BMJ Open

Individual and Community level Determinants of Maternal Health Services Utilization in Northwest Ethiopia: Multilevel Analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-061293
Article Type:	Original research
Date Submitted by the Author:	25-Jan-2022
Complete List of Authors:	Amentie, Muluwas; Addis Ababa University College of Health Sciences, Reproductive Health; Assosa University, Public Health Worku, Alemayehu; Addis Ababa University, School of Public Health Debelew, Gurmesa Tura; Jimma University,
Keywords:	Public health < INFECTIOUS DISEASES, Maternal medicine < OBSTETRICS, PUBLIC HEALTH

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Individual and Community level Determinants of Maternal Health Services Utilization in Northwest Ethiopia: Multilevel Analysis

Muluwas Amentie Zelka[1, 2 *], Alemayehu Worku Yalew[3], Gurmesa Tura Debelew[4]

[1]Department of Public Health, College of Health Sciences, Assosa University, Assosa, Ethiopia

[2]Department of Reproductive Health, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia

[3]Department of Biostatics and Epidemiology, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia

[4]Department of Population and Family Health, Institute of Health, Jimma University, Jimma, Ethiopia

E-Mail Address:

Muluwas Amentie Zelka (M.A. Zelka): muluwas12@gmail.com

Alemayehu Worku Yalew (A.W. Yalew): alemayehuwy@yahoo.com

Gurmesa Tura Debelew (G.T. Debelew): gurmesatura@gmail.com

*** Corresponding author**

Muluwas Amentie Zelka (M.A. Zelka): muluwas12@gmail.com , P.O.Box 18, Assosa Univerity, Assosa, Ethiopia

Abstract

Objective: Utilization of maternal health services is an important indicator for maternal health and socio-economic development. However, utilization of maternal health service was extremely low. Evidence on individual and community level determinants for underutilization of these services in Benishangul Gumuz Region was not found. Hence, this study fills this gap.

Methods: Prospective follow up study design was conducted among 2,198 pregnant women from March 2020– January 2021 in the region. Multistage sampling technique was used to select study subjects. Data were collected via face to face interview using pretested semi-structured questionnaires. Collected data were coded, cleaned and analyzed using STATA software version 14.1. Multilevel regression models were applied to identify factors.

Results: This study found that the proportion of women who visited antenatal care (ANC 4^{+}), received skilled delivery care and postnatal care (PNC) were 66.1%, 58.3% and 58.6% respectively. Beside these, community and different individual level predictors for those three indicators were identified. For ANC 4^{th} visits: being rural (AOR=3.82), having information on MHS (AOR=2.13), having history of pregnant related problems for previous birth (AOR=1.83), having history of stillbirth (AOR=1.67) and women have decision making power (AOR=1.74). Similarly, for skilled delivery were women attended tertiary school (AOR=4.12), attending ANC visit 4^{th} (AOR=2.29) and delay initiation of 1^{st} ANC visit between 4–6 months of GA (AOR=0.66). Finally, for PNC services were partner attended tertiary education (AOR=3.67), women have decision making power (AOR=1.8), attending ANC visit 4^{th} (AOR = 10.8), women receiving IFA during pregnancy (AOR=1.96) and receiving skilled delivery care (AOR=1.63)

Conclusion: The proportion of women attended antenatal care, skilled delivery and postnatal cares were low. Different individual and community level factors that influenced utilization of the services were discovered. Therefore, strategies that aimed to improve maternal health service utilization should target to those individual and community level factors.

Key words: *Benishangul Gumuz, Factors, Maternal Health, Service Utilization*

Strength and limitation of the study

- The strengths of this study were using prospective follow up study that helped to measure the true cause and effect relationship, large sample size were used that resulted in high power and precision for the multilevel analyses and using advanced statistical models to handle clustering effects and identify factors at different levels for intervention purposes.
- The limitation of this study was health facility based data were collected by health workers that result social desirability bias which might be compromised the finding.
- Around 8.5% of the study participates were lost to follow up that might have some deviation on the result.

Introduction

Regardless of significant reduction of maternal and neonatal mortality globally and developed countries, still maternal and neonatal mortality in developing countries including Ethiopia was highest and no significant reduction(1, 2). However, proper provision of maternal health services are essential for women and baby health(1). Thus, antenatal care (ANC), delivery services and postnatal care (PNC) are the major pillar of maternal health services that have an effort to reduce maternal and neonatal mortality (3, 4). Even though, utilization of maternal health services are an indirect indicator of maternal and perinatal death, fewer women were using ANC, facility delivery and PNC that is an alarming challenge to rapidly reduce maternal and neonatal mortality rate(3, 5).

According to WHO directives, every pregnant women had used at least 4th ANC visits to achieve the full life saving potential for women and babies and also warrant more programmatic attention (6, 7). However, utilization of ANC services is low and varies across nation and within the country (1, 7-26). This underutilization of ANC services because of different factors: socio-demographic characteristics (1, 3, 4, 21, 24-27), availability of health facility(27), household index(1, 4, 21, 24, 25), women empowerment (21), present and past obstetric history(3, 4, 21, 26), information and perception on maternal health services(4, 25, 26) and health insurance(21)

In fact, use of skilled delivery is extremely low and a big variability between utilization of skilled delivery and ANC within the nation and abroad the countries (1, 5, 9-13, 18, 19, 22, 24,

28). Empirical evidence identified different factors that affect uptake of institutional delivery services such as socio-demographic and economic factors(1, 3, 4, 21, 26, 27, 29), obstetric history (3, 4, 21, 26, 27, 30), transportation services and perception on quality of services (26, 29).

Health interventions after delivery are crucial time period and key strategy to reduce maternal and neonatal mortality (10, 29). But, utilization of postnatal services was extremely low even as compared with use of ANC and delivery services (1, 9-11, 14, 18, 19, 21, 22, 24, 25, 31). This underutilization of the services is due to different factors: socio-demographic factors (4, 21, 32), household wealth index (4, 21), obstetric factors(3, 4, 21), women empowerment (21) and health insurance (21).

However, prior studies were determining magnitude and explore individual level factors using traditional regression model which excluded community level factors and advance statistical modeling. This might lead to underestimate or overestimate the magnitude and their predictors which are crucial for the establishment of community based intervention for maternal health services. Multilevel regression modeling is an appropriate method for controlling the nesting effect of clusters at different levels, which is not addressed in previous studies. Therefore, by overcoming the limitation of previous study, the aim of this study was to determine individual (*level – 1*) and community level (*level – 2*) determinants of maternal health services.

Methods

Study settings

This study was conducted in Benishangul Gumuz Regional State. It is one of the eleven regions constituting the Federal Democratic Republic of Ethiopia, located in the Northwest Ethiopia. The capital city of the region is Assosa town, located 670km away from Addis Ababa, capital city of Ethiopia. Administratively, the region has three zones, three town administrative city, one special woreda and 475 kebeles (439 rural and 36 urban kebeles). The region hosts near to 60,000 refugees. Based on 2007 national population and household census, 2018 population projection revealed that total population of the region was 1,127,001 that covers 1.1% of the national population, total number of pregnant women in region and the selected study districts were 36,754 and 15,368 pregnant women respectively(33). Health facilities serving these

populations were 446 public health facilities (401 health posts; 41 health centers; 4 primary hospitals and 2 general hospitals); 119 private and NGO health institutes (15 medium clinics and 104 primary clinics) and 91 private pharmaceutics (3 pharmacies, 50 drug stores and 38 rural drug venders).

Study design and Period

A community and health facility linked prospective follow up study design has been carried out from March 2020 to January 2021.

Source population and study participants

All pregnant women within the study area during the time of baseline survey were source population. A randomly selected pregnant women using sampling technique were study participants.

Sample size and sampling procedure

Sample size was computed using both single and double population proportion formulas. For the single population proportion, the following assumptions were considers while computing the sample size: magnitude of using the whole maternal health care service is 60%(p = 0.6)(34). The margin of error is 5% (d=0.05) with 95% level of confidence interval (1.96), taking a design effect of 2 and a non-response rate of 10%. Then, the sample size calculated is *812* pregnant women. Similarly, double population proportion formula was used to compute sample size for each determinants of maternal health services utilization. Among all the factors considered for sample size calculation, women age is found to have maximum sample size. Thus, considering the following assumption for double population formula: the proportion of women who completed continuum of care, among women whose age is greater than 35 is 48% (p_1 = 0.48) and among women whose age between 20 – 35 years old is 62% (p_2 = 0.62)(34); pooled population proportion (P = 0.55); r =1:1 ratio of exposure to non-exposure; 5% significant level; 80% power, design effect of 2 and 10 non-response rate. Then, *874* sample sizes were generated through STATA/MP 13.0 software. As a result, a total of 874 pregnant women were calculated for this study. This study, however, was part of a larger research work, and the sample size determined for another objective was 2,402 pregnant women, which was used as the final sample size for this study. Multistage sampling technique was employed to reach the study participants. In this study, the study area was first stratified into three zones and three town administrative cities with one special woredas. In the first stage, of these stratified areas, two zones and one town administrative city were selected using simple random sampling technique. Then after,

seven districts/woredas and two town districts/woredas were randomly selected from two zones and one town administrative city respectively as the second stage. Subsequently, at third stage, 51 Kebeles/clusters were randomly selected from the selected districts/woredas. A one-month baseline census was conducted to identify pregnant women using a pregnancy screening criterion to prepare a sampling frame. Then, all pregnant women who resided in the selected kebeles/clusters were included in the study then followed for an average of 11 months. Meantime of house-to-house survey, public health facilities that providing at least basic maternal health services for the community were identified. Then, all eligible public health facilities were recruited and make a candidate for facility based survey. Based on these, 46 health facilities (3 hospitals, 12 health centers and 31 health posts) were included for health facility based survey.

Data collection and quality control

The research questionnaire was prepared in English which were adopted from EDHS 2016(2), National Technical Guidance for MPDSR 2017(35), MCH Program Indictor Survey 2013(36), Survey tools conduct in Jimma Zone, Southwest Ethiopia(37), Survey tools conducted in Rural South Ethiopia(5) and other relevant different literatures. After finalized instrument preparation, training, pretest, supervision and use of local languages were made to ensure the quality of data. Then, the trained data collectors gather information through face to face interviews at comfortable and convenient places. After all, completed questionnaires were reviewed by supervisors on monthly base for accuracy and consistency.

Variables and Measurement

Outcome variables

In this study, the composite outcome variable is the utilization of maternal health services. Beside these, maternal health service encompasses care during pregnancy, childbirth and after birth within 42 days. Therefore, we have three outcomes: receiving recommended ANC visits (4^{th} visits or more), skilled delivery care and receiving PNC 4^{th} visits with 42 days.

Independent variables

Independent variables were categorized in to two levels. ***Individual level variables (level – 1)*** included individual and household related factors: household wealth index, women age, educational level (women and partner), occupational status (women and partner), information on maternal health services, age at first marriage and pregnant, past and present bad obstetric history, women and partner decision making power in health seeking behaviors, IFA

supplementation during pregnancy and provision of TT vaccination during pregnancy. ***Higher level variables (cluster - 2)*** included community and health facility related factors such as place of resident and access to health facility.

Data management and statistical modeling

Collected data was coded and entered into Epi. Info version 7.2.2.6 to develop skipping patterns and avoid logical mistakes. After data entry was completed, it was exported to STATA software version 14.1. Then, data were cleaned, edited, and analyzed using STATA Software version 14.1. Descriptive statistics and crude odds ratio at 95%CI were computed for all variables to select candidate variable for multivariable analysis ($p < 0.25$). The composite indicator of household wealth index was computed and categorized into three categories using principal Component Analysis (PCA). Before running the full model, coefficient of the interaction term at $p \geq 0.1$ and multi-collinarity effect between independent variables was determined by using variance inflation factors (VIF > 10%) were determined. Finally, all included variables had no multi-collinearity and interaction effect.

Even though multistage clustered sampling method was used in the study, multilevel regression model was applied by using STATA 14 to identify cluster and individual level factors having significant association with maternal health care utilization (ANC 4th visits or more, skilled delivery care and PNC 4th visits). Kebele/Ketena was considered as cluster and cluster level variables: place of residence and access to health post were taken as higher level (level – 2). Whereas, individual and household factors such as household wealth index, socio-demographic, obstetric history, age at first marriage and pregnancy, information to maternal health services, women decision making power, key services offered during pregnancy and pregnant related problems were taken as lower level (level-1). Goodness of fit of the multilevel model was tested by the log likelihood ratio (LR) test found to be statistical significant such as data fit the model.

Ethics approval and consent to participate

Ethical approval was obtained from Research Review and Ethics Committee (REC) of School of Public Health, Addis Ababa University's with protocol number SPH/3089/011 and Institutional Review Board (IRB) of College of Health Sciences of Addis Ababa University with protocol number 048/19/SPH. Necessary permission letters were obtained from Regional Health Bureau and respective all local districts. Confidentiality was maintained by avoiding any identities from

the questionnaire. Before starting actual data collection, written and verbal consent was obtained from each study subjects.

Patient and Public Involvement

In this study work, patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research

Result

Magnitude of Maternal Health Services utilization

Utilization of ANC services and related issue

ANC service utilization is an entry point of the continuum of care in maternal health services. Among all, 1453 (66.1%; 95%CI: 64.1 – 68.1%) were attended the recommended ANC visits. Patterns of ANC visit were 1st ANC 1919 (87.3%), 2nd ANC 1815 (82.6%), 3rd ANC 1674 (76.2%), and 4th ANC 1453 (66.1%). The key interventions received during ANC contact were informed on the danger signs of pregnancy 1740 (79.2%) followed by blood pressure measured 1701 (77.4%) and iron folic acid supplementation 1677 (76.3%). Two thirds, 1330 (65.5%) were initiated their first ANC contact within the gestational age of the second trimester (4 – 6 months of pregnancy) and 1901(86.5%) of women were informed to deliver at the health facility. However, 466 (24.3%) women were dropping out from follow-up ANC service due to different reasons such as lack of knowledge on the benefit of ANC services 324 (69.5%), absence of problems 298 (63.9%) and fear of privacy 139 (29.8%)(Table 1).

Table 1: Utilization of ANC services and related issues of study subjects in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Visit of ANC received during last pregnancy		
1st ANC contact	1919	87.3
2nd ANC contact	1815	82.6
3rd ANC contact	1674	76.2
4th ANC contact	1453	66.1
Key interventions received during ANC contact (*n = 1919, multiple response*)		
Informed on danger sign of pregnant	1740	79.2
Blood pressure measured	1701	77.4
Iron foliate supplementation	1677	76.3

Nutritional counseling	1623	73.8
Urine sample taken	1607	73.1
Blood sample taken	1578	71.8
Protection of birth from tetanus	1562	71.1
Other	22	1.0
Reason for dropout from ANC follow up (*n = 466 multiple response*)		
Didn't know about importance of ANC	324	69.5
No problems encountered	298	63.9
Fear of lack of privacy	139	29.8
Influence of other peoples	137	29.4
Couldn't pay for transportation	114	24.5
Health institution was too far	111	23.8
No transportation services	56	12.0
Male health professionals	45	9.7
No money to pay for services	38	8.2
Time of first ANC services initiation (*n = 2032*)		
1-3 months of pregnancy	570	28.1
4-6 months of pregnancy	1330	65.5
After 6 months of pregnancy	132	6.5
Did the information offered to deliver at HF		
Yes	1901	86.5
No	297	13.5

Institutional delivery services and related issue

Skilled delivery services are the second pillar of the continuum of care in maternal health services. The prevalence of skilled delivery service was 58.3% (95%CI: 56.2% – 60.4%). Even though 1,404 (63.9%) of women were give birth at the facility, 1184 (53.9%) of delivery were attended by Midwifery/Nurses/Health Officer and 1941 (88.3%) were delivered via spontaneous vaginal delivery. The main reasons for health facility delivery: informed her to deliver in the HF 1277 (91.0%) and previous bad experience from home delivery 263 (18.7%). Whereas, the main reasons for home delivery: labour was going well 424 (53.4%), feeling more comfortable at home delivery 392 (49.4%), to get close attention/support from relatives/families 332 (41.8%) and being as a usual practice 331 (41.8%). Moreover, 295 (14.3%) of women were suffered from pregnant-related complications during childbirth. The main pregnant related complications: obstructed /prolonged labour 187 (63.4%), excessive bleeding 102 (34.6%), elevated blood pressure 76 (25.8%) and premature rupture of membranes 69 (23.4%)(Table 2).

Table 2: Delivery services and related issues for current delivery services in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Delivery services for last delivery		
Skilled care	1281	58.3
Unskilled care	917	41.7
Place of last delivery		
Home	794	36.1
Health post	353	16.1
Health center	775	35.3
Hospital	276	12.6
Attendant of last delivery		
Families/Friends/Relatives	611	27.8
Traditional Birth Attendants (TBAs)	166	7.6
Health Extension Workers (HEWs)	141	16.4
Midwifery/Nurses/Health Officers	1184	53.9
Medical Doctors	96	4.4
Mode of last delivery		
Spontaneous vaginal (SVD)	1943	88.4
Assisted vaginal delivery (AVD)	156	7.1
Caesarean section (C/S)	74	3.4
Assisted delivered stillbirth	25	1.1
Reason for health facility delivery (*n = 1404*)		
She was informed to deliver in HFs	1277	91.0
Previous bad experience from home delivery	263	18.7
She faced problems: forced to deliver in HF	227	16.2
Others	53	3.8
Reason for Home delivery (*n = 794*)		
The labour was going well	424	53.4
She feel more comfortable at home	392	49.4
Close attention from relatives/family	332	41.8
It is usual practice	331	41.8
No transportation services	248	31.2
Cannot pay for transportation services	202	25.4
Previous bad experience from ID	65	8.2
Cannot afford to pay for health services	22	2.8
Culture doesn't allow to give birth at HF	15	1.9
Others	5	0.6
Pregnant related complications at labour (*n = 2065*)		
No	1769	85.7

Yes	295	14.3
Pregnant related complications at labour/childbirth (*n = 295, multiple responses*)		
Obstructed/Prolonged labour	187	63.4
Excessive bleeding during labour	102	34.6
Elevated blood pressure	76	25.8
Premature rupture of membranes	69	23.4
Intrauterine fetal death	47	15.9
Preterm labour	12	4.1
Others	5	1.7

Postnatal (PNC) service utilization and related issues

More than half (58.6%) were received the recommended PNC services with the 95% CI (56.4 – 60.7). The frequency of PNC visits, 1783 (86.3%), 1545 (74.8%), 1373 (66.5%) and 1210 (58.6%) of women were attended 1st PNC, 2nd PNC, 3rd PNC and 4th PNC services respectively. The key services received during the postnatal visits: immunization of baby 1692 (81.9%), counseling on proper nutrition 1516 (73.4%), breast feeding education 1436 (69.5%), physical examination 1248 (60.4%) and family planning 1074 (52.0%). Five hundred four (28.9%) of the women were initiated the first postnatal service within 48 hours. The main reasons for utilization of postnatal: baby needed immunization 1598 (89.6%), the midwifery had told her to use services 1305 (73.2%) and she could want to start family planning 975 (54.7%). In other direction, the reasons explored for not utilize postnatal services were they didn't teach them well 181 (64.2%), ignorance of her privacy 137 (48.6%) and waiting more time at health facility 95 (33.7%). Around, 249 (12.1%) of women had postpartum complications, of them, the common postpartum complications were headache with visual disturbances 170 (68.3%), convulsions/rigidity 118 (47.4%) and fever with or without chills 85 (34.1%) (Table 3).

