 times higher for PLWs who received SMS messages from JANO compared to the PLWs who did not receive messages. The functional status of the community clinic significantly influenced the likelihood of receiving 4+ ANC services. The PLWs residing around the fully functioning community clinics had 53 % higher likelihood of receiving 4+ ANC services compared to those under partially operational clinics.

Table 3 shows the values of pseudo R^2 for reduced models for individual level, family level and community level covariates. The values of pseudo R^2 were found 0.09, 0.03 and 0.01 for community level, individual level and family level predictors respectively. The findings clearly revealed that the reduced model for community level predictors measures more improvement over the null model than the individual level and family level predictors.

Table 3
Values of pseudo R^2 for reduced models.

Models with Different Levels of Covariates	Pseudo R square
Reduced Model 1: Community level Covariates	0.09
Reduced Model 2: Family level Covariates	0.01
Reduced Model 3: Individual level Covariates	0.03

4. Discussion

This study's major goal is to determine if community-level determinants (supply-side variables) outweigh individual/family-level predictors (demand-side variables) for accessing 4+ ANC services. In addition to univariate and bi-variate analysis, the study employed logistic regression models to identify the various level predictors. At the national level, the percentage of women who received four or more ANC visits rose from 17 % to 47 % between 2004 and 2017 [2,25]. Based on the community-based data of 3 areas (2 rural and an urban) of Northern Bangladesh, a study documented that about 35 % rural women and 58 % urban received 4+ ANCs by medically trained practitioner [13]. The status of receiving ANC services in the study areas was very impressive, as 72.7 % of PLWs were found to receive at least four ANC visits, which is far ahead of the national figure as well as the target set by the Government of Bangladesh (50 % women ought to receive four or more ANC services during pregnancy by 2020) [14]. In the study areas, JANO project has taken a multi-sectoral approach to promote the functioning of government health facilities, particularly community clinics and associated bodies/forums as well as raise awareness among community people of nutrition sensitive and specific services. This remarkable gain in receiving 4 or more ANC services in the selected areas might be due to the functional health facilities available at the entrance of the rural community, as well as increased ICT services, both of which are supported by the JANO project.

The regression model-based analysis of the data of the JANO intervention areas indicates that education of the PLW, knowledge on danger signs, status of women's empowerment, household size, functional status of community clinic, sources of information for ANC services (SMS message) and place of ANC services (community clinic) were the significant predictors of the desired number of ANC visits in the surveyed rural areas of Bangladesh. The education of PLWs is regarded as one of the factors which has had significant effects on receiving the desired number of ANC services. Previous studies also documented that educational status of the women had a strong bearing on receiving ANC services [2,13,25,29]. This is due to the fact that educated women were aware of the merits of receiving the desired number of ANC visits, as well as because education enhances female participation in the labour force, thereby raising their empowerment and consciousness of health and nutrition issues.

The knowledge on danger signs during pregnancy appeared as an important predictor and this could be due to its strong association with the number of visits for ANC services. Studies found significant positive association between number of ANC visits and number of items covered as ANC services [25]. Counseling on danger signs during pregnancy is an integral part of ANC services. The increase of number of ANC services could raise the knowledge on danger signs and vice-versa. Freedom of movement is also an integral part of women's empowerment and therefore empowered PLWs had 1.63 times higher likelihoods of receiving ANC services. This may be because they can take the services independently. In addition, empowered women have a strong voice in household decision-making processes regarding economic, social, and health related issues, which also helped them to receive the desired number of ANC services.