Table 3: Postnatal services and related issues of study participants in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Component of PNC contact, she received (*n = 2065*)		
1st contact of PNC services	1783	86.3
2nd contact of PNC services	1545	74.8
3rd contact of PNC services	1373	66.5
4th contact of PNC services	1210	58.6
The key interventions offered during postnatal		

period (*n = 2065, multiple response*)		
Immunization of baby	1692	81.9
Counseling on proper nutrition	1516	73.4
Breast feeding education	1436	69.5
Physical examination	1248	60.4
Family planning services	1074	52.0
Other	30	1.5
Time interval for first PNC visit (*n = 1741*)		
Within 2days after delivery	504	28.9
B/n 3 – 7 days after delivery	754	43.3
B/n 8 – 42days after delivery	483	27.7
Reason for seeking PNC services (*n = 1783*)		
The baby needed it's immunization	1598	89.6
The midwife had told me to seek the services	1305	73.2
She wanted to start family planning	975	54.7
She wanted to make sure she is back to normal	834	46.8
Because of illness	272	15.3
Reason for not seeking PNC services (*n = 282*)		
They did not teach properly	181	64.2
Fear of privacy	137	48.6
Waiting more time at HF	95	33.7
They examined roughly	77	27.3
Religious forbidden	64	22.7
Health professional shouted at me	37	13.1
Other	14	5.0
Postpartum complications (*n = 2065*)		
No	1816	87.9
Yes	249	12.1
Type of postpartum complications (*n = 249*)		
Headache, visual disturbances	170	68.3
Convulsions/rigidity	118	47.4
Fever with or without chills	85	34.1
Heavy bleeding	66	26.5
Loss of consciousness	66	26.5
Foul smelling discharge	52	20.9
Severe abdominal pain	5	2.0
Other*	3	1.2

* *Leg edema, nausea, vomiting and sever malaria during pregnancy*

Determinants of maternal health care utilization

Individual and community leve1 factors affecting utilization of maternal health care were detected by using mixed effects multilevel logistic regression model. To make decision whether the data fit for a mixed effects multilevel model or not, ICC (ρ) was calculated in the empty model for each outcome (ANC 4th, skill delivery care and PNC 4th). Meantime, ICC/*rho* (ρ) was calculated as a full model for the outcomes to detect the variability attributed to clusters after controlling the individual level.

Rho (ρ)/ICC was calculated for the ANC 4th visits in the empty model and it was found to be 0.37 indicating that 37% of the variation was contributed by cluster variations. The test of preference of log-likelihood *versus* logistic regression was statistically significant (P<0.0001). Then, the full model was run by including both the community level and individual level variables and the ICC (ρ) was increased to 0.46 This again indicated that 46% of the variation was attributed to cluster level variables. The preference of log likelihood *Vs* logistic regression was statistically significant (P < 0.0001). Hence, this is suggesting that the preference model for this outcome variable was mixed effects multilevel model. Similarly, Rho (ρ)/ICC and test preference of log-likelihood was determine in the empty and full model for both skilled delivery care and PNC 4th visits and indicating that statistical significant association. Hence, mixed effects multilevel model is the preference model for the outcome variables (Table 4).

Table 4: Parameter of odd ratio and Test of Goodness-of-fit for Mixed-effect Multilevel Models, Benishangul Gumuz Region, Northwest Ethiopia, 2021

Models	Fixed intercept - cons(95%CI)	Random effect as Level-2 variance var(-cons (95%CI))	Intra-class Correlation Coefficient: ICC(ρ)	Log likelihood (LR)-deviance	Significance of LR test Vs Logistic regression (P-value)
ANC 4th and more					
Empty model	2.54(1.7, 3.78)	1.92(1.23, 3.04)	0.37 = 37%	-1161.48	P < 0.0001
Full model	0.26(0.04,1.67)	2.76 (1.54, 4.96)	0.46 = 46%	-633.06	P < 0.00001
Skilled delivery					
Empty model	1.48(1.17, 1.87)	0.59(0.36, 0.96)	0.15 = 15%	-1402.31	P < 0.0001
Full model	1.18(0.3,4.66)	1.1(0.63, 1.92)	0.25 = 25%	-706.65	P < 0.00001
PNC 4th					

Empty model	1.59(0.99, 2.54)	2.72(1.72, 4.33)	0.45 = 45%	-1099.36	P < 0.0001
Full model	0.08(0.01,0.71)	2.25 (1.27, 3.98)	0.40 = 40%	-523.25	P < 0.00001

P value less than 0.05 is statistically significant and the data fit for the multilevel model
** Multilevel regression model applied to measure the effect of factors on outcome*

After controlling for any confounders in the final multilevel model, among the community level variables: place of resident was statistically significant association with utilization of the recommended ANC visits (4th visits or more) but it was not statistical significant association with skilled delivery care and recommended PNC visits (PNC 4th). The odds of receiving the recommended ANC visits (4th visits or more) among women who reside in rural resident (AOR = 3.82; 95%CI: 1.35, 10.78) were four times higher than among women who reside in rural area. In the individual level (level – 1) variables: multiple determinant factors were detected that had programmatically important implication and depicted that statistical significant association with maternal health care utilization.

With the regards of individual level determinants of ANC services utilization, we found that the odds of receiving the recommended ANC visits (ANC 4th or more) among women who had any information on maternal health services (AOR=2.13; 95%CI: 1.12, 3.75) were two times higher than among women who didn't have any information on maternal health services. Moreover, women with history of pregnant related problems during labour for previous birth (AOR = 1.83; 95%CI: 1.15, 2.2), women with history of stillbirth (AOR = 1.67; 95%CI: 1.02, 2.73) and women who have decision making power (AOR = 1.74; 95%CI: 1.14, 2.68) were two times higher in odds of receiving recommended ANC visit (4th visits or more) than women belonged with their counterpart

Similarly, the determinant factors of skilled delivery care, this study found that the odds of utilizing skilled delivery care among women who completed recommended ANC visit or more (AOR = 2.29; 95%CI: 1.59, 3.32) were two times higher than among women who discontinued ANC visit. Similarly, women belonged in 3rd quintile wealth index (rich) family (AOR = 2.23; 95%CI: 1.27, 3.89), women who attended primary school (AOR = 1.71; 95%CI: 1.04, 2.81) and tertiary school (AOR = 4.12; 95%CI: 1.49, 11.33) were higher in the odds of attending skilled delivery care than women residing with their counterpart. However, women having history of pregnant related problems during labour for previous birth (AOR = 0.57; 95%CI: 0.37, 0.86) and

history of stillbirth (AOR = 0.43; 95%CI: 0.28, 0.66) were 60% lower in the odds of receiving skilled delivery care than among women who were free from any problems. The odds of skilled delivery care utilization among women who delay 1st ANC visit initiation between 4 – 6 months of GA (AOR = 0.66; 95%CI: 0.45, 0.96) and after 6 months of GA (AOR = 0.33; 95%CI: 0.16, 0.68) were 34% and 67% lower than among women who initiate 1st ANC visit early (within 3 months of GA).

Finally, the individual level factors that determine utilization of postnatal services were identified. The odds of utilizing PNC services among women who received ANC 4th visits or more (AOR = 10.8; 95%CI: 6.79, 17.2) and women whose partner attended tertiary education (AOR = 3.67; 95%CI: 1.40, 9.58) were 11 and 4 times higher than among women who belonged within their counterpart respectively. Similarly, women who have decision making power (AOR = 1.8; 95%CI: 1.09, 2.97), women who have received iron folic acid (IFA) supplementation during pregnancy (AOR = 1.96; 95%CI: 1.11, 3.49) and women who attended skilled delivery care (AOR = 1.63; 95%CI: 1.11, 2.42) were two fold higher in the odds of receiving PNC services than among women who resided within their counterpart. However, the odds of PNC service utilization among women who have history of stillbirth (AOR = 0.51; 95%CI: 0.29, 0.87), women delay initiating 1st ANC visit within 4 – 6 months of GA (AOR = 0.39; 95%CI: 0.24, 0.61) and after 6 months of GA (AOR = 0.1; 95%CI: 0.03, 0.24) were 49%, 61% and 90% lower than among women with their counterpart (*Table 5*).

Table 5: Individual and community level determinants of maternal health care utilization in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	*ANC 4th + Visits*	*Skilled delivery care*	*PNC 4th*
	AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**
Level – 2 (Community level) variables			
Place of resident			
Urban	**1**	1	1
Rural	**3.82(1.35, 10.78)**	1.22(0.55, 2.73)	1.14(0.44, 2.91)
Distance to Health Post			
< 2 Hours	1	1	1
>= 2 Hours	0.25(0.02,2.73)	0.49(0.08, 2.89)	0.88(0.1, 10.26)
Leve-1 (individual level) variables			
Household Wealth Index			
1st Quintile (Poor)	1	1	1

2nd Quintile (Middle)	1.06(0.69, 1.61)	1.13(0.78, 1.63)	0.74(0.46, 1.21)
3rd Quintile (Rich)	1.46(0.81, 2.62)	**2.23(1.27, 3.89)**	0.43(0.22, 1.06)
Age (Years)			
< 20	1	-	1
20 – 29	0.95(0.27, 3.31)	-	1.53(0.42,5.62)
>= 30	0.86 (0.24, 3.02)	-	1.33(0.36,4.96)
Women educational level			
No formal education	1	1	1
Primary school	0.92(0.54, 1.57)	**1.71(1.04, 2.81)**	0.69(0.38, 1.27)
High school	1.14(0.57, 2.28)	1.49(0.77, 2.89)	0.68(0.3, 1.52)
Tertiary education	1.43(0.60, 3.37)	**4.12(1.49, 11.33)**	0.52(0.2, 1.37)
Partner educational level			
No formal education	1	1	1
Primary school	1.22(0.69, 2.15)	0.66(0.39, 1.1)	1.07(0.57, 1.98)
High school	0.87(0.48, 1.59)	0.76(0.44, 1.32)	1.49(0.75, 2.95)
Tertiary education	1.98(0.88, 4.45)	0.56(0.25, 1.25)	**3.67(1.40, 9.58)**
Partner occupational status			
Governmental employee	1	1	1
Others	1.23(0.64, 2.36)	0.61(0.31, 1.21)	1.48(0.69, 3.18)
Information on MHS			
No	**1**	1	1
Yes	**2.13 (1.21, 3.75)**	1.23(0.7, 2.17)	1.04(0.49, 2.18)
Age at first marriage (year)			
< 18	1	1	1
>=19	0.92(0.54, 1.56)	1.13(0.7, 1.82)	0.98(0.54, 1.73)
Age at first pregnancy (year)			
< 19	1	1	1
>= 19	1.13(0.67, 1.91)	1.24(0.77, 2.01)	0.98(0.55, 1.74)
History of pregnant related problem during labour for previous birth			
No	**1**	**1**	1
Yes	**1.83 (1.15, 2.92)**	**0.57 (0.37, 0.86)**	1.63(0.98, 2.7)
History of stillbirth			
No	**1**	**1**	**1**
No	**1.67(1.02, 2.73)**	**0.43 (0.28, 0.66)**	**0.51(0.29, 0.87)**
Women decision making power			
Didn't make decision	1	1	**1**
Make decision	**1.74(1.14, 2.68)**	1.22 (0.81, 1.85)	**1.8(1.09, 2.97)**
ANC 4th visit completed			
No	-	1	**1**
Yes		**2.29(1.59, 3.32)**	**10.8(6.79, 17.2)**

Offered information of danger sign during ANC visit			
No	-	1	1
Yes		0.7 (0.44, 1.12)	0.71(0.38, 1.33)
Time of 1st ANC visit start			
Within 3 months of GA	-	**1**	**1**
4 – 6 months of GA	-	**0.66(0.45, 0.96)**	**0.39(0.24, 0.61)**
After 6 months of GA	-	**0.33(0.16, 0.68)**	**0.1(0.03, 0.24)**
Provision of information on health facility delivery			
No		1	1
Yes	-	0.9(0.49, 1.68)	1.05(0.51, 2.17)
IFA supplementation during pregn.			
No			**1**
Yes	-	-	**1.96(1.11, 3.49)**
Provision of TT during pregnant			
No			1
Yes	-	-	1.58(0.93, 2.69)
Skilled delivery care			
No			1
Yes	-	-	**1.63(1.11, 2.42)**
Pregnant related problems immediately after labour			
No			1
Yes	-	-	1.1(0.55, 2.21)

Discussion

Magnitude of maternal health services utilization

The target intervention particularly 4th or more ANC visit play a pivotal role within maternal health services and warrant more programmatic attention (6, 7). Beside, this study found 66.1% pregnant women were attended the recommended ANC visits which is consistent with studies in North Ethiopia 63.9% (7, 16), Cambodia 60% (12) and Bihar, India 55.94% (13). However, this finding is lower than national target figure in Ethiopia, South Asia and Sub-Saharan Africa (7), Debre Berhan town 74.5% (17) and Northern Bangladesh 78%(8). But, it is higher that evidence in Pakistan 38.4% (9), Ratanakiri, Cambodia 32.6% (10), Rural Khammouane, Lao PDR 54.4% (11), Sub–Saharan Africa 51% (14), EDHS 2014, 33% (15), Arba Minch districts 25.2% (19), West Gojjam zone 39.9% (18) and Tigrary 49.9% (20). This disparity could be explained by differences in socio-cultural, economic status, study time and design.

Measurement of maternal health services were only capturing contact rather than content of each measurement parameters (14).The implication of merely focus on increasing coverage of recommended contacts within the health system rather than emphasis essential packages of maternal health services are insufficient to reduce maternal and neonatal mortality and morbidity and also it doesn't give clues on quality of maternal health services. As result, this study found that core package of ANC services offered for women during pregnancy were informed on the danger signs of pregnant (79.2%), blood pressure measured (77.4%), iron folic acid supplementation (76.3%), nutritional counseling (73.8%), urine sample taken (73.1%), blood sample taken (71.8%) and protection of birth from tetanus (71.1%). This finding consistent with prior study in Bihar India(13), Ghana (31), Sub – Saharan Africa (14), Northern Ethiopia(16), Arba Minch (19) and West Gojjam zone (18). However, this finding is lower than study done in Rural Khammouane, Lao PDR (11) and Debre Berhan town (17). This is due to variability of socio-demographic, wealth status of the nations, availability and accessibility health facility and medical equipment's in the health system.

In this study, 28.1% pregnant women were initiated their first ANC contact within the recommended time schedule. This finding is lower than evidence in Rural Khammouane 41.1% (11), South Asia 47% (7), Ghana 55 % (38), EDHS (2014) 37.4% (15), Arba Minch 78% (19) and Debre Berhan town 81.8% (17). Whereas, this finding was higher than Sub-Sahara Africa 24% (7) and West Gojjam zone (14.9%) (18). This discrepancy may be, in the study area, there is low awareness and lack of knowledge on early initiation of maternal health services and also it is a remote area, which lack availability and accessibility of health facility and lack skilled health providers. Not only delay of ANC initiation but also one fourth of pregnant women were dropping out from ANC follow up due to lack of knowledge on the benefit of services, believing as absence of problems, fear of privacy and influence of other people.

Skilled delivery services are the second pillar of maternal health services, found that 58.3% of birth attended by skilled providers which was consistent with study in Pakistan 56.8% (9). This finding was lower than study in Cambodia 74% (12); Tanzania found 67% (28); Bihar, India 83.93% (13). Whereas, it was higher than evidence in Ratanakiri, Cambodia 40.1% (10), Rural Khammouane 30.4% (11), West Gojjam 47.5% (18) and Arba Minch South Ethiopia 46.3% (19). This discrepancy might be due to variation of socio-demographic and economic, culture, belief,

time of study and design. This study found that the main reasons for health facility delivery were informed her to delivery at health facility and previous bad experience from home delivery. This evidence supported by study done in west Gojjam (18). In contrast to reason mention for facility delivery, this study found that the main reasons for home delivery: labour was going well, being feel more comfortable at home delivery, to get close attention/support from relatives/families and being as a usual practice which were consistent with study done in West Gojjam(18).

Provision of standard care during the postnatal period both at home and with strong referral linkage to health facilities is crucial for reducing maternal and newborn deaths and it create an opportunity in order to support the initiation of key healthy behaviors that leads to beneficial effect. Hence, postnatal care is the key strategy to improve the completion of maternal health services and reduce maternal and neonatal mortality and morbidity (10). Beside, 58.6% of women received the recommended PNC services in this study, which was lower than study in Pakistan 63.2% (9), Sub – Saharan Africa 65% (14) and Ghana 70.6% (31). Whereas, this finding was higher than study in West Gojjam Zone 43.0% (18), Ratanakiri, Cambodia 16.1%(10), Arba Minch 37.7% (19) and Rural Khammouane 30.8% (11). In line with these, the effectiveness of PNC services was not only determined by coverage of the services utilization but also the key services and quality of postnatal services were crucial. As a result, this study found that key PNC services provided for women and newborn: immunization of baby (81.9%), counseling on proper nutrition (73.4%), breast feeding education (69.5%), physical examination (60.4%) and counseling on family planning (52.0%). This finding is similar with study conducted in Arba Minch (19), West Gojjam Zone(18) and Ghana (31).

Determinants of maternal health care utilization

Since this study targeted to determine individual and community level factors of maternal health care utilization, the community level factors (place of residence) and different individual level factors are discovered that have significant implication on maternal and child health program.

In this study, we found that the odds of completing recommended ANC visits (4th visits or more) among women reside in rural resident were four times higher than among women reside in urban areas. In contrast, evidence in South Asia and Sub-Saharan Africa found that rural women having lower odds of receiving all the elements compared to urban women (7). This discrepancy is due to, in the study region, private health institutes were concentrated in urban area which

provides maternal health services. As a result, once women confirmed her pregnancy and initiate ANC follow up at public health facilities, then after, they switch to the private health institute. This argument supported by women who obtained ANC in the private sector had nearly two times greater odds of receiving continuous care compared with those who received care in the public sector (39). Moreover, this study didn't include private health sectors to measure the level of completing the recommended ANC visits. Others reasons, in the rural areas, there are strong defaulter tracing mechanism by HEW, they have a list of all pregnant women with their name in their catchment areas, then follow the pregnant women up to postnatal period during home visit.

Health seeking behavior may be influenced by health information offered for pregnant women on the issue of maternal health services. In this study, the odds of women receiving the recommended ANC visit among women who had information on maternal health services were two times higher than women who had no information on maternal health services. This study similar with study conducted in Ethiopia(4)and Rural areas of Ethiopia(25).

This study found that the odd of completion of whole ANC visits among women who had history of pregnant related problems during labour for previous birth and history of stillbirth were two times higher than their counterpart. This evidence supported by other study done in Kombolcha (26). This is because prior bad experiences give a big lesson for women on maternal health services which encourage and motivated the women to consult the health professional during pregnancy and also the women will initiate ANC services early and receive the recommended ANC visits.

Women and partner decision making power has had a significant role on the utilization of maternal health services. In this study, we found that the odds of using the recommended ANC visit among women who had decision making power within the households were almost two times higher than women who had no decision making power. This finding is consistent with study done in Nigeria (21). This might be because if the household resources are controlled by others and no power to decide on their resources, women do not have the freedom to access maternal health services whenever they need care. Autonomy may also be related to other variables such as women's education level, information on maternal health services and urban

residence, all of the parameters increase the likelihood of using maternal health services particularly ANC which is an entry point of maternal health services.

This study has found that education of women has had a significant effect on the utilization of institutional delivery services. This finding has been consistently supported by many other studies conducted within Ethiopia and abroad the nation which showed a positive influence of education on the use of institutional delivery services (4, 21, 24, 26, 40). This positive correlation can be explained by the fact that educated women are more aware of the importance of medical services to their mothers. They have access to written information and may have a more modern cultural perspective.

In this study, we found that socio-economic status especially household wealth is strongly linked to place of delivery such that as household wealth index increases, the uptake of institutional delivery service is also increase. This evidence is supported by different studies in Sub Saharan Africa(29), Nigeria (21), Ethiopia (4) and EDHS 2016 (24). This is because the wealthier families are able to afford the direct and indirect costs associated with birth in the health facilities.

This found that uptake of the recommend ANC care during pregnancy and early initiation ANC within WHO recommended time period was significantly affect the use of institutional delivery services. These findings are supported by studies conducted in Ethiopia (40) and Nigeria (21). This may be because women will be aware of the importance of institutional and skilled delivery services as they might be educated during the ANC session. Even though, women have got adequate information on maternal health services; the probability of utilizing maternal health services will be increased (32, 40, 41). Other evidence supported that use of ANC is one of the strongest determinants for the use of skilled delivery attendants during delivery and institutional delivery services (21).

In this study, uptake of postnatal care service is directly related with partner education which showed a positive influence on utilization of PNC services. This study is consistent with other studies conducted in Ethiopia and abroad the nation (4, 21, 32). This is because educated husbands may have a better understanding on the benefit of PNC services and good communication with their wives and willingness to discuss the use of maternal health services.

This study found that receiving the recommended ANC visits, timely initiation of ANC services and skilled delivery services are strongly significant association with the utilization of PNC services. This evidence is strongly supported by systematic review and meta-analysis pooled result(42) and also other studies done in Nigeria (21) and Ethiopia (3, 4). However, the odds of use of PNC services among women have a history of stillbirth are 49% times lower than women free of stillbirth history. This finding is consistent with evidence in Lubumbashi City of Democratic Republic of Congo (3). This is due to when women encountered with stillbirth, the chance of women go to the health facility for checkup purpose is poor and null. Other reason may be women have no confidence and motivation to treat and checkups herself after the event of stillbirth.

Strength and limitation of the study

The strengths of this study were using prospective follow up study that helped to measure the true cause and effect relationship, large sample size that resulted in high power and precision for the multilevel analyses and using advanced statistical models to handle clustering effects and identify factors at different levels for intervention purposes.

However, the limitation of this study was health facility based data were collected by health workers that result social desirability bias which might be compromised the finding. Around 8.5% of the study participates were lost to follow up that might have some deviation on the result.

Conclusion and Recommendation

The proportion of women, who attended antenatal care, skilled delivery care and postnatal cares were low as compared with national target. In this study, we found that different individual and community level factors that influenced utilization of the services. Those factors were place of resident, household wealth index, women and partner education, information on MHS, history of pregnant related problems for previous birth, history of stillbirth, ANC visit 4th, early initiation of 1st ANC visit, IFA supplementation during pregnancy, skilled delivery care and women decision making power. Hence, this study strongly recommended that reinforcing women's autonomy, particularly household decision–making power, efforts are also needed to reinforce and improve the information given to pregnant women, as well as strengthen the communication system

between the healthcare providers and the community, and participating within the community dialogues. This will contribute to raising awareness of women on safe motherhood initiatives, particularly ANC, institutional delivery, and PNC services in the study area.

Acknowledgements

We would like to thank Addis Ababa University, College of Health for providing ethical approval and partially sponsored this project work. The authors would also want to express their gratitude to all of the pregnant women, data collectors, supervisors, and other individuals who contributed directly or indirectly to the study's success. Last but not least, the author wishes to express his gratitude to Miss Abebech Tefera, Miss Chaltu Argeta, Dr. Nigatu Disassa, and Assistant professor Atnafu Morka for their unwavering assistance in the preparation, magement and duplication of research questionnaires.

List of abbreviations

ANC: Antenatal Care

AOR: Adjusted Odds Ratio

BF: Breast Feeding

BGRS: Benishangul Gumuz Region

CI: Confidence Interval

EDHS: Ethiopia Demographic and Health Survey

GA: Gestational Age

HF: Health Facility

ICC: Intra class Correlation

IFA: Iron Folic Acid

IGA: Income Generating Activities

IRB: Institutional Review Board

LR: Log Likelihood

MCH: Maternal and Child Health

MHS: Maternal Health Service

MPDSR: Maternal and Perinatal Death Surveillance Response

NGO: Non-Governmental Organization

PCA: Principal Component Analysis

PNC: Postnatal Care

SMI: Safe Motherhood Initiative

SPH: School of Public Health

SRMA: Systematic Review and Meta-analysis

TT: Tetanus Toxoid

VIF: Variance Inflation Factors

Authors' contributions

MA conceived and designed the study. Then after, data was collected, analyzed, interpreted and wrote the whole document. *AW and GT* were critically commenting the whole document and genuinely guide the whole work. All authors read and approved the final manuscripts.

Funding

This study funded by Addis Ababa University but there is no other funding agencies for this works

Competing interests

The authors declare that they have no competing interests.

Patient consent for publication

Not required

Data sharing statement:

All relevant data are available within the manuscript. The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Central Statistical Agency (CSA), Ethiopia, ICF. Ethiopia Demographic and Health Survey. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.: The DHS Program ICF Rockville, Maryland, USA; 2016.
2. Central Statistical Agency (CSA), Ethiopia, ICF, editors. Ethiopia Demographic and Health Survey2011; Addis Ababa: The DHS Program ICF Rockville, Maryland, USA.
3. Abel Ntambue ML, Françoise Malonga K, Dramaix-Wilmet M*, et al.* Determinants of maternal health services utilization in urban settings of the Democratic Republic of Congo, a case study of Lubumbashi City. BMC Pregnancy Childbirth. 2012;12(66).
4. Tarekegn SM, Lieberman LS, Giedraitis V. Determinants of maternal health service utilization in Ethiopia: Analysis of the 2011 Ethiopia Demographic and Health Survey. 2014;14(161).
5. Balla YY, Data T, Lindtjorn B. Maternal and neonatal mortality in rural south Ethiopia:Outcomes of Community-Based Birth Registration by Health Extension Workers. 2015;10(3).
6. Singh K, Story WT, Moran AC. Assessing the Continuum of Care Pathway for Maternal Health in South Asia and Sub-Saharan Africa. Maternal and child health journal. 2016;20(2):281-9.
7. Singh K, Story WT, Moran AC. Assessing the Continuum of Care Pathway for Maternal Health in South Asia and Sub-Saharan Africa. Matern Child Health J. 2016;20(2):281-9.

8. Sarker BK, Rahman M, Rahman T*, et al.* Status of the WHO recommended timing and frequency of antenatal care visits in Northern Bangladesh. PLOS ONE. 2020;15(11):e0241185.
9. Iqbal S, Maqsood S, Zakar R*, et al.* Continuum of care in maternal, newborn and child health in Pakistan: analysis of trends and determinants from 2006 to 2012. BMC Health Serv Res. 2017;17(1):189.
10. Kikuchi K, Yasuoka J, Nanishi K*, et al.* Postnatal care could be the key to improving the continuum of care in maternal and child health in Ratanakiri, Cambodia2018. e0198829 p.
11. Sakuma S, Yasuoka J, Phongluxa K*, et al.* Determinants of continuum of care for maternal, newborn, and child health services in rural Khammouane, Lao PDR. 2019;14(4):e0215635.
12. Wang W, Hong R. Levels and determinants of continuum of care for maternal and newborn health in Cambodia-evidence from a population-based survey. BMC Pregnancy Childbirth. 2015;15:62.
13. Balakrishnan R, Gopichandran V, Chaturvedi S*, et al.* Continuum of Care Services for Maternal and Child Health using mobile technology - a health system strengthening strategy in low and middle income countries. BMC Med Inform Decis Mak. 2016;16:84.
14. Carvajal-Aguirre L, Amouzou A, Mehra V*, et al.* Gap between contact and content in maternal and newborn care: An analysis of data from 20 countries in sub-Saharan Africa. J Glob Health. 2017;7(2):020501.
15. Muchie KF. Quality of antenatal care services and completion of four or more antenatal care visits in Ethiopia: a finding based on a demographic and health survey. BMC Pregnancy and Childbirth. 2017;17(1).
16. Ftwi M, Gebretsadik GG-e, Berhe H*, et al.* Coverage of completion of four ANC visits based on recommended time schedule in Northern Ethiopia: A community-based cross-sectional study design. PLOS ONE. 2020;15(8):e0236965.
17. Tizazu MA, Sharew NT, Mamo TR*, et al.* Completing the Continuum of Maternity Care and Associated Factors in Debre Berhan Town, Amhara, Ethiopia, 2020. 2021;14:21-32.
18. Emiru AA, Alene GD, Debelew GT. Women's retention on the continuum of maternal care pathway in west Gojjam zone, Ethiopia: multilevel analysis. BMC Pregnancy Childbirth. 2020;20(1):258.
19. Haile D, Kondale M, Andarge E. Level of completion along continuum of care for maternal and newborn health services and factors associated with it among women in Arba Minch Zuria woreda, Gamo zone, Southern Ethiopia: A community based cross-sectional study. 2020;15(6):e0221670.
20. Haftu A, Hagos H, Mehari MA*, et al.* Pregnant women adherence level to antenatal care visit and its effect on perinatal outcome among mothers in Tigray Public Health institutions, 2017: cohort study. BMC Res Notes. 2018;11(1):872.
21. Tukur Dahiru OMO. Determinants of antenatal care, institutional delivery and postnatal care services utilization in Nigeria. PanAfrican Medical Journal. 2015.
22. Srivastava A, Mahmood S, Mishra P*, et al.* Correlates of Maternal Health Care Utilization in Rohilkhand Region. June 2014;4(3).
23. G Anil Kumar RD, Priyanka Chaman, Priyanka Singh and Lalit Dandona. A population-based study of neonatal mortality and maternal care utilization in the Indian state of Bihar. 2014;14(357).
24. Agency CS, editor Ethiopia Demographic and Health SurveyOctober, 2016; Addis Ababa: The DHS Program ICF Rockville, Maryland, USA.
25. Araya Medhanyie MS, Yohannes Kifle, Nikki Schaay, David Sanders, Roman Blanco,Dinant GeertJan and Yemane Berhane. The role of health extension workers in improving utilization of maternal health services in rural areas in Ethiopia: a cross sectional study. 2012;12(352).
26. Desalew Zelalem Ayele BB, Kedir Teji and Desalegn Admassu Ayana. Factors Affecting Utilization of Maternal Health Care Services in Kombolcha District, Eastern Hararghe Zone, Oromia Regional State, Eastern Ethiopia. October 2014;2014 (Article ID 917058, 7 pages).

27. Tsegay Y, Gebrehiwot T, Goicolea I*, et al.* Determinants of antenatal and delivery care utilization in Tigray region, Ethiopia: a cross-sectional study. International Journal for Equity in Health. 2013;12(1):30.
28. Mohan D, LeFevre AE, George A*, et al.* Analysis of dropout across the continuum of maternal health care in Tanzania: findings from a cross-sectional household survey. Health Policy Plan. 2017;32(6):791-9.
29. De Graft-Johnson J, Kerber K, Tinker A. The maternal, newborn and child health continuum of care: Opportunities for Africa's newborns. Partnership for Maternal, Newborn and Child Health. 2011;2006:23–36.
30. Taylor E. Hurst KS, Manasa Patna, Atul Gawande and Lisa R. Hirschhorn. Demand-side interventions for maternal care: evidence of more use, not better outcomes. 2015;15(297).
31. Shibanuma A, Yeji F, Okawa S*, et al.* The coverage of continuum of care in maternal, newborn and child health: a cross-sectional study of woman-child pairs in Ghana. BMJ Glob Health. 2018;3(4):e000786.
32. Britta C. Mullany SBaMJH. The impact of including husbands in antenatal healtheducation services on maternal health practices inurban Nepal: results from a randomized controlled trial. July, 2006;22(2, 2007).
33. Federal Democratic Republic of Ethiopia Central Statistical Agency. Population Projection of Ethiopia for All Regions At Wereda Level from 2014 – 2017. 2013.
34. Wang W, Hong R. Completing the continuum of care for maternal and newborn health in Cambodia: Who drops out? Calverton, Maryland, USA: ICF International, 2013.
35. Ethiopian Minisry of Health (MoH). National Technical Guidance For Mataernal and Perinatal Death Surveillance and Response (MPDSR). In: INSTITUE EPH, editor. 2017.
36. Agha S, Williams E. Maternal and Child Health Program Indicator Survey 2013, Sindh Province. MNCH Services Component, USAID/Pakistan MCH Program. Karachi, Pakistan: Jhpiego. 2013.
37. Debelew GT, Afework MF, Yalew AW. Determinants and causes of neonatal mortality in Jimma Zone, Southwest Ethiopia: a multilevel analysis of prospective follow up study. PLoS One. 2014;9(9):e107184.
38. Afulani PA. Determinants of stillbirths in Ghana: does quality of antenatal care matter? BMC Pregnancy Childbirth. 2016;16(1):132.
39. Dennis ML, Benova L, Abuya T*, et al.* Initiation and continuity of maternal healthcare: examining the role of vouchers and user-fee removal on maternal health service use in Kenya. Health Policy Plan. 2019;34(2):120-31.
40. Determinants of antenatal and delivery care utilization in Tigrary Region. 2013;12(30).
41. Muluwas Amentie MAaMa. Utilization of Institutional Delivery Care Services and Influencing Factorsamong Women of Child Bearing Age in Assosa District, Benishangul Gumuz Regional State, West Ethiopia. 2016;16(3).
42. Geremew AB, Boke MM, Yismaw AE. The Effect of Antenatal Care Service Utilization on Postnatal Care Service Utilization: A Systematic Review and Meta-analysis Study. Journal of pregnancy. 2020;2020:7363242.

BMJ Open

Individual and community-level determinants of maternal health services utilization in northwest Ethiopia: a prospective follow-up study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-061293.R1
Article Type:	Original research
Date Submitted by the Author:	11-Jul-2022
Complete List of Authors:	Amentie, Muluwas; Addis Ababa University College of Health Sciences, Reproductive Health; Assosa University, Public Health Worku, Alemayehu; Addis Ababa University College of Health Sciences, School of Public Health Debelew, Gurmesa Tura; Jimma University,
Primary Subject Heading:	Public health
Secondary Subject Heading:	Reproductive medicine, Sexual health, Health services research
Keywords:	Public health < INFECTIOUS DISEASES, PUBLIC HEALTH, Maternal medicine < OBSTETRICS, EPIDEMIOLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Individual and community-level determinants of maternal health services utilization in northwest Ethiopia: a prospective follow-up study

Muluwas Amentie Zelka[1, 2 *], Alemayehu Worku Yalew[3], Gurmesa Tura Debelew[4]

[1]Department of Public Health, College of Health Sciences, Assosa University, Assosa, Ethiopia

[2]Department of Reproductive Health, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia

[3]Department of Biostatics and Epidemiology, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia

[4]Department of Population and Family Health, Institute of Health, Jimma University, Jimma, Ethiopia

E-Mail Address:

Muluwas Amentie Zelka (M.A. Zelka): muluwas12@gmail.com

Alemayehu Worku Yalew (A.W. Yalew): alemayehuwy@yahoo.com

Gurmesa Tura Debelew (G.T. Debelew): gurmesatura@gmail.com

*** Corresponding author**

Muluwas Amentie Zelka (M.A. Zelka): muluwas12@gmail.com , P.O.Box 18, Assosa Univerity, Assosa, Ethiopia

Abstract

Objective: The utilization of maternal health services is an important indicator of maternal health and socio-economic development. Evidence on individual and community level determinants of maternal health services utilization in Benishangul Gumuz Region was not well known so far. Hence, this study fills this gap.

Design: A prospective follow-up study

Setting: This study was conducted from March 2020–January 2021 in northwest Ethiopia.

Participants: 2,198 pregnant women were participated in the study.

Main outcome measures: A multistage random sampling technique was used to select study subjects. Data were collected via face-to-face interviews using pretested semi-structured questionnaires. Collected data were coded, cleaned, and analyzed using STATA software. Multilevel regression models were applied to determine individual and community-level factors of maternal health services utilization.

Results: This study found that the proportion of women who visited recommended antenatal care, received skilled delivery care, and postnatal care were 66.1%, 58.3%, and 58.6% respectively. Being rural(AOR=3.82:95%CI: 1.35-10.78), having information on maternal health services(AOR=2.13:95%CI: 1.21-3.75), with a history of pregnancy-related problems (AOR=1.83:95%CI: 1.15-2.92), and women with decision-making power(AOR=1.74:95%CI: 1.14-2.68) were more likely to receive 4th antenatal care visits. Similarly, women who attended tertiary school(AOR=4.12:95%CI: 1.49-11.33), and who initiate 1st antenatal care visit within 4-6 months of pregnancy(AOR=0.66:95%CI: 0.45-0.96) were determinants of skilled delivery care. Finally, women whose partners attended tertiary education(AOR=3.67:95%CI: 1.40-9.58), women with decision-making power(AOR=1.8:95%CI: 1.09-2.97), women who attended 4th antenatal care visit(AOR = 10.8:95%CI: 6.79-17.2), women received iron-folic acid during pregnancy(AOR=1.96:95%CI: 1.11-3.49), and women who received skilled delivery care(AOR=1.63:95%CI: 1.1-2.42) were more likely to get post-natal care services.