The positive impact of household size on the number of ANC services might be due to the additional members in the households who may help the PLWs for taking rest as well as accompanying them when receiving ANC services. Another plausible reason might be that these women, having experienced pregnancy before, understand how to get ANC services even when there is limited additional manpower in their household. Women's exposure to mass media has been shown to be a strong predictor of getting maternal healthcare services, especially the frequency of ANC visits [13,25]. Alike women's exposure to mass media, this study has considered sources of information (SMS Messages) as a covariate, and it appeared as a highly significant predictor of receiving 4 or more ANC services. Thus, SMS from JANO appeared a vital predictor for desired number of services because it helped to remind the PLWs of the ANC services. The services received from the community clinic are regarded as one of the factors which has a significant effect on receiving desired number of ANC services because of the proximity of the community clinics to the households. This indicates that the distance of health facilities from the receiver's home is regarded as an important factor for receiving maternal healthcare services in Bangladesh [30]. The functionality of community clinic is perhaps regarded as an important predictor of receiving the desired number of ANC services for PLWs because functional status is associated with many factors including provision of 5 services, operation 6 days/week, quality of services and availability of manpower. While comparing the coverage of ANC visits between rural and urban areas, it is documented that unavailability of skilled provider, poverty, distance to the health facility, waiting duration for services, scarcity of female health staff including birth attendant, lack of education were the constraints to access maternal health services in rural Bangladesh [25,30]. It can be perceived that functioning of community clinics may resolve most of the constraints to access maternal health services in rural areas of Bangladesh, where 78 % of people are living and only 30 % doctors are stationed [31].

The overall findings (estimated value of the coefficients and values of pseudo R^2 for reduced models) reflected that the community level predictors associated with the supply side of nutrition specific services were more impactful in receiving 4 or more ANC services by PLWs in selected rural areas of Bangladesh. The community level predictors are interlinked with government health facilities, and it appeared from the findings that enhanced government healthcare facilities might ensure the desired number of ANC services. It is to be mentioned that each of the community clinic is governed by a committee, known as the Community Group (CG). There is a provision that 3 Community Support Groups (CSG) to work in the catchment area of each community clinic, each consisting of seventeen members to mobilize community people in receiving health and nutrition services, create greater awareness among community people and establish linkage with different services.

It is clear from the findings and discussions that the effective operation of community clinics along with awareness raising among PLWs through SMS are potential factors for receiving the desired number of ANC services in rural areas of Bangladesh. The initiative of Union Development and Coordination Committees (UDCCs) in terms of supervision for effective operation of CGs and CSGs might be helpful for ensuring the services of community clinics as well as boosting the awareness of community people for receiving healthcare services. Study revealed that the ANC facilities can be enhanced remarkably within the existing government set-up along with introduction to SMS provision for probable PLWs. The list of probable PLWs with their contact information can be generated with the help of CSGs. In short, lessons learned from this study may be beneficial for ensuring maternal and child healthcare services from

community clinics in the rural areas of Bangladesh. Therefore, the JANO project's interventions may be repeated in other parts of the country in order to meet the SDG targets concerning maternal and child health care indicators of Bangladesh.

The strength of this research is its sound study design, adequacy of sample size, freshness of data in terms of study period, precise analytical method, and application of findings in terms of informing policy formulation. This study is based on primary data collected between August–October 2022. The study incorporated community level covariates along with individual/family level covariates to identify the predictors of desired number of ANC services. The results of the study might be useful for policy formulation to improve ANC services in Bangladesh. The replication of the main interventions (full functioning of the community clinic and arrangement for sending SMS messages to PLWs) in other parts of the country might enhance the desired number of ANC visits by PLWs. The household listing of the study has provided the number of households that need to be visited to get an eligible PLW, which might support other researchers in designing studies. On average, 5.74 households were required to be visited in order to get an eligible PLW in rural areas of Bangladesh. In addition, the study was done in an area where a large, multi-sectoral program (JANO) was being implemented specifically targeting PLW and children, and therefore there are unique insights into the impact/potential of such initiatives, which may be useful for the design of future interventions.