Conclusions: The proportion of women who attended antenatal care, received skilled delivery services, and postnatal cares were low. Different individual and community-level factors that influenced the utilization of these services were discovered. Therefore, community-based interventions should target those identified factors to improve maternal health services.

Keywords: *Benishangul Gumuz, Factors, Maternal Health, Service Utilization*

Strength and limitations of the study

- The strengths of this study are using of a prospective follow-up study design that helped to measure the true cause and effect relationship, a large sample size used that resulted in high power and precision for the multilevel analyses, and using advanced statistical models to handle clustering effects and identifying factors at different levels for intervention purposes.
- The limitation of this study is health facility data were collected by health workers who were liable to social desirability bias which might compromise the findings.
- Around 8.5% of the study participants were lost to follow up which might have some deviation from the result.
- This study did not include private health facilities which might compromise the findings

Introduction

Regardless of the significant reduction in maternal and neonatal mortality globally and also in developed countries, still maternal and neonatal mortality in developing countries including Ethiopia was the highest and had no significant reduction(1, (2). However, proper provision of maternal health services is essential for women's and babies' health(1). Thus, antenatal care (ANC), delivery services, and postnatal care (PNC) are the major pillars of maternal health services that have an effort to reduce maternal and neonatal mortality (3, (4). Even though utilization of maternal health services is an indirect indicator of maternal and perinatal death, fewer women were using ANC, facility delivery, and PNC which is an alarming challenge to rapidly reducing maternal and neonatal mortality rates(3, (5).

According to WHO guidelines, every pregnant woman had used at least a 4th ANC visit to achieve the full life-saving potential for women and babies which also warrants more programmatic attention (6, (7). Then utilization of ANC services is low and varies across the nations and within the country (1, (7, (8, (9, (10, (11, (12, (13, (14, (15, (16, (17, 2020/05/01 (18, (19, 2018/12/12 (20, (21, (22, (23, (24, (25, (26). This underutilization of ANC services because of different factors: socio-demographic characteristics (1, (3, (4, (21, (24, (25, (26, (27), availability of health facilities(27), household index(1, (4, (21, (24, (25), women empowerment (21), present and past obstetric history(3, (4, (21, (26), information and perception on maternal health services(4, (25, (26) and health insurance(21)

The utilization of skilled delivery is extremely low and a big variability between the uptake of skilled delivery and ANC within the nation and abroad countries (1, (5, (9, (10, (11, (12, (13, 2020/05/01 (18, (19, (22, (24, (28). Empirical evidence identified different factors that affect the uptake of institutional delivery services such as socio-demographic and economic factors (1, (3, (4, (21, (26, (27, (29), obstetric history (3, (4, (21, (26, (27, (30), transportation services and perception on quality of services (26, (29).

Health interventions after delivery are a crucial period and key strategy to reduce maternal and neonatal mortality (10, (29). But, utilization of postnatal services was extremely low even compared with the use of ANC and delivery services (1, (9, (10, (11, (14, 2020/05/01 (18, (19, (21, (22, (24, (25, (31). This underutilization of the services is due to different factors: socio-demographic factors (4, (21, (32), household wealth index (4, (21), obstetric factors(3, (4, (21), women empowerment (21), and health insurance (21).

However, prior studies determined the magnitude of maternal health services utilization and explored individual-level factors using the traditional regression model which excluded community-level factors and advances statistical modeling. This might lead to underestimating or overestimating magnitude and their predictors which are crucial for the establishment of community-based interventions for maternal health services. Multilevel regression modeling is an appropriate method for controlling the nesting effect of clusters at different levels, which is not addressed in previous studies. Therefore, by overcoming the limitation of the previous study, this study aimed to determine individual-level (*level – 1*) and community-level (*level – 2*) determinants of maternal health services.

Methods

Study settings

This study was conducted in Benishangul Gumuz Regional State. It is one of the eleven regions constituting the Federal Democratic Republic of Ethiopia, located in Northwest Ethiopia. The capital city of the region is Assosa town, located 670km away from Addis Ababa, the capital city of Ethiopia. Administratively, the region has three zones (*namely Assosa zone, Metekel zone and Kamashi zone)*, three towns' administrative cities (namely Assosa town, Gilgel Beles town and Kamash town administrative city), one special woreda (namely Mao-Komo special woreda), and 475 kebeles (439 rural and 36 urban kebeles). The region hosts near to 60,000 refugees.

Based on the 2007 national population and household census, the 2018 population projection revealed that the total population of the region was 1,127,001 which covers 1.1% of the national population, the total number of pregnant women in the region, and the selected study districts was 36,754 and 15,368 pregnant women respectively(33). Health facilities serving these populations were 446 public health facilities (401 health posts; 41 health centers; 4 primary hospitals and 2 general hospitals); 119 private and NGO health institutes (15 medium clinics and 104 primary clinics) and 91 private pharmaceutics (3 pharmacies, 50 drug stores, and 38 rural drug vendors).

Study design and Period

A community and health facility-linked prospective follow-up study design was carried out from March 2020 to January 2021.

Source population and study participants

All pregnant women within the study area during the time of the baseline survey were the source population. Randomly selected pregnant women using the sampling technique were study participants. The inclusion criteria were women who were permanent residents (living more than 6 months) in the selected districts and categorized as pregnant women, women whose gestational age is > 8 weeks and also fulfill pregnancy screening criteria. Whereas, the exclusion criteria were pregnant women who have hearing or other disabilities hindering communication; severely ill and mentally distorted, pregnant women who reported their pregnancy is less than 8 weeks, and pregnant women who completed 4th ANC visit during the time of baseline survey.

Sample size and sampling procedure

The sample size was computed using both single and double population proportion formulas. For the single population proportion, the following assumptions were considered while computing the sample size: the magnitude of using the whole maternal health care service is 60%(p = 0.6)(34). The margin of error is 5% (d=0.05) with a 95% level of confidence interval (1.96), taking a design effect of 2 and a non-response rate of 10%. Then, the sample size calculated is *812* pregnant women.

Similarly, the double population proportion formula was used to compute the sample size for each determinant of maternal health services utilization. Among all the factors considered for sample size calculation, women's age is found to have the maximum sample size. Thus, considering the following assumption for double population formula: the proportion of women who completed continuum of care, among women whose age is greater than 35 is 48% (p_1 =

0.48) and among women whose age between 20 – 35 years old is 62% (p_2 = 0.62)(34); pooled population proportion (P = 0.55); r =1:1 ratio of exposure to non-exposure; 5% significant level; 80% power, design effect of 2 and 10 non-response rate. Then, *874* sample sizes were generated through STATA/MP 13.0 software. As a result, a total of 874 pregnant women were calculated for this study. This study, however, was part of larger research work(35), and the sample size determined for another objective was 2,402 pregnant women, which was used as the final sample size for this study.

A multistage random sampling technique was employed to reach the study participants. In this study, the study area was first stratified into three zones and three town administrative cities with one special woreda. In the first stage, of these stratified areas, two zones and one town administrative city were selected using a simple random sampling technique. Then after, seven districts/woredas and two town districts/woredas were randomly selected from two zones and one town administrative city respectively as the second stage. Subsequently, at the third stage, 51 Kebeles/clusters were randomly selected from the selected districts/woredas.

A one-month baseline census was conducted to identify pregnant women using a pregnancy screening criterion to prepare a sampling frame. Then, all pregnant women who resided in the selected kebeles/clusters were included in the study and then followed for an average of 11 months.

Meantime of the house-to-house survey, public health facilities that provide at least basic maternal health services for the community were identified. Then, all eligible public health facilities were recruited and made a candidate for a facility-based survey. Based on these, 46 health facilities (3 hospitals, 12 health centers, and 31 health posts) were included in the health facility-based survey.

Data collection and quality control

The research questionnaire was prepared in English which was adopted from EDHS 2016(2), National Technical Guidance for MPDSR 2017(36), MCH Program Indicator Survey 2013(37), Survey tools conduct in Jimma Zone, Southwest Ethiopia(38), Survey tools conducted in Rural South Ethiopia(5), and other relevant different works of literature. After finalized instrument preparation, training, pretest, supervision, and use of local languages were made to ensure the quality of data. Then, the trained data collectors gather information through face-to-face

interviews at comfortable and convenient places. After all, completed questionnaires were reviewed by supervisors on a monthly base for accuracy and consistency.

Variables and measurement

Outcome variables

In this study, the composite outcome variable is the utilization of maternal health services. Besides these, maternal health service encompasses care during pregnancy, childbirth, and after birth within 42 days. Therefore, we have three outcomes: receiving recommended ANC visits (4^{th} visits or more), skilled delivery care, and receiving PNC 4^{th} visits within 42 days.

Independent variables

Independent variables were categorized into two levels. ***Individual-level variables (level – 1)*** included individual and household-related factors: household wealth index, women's age, educational level (women and partner), occupational status (women and partner), information on maternal health services, age at first marriage, and pregnant, past and present bad obstetric history, women and partner decision making power in health-seeking behaviors, IFA supplementation during pregnancy and provision of TT vaccination during pregnancy. ***Higher-level variables (cluster - 2)*** included community and health facility-related factors such as place of residence, accessibility of health facilities, availability of health facilities within the community, and quality of maternal health services.

Data management and statistical modeling

The collected data were coded and entered into Epi. Info version 7.2.2.6. After data entry was completed, it was exported to STATA software version 14.1. Then, data were cleaned, edited, and analyzed using STATA Software. Descriptive statistics and crude odds ratio at 95%CI were computed for all variables to select candidate variables for multivariable analysis ($p < 0.25$). The composite indicator of the household wealth index was computed and categorized into three categories using Principal Component Analysis (PCA). Before running the full model, the coefficient of the interaction term at $p \geq 0.1$ and the multi-collinearity effect between independent variables was determined by using variance inflation factors (VIF > 10%) were determined. Finally, all included variables had no multi-collinearity and interaction effect.

Even though a multistage random sampling method was used in the study, a multilevel regression model was applied by using STATA 14 to identify community and individual-level factors having significant association with maternal health care utilization (ANC 4^{th} visits or more, skilled delivery care, and PNC 4^{th} visits). Kebele/Ketena was considered as cluster and

cluster-level variables: a place of residence and access to health posts were taken as higher levels (level – 2). Whereas, individual and household factors such as household wealth index, socio-demographic, obstetric history, age at first marriage and pregnancy, information on maternal health services, women-decision making power, key services offered during pregnancy, and pregnancy-related problems were taken as lower levels (level-1). The goodness of fit of the multilevel model was tested by the log-likelihood ratio (LR) test and found to be statistically significant such as data fit the model.

Patient and Public Involvement

In this study work, patients or the public were not involved in the design, conduct, reporting, or dissemination plans of our research

Result

Socio-demographic characteristics

A total of 2,439 pregnant women were enrolled and included in the study. Of them, 2,198 participants were completed a follow-up period and included in the final analysis (Figure – 1). Of these participants, 1,403 (63.8%) were rural residents and belonged to the age group of 25–29 years with a mean (+SD) of 26.34+5.25. A majority, 2,102 (95.6%) of women were married and 1,084 (49.3%) were illiterate. In line with occupational status, 1,733 (78.8) of the women were housewife (Table 1).

Table 1: Socio-demographic characteristics of study subjects in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent (%)
Place of Residence		
Rural	1403	63.8
Urban	795	36.2
Age (Years)		
15 – 19	186	8.5
20 – 24	608	27.7
25 – 29	795	36.2
30 – 34	400	18.2
35 – 39	177	8.1
40 – 45	32	1.5
Marital Status		
Married	2102	95.6
Single	84	3.8
Divorced	12	0.6

Woman education level		
Illiterate	1084	49.3
Read and write	251	11.4
First Cycle (Grade 1 – 4)	106	4.8
Secondary Cycle (Grade 5 – 8)	316	14.4
High School (Grade 9 – 12)	248	11.3
Tertiary education (12^{+})	193	8.8
Woman occupational status		
Housewife	1733	78.8
Governmental employee	185	8.4
Student	139	6.3
Merchant	94	4.3
Farmer	47	2.1

The magnitude of maternal health services utilization

Utilization of ANC services and related issue

Among the study participants, 1453 (66.1%; 95%CI: 64.1 – 68.1%) of pregnant women attended the recommended ANC visits. The key interventions received during ANC contact were informed on the danger signs of pregnancy 1740 (79.2%) followed by blood pressure measured 1701 (77.4%). Two-thirds, 1330 (65.5%) were initiated their first ANC contact within the gestational age of the second trimester (4 – 6 months of pregnancy). However, 466 (24.3%) women were dropped out their ANC follow-up service due to different reasons such as lack of knowledge on the benefit of ANC services 324 (69.5%) and fear of privacy 139 (29.8%)(Table 2).

Table 2: Utilization of ANC services and related issues of study subjects in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Visit of ANC received during last pregnancy		
1^{st} ANC contact	1919	87.3
2^{nd} ANC contact	1815	82.6
3^{rd} ANC contact	1674	76.2
4^{th} ANC contact	1453	66.1
Key interventions received during ANC contact (*n = 1919, multiple responses*)		
Informed on danger signs of pregnant	1740	79.2
Blood pressure measured	1701	77.4
Iron folic acid supplementation	1677	76.3
Nutritional counseling	1623	73.8
Urine sample taken	1607	73.1

Blood sample taken	1578	71.8
Protection of birth from tetanus	1562	71.1
Other	22	1.0
Reason for dropout from ANC follow-up (*n = 466 multiple responses*)		
Didn't know about the importance of ANC	324	69.5
No problems encountered	298	63.9
Fear of lack of privacy	139	29.8
Influence of other peoples	137	29.4
Couldn't pay for transportation	114	24.5
Health institution was too far	111	23.8
No transportation services	56	12.0
Male health professionals	45	9.7
No money to pay for services	38	8.2
Time of first ANC services initiation (*n = 2032*)		
1-3 months of pregnancy	570	28.1
4-6 months of pregnancy	1330	65.5
After 6 months of pregnancy	132	6.5
Did the information offered to deliver at HF		
Yes	1901	86.5
No	297	13.5

Institutional delivery services and related issues

The prevalence of skilled delivery service was 58.3% (95%CI: 56.2% – 60.4%), of which, 1,404 (63.9%) of women gave birth at the facility. The main reasons for health facility delivery were informed her to deliver in the health facility 1277 (91.0%) and previous bad experiences from home delivery 263 (18.7%). Whereas, the main reasons for home delivery: labour was going well 424 (53.4%) and feeling more comfortable at home delivery 392 (49.4%). Moreover, 295 (14.3%) women suffered from pregnant-related complications during childbirth. Common pregnant-related complications were obstructed/prolonged labour 187 (63.4%) and excessive bleeding 102 (34.6%) (Table 3).

Table 3: Delivery services and related issues for current delivery services in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Delivery services for last delivery		
Skilled care	1281	58.3
Unskilled care	917	41.7
Place of last delivery		
Home	794	36.1

Health post	353	16.1
Health center	775	35.3
Hospital	276	12.6
Attendant of last delivery		
Families/Friends/Relatives	611	27.8
Traditional Birth Attendants (TBAs)	166	7.6
Health Extension Workers (HEWs)	141	16.4
Midwifery/Nurses/Health Officers	1184	53.9
Medical Doctors	96	4.4
Mode of last delivery		
Spontaneous vaginal (SVD)	1943	88.4
Assisted vaginal delivery (AVD)	156	7.1
Caesarean section (C/S)	74	3.4
Assisted delivered stillbirth	25	1.1
Reason for health facility delivery (*n = 1404*)		
She was informed to deliver in HFs	1277	91.0
Previous bad experiences with home delivery	263	18.7
She faced problems: forced to deliver in HF	227	16.2
Others	53	3.8
Reason for Home delivery (*n = 794*)		
The labour was going well	424	53.4
She feels more comfortable at home	392	49.4
Close attention from relatives/family	332	41.8
It is usual practice	331	41.8
No transportation services	248	31.2
Cannot pay for transportation services	202	25.4
Previous bad experiences with ID	65	8.2
Cannot afford to pay for health services	22	2.8
Culture doesn't allow to give birth at HF	15	1.9
Others	5	0.6
Pregnant related complications at labour (*n = 2065*)		
No	1769	85.7
Yes	295	14.3
Pregnant related complications at labour/childbirth (*n = 295, multiple responses*)		
Obstructed/Prolonged labour	187	63.4
Excessive bleeding during labour	102	34.6
Elevated blood pressure	76	25.8
Premature rupture of membranes	69	23.4
Intrauterine fetal death	47	15.9

Preterm labour	12	4.1
Others	5	1.7

Postnatal (PNC) service utilization and related issues

This study revealed that more than half (58.6%) of women received the recommended PNC services with a 95% CI (56.4% – 60.7%). Of them, 504 (28.9%) of women initiated the first postnatal services within 48 hours. The key services received during the postnatal visits were immunization of baby 1692 (81.9%) and physical examination of the mother 1248 (60.4%). The main reasons for utilization of postnatal care were baby needed immunization 1598 (89.6%) and the midwifery had told her to use services 1305 (73.2%). In other direction, the reasons for not utilizing postnatal services were ignorance of women's privacy 137 (48.6%) and long waiting time at health facilities 95 (33.7%). Around, 249 (12.1%) of women had postpartum complications (Table 4).

Table 4: Postnatal services and related issues of study participants in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Component of PNC contact, she received (*n = 2065*)		
1st contact of PNC services	1783	86.3
2nd contact of PNC services	1545	74.8
3rd contact of PNC services	1373	66.5
4th contact of PNC services	1210	58.6
The key interventions offered during the postnatal period (*n = 2065, multiple responses*)		
Immunization of baby	1692	81.9
Counseling on proper nutrition	1516	73.4
Breastfeeding education	1436	69.5
Physical examination	1248	60.4
Family planning services	1074	52.0
Other	30	1.5
Time interval for first PNC visit (*n = 1741*)		
Within 2days after delivery	504	28.9
B/n 3 – 7 days after delivery	754	43.3
B/n 8 – 42days after delivery	483	27.7
Reason for seeking PNC services (*n = 1783*)		
The baby needs immunization	1598	89.6
The midwife had told me to seek the services	1305	73.2
She wanted to start family planning	975	54.7
She wanted to make sure she is back to normal	834	46.8

Because of her illness	272	15.3
Reason for not seeking PNC services (*n = 282*)		
They did not teach properly	181	64.2
Fear of privacy	137	48.6
Waiting more time at HF	95	33.7
They examined roughly	77	27.3
Religious forbidden	64	22.7
A health professional shouted at me	37	13.1
Other	14	5.0
Postpartum complications (*n = 2065*)		
No	1816	87.9
Yes	249	12.1
Type of postpartum complications (*n = 249*)		
Headache, visual disturbances	170	68.3
Convulsions/rigidity	118	47.4
Fever with or without chills	85	34.1
Heavy bleeding	66	26.5
Loss of consciousness	66	26.5
Foul-smelling discharge	52	20.9
Severe abdominal pain	5	2.0
Other*	3	1.2

** Leg edema, nausea, vomiting, and severe malaria during pregnancy*

Individual and community-level determinants of maternal health services

Individual and community-level factors affecting the utilization of maternal health care were detected by using a multilevel regression model. Before running the multilevel regression model, ICC (ρ) was calculated in the empty model for each outcome (ANC 4th, skill delivery care, and PNC 4th). Meantime, ICC/*rho* (ρ) was calculated as a full model for the outcomes to detect the variability attributed to clusters after controlling the individual level.

Rho (ρ)/ICC was calculated for the ANC 4th visits in the empty model and it was found to be 0.37 indicating that 37% of the variation was contributed by cluster variations. The test of preference of log-likelihood *versus* logistic regression was statistically significant (P<0.0001). Then, the full model was run by including both the community level and individual level variables and the ICC (ρ) was increased to 0.46. This again indicated that 46% of the variation was attributed to cluster-level variables. The preference for log-likelihood *versus* logistic regression was statistically significant (P < 0.0001). Hence, this is suggesting that the preferred model for this outcome variable was the multilevel logistic regression model. Similarly, Rho

(ρ)/ICC and test preference of log-likelihood were determined in the empty and full model for both skilled delivery care and PNC 4th visits, and indicating that statistically significant association. Hence, a multilevel logistic regression model is the preferred model for these outcomes (Table 5).

Table 5: Parameter of odd ratio and Test of Goodness-of-fit for Multilevel Models, Benishangul Gumuz Region, Northwest Ethiopia, 2021

Models	Fixed intercept -cons(95%CI)	Random effect as Level-2 variance var(-cons (95%CI))	Intra-class Correlation Coefficient: ICC(ρ)	Log likelihood (LR)-deviance	Significance of LR test Vs Logistic regression (P-value)
ANC 4th and more					
Empty model	2.54(1.7, 3.78)	1.92(1.23, 3.04)	0.37 = 37%	-1161.48	P < 0.0001
Full model	0.26(0.04,1.67)	2.76 (1.54, 4.96)	0.46 = 46%	-633.06	P < 0.00001
Skilled delivery					
Empty model	1.48(1.17, 1.87)	0.59(0.36, 0.96)	0.15 = 15%	-1402.31	P < 0.0001
Full model	1.18(0.3,4.66)	1.1(0.63, 1.92)	0.25 = 25%	-706.65	P < 0.00001
PNC 4th					
Empty model	1.59(0.99, 2.54)	2.72(1.72, 4.33)	0.45 = 45%	-1099.36	P < 0.0001
Full model	0.08(0.01,0.71)	2.25 (1.27, 3.98)	0.40 = 40%	-523.25	P < 0.00001

A p-value less than 0.05 is statistically significant and the data fit for the multilevel model
** Multilevel regression model applied to measure the effect of factors on outcome*

Community-level factors

Regarding community-level factors, different programmatic important indicators (place of residence, quality of maternal health services, accessibility, and availability of health facilities within the community) were assessed. Of them, place of residence and accessibility of health posts were selected as candidate variables for multivariable multilevel logistic regression analysis.

After controlling for any confounders in the final multilevel model, among the community level variables: a place of residence was a statistically significant association with utilization of the recommended ANC visits (4th visits or more) but it was not statistically significant association with skilled delivery care and recommended PNC visits (PNC 4th). The odds of receiving the recommended ANC visits (4th visits or more) among women who reside in rural resident (AOR = 3.82; 95%CI: 1.35, 10.78) were four times higher than among women who reside in the urban area.

Individual-level factors

In the individual-level (level – 1) variables: multiple factors were detected that had programmatically important implications and depicted that statistically significant association with maternal health care utilization.

Concerning individual-level factors of ANC services utilization, we found that the odds of receiving the recommended ANC visits (ANC 4th or more) among women who had any information on maternal health services (AOR=2.13; 95%CI: 1.12, 3.75) were two times higher than among women who didn't have any information on maternal health services. Moreover, women with a history of pregnancy-related problems (AOR = 1.83; 95%CI: 1.15, 2.2), women with a history of stillbirth (AOR = 1.67; 95%CI: 1.02, 2.73), and women with decision-making power (AOR = 1.74; 95%CI: 1.14, 2.68) were two times higher in odds of receiving recommended ANC visits than women belonged with their counterpart.

This study found that the odds of utilizing skilled delivery care among women who completed recommended ANC visit or more (AOR = 2.29; 95%CI: 1.59, 3.32), who belonged to the 3rd quintile wealth index of household (AOR = 2.23; 95%CI: 1.27, 3.89), who attended primary school (AOR = 1.71; 95%CI: 1.04, 2.81) and tertiary school (AOR = 4.12; 95%CI: 1.49, 11.33) were higher in the odds of attending skilled delivery care than women residing with their counterpart. However, women with a history of pregnancy-related problems (AOR = 0.57; 95%CI: 0.37, 0.86), and a history of stillbirth (AOR = 0.43; 95%CI: 0.28, 0.66) were 60% lower in the odds of receiving skilled delivery care than among women who were free from any problems. The odds of skilled delivery care utilization among women who delay 1st ANC visit initiation between 4 – 6 months of GA (AOR = 0.66; 95%CI: 0.45, 0.96) were 34% lower than among women who initiate 1st ANC visit early (within 3 months of GA).

Similarly, this study indicated that the odds of utilizing the recommended PNC services among women who received ANC 4th visits or more (AOR = 10.8; 95%CI: 6.79, 17.2), a partner who attended tertiary education (AOR = 3.67; 95%CI: 1.40, 9.58), women decision making power (AOR = 1.8; 95%CI: 1.09, 2.97), iron-folic acid (IFA) supplementation during pregnancy (AOR = 1.96; 95%CI: 1.11, 3.49) and women attended skilled delivery care (AOR = 1.63; 95%CI: 1.11, 2.42) were higher than among women who belonged within their counterpart. However, the odds of PNC service utilization among women with history of stillbirth (AOR = 0.51; 95%CI: 0.29, 0.87), women delay initiating 1st ANC visit within 4 – 6 months of GA (AOR = 0.39; 95%CI: 0.24, 0.61) and after 6 months of GA (AOR = 0.1; 95%CI: 0.03, 0.24) were 49%, 61% and 90% lower respectively than among women with their counterpart (*Table 6*).

Table 6: Individual and community-level determinants of maternal health care utilization in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	*ANC 4th + Visits*	*Skilled delivery care*	*PNC 4th*

	AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
Level – 2 (Community level) variables			
Place of resident			
Urban	**1**	1	1
Rural	**3.82(1.35, 10.78)**	1.22(0.55, 2.73)	1.14(0.44, 2.91)
Distance to Health Post			
< 2 Hours	1	1	1
>= 2 Hours	0.25(0.02,2.73)	0.49(0.08, 2.89)	0.88(0.1, 10.26)
Leve-1 (individual level) variables			
Household Wealth Index			
1st Quintile (Poor)	1	1	1
2nd Quintile (Middle)	1.06(0.69, 1.61)	1.13(0.78, 1.63)	0.74(0.46, 1.21)
3rd Quintile (Rich)	1.46(0.81, 2.62)	**2.23(1.27, 3.89)**	0.43(0.22, 1.06)
Age (Years)			
< 20	1	-	1
20 – 29	0.95(0.27, 3.31)	-	1.53(0.42,5.62)
>= 30	0.86 (0.24, 3.02)	-	1.33(0.36,4.96)
Women educational level			
No formal education	1	1	1
Primary school	0.92(0.54, 1.57)	**1.71(1.04, 2.81)**	0.69(0.38, 1.27)
High school	1.14(0.57, 2.28)	1.49(0.77, 2.89)	0.68(0.3, 1.52)
Tertiary education	1.43(0.60, 3.37)	**4.12(1.49, 11.33)**	0.52(0.2, 1.37)
Partner educational level			
No formal education	1	1	1
Primary school	1.22(0.69, 2.15)	0.66(0.39, 1.1)	1.07(0.57, 1.98)
High school	0.87(0.48, 1.59)	0.76(0.44, 1.32)	1.49(0.75, 2.95)
Tertiary education	1.98(0.88, 4.45)	0.56(0.25, 1.25)	**3.67(1.40, 9.58)**
Partner occupational status			
Governmental employee	1	1	1
Others	1.23(0.64, 2.36)	0.61(0.31, 1.21)	1.48(0.69, 3.18)
Information on MHS			
No	**1**	1	1
Yes	**2.13 (1.21, 3.75)**	1.23(0.7, 2.17)	1.04(0.49, 2.18)
Age at first marriage (year)			
< 18	1	1	1
>=19	0.92(0.54, 1.56)	1.13(0.7, 1.82)	0.98(0.54, 1.73)
Age at first pregnancy (year)			
< 19	1	1	1
>= 19	1.13(0.67, 1.91)	1.24(0.77, 2.01)	0.98(0.55, 1.74)
History of pregnancy-related problems during labour for a			

previous birth No Yes	**1** **1.83 (1.15, 2.92)**	**1** **0.57 (0.37, 0.86)**	1 1.63(0.98, 2.7)
History of stillbirth No No	**1** **1.67(1.02, 2.73)**	**1** **0.43 (0.28, 0.66)**	**1** **0.51(0.29, 0.87)**
Women decision-making power Didn't make a decision Make decision	1 **1.74(1.14, 2.68)**	1 1.22 (0.81, 1.85)	**1** **1.8(1.09, 2.97)**
ANC 4th visit completed No Yes	-	1 **2.29(1.59, 3.32)**	**1** **10.8(6.79, 17.2)**
Offered information on danger signs during ANC visit No Yes	-	1 0.7 (0.44, 1.12)	1 0.71(0.38, 1.33)
Time of 1st ANC visit start Within 3 months of GA 4 – 6 months of GA After 6 months of GA	- - -	**1** **0.66(0.45, 0.96)** **0.33(0.16, 0.68)**	**1** **0.39(0.24, 0.61)** **0.1(0.03, 0.24)**
Provision of information on health facility delivery No Yes	-	1 0.9(0.49, 1.68)	1 1.05(0.51, 2.17)
IFA supplementation during pregnancy No Yes	-	-	**1** **1.96(1.11, 3.49)**
Provision of TT during pregnant No Yes	-	-	1 1.58(0.93, 2.69)
Skilled delivery care No Yes	-	-	1 **1.63(1.11, 2.42)**
Pregnancy-related problems immediately after labour No Yes	-	-	1 1.1(0.55, 2.21)

Discussion

The magnitude of maternal health services utilization

The recommended ANC visits (4th or more ANC visits) play a pivotal role in maternal health services and warrant more programmatic attention (6, (7). Besides, this study found that 66.1% of pregnant women attended the recommended ANC visits, which is consistent with studies in

North Ethiopia 63.9% (7, (16), Cambodia 60% (12), and Bihar India 55.94% (13). However, this finding is lower than studies in South Asia and Sub-Saharan Africa (7), Debre Berhan town 74.5% (17), and Northern Bangladesh 78%(8). But, it is higher than evidence in Pakistan 38.4% (9), Ratanakiri Cambodia 32.6% (10), Rural Khammouane Lao PDR 54.4% (11), Sub–Saharan Africa 51% (14), EDHS 2014 (33%) (15), Arba Minch districts 25.2% (19), West Gojjam zone 39.9% 2020/05/01 (18), and Tigray 49.9% 2018/12/12 (20). This disparity could be explained by different in the health system and infrastructure among the study areas to deliver maternal health services to the community. Moreover, in the study areas, there are misperceptions and cultural barriers that hinder the utilization of maternal health services.

Measurements of maternal health services were only capturing contact rather than the content of each measurement parameter (14). The implication of merely focusing on increasing coverage of recommended contacts within the health system rather than emphasizing essential packages of maternal health services is insufficient to reduce maternal and neonatal mortality and morbidity. As result, this study found that the core package of ANC services offered to women during pregnancy was informed of the danger signs of pregnant (79.2%) and blood pressure measured (77.4%). This finding is consistent with the evidence in Bihar India(13), Ghana (31), Sub – Saharan Africa (14), Northern Ethiopia(16), Arba Minch (19), and the West Gojjam zone 2020/05/01 (18). Whereas, this finding is lower than the study done in Rural Khammouane, Lao PDR (11), and Debre Berhan town (17). This is due to the variability of socio-demographic status, wealth status, availability of health facilities, accessibility of health facilities, and medical equipment in the health system of the study. In this study, 28.1% of pregnant women initiated their first ANC contact within the recommended schedule. This finding is lower than evidence from Rural Khammouane 41.1% (11), South Asia 47% (7), Ghana 55% (39), EDHS (2014) 37.4% (15), Arba Minch 78% (19), and Debre Berhan town 81.8% (17). But it was higher than Sub-Sahara Africa 24% (7) and the West Gojjam zone (14.9%) 2020/05/01 (18). This discrepancy may be that in the study area, there is low awareness and lack of knowledge on early initiation of maternal health services and also it is a remote area, which lacks availability and accessibility of health facilities and lacks skilled health providers. Not only delay ANC initiation but also one-fourth of pregnant women were dropping out from ANC follow-up due to lack of knowledge on the benefit of services, belief in the absence of problems, fear of privacy, and influence of other people.

The current study found that 58.3% of births were attended by skilled provider which is consistent with a study in Pakistan 56.8% (9). But this finding was lower than the study in Cambodia 74% (12); Tanzania 67% (28), and Bihar, India 83.93% (13). Whereas, it was higher than evidence in Ratanakiri, Cambodia 40.1% (10), Rural Khammouane 30.4% (11), West Gojjam 47.5% 2020/05/01 (18), and Arba Minch South Ethiopia 46.3% (19). This discrepancy might be due to variations in socio-demographic and economic status, culture, belief, time of the study, and design. This study found that the main reasons for health facility delivery were being informed on the benefits of delivering at the health facility and previous bad experiences from home delivery. This evidence is supported by a study done in west Gojjam 2020/05/01 (18). In contrast to the reasons mentioned for facility delivery, the main reasons for home delivery were labour was going well, being felt more comfortable at home delivery, getting close attention/support from relatives/families, and being as a usual practice, which is also consistent with a study done in West Gojjam2020/05/01 (18).

Postnatal care is the key strategy to improve the completion of maternal health services and neonatal health services and it is key in reducing maternal and neonatal mortality and morbidity (10). This study indicated that 58.6% of women received the recommended PNC services, which is lower than the study in Pakistan 63.2% (9), Sub – Saharan Africa 65% (14), and Ghana 70.6% (31). However, it is higher than study in West Gojjam Zone 43.0% 2020/05/01 (18), Ratanakiri, Cambodia 16.1%(10), Arba Minch 37.7% (19), and Rural Khammouane 30.8% (11). In line with these, the effectiveness of PNC services was not only determined by coverage of the utilization of the services but also by the key services and quality of postnatal services. This study found that key PNC services provided for women and newborns were immunization of babies (81.9%) and counseling on proper nutrition (73.4%). This finding is similar to studies conducted in Arba Minch (19), West Gojjam Zone2020/05/01 (18), and Ghana (31).

Community and individual- level determinants of maternal health care utilization

Community-level factors on maternal health services

In this study, we found that the odds of completing recommended ANC visits (4th visits or more) among women residing in rural resident were four times higher than among women residing in urban areas. In contrast, evidence in South Asia and Sub-Saharan Africa found that rural women had lower odds of receiving all the elements compared to urban women (7). This discrepancy is due to, in the study region, private health institutes were concentrated in urban area which

provides maternal health services. As a result, once women confirmed their pregnancy and initiated ANC follow-up at public health facilities, then after, they switch to the private health institute. This argument is supported by women who obtained ANC in the private sector had nearly two times greater odds of receiving continuous care compared with those who received care in the public sector 2019/03/08 (40). Moreover, this study didn't include private health sectors to measure the level of maternal health services utilization. Other reasons, in the rural areas, there are strong defaulter tracing mechanisms by HEW; they have a list of all pregnant women with their names in their catchment areas, and then follow the pregnant women up to the postnatal period during home visits.

Individual-level factors on maternal health services

Health-seeking behavior may be influenced by health information offered to pregnant women on the issue of maternal health services. In this study, the odds of women receiving the recommended ANC visits among women who did have information on maternal health services were two times higher than women who didn't have information on maternal health services. This study is similar to the study conducted in Ethiopia(4)and the Rural areas of Ethiopia(25).

This study indicated that the odds of completion of whole ANC visits among women with a history of pregnancy-related problems during labour and a history of stillbirth were two times higher than women who belonged within their counterparts. This evidence is supported by a study done in Kombolcha (26). This is because prior bad experiences give a big lesson for women on maternal health services which encouraged and motivated the women to consult the health professional during their subsequent pregnancies and also women will start ANC services early and receive the recommended ANC visits.

Women and partner decision-making powers have had a significant role in the utilization of maternal health services. In line with these, this study found that the odds of using the recommended ANC visits among women who had decision-making power within the households were almost two times higher than women who had no decision-making power. This finding is consistent with the study done in Nigeria (21). This might be because, if the household resources are controlled by others and no power to decide on their resources, women do not have the freedom to access maternal health services whenever they need care. Autonomy may also be related to other variables such as women's education level, information on maternal health

services, and urban residence, all of these parameters increase the likelihood of using maternal health services, particularly ANC services, which is an entry point of maternal health services.

This study found that the education of women has a significant effect on the utilization of institutional delivery services. This finding has been consistently supported by many other studies conducted in different parts of the World including Ethiopia (4, (21, (24, (26, (41). This positive correlation can be explained by the fact that educated women are more aware of the importance of medical services to themselves and their newborns and also they have a more modern cultural perspective on utilization of maternal health services.

In this study, we found that socio-economic status especially the household wealth index is strongly linked to a place of delivery. As the household wealth index increases, the uptake of institutional delivery service is also increases. This evidence is supported by different studies in Sub-Saharan Africa(29), Nigeria (21), Ethiopia (4), and EDHS 2016 (24). This is because the wealthier families can afford the direct and indirect costs associated with birth in the health facilities.