The study's drawback is that it was done in one region of Bangladesh; thus, the analysis is based on regional data rather than national data. The study has measured 4 or more ANC services as the desired number of visits considering the target set by the government of Bangladesh, although the WHO has recommended 8 or more visits under normal circumstances in 2016. Moreover, the data was collected through retrospective interview under a cross-sectional design, which may lead to some bias in the results. The desired number of ANC services may be influenced by some other variables (e.g., distance of household from health facility, awareness regarding timing of ANCs etc.) which could not be considered due to data limitation. The government of Bangladesh should introduce the WHO recommended 8 or more ANC visits in its development targets in order to get maximum benefit from ANC visits. The health card for PLWs was hardly practiced and the recall bias can be reduced remarkably if health card strictly administered. A study using national-level data addressing these limitations can produce the robust estimates of the determinants of ANC services in Bangladesh.

5. Conclusion

The study has identified education of PLWs, knowledge on danger signs, status of women empowerment and household size as individual/family level predictors for the desired number of ANC services. In addition, functional status of community clinic, sources of information and place of ANC services were identified as the community level predictors for remarkable improvement of ANC services in the study area. The values of pseudo R^2 reveals that the community level predictors were more influential than the individual/family level predictors in receiving 4+ ANC services. It is observed that two of the community level predictors are directly associated with the community clinic. Therefore, attention should be given to ensuring the full functioning of the community clinics and associated bodies/forums for both delivering and receiving ANC services to achieve the targets set in development plans of Bangladesh to reduce the maternal mortality ratio and neonatal mortality rate. The results of the study suggest that for a notable improvement in ANC visits for PLWs, the lessons acquired from the JANO initiative should be replicated in other regions of the nation. In summary, ensuring the community clinics' full functionality as well as offering SMS addressing healthcare and nutrition may be effective for reaching the desired ANC visits for PLWs.

Ethical approval and consent for data collection

The study was approved by the Ethical Review Committee, School of Physical Sciences, Shahjalal University of Science & Technology, Sylhet-3114, Bangladesh (Research Project Number: DPS/115). Ethical issues were duly considered at each stage of the study. Both written and verbal consent was taken from each participant before initiating the interview for data collection.

It is to be mentioned that the data were collected through ODK-based SurveyCTO tools using tablet. The respondents are asked to carefully read the consent form and if agreed put the tick mark to continue the interview. For illiterate or poorly educated respondents, the consent form was read by the interviewer and the interview was continued if the respondents provided the permission spontaneously. The consent form was an integral part of the survey questionnaire, which was placed at the beginning of the questionnaire. In the consent form, a brief introduction on the aims and objectives of the study was given first and each of the respondent was assured regarding the confidentiality and privacy of information. It is also stated that the information would be used only for research purposes, their participation was fully voluntary and if intended upon may completely withdraw from this survey, and neither their participation nor withdrawal would have any impact in terms of receiving facilities from the JANO project. Participants who were agreed with the consent were finally included.

Data availability statement

The data of this study is publicly available at the data repository of the Department of Statistics, Shahjalal University of Science & Technology, Sylhet, Bangladesh. The link is given below: https://www.sust.edu/d/sta/research and/or https://drive.google.com/drive/folders/1T0j_uvsNyWQ8Jj-Zk9BGL0CRhh–hWbl?usp=drive_link.

Funding statement

The study was supported by the CARE Bangladesh [Ref: BGD01-0000011614] with financial assistance from European Union and

Austrian Development Cooperation. However, no specific grant from funding organizations in the public, private, or not-for-profit sectors was given to this research for journal publication.

CRediT authorship contribution statement

Md Zakir Hossain: Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Conceptualization. **Md Mizanur Rahman:** Supervision, Project administration, Investigation, Conceptualization. **Nazneen Rahman:** Writing – original draft, Project administration, Funding acquisition, Conceptualization. **Md Shahab Uddin:** Software, Methodology, Investigation, Formal analysis, Data curation. **Morgan Siegel:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was supported by the JANO project, which is funded by the European Union, with co-funding from the Austrian Development Cooperation, and implemented by CARE as consortium lead, Plan International, and Eco-Social Development Organization (ESDO). The authors thank Andrea Maria Menefee, Director, Nutrition, CARE USA, and Caitlin Shannon, Research and Evidence Lead, CARE USA for reviewing the draft and for assistance with necessary edits of the article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25005.

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