This study found that uptake of the recommended ANC services during pregnancy and early initiation of ANC within the WHO-recommended time significantly affected the use of institutional delivery services. These findings are supported by studies conducted in Ethiopia (41) and Nigeria (21). This may be because the women will be aware of the importance of institutional and skilled delivery services as they might be educated during the ANC session. Even though, women have got adequate information on maternal health services; the probability of utilizing maternal health services will be increased (32, (41, (42). Other evidence supported that use of ANC is one of the strongest determinants for the use of skilled delivery and institutional delivery services (21).

In this study, uptake of postnatal care service is directly related to partner education which showed a positive influence on utilization of PNC services. This study is consistent with other studies conducted in Ethiopia and abroad the nation (4, (21, (32). This is because educated husbands may have a better understanding of the benefit of PNC services and good communication with their wives and willingness to discuss the use of maternal health services.

This study found that receiving the recommended ANC visits, timely initiation of ANC services and skilled delivery services are strong significantly associated with the utilization of PNC services. This evidence is strongly supported by systematic review and meta-analysis pooled

results (43) and also other studies done in Nigeria (21) and Ethiopia (3, (4). Whereas, the odds of use of PNC services among women with a history of stillbirth are 49% times lower than women free of stillbirth history. This finding is consistent with the evidence in Lubumbashi City in the Democratic Republic of Congo (3). This is due to when women encountered stillbirth, the chance of women going to the health facility for checkup purpose is poor and null. Another reason may be women have no confidence and motivation to treat and checkups themselves after the event of stillbirth.

Generalizability (External validity)

Since this study used a representative large number of sample size (2,198 study participants) randomly selected 51 kebeles, it can be generalized to Benishangul Gumuz Region having similar characteristics in population, socio-culture, access to and availability of health care and health services seeking behaviors.

Strength and limitations of the study

The strengths of this study were using a prospective follow-up study that helped to measure the cause and effect relationship, a large sample size that resulted in high power and precision for the multilevel analyses, and using advanced statistical models to handle clustering effects and identify factors at different levels for intervention purposes.

However, the limitation of this study was health facility data were collected by health workers who were liable to social desirability bias which might compromise the findings. Around 8.5% of the study participants were lost to follow-up which might have some deviation in the result. Finally, this study did not include private health facilities which might compromise the findings.

Conclusion and Recommendation

The proportion of women, who attended antenatal care, received skilled delivery care, and postnatal care were low as compared with the national target. In this study, we found different individual-level factors that influenced the utilization of these services. Those factors were household wealth index, women and partner education, information on maternal health services, history of pregnancy-related problems for previous birth, history of stillbirth, ANC visit 4th, early initiation of 1st ANC visit, iron-folic acid supplementation during pregnancy, skilled delivery care and women decision making power. Among community-level factors, only place of residence had significantly influenced the utilization of maternal health services.

Therefore, this study strongly recommended that reinforcing women's autonomy, particularly household decision–making power, efforts are also needed to reinforce and improve the information given to pregnant women, as well as strengthen the communication system between the healthcare providers and the community, and participating within the community dialogues. This will contribute to raising awareness of women on safe motherhood initiatives, particularly ANC, institutional delivery, and PNC services in the study area.

Acknowledgments

We would like to thank Addis Ababa University, College of Health for providing ethical approval and supporting of this study. The authors would also want to express their gratitude to all of the pregnant women, data collectors, supervisors, and other individuals who contributed directly or indirectly to the study's success. Last but not least, we wish to express our gratitude to Miss Abebech Tefera, Miss Chaltu Argeta, Dr. Nigatu Disassa, and Assistant professor Atnafu Morka for their unwavering support..

List of abbreviations

ANC: Antenatal Care
AOR: Adjusted Odds Ratio
BF: Breast Feeding
BGRS: Benishangul Gumuz Regional State
CI: Confidence Interval
EDHS: Ethiopia Demographic and Health Survey
GA: Gestational Age
HF: Health Facility
ICC: Intra-class Correlation
IFA: Iron Folic Acid
IGA: Income Generating Activities
IRB: Institutional Review Board
LR: Log-Likelihood
MCH: Maternal and Child Health
MHS: Maternal Health Service
MPDSR: Maternal and Perinatal Death Surveillance Response
NGO: Non-Governmental Organization
PCA: Principal Component Analysis
PNC: Postnatal Care
SMI: Safe Motherhood Initiative
SPH: School of Public Health
SRMA: Systematic Review and Meta-analysis
TT: Tetanus Toxoid
VIF: Variance Inflation Factors

Authors' contributions

MA conceived and designed the study. Then after, data was collected, analyzed, interpreted, and wrote the whole document. *AW and GT* were critically commenting on the whole document and genuinely guide the whole work. All authors read and approved the final manuscripts.

Funding

This study was funded by Addis Ababa University.

Competing interests

The authors declare that they have no competing interests.

Patient consent for publication

Not required

Ethics approval and consent to participate

Ethical approval was obtained from the Research Review and Ethics Committee (REC) of the School of Public Health, Addis Ababa University with protocol number SPH/3089/011, and the Institutional Review Board (IRB) of the College of Health Sciences of Addis Ababa University with the protocol number 048/19/SPH. Necessary permission letters were obtained from Regional Health Bureau and respective all local districts. Confidentiality was maintained by avoiding any identities from the questionnaire. Before starting actual data collection, written and verbal consent was obtained from each study subject.

Data availability statement

All data relevant to the study are included in the article.

References

1. Central Statistical Agency (CSA), Ethiopia, ICF. Ethiopia Demographic and Health Survey. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.: The DHS Program ICF Rockville, Maryland, USA; 2016.
2. Central Statistical Agency (CSA), Ethiopia, editors. Ethiopia Demographic and Health Survey2011; Addis Ababa: The DHS Program ICF Rockville, Maryland, USA.
3. Abel Ntambue ML, Françoise Malonga K, Dramaix-Wilmet M, *et al.* Determinants of maternal health services utilization in urban settings of the Democratic Republic of Congo, a case study of Lubumbashi City. BMC Pregnancy Childbirth. 2012;12(66).
4. Tarekegn SM, Lieberman LS, Giedraitis V. Determinants of maternal health service utilization in Ethiopia: Analysis of the 2011 Ethiopia Demographic and Health Survey. 2014;14(161).
5. Balla YY, Data T, Lindtjorn B. Maternal and neonatal mortality in rural south Ethiopia:Outcomes of Community-Based Birth Registration by Health Extension Workers. 2015;10(3).
6. Singh K, Story WT, Moran AC. Assessing the Continuum of Care Pathway for Maternal Health in South Asia and Sub-Saharan Africa. Maternal and child health journal. 2016;20(2):281-9.
7. Singh K, Story WT, Moran AC. Assessing the Continuum of Care Pathway for Maternal Health in South Asia and Sub-Saharan Africa. Matern Child Health J. 2016;20(2):281-9.
8. Sarker BK, Rahman M, Rahman T, *et al.* Status of the WHO recommended timing and frequency of antenatal care visits in Northern Bangladesh. PLOS ONE. 2020;15(11):e0241185.
9. Iqbal S, Maqsood S, Zakar R, *et al.* Continuum of care in maternal, newborn and child health in Pakistan: analysis of trends and determinants from 2006 to 2012. BMC Health Serv Res. 2017;17(1):189.
10. Kikuchi K, Yasuoka J, Nanishi K, *et al.* Postnatal care could be the key to improving the continuum of care in maternal and child health in Ratanakiri, Cambodia2018. e0198829 p.
11. Sakuma S, Yasuoka J, Phongluxa K, *et al.* Determinants of continuum of care for maternal, newborn, and child health services in rural Khammouane, Lao PDR. 2019;14(4):e0215635.

12. Wang W, Hong R. Levels and determinants of continuum of care for maternal and newborn health in Cambodia-evidence from a population-based survey. BMC Pregnancy Childbirth. 2015;15:62.
13. Balakrishnan R, Gopichandran V, Chaturvedi S*, et al.* Continuum of Care Services for Maternal and Child Health using mobile technology - a health system strengthening strategy in low and middle income countries. BMC Med Inform Decis Mak. 2016;16:84.
14. Carvajal-Aguirre L, Amouzou A, Mehra V*, et al.* Gap between contact and content in maternal and newborn care: An analysis of data from 20 countries in sub-Saharan Africa. J Glob Health. 2017;7(2):020501.
15. Muchie KF. Quality of antenatal care services and completion of four or more antenatal care visits in Ethiopia: a finding based on a demographic and health survey. BMC Pregnancy and Childbirth. 2017;17(1).
16. Ftwi M, Gebretsadik GG-e, Berhe H*, et al.* Coverage of completion of four ANC visits based on recommended time schedule in Northern Ethiopia: A community-based cross-sectional study design. PLOS ONE. 2020;15(8):e0236965.
17. Tizazu MA, Sharew NT, Mamo TR*, et al.* Completing the Continuum of Maternity Care and Associated Factors in Debre Berhan Town, Amhara, Ethiopia, 2020. 2021;14:21-32.
18. Emiru AA, Alene GD, Debelew GT. Women's retention on the continuum of maternal care pathway in west Gojjam zone, Ethiopia: multilevel analysis. BMC Pregnancy Childbirth. 2020;20(1):258.
19. Haile D, Kondale M, Andarge E. Level of completion along continuum of care for maternal and newborn health services and factors associated with it among women in Arba Minch Zuria woreda, Gamo zone, Southern Ethiopia: A community based cross-sectional study. 2020;15(6):e0221670.
20. Haftu A, Hagos H, Mehari MA*, et al.* Pregnant women adherence level to antenatal care visit and its effect on perinatal outcome among mothers in Tigray Public Health institutions, 2017: cohort study. BMC Res Notes. 2018;11(1):872.
21. Tukur Dahiru OMO. Determinants of antenatal care, institutional delivery and postnatal care services utilization in Nigeria. PanAfrican Medical Journal. 2015.
22. Srivastava A, Mahmood S, Mishra P*, et al.* Correlates of Maternal Health Care Utilization in Rohilkhand Region. June 2014;4(3).
23. G Anil Kumar RD, Priyanka Chaman, Priyanka Singh and Lalit Dandona. A population-based study of neonatal mortality and maternal care utilization in the Indian state of Bihar. 2014;14(357).
24. Agency CS, editor Ethiopia Demographic and Health SurveyOctober, 2016; Addis Ababa: The DHS Program ICF Rockville, Maryland, USA.
25. Araya Medhanyie MS, Yohannes Kifle, Nikki Schaay, David Sanders, Roman Blanco,Dinant GeertJan and Yemane Berhane. The role of health extension workers in improving utilization of maternal health services in rural areas in Ethiopia: a cross sectional study. 2012;12(352).
26. Desalew Zelalem Ayele BB, Kedir Teji and Desalegn Admassu Ayana. Factors Affecting Utilization of Maternal Health Care Services in Kombolcha District, Eastern Hararghe Zone, Oromia Regional State, Eastern Ethiopia. October 2014;2014 (Article ID 917058, 7 pages).
27. Tsegay Y, Gebrehiwot T, Goicolea I*, et al.* Determinants of antenatal and delivery care utilization in Tigray region, Ethiopia: a cross-sectional study. International Journal for Equity in Health. 2013;12(1):30.
28. Mohan D, LeFevre AE, George A*, et al.* Analysis of dropout across the continuum of maternal health care in Tanzania: findings from a cross-sectional household survey. Health Policy Plan. 2017;32(6):791-9.
29. De Graft-Johnson J, Kerber K, Tinker A. The maternal, newborn and child health continuum of care: Opportunities for Africa's newborns. Partnership for Maternal, Newborn and Child Health. 2011;2006:23–36.

30. Taylor E. Hurst KS, Manasa Patna, Atul Gawande and Lisa R. Hirschhorn. Demand-side interventions for maternal care: evidence of more use, not better outcomes. 2015;15(297).
31. Shibanuma A, Yeji F, Okawa S*, et al.* The coverage of continuum of care in maternal, newborn and child health: a cross-sectional study of woman-child pairs in Ghana. BMJ Glob Health. 2018;3(4):e000786.
32. Britta C. Mullany SBaMJH. The impact of including husbands in antenatal healtheducation services on maternal health practices inurban Nepal: results from a randomized controlled trial. July, 2006;22(2, 2007).
33. Federal Democratic Republic of Ethiopia Central Statistical Agency. Population Projection of Ethiopia for All Regions At Wereda Level from 2014 – 2017. 2013.
34. Wang W, Hong R. Completing the continuum of care for maternal and newborn health in Cambodia: Who drops out? Calverton, Maryland, USA: ICF International, 2013.
35. Zelka MA, Yalew AW, Debelew GT. Effects of continuum of care in maternal health services on adverse birth outcome in Northwest Ethiopia: a prospective follow up study. Research Square; 2021.
36. Ethiopian Minisry of Health (MoH). National Technical Guidance For Mataernal and Perinatal Death Surveillance and Response (MPDSR). In: INSTITUE EPH, editor. 2017.
37. Agha S, Williams E. Maternal and Child Health Program Indicator Survey 2013, Sindh Province. MNCH Services Component, USAID/Pakistan MCH Program. Karachi, Pakistan: Jhpiego. 2013.
38. Debelew GT, Afework MF, Yalew AW. Determinants and causes of neonatal mortality in Jimma Zone, Southwest Ethiopia: a multilevel analysis of prospective follow up study. PLoS One. 2014;9(9):e107184.
39. Afulani PA. Determinants of stillbirths in Ghana: does quality of antenatal care matter? BMC Pregnancy Childbirth. 2016;16(1):132.
40. Dennis ML, Benova L, Abuya T*, et al.* Initiation and continuity of maternal healthcare: examining the role of vouchers and user-fee removal on maternal health service use in Kenya. Health Policy Plan. 2019;34(2):120-31.
41. Determinants of antenatal and delivery care utilization in Tigrary Region. 2013;12(30).
42. Muluwas Amentie MAaMa. Utilization of Institutional Delivery Care Services and Influencing Factorsamong Women of Child Bearing Age in Assosa District, Benishangul Gumuz Regional State, West Ethiopia. 2016;16(3).
43. Geremew AB, Boke MM, Yismaw AE. The Effect of Antenatal Care Service Utilization on Postnatal Care Service Utilization: A Systematic Review and Meta-analysis Study. Journal of pregnancy. 2020;2020:7363242.

Figure legends/caption

Figure- 2: Flow-diagram of the overall study process in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

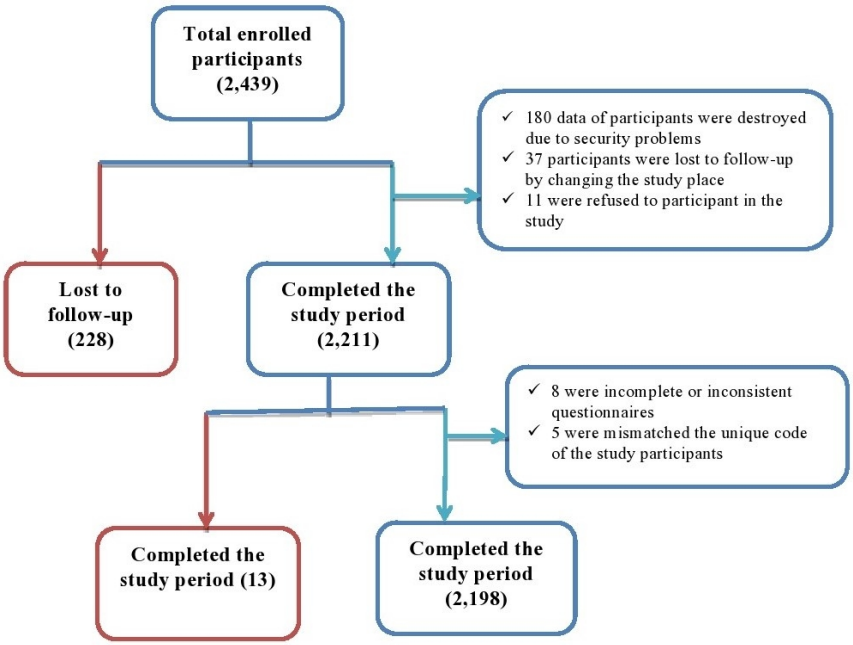

Figure- 1: Flow-diagram of the overall study process in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

307x250mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Indicated page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	*It is clearly indicated in the title and abstract. See on Title section, page 1 and abstract section, at page-2*
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	*It is properly described according to the guideline of journal and also the strengths and limitations of the study incorporate in the document. See page number 2 and 3*
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	*It is concisely formulated and stated in the introduction section. See page number 3 – 4.* *The rationality of the study is clearly described at the last paragraph under the section of introduction. Page - 4*
Objectives	3	State specific objectives, including any pre-specified hypotheses	*It is clearly formulated and indicated at the end of introduction section. See page number 4*
Methods			
Study design	4	Present key elements of study design early in the paper	*It is stated at page number 5*
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	*It is stated in the first section of methods part. See at page number 4 – 5*
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	*It is elaborated in detail. see at page number 5 – 6*
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	*NA*
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	*See at page number 7*
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*See at page number 7*
Bias	9	Describe any efforts to address potential sources of bias	*- It is stated clearly under subsection of data collection and quality control see page 7* *- It is also explained under subsection of data management and statistical modelling see at page 8*
Study size	10	Explain how the study size was arrived at	*See page number 5 – 6*

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	*See page number 7 – 8*
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	*See page number 8*
		(*b*) Describe any methods used to examine subgroups and interactions	*See page number 8*
		(*c*) Explain how missing data were addressed	*It was excluded from the final analysis*
		(*d*) If applicable, explain how loss to follow-up was addressed	*It was excluded from the final analysis*
		(*e*) Describe any sensitivity analyses	*NA*
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	*It was stated at page number 9*
		(b) Give reasons for non-participation at each stage	*It was stated at page number 9 and see figure – 1*
		(c) Consider use of a flow diagram	See page number – 9 and figure – 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	*It was stated at page number 9*
		(b) Indicate number of participants with missing data for each variable of interest	*It was clearly formulated under table 2 – 4*
		(c) Summarise follow-up time (eg, average and total amount)	*NA*
Outcome data	15*	Report numbers of outcome events or summary measures over time	*See page number 10, 11 and 12*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	*It was stated at page number 15 – 18*
		(*b*) Report category boundaries when continuous variables were categorized	See page number 17
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			

Key results	18	Summarise key results with reference to study objectives	See page number 19 – 23
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	See page number 23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	See page number 19 – 23
Generalisability	21	Discuss the generalisability (external validity) of the study results	See page number 23
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	See page number 25

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Individual and community-level determinants of maternal health services utilization in northwest Ethiopia: a prospective follow-up study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-061293.R2
Article Type:	Original research
Date Submitted by the Author:	21-Sep-2022
Complete List of Authors:	Amentie, Muluwas; Addis Ababa University College of Health Sciences, Reproductive Health; Assosa University, Public Health Worku, Alemayehu; Addis Ababa University College of Health Sciences, School of Public Health Debelew, Gurmesa Tura; Jimma University,
Primary Subject Heading:	Public health
Secondary Subject Heading:	Reproductive medicine, Sexual health, Health services research
Keywords:	Public health < INFECTIOUS DISEASES, PUBLIC HEALTH, Maternal medicine < OBSTETRICS, EPIDEMIOLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Individual and community-level determinants of maternal health services utilization in northwest Ethiopia: a prospective follow-up study

Muluwas Amentie Zelka[1, 2 *], Alemayehu Worku Yalew[3], Gurmesa Tura Debelew[4]

[1]Department of Public Health, College of Health Sciences, Assosa University, Assosa, Ethiopia

[2]Department of Reproductive Health, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia

[3]Department of Biostatics and Epidemiology, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia

[4]Department of Population and Family Health, Institute of Health, Jimma University, Jimma, Ethiopia

E-Mail Address:

Muluwas Amentie Zelka (M.A. Zelka): muluwas12@gmail.com

Alemayehu Worku Yalew (A.W. Yalew): alemayehuwy@yahoo.com

Gurmesa Tura Debelew (G.T. Debelew): gurmesatura@gmail.com

*** Corresponding author**

Muluwas Amentie Zelka (M.A. Zelka): muluwas12@gmail.com , P.O.Box 18, Assosa Univerity, Assosa, Ethiopia

Abstract

Objective: The utilization of maternal health services is an important indicator of maternal health and socio-economic development. Evidence on individual and community level determinants of maternal health services utilization in Benishangul Gumuz Region was not well known so far. Hence, this study fills this gap.

Design: A prospective follow-up study

Setting: This study was conducted from March 2020–January 2021 in northwest Ethiopia.

Participants: A total of 2,198 pregnant women were participated in the study.

Main outcome measures: A multistage random sampling technique was used to select study subjects. Data were collected via face-to-face interviews using pretested semi-structured questionnaires. Collected data were coded, cleaned, and analyzed using STATA software. Multilevel regression models were applied to determine individual and community-level factors of maternal health services utilization.

Results: This study found that the proportion of women who visited recommended antenatal care, received skilled delivery care, and postnatal care were 66.1%, 58.3%, and 58.6% respectively. Being rural(AOR=3.82:95%CI: 1.35-10.78), having information on maternal health services(AOR=2.13:95%CI: 1.21-3.75), with a history of pregnancy-related problems (AOR=1.83:95%CI: 1.15-2.92), and women with decision-making power(AOR=1.74:95%CI: 1.14-2.68) were more likely to receive 4th antenatal care visits. Similarly, women who attended tertiary school(AOR=4.12:95%CI: 1.49-11.33), and who initiate 1st antenatal care visit within 4-6 months of pregnancy(AOR=0.66:95%CI: 0.45-0.96) were determinants of skilled delivery care. Finally, women whose partners attended tertiary education(AOR=3.67:95%CI: 1.40-9.58), women with decision-making power(AOR=1.8:95%CI: 1.09-2.97), women who attended 4th antenatal care visit(AOR=10.8:95%CI: 6.79-17.2), women received iron-folic acid during pregnancy(AOR=1.96:95%CI: 1.11-3.49), and women who received skilled delivery care(AOR=1.63:95%CI: 1.1-2.42) were more likely to get post-natal care services.

Conclusions: The proportion of women who attended antenatal care, received skilled delivery services, and postnatal cares were low. Different individual and community-level factors that influenced the utilization of these services were discovered. Therefore, community-based interventions should target those identified factors to improve maternal health services.

Keywords: *Benishangul Gumuz, Factors, Maternal Health, Service Utilization*

Strength and limitations of the study

- The strengths of this study are using of a prospective follow-up study design that helped to measure the true cause and effect relationship, a large sample size was used for this study that resulted in high power and precision for the multilevel analyses, and using advanced statistical models to handle clustering effects and identifying factors at different levels for intervention purposes.
- The limitation of this study is health facility data were collected by health workers who were liable to social desirability bias which might compromise the findings.
- Around 8.5% of the study participants were lost to follow up which might have some deviation from the result.
- In the region, fifteen medium clinics were providing maternal health services but the rest of the private health facilities did not provide maternal health services for the community. However, this study did not include private health facilities which might compromise the findings.

Introduction

Regardless of the significant reduction in maternal and neonatal mortality globally and also in developed countries, still maternal and neonatal mortality in developing countries including Ethiopia is the highest and have no significant reduction(1, 2). However, proper provision of maternal health services is essential for women's and babies' health(1). Thus, antenatal care (ANC), delivery services, and postnatal care (PNC) are the major pillars of maternal health services that have an effort to reduce maternal and neonatal mortality (3, 4). Even though utilization of maternal health services is an indirect indicator of maternal and perinatal death, fewer women are using ANC, facility delivery, and PNC, which is an alarming challenge to rapidly reduce maternal and neonatal mortality rates(3, 5).

According to WHO recommendation, every pregnant woman receives at least 4th ANC visits to save the life of women and babies, which warrants more programmatic attention (6, 7). However, utilization of ANC services is low and varies across the nations and within the country (1, 7-26). This underutilization of ANC services because of different factors: socio-demographic characteristics (1, 3, 4, 21, 24-27), availability of health facilities(27), household wealth index(1, 4, 21, 24, 25), women empowerment (21), present and past obstetric history(3, 4, 21, 26), information and perception on maternal health services(4, 25, 26) and health insurance(21)

The utilization of skilled delivery is extremely low and a big variability between the uptake of skilled delivery and ANC within the nation and abroad the countries (1, 5, 9-13, 18, 19, 22, 24, 28). Empirical evidences identify different factors that affect the uptake of institutional delivery services such as socio-demographic and economic factors (1, 3, 4, 21, 26, 27, 29), obstetric history (3, 4, 21, 26, 27, 30), transportation services and perception on quality of services (26, 29).

Health interventions after delivery are a crucial period and key strategy to reduce maternal and neonatal mortality (10, 29). But, utilization of postnatal services was extremely low even comparing with the use of ANC and delivery services (1, 9-11, 14, 18, 19, 21, 22, 24, 25, 31). This underutilization of the services is due to different factors: socio-demographic factors (4, 21, 32), household wealth index (4, 21), obstetric factors(3, 4, 21), women empowerment (21), and health insurance (21).

However, prior studies determine the magnitude of maternal health services utilization and explore individual-level factors using the traditional logistic regression model which exclude community-level factors and advance statistical modeling. These may lead to underestimating or overestimating magnitudes and their predictors of maternal health services which are crucial for the establishment of community-based interventions for maternal and child health (MCH) programs. Multilevel regression modeling is an appropriate method for controlling the nesting effect of clusters at different levels, which is not addressed in previous studies. Therefore, by overcoming the drawbacks of the previous studies, this study aimed to determine individual-level (*level – 1*) and community-level (*level – 2*) determinant factors of maternal health services (at least 4th ANC visit, skilled delivery and PNC services).

Methods

Study settings

This study was conducted in Benishangul Gumuz Regional State. It is one of the eleven regions constituting in the Federal Democratic Republic of Ethiopia (FDRE), located in Northwest Ethiopia. The capital city of the region is Assosa town, located at 670KMs away from Addis Ababa, the capital city of Ethiopia. Administratively, the region has three zones (*namely Assosa zone, Metekel zone and Kamashi zone)*, three towns administration (namely Assosa town, Gilgel Beles town and Kamashi town administration), one special woreda (namely Mao-Komo special woreda), and 475 kebeles (439 rural and 36 urban). The region hosts near to 60,000 refugees.

Based on the 2007 national population and household census, the 2018 population projection revealed that the total population of the region was 1,127,001 which covers 1.1% of the national population, the total number of pregnant women in the region, and the selected study districts were 36,754 and 15,368 pregnant women respectively(33). Health facilities serving these populations were 446 public health facilities (401 health posts; 41 health centers; 4 primary hospitals and 2 general hospitals); 119 private and NGO health institutes (15 medium clinics and 104 primary clinics) and 91 private pharmaceutics (3 pharmacies, 50 drug stores, and 38 rural drug vendors).

Study design and Period

A community and health facility-linked prospective follow-up study design was carried out from March 2020 to January 2021.

Source population and study participants

All pregnant women within the study area during the time of the baseline survey were the source population. Randomly selected pregnant women using the sampling technique were study participants. The inclusion criteria were women who were permanent residents (living more than 6 months) in the selected districts and categorized as pregnant women, women whose gestational age is ≥ 8 weeks and also fulfill pregnancy screening criteria. Whereas, the exclusion criteria were pregnant women who have hearing or other disabilities hindering communication; severely ill and mentally disturbed, pregnant women who reported their pregnancy is less than 8 weeks, and pregnant women who completed 4th ANC visit during the time of baseline survey.

Sample size and sampling procedure

The sample size was computed using both single and double population proportion formulas. For the single population proportion, the following assumptions were considered while computing the sample size: the proportion of women who used the whole maternal health care service is 60%(p = 0.6)(34). The margin of error is 5% (d=0.05) with a 95% level of confidence interval (1.96), taking a design effect of 2 and a non-response rate of 10%. Then, the sample size calculated is *812* pregnant women.

Similarly, the double population proportion formula was used to compute the sample size for each determinant of maternal health services utilization. Among all the factors considered for sample size calculation, women's age is found to have the maximum sample size. Thus, considering the following assumption for double population formula: the proportion of women who completed the whole maternal health services (ANC, skilled delivery and PNC services),

among women whose age is greater than 35 is 48% (p_1 = 0.48) and among women whose age between 20 – 35 years old is 62% (p_2 = 0.62)(34); pooled population proportion (P = 0.55); r =1:1 ratio of exposure to non-exposure; 5% significant level; 80% power, design effect of 2 and 10 non-response rate. Then, *874* sample sizes were generated through STATA/MP 13.0 software. As a result, a total of 874 pregnant women were calculated for this study. This study, however, was part of larger research work(35), and the sample size determined for another objective was 2,402 pregnant women, which was used as the final sample size for this study.

A multistage clustered sampling technique was employed to reach the study participants. In this study, the study area was first stratified into three zones and three town administration with one special woreda. In the first stage, of these stratified areas, two zones and one town administration were selected using a simple random sampling technique. Then after, seven districts/woredas and two town districts/woredas were randomly selected from two zones and one town administration respectively as the second stage. Subsequently, at the third stage, 51 Kebeles/clusters were randomly selected from the selected districts/woredas.

A one-month baseline census was conducted to identify pregnant women using a pregnancy screening criterion to prepare a sampling frame. Then, all pregnant women who resided in the selected kebeles/clusters were included in the study and then followed for an average of 11 months.

Meantime of the house-to-house survey, public health facilities that provide at least basic maternal health services for the community were identified. Then, all eligible public health facilities were recruited and made a candidate for a facility-based survey. Based on these, 46 health facilities (3 hospitals, 12 health centers, and 31 health posts) were included in the health facility-based survey.

Data collection and quality control

The research questionnaire was prepared in English which was adapted from EDHS 2016(2), National Technical Guidance for MPDSR 2017(36), MCH Program Indicator Survey 2013(37), Survey tools conduct in Jimma Zone, Southwest Ethiopia(38), Survey tools conducted in Rural South Ethiopia(5), and other relevant different works of literatures. After finalized the research instrument preparation; training, pretest, supervision, and use of local languages were made to ensure the quality of data. Then, the trained data collectors gather information through face-to-

face interviews at comfortable and convenient places. After all, completed questionnaires were reviewed by supervisors on a monthly base for accuracy and consistency.

Variables and measurement

Outcome variables

In this study, maternal health service encompasses care during pregnancy, childbirth, and after birth within 42 days. Therefore, we have three primary outcomes: receiving recommended ANC visits (4th visits or more), skilled delivery care, and receiving PNC 4th visits within 42 days.

Independent variables

Independent variables were categorized into two levels. ***Individual-level variables (level – 1)*** included individual and household-related factors: household wealth index, women's age, educational level (women and partner), occupational status (women and partner), information on maternal health services, age at first marriage and pregnant, past and present bad obstetric history, women and partner decision making power in health-seeking behaviors, iron and folic acid supplementation during pregnancy and provision of TT vaccination during pregnancy. ***Higher-level variables (cluster - 2)*** included community and health facility-related factors such as place of residence, accessibility of health facilities, availability of health facilities within the community, and quality of maternal health services.

Data management and statistical modeling

The collected data were coded and entered into Epi. Info version 7.2.2.6. After data entry was completed, it was exported to STATA software version 14.1. Then, data were cleaned, edited, and analyzed using STATA Software. Descriptive statistics and crude odds ratio at 95%CI were computed for all variables to select candidate variables for multivariable analysis ($p < 0.25$). The composite indicator of the household wealth index was computed and categorized into three categories using Principal Component Analysis (PCA). Before running the full model, the coefficient of the interaction term at $p \geq 0.1$ and the multi-collinearity effect between independent variables was determined by using variance inflation factors (VIF > 10%) were determined. Finally, all included variables had no multi-collinearity and interaction effect.

Even though a multistage clustered sampling method was used in the study, a multilevel regression model was applied by using STATA 14 to identify community and individual-level factors having significant association with maternal health care utilization (ANC 4th visits or more, skilled delivery care, and PNC 4th visits). Kebele/Ketena was considered as cluster and cluster-level variables: a place of residence, access to health posts and household wealth index

were taken as higher levels (level – 2). Whereas, individual factors such as socio-demographic, obstetric history, age at first marriage and pregnancy, information on maternal health services, women-decision making power, key services offered during pregnancy, and pregnancy-related problems were taken as lower levels (level-1). The goodness of fit of the multilevel model was tested by the log-likelihood ratio (LR) test and found to be statistically significant such as data fit the model.

Patient and Public Involvement

In this study work, patients or the public were not involved in the design, conduct, reporting, or dissemination plans of our research

Result

Socio-demographic characteristics

A total of 2,439 pregnant women were enrolled and included in the study. Of them, 2,198 participants completed a follow-up period and included in the final analysis (Figure – 1). Of these participants, 1,403 (63.8%) resided in rural areas and belonged to the age group of 25–29 years with a mean (±SD) of 26.34+5.25. Majority of the women were married 2,102 (95.6%) and were illiterate 1,084 (49.3%). In line with occupational status, 1,733 (78.8) of the women were housewives (Table 1).

Table 1: Socio-demographic characteristics of study subjects in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent (%)
Place of Residence		
Rural	1403	63.8
Urban	795	36.2
Age (Years)		
15 – 19	186	8.5
20 – 24	608	27.7
25 – 29	795	36.2
30 – 34	400	18.2
35 – 39	177	8.1
40 – 45	32	1.5
Marital Status		
Married	2102	95.6
Single	84	3.8
Divorced	12	0.6
Woman education level		

Illiterate	1084	49.3
Read and write	251	11.4
First Cycle (Grade 1 – 4)	106	4.8
Secondary Cycle (Grade 5 – 8)	316	14.4
High School (Grade 9 – 12)	248	11.3
Tertiary education (12^{+})	193	8.8
Woman occupational status		
Housewife	1733	78.8
Governmental employee	185	8.4
Student	139	6.3
Merchant	94	4.3
Farmer	47	2.1

Coverage of maternal health services utilization

Utilization of ANC services and related issue

Among the study participants, 1453 (66.1%; 95%CI: 64.1 – 68.1%) of pregnant women attended the recommended ANC visits. The key interventions received during ANC visits were informed on the danger signs of pregnancy 1740 (79.2%) followed by blood pressure measured 1701 (77.4%). Two-thirds, 1330 (65.5%) were initiated their first ANC visit within the second trimester (4 – 6 months of gestational age). However, 466 (24.3%) women were dropout from ANC follow-up service due to different reasons such as lack of knowledge on the benefit of ANC services 324 (69.5%) and fear of privacy 139 (29.8%)(Table 2).

Table 2: Utilization of ANC services and related issues of study subjects in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Ever receive ANC services during last pregnancy		
No	279	12.7
Yes	1,919	87.3
Visit of ANC received during last pregnancy		
1st ANC visit	1919	87.3
2nd ANC visit	1815	82.6
3rd ANC visit	1674	76.2
4th ANC contact	1453	66.1
Key interventions received during ANC contact (*n = 1919, multiple responses*)		
Informed on danger signs of pregnant	1740	79.2
Blood pressure measured	1701	77.4
Iron folic acid supplementation	1677	76.3
Nutritional counseling	1623	73.8

Urine sample taken	1607	73.1
Blood sample taken	1578	71.8
Protection of birth from tetanus	1562	71.1
Other	22	1.0
Reason for dropout from ANC follow-up (*n = 466 multiple responses*)		
Didn't know about the importance of ANC	324	69.5
No problems encountered	298	63.9
Fear of lack of privacy	139	29.8
Influence of other peoples	137	29.4
Couldn't pay for transportation	114	24.5
Health institution was too far	111	23.8
No transportation services	56	12.0
Male health professionals	45	9.7
No money to pay for services	38	8.2
Time of first ANC services initiation (*n = 2032*)		
1-3 months of pregnancy	570	28.1
4-6 months of pregnancy	1330	65.5
After 6 months of pregnancy	132	6.5
Information offered to deliver at health facility		
Yes	1901	86.5
No	297	13.5

Institutional delivery services and related issues

The prevalence of skilled delivery service was 58.3% (95%CI: 56.2% – 60.4%). Among the study participants, 1,404 (63.9%) of women gave birth at the facility. The main reasons for health facility delivery were informed her to deliver in the health facility 1277 (91.0%) and previous bad experiences from home delivery 263 (18.7%). Whereas, more than one third (36.1%) of women gave birth at home. The main reasons for home delivery: labour was going well 424 (53.4%) and feeling more comfortable at home delivery 392 (49.4%). Moreover, 295 (14.3%) women suffered from pregnant-related complications during childbirth. Common pregnant-related complications were obstructed/prolonged labour 187 (63.4%) and excessive bleeding 102 (34.6%) (Table 3).

Table 3: Delivery services and related issues for current delivery services in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Delivery services for last delivery		
Skilled care	1281	58.3

Unskilled care	917	41.7
Place of last delivery		
Home	794	36.1
Health post	353	16.1
Health center	775	35.3
Hospital	276	12.6
Attendant of last delivery		
Families/Friends/Relatives	611	27.8
Traditional Birth Attendants (TBAs)	166	7.6
Health Extension Workers (HEWs)	141	16.4
Midwifery/Nurses/Health Officers	1184	53.9
Medical Doctors	96	4.4
Mode of last delivery		
Spontaneous vaginal (SVD)	1943	88.4
Assisted vaginal delivery (AVD)	156	7.1
Caesarean section (C/S)	74	3.4
Assisted delivered stillbirth	25	1.1
Reason for health facility delivery (*n = 1404*)		
She was informed to deliver in HFs	1277	91.0
Previous bad experiences with home delivery	263	18.7
She faced problems: forced to deliver in HF	227	16.2
Others	53	3.8
Reason for Home delivery (*n = 794*)		
The labour was going well	424	53.4
She feels more comfortable at home	392	49.4
Close attention from relatives/family	332	41.8
It is usual practice	331	41.8
No transportation services	248	31.2
Cannot pay for transportation services	202	25.4
Previous bad experiences with ID	65	8.2
Cannot afford to pay for health services	22	2.8
Culture doesn't allow to give birth at HF	15	1.9
Others	5	0.6
Pregnant related complications at labour (*n = 2065*)		
No	1769	85.7
Yes	295	14.3
Pregnant related complications at labour/childbirth (*n = 295, multiple responses*)		
Obstructed/Prolonged labour	187	63.4
Excessive bleeding during labour	102	34.6

Elevated blood pressure	76	25.8
Premature rupture of membranes	69	23.4
Intrauterine fetal death	47	15.9
Preterm labour	12	4.1
Others	5	1.7

Postnatal (PNC) service utilization and related issues

This study revealed that more than half (58.6%) of women received the recommended PNC services with a 95% CI (56.4% – 60.7%). Of them, 504 (28.9%) of women initiated the first postnatal services within 48 hours. The key services received during the postnatal visits were immunization of baby 1692 (81.9%) and physical examination of the mother 1248 (60.4%). The main reasons for utilization of postnatal care were baby needed immunization 1598 (89.6%) and the midwifery had told her to use the services 1305 (73.2%). In other direction, the reasons for not utilizing postnatal services were ignorance of women's privacy 137 (48.6%) and long waiting time at health facilities 95 (33.7%). Around, 249 (12.1%) of women had postpartum complications (Table 4).

Table 4: Postnatal services and related issues of study participants in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	Frequency	Percent
Component of PNC contact, she received (*n = 2065*)		
1st contact of PNC services	1783	86.3
2nd contact of PNC services	1545	74.8
3rd contact of PNC services	1373	66.5
4th contact of PNC services	1210	58.6
The key interventions offered during the postnatal period (*n = 2065, multiple responses*)		
Immunization of baby	1692	81.9
Counseling on proper nutrition	1516	73.4
Breastfeeding education	1436	69.5
Physical examination	1248	60.4
Family planning services	1074	52.0
Other	30	1.5
Time interval for first PNC visit (*n = 1741*)		
Within 2days after delivery	504	28.9
B/n 3 – 7 days after delivery	754	43.3
B/n 8 – 42days after delivery	483	27.7
Reason for seeking PNC services (*n = 1783*)		
The baby needs immunization	1598	89.6

The midwife had told me to seek the services	1305	73.2
She wanted to start family planning	975	54.7
She wanted to make sure she is back to normal	834	46.8
Because of her illness	272	15.3
Reason for not seeking PNC services (*n = 282*)		
They did not teach properly	181	64.2
Fear of privacy	137	48.6
Waiting more time at HF	95	33.7
They examined roughly	77	27.3
Religious forbidden	64	22.7
A health professional shouted at me	37	13.1
Other	14	5.0
Postpartum complications (*n = 2065*)		
No	1816	87.9
Yes	249	12.1
Type of postpartum complications (*n = 249*)		
Headache, visual disturbances	170	68.3
Convulsions/rigidity	118	47.4
Fever with or without chills	85	34.1
Heavy bleeding	66	26.5
Loss of consciousness	66	26.5
Foul-smelling discharge	52	20.9
Severe abdominal pain	5	2.0
Other*	3	1.2

** Leg edema, nausea, vomiting, and severe malaria during pregnancy*

Individual and community-level determinants of maternal health services

Individual and community-level factors affecting the utilization of maternal health care were detected by using a multilevel regression model. Before running the multilevel regression model, ICC (ρ) was calculated in the empty model for each outcome (ANC 4th, skilled delivery care, and PNC 4th). Meantime, ICC/*rho* (ρ) was calculated as a full model for the outcomes to detect the variability attributed to clusters after controlling the individual level.

Rho (ρ)/ICC was calculated for the ANC 4th visits in the empty model and it was found to be 0.37 indicating that 37% of the variation was contributed by cluster variations. The test of preference of log-likelihood *versus* logistic regression was statistically significant (P<0.0001). Then, the full model was run by including both the community level and individual level variables and the ICC (ρ) was increased to 0.46. This again indicated that 46% of the variation

was attributed to cluster-level variables. The preference for log-likelihood *versus* logistic regression was statistically significant (P < 0.0001). Hence, this is suggesting that the preferred model for this outcome variable was the multilevel logistic regression model. Similarly, Rho (ρ)/ICC and test preference of log-likelihood were determined in the empty and full model for both skilled delivery care and PNC 4th visits, and indicating that statistically significant association. Hence, a multilevel logistic regression model is the preferred model for these outcomes (Table 5).

Table 5: Parameter of odd ratio and Test of Goodness-of-fit for Multilevel Models, Benishangul Gumuz Region, Northwest Ethiopia, 2021

Models	Fixed intercept -cons(95%CI)	Random effect as Level-2 variance var(-cons (95%CI))	Intra-class Correlation Coefficient: ICC(ρ)	Log likelihood (LR)-deviance	Significance of LR test Vs Logistic regression (P-value)
ANC 4th and more					
Empty model	2.54(1.7, 3.78)	1.92(1.23, 3.04)	0.37 = 37%	-1161.48	P < 0.0001
Full model	0.26(0.04,1.67)	2.76 (1.54, 4.96)	0.46 = 46%	-633.06	P < 0.00001
Skilled delivery					
Empty model	1.48(1.17, 1.87)	0.59(0.36, 0.96)	0.15 = 15%	-1402.31	P < 0.0001
Full model	1.18(0.3,4.66)	1.1(0.63, 1.92)	0.25 = 25%	-706.65	P < 0.00001
PNC 4th					
Empty model	1.59(0.99, 2.54)	2.72(1.72, 4.33)	0.45 = 45%	-1099.36	P < 0.0001
Full model	0.08(0.01,0.71)	2.25 (1.27, 3.98)	0.40 = 40%	-523.25	P < 0.00001

A p-value less than 0.05 is statistically significant and the data fit for the multilevel model
** Multilevel regression model applied to measure the effect of factors on outcome*

Community-level factors

Regarding community-level factors, different programmatic important indicators (place of residence, household wealth index, quality of maternal health services, accessibility, and availability of health facilities within the community) were assessed. Of them, place of residence, household wealth index and accessibility of health posts were selected as candidate variables for multivariable multilevel logistic regression analysis.

After controlling for any confounders in the final multilevel model, among the community level variables: a place of residence was a statistically significant association with utilization of the recommended ANC visits (4th visits or more) but it was not statistically significant association with skilled delivery care and recommended PNC visits (PNC 4th). The odds of receiving the recommended ANC visits (4th visits or more) among women who reside in rural resident (AOR = 3.82; 95%CI: 1.35, 10.78) were four times higher than among women who reside in the urban area. Similarly, among community level factors, household wealth index was a statistically significant association with the skilled delivery services but not statistically significant

association with the 4th ANC visits and recommended PNC visits. The odds of receiving skilled delivery services among women belonged to the 3rd quintile wealth index of household (AOR = 2.23; 95%CI: 1.27, 3.89) were two times higher than among women who belonged to 1st quintile wealth index of the household.

Individual-level factors

In the individual-level (level – 1) variables: multiple factors were detected that had programmatically important implications and depicted that statistically significant association with maternal health care utilization.

Concerning individual-level factors of ANC services utilization, we found that the odds of receiving the recommended ANC visits (ANC 4th or more) among women who had any information on maternal health services (AOR=2.13; 95%CI: 1.12, 3.75) were two times higher than among women who didn't have any information on maternal health services. Moreover, women with a history of pregnancy-related problems (AOR = 1.83; 95%CI: 1.15, 2.2), women with a history of stillbirth (AOR = 1.67; 95%CI: 1.02, 2.73), and women with decision-making power (AOR = 1.74; 95%CI: 1.14, 2.68) were two times higher in odds of receiving recommended ANC visits than women belonged with their counterpart.

This study found that the odds of utilizing skilled delivery care among women who completed recommended ANC visit or more (AOR = 2.29; 95%CI: 1.59, 3.32), who attended primary school (AOR = 1.71; 95%CI: 1.04, 2.81) and tertiary school (AOR = 4.12; 95%CI: 1.49, 11.33) were higher in the odds of attending skilled delivery care than women residing with their counterpart. However, women with a history of pregnancy-related problems (AOR = 0.57; 95%CI: 0.37, 0.86), and a history of stillbirth (AOR = 0.43; 95%CI: 0.28, 0.66) were 60% lower in the odds of receiving skilled delivery care than among women who were free from any problems. The odds of skilled delivery care utilization among women who delay 1st ANC visit initiation between 4 – 6 months of gestational age (AOR = 0.66; 95%CI: 0.45, 0.96) were 34% lower than among women who initiate 1st ANC visit early (within 3 months of gestational age).

Similarly, this study indicated that the odds of utilizing the recommended PNC services among women who received ANC 4th visits or more (AOR = 10.8; 95%CI: 6.79, 17.2), a partner who attended tertiary education (AOR = 3.67; 95%CI: 1.40, 9.58), women decision making power (AOR = 1.8; 95%CI: 1.09, 2.97), iron and folic acid (IFA) supplementation during pregnancy (AOR = 1.96; 95%CI: 1.11, 3.49) and women attended skilled delivery care (AOR = 1.63;

95%CI: 1.11, 2.42) were higher than among women who belonged within their counterpart. However, the odds of PNC service utilization among women with history of stillbirth (AOR = 0.51; 95%CI: 0.29, 0.87), women delay initiating 1st ANC visit within 4 – 6 months of gestational age (AOR = 0.39; 95%CI: 0.24, 0.61) and after 6 months of gestational age (AOR = 0.1; 95%CI: 0.03, 0.24) were 49%, 61% and 90% lower respectively than among women within their counterpart (*Table 6*).

Table 6: Individual and community-level determinants of maternal health care utilization in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

Variables	*ANC 4th + visits*	*Skilled delivery care*	*PNC 4th visits*
	AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**
Level – 2 (Community level) variables			
Place of resident			
Urban	**1**	1	1
Rural	**3.82(1.35, 10.78)**	1.22(0.55, 2.73)	1.14(0.44, 2.91)
Distance to Health Post			
< 2 Hours	1	1	1
>= 2 Hours	0.25(0.02,2.73)	0.49(0.08, 2.89)	0.88(0.1, 10.26)
Household Wealth Index			
1st Quintile (Poor)	1	1	1
2nd Quintile (Middle)3rd	1.06(0.69, 1.61)	1.13(0.78, 1.63)	0.74(0.46, 1.21)
Quintile (Rich)	1.46(0.81, 2.62)	**2.23(1.27, 3.89)**	0.43(0.22, 1.06)
Leve-1 (individual level) variables			
Age (Years)			
< 20	1	-	1
20 – 29	0.95(0.27, 3.31)	-	1.53(0.42,5.62)
>= 30	0.86 (0.24, 3.02)	-	1.33(0.36,4.96)
Women educational level			
No formal education	1	1	1
Primary school	0.92(0.54, 1.57)	**1.71(1.04, 2.81)**	0.69(0.38, 1.27)
High school	1.14(0.57, 2.28)	1.49(0.77, 2.89)	0.68(0.3, 1.52)
Tertiary education	1.43(0.60, 3.37)	**4.12(1.49, 11.33)**	0.52(0.2, 1.37)
Partner educational level			
No formal education	1	1	1
Primary school	1.22(0.69, 2.15)	0.66(0.39, 1.1)	1.07(0.57, 1.98)
High school	0.87(0.48, 1.59)	0.76(0.44, 1.32)	1.49(0.75, 2.95)
Tertiary education	1.98(0.88, 4.45)	0.56(0.25, 1.25)	**3.67(1.40, 9.58)**
Partner occupational status			
Governmental employee	1	1	1
Others	1.23(0.64, 2.36)	0.61(0.31, 1.21)	1.48(0.69, 3.18)

Information on MHS			
No	**1**	1	1
Yes	**2.13 (1.21, 3.75)**	1.23(0.7, 2.17)	1.04(0.49, 2.18)
Age at first marriage (year)			
< 18	1	1	1
>=19	0.92(0.54, 1.56)	1.13(0.7, 1.82)	0.98(0.54, 1.73)
Age at first pregnancy (year)			
< 19	1	1	1
>= 19	1.13(0.67, 1.91)	1.24(0.77, 2.01)	0.98(0.55, 1.74)
History of pregnancy-related problems during labour for a previous birth			
No	**1**	**1**	1
Yes	**1.83 (1.15, 2.92)**	**0.57 (0.37, 0.86)**	1.63(0.98, 2.7)
History of stillbirth			
No	**1**	**1**	**1**
No	**1.67(1.02, 2.73)**	**0.43 (0.28, 0.66)**	**0.51(0.29, 0.87)**
Women decision-making power			
Didn't make a decision	1	1	**1**
Make decision	**1.74(1.14, 2.68)**	1.22 (0.81, 1.85)	**1.8(1.09, 2.97)**
ANC 4th visit completed			
No	-	1	**1**
Yes		**2.29(1.59, 3.32)**	**10.8(6.79, 17.2)**
Offered information on danger signs during ANC visit			
No	-	1	1
Yes		0.7 (0.44, 1.12)	0.71(0.38, 1.33)
Time of 1st ANC visit start			
Within 3 months of GA	-	**1**	**1**
4 – 6 months of GA	-	**0.66(0.45, 0.96)**	**0.39(0.24, 0.61)**
After 6 months of GA	-	**0.33(0.16, 0.68)**	**0.1(0.03, 0.24)**
Provision of information on health facility delivery			
No		1	1
Yes	-	0.9(0.49, 1.68)	1.05(0.51, 2.17)
IFA supplementation during pregnancy			
No	-	-	**1**
Yes			**1.96(1.11, 3.49)**
Provision of TT during pregnancy			
No			1
Yes	-	-	1.58(0.93, 2.69)
Skilled delivery care			
No			1

Yes	-	-	**1.63(1.11, 2.42)**
Pregnancy-related problems immediately after labour			
No			1
Yes	-	-	1.1(0.55, 2.21)

Discussion

Status of maternal health services utilization

Among 2,198 pregnant women, 66.1% of the women received the recommended ANC visits. Of them, 28.1% of the pregnant women initiated 1st ANC visit within the first trimester. Similarly, more than half (58.3%) of the births were attended by skilled providers, and 58.6% of the women received the recommended PNC visits.

The recommended ANC visits (4th or more ANC visits) play a pivotal role in maternal health services and warrant more programmatic attention (6, 7). Besides, two third (66.1%) of the pregnant women attended the recommended ANC visits, which is consistent with studies done in North Ethiopia (7, 16), Cambodia (12), and Bihar India (13). However, this finding is lower than studies in South Asia and Sub-Saharan Africa (7), Debre Berhan town (17), and Northern Bangladesh(8). But, it is higher than evidence in Pakistan (9), Ratanakiri Cambodia (10), Rural Khammouane Lao PDR (11), Sub–Saharan Africa 51% (14), EDHS 2014 (33%) (15), Arba Minch districts 25.2% (19), West Gojjam zone 39.9% (18), and Tigray 49.9% (20). This disparity could be explained by variability of health delivery system and infrastructure among the study areas to deliver maternal health services to the community. Moreover, in the study areas, there are misperceptions and cultural barriers that hinder the utilization of maternal health services. Similarly, this study found that 28.1% of pregnant women initiated their first ANC contact within the recommended schedule. This finding is lower than evidences from Rural Khammouane (11), South Asia (7), Ghana (39), EDHS (2014) (15), Arba Minch (19), and Debre Berhan town (17). But it was higher than studies done in Sub-Sahara Africa (7) and the West Gojjam zone (18). This discrepancy may be in the study area, there is low awareness and lack of knowledge on early initiation of maternal health services and also the region is a remote area and hard to reach area in Ethiopia, which lacks availability and accessibility of health facilities and lacks skilled health providers. Not only delay of ANC initiation but also one-fourth of pregnant women were dropout from ANC follow-up due to lack of knowledge on the benefit of services, perceive as the absence of problems, fear of privacy, and influence of other people.

The current study found that 58.3% of births were attended by skilled provider which is consistent with a study in Pakistan (9). But this finding is lower than the study in Cambodia (12); Tanzania (28), and Bihar, India (13). Whereas, it is higher than evidence in Ratanakiri, Cambodia (10), Rural Khammouane (11), West Gojjam (18), and Arba Minch South Ethiopia (19). This discrepancy might be due to variations in socio-demographic and economic status, culture, belief, time of the study, and design. The main reasons for health facility delivery were being informed on the benefits of delivering at the health facility and previous bad experiences from home delivery. This evidence is supported by a study done in west Gojjam (18). In contrast to the reasons mentioned for facility delivery, the main reasons for home delivery were labour was going well, being felt more comfortable at home delivery, getting close attention/support from relatives/families, and being as a usual practice, which is also consistent with a study done in West Gojjam(18).

Postnatal care is the key strategy in reducing maternal and neonatal mortality and morbidity (10). Hence, more than half (58.6%) of the women received the recommended PNC visits, which is lower than the study done in Pakistan (9), Sub – Saharan Africa (14), and Ghana (31). However, it is higher than the study done in West Gojjam Zone (18), Ratanakiri, Cambodia (10), Arba Minch (19), and Rural Khammouane (11). In line with these, the effectiveness of PNC services was not only determined by coverage of the utilization of the services but also by the key services and quality of postnatal services. As a result, key PNC services provided for women and newborns were immunizing the babies (81.9%), counseling on proper nutrition (73.4%), breastfeeding education (69.5%), physical examination for women (60.4%) and family planning services (52.0%). This finding is similar to the studies conducted in Arba Minch (19), West Gojjam Zone(18), and Ghana (31).

Community and individual- level determinants of maternal health services

Community-level factors on maternal health services

In this study, we found that resident of women was statistically significant association with the recommended ANC visit (4th ANC visit) but not statistically significant association with the skilled delivery services and PNC visits. Similarly, household wealth index was statistically significant association with the skilled delivery services but not statistical significant association with the recommended ANC visits and PNC visit. However, quality of maternal health services,

accessibility and availability of health facility are not statistical significant association with utilization of maternal health services.

The odds of completing recommended ANC visits (4th visits or more) among women residing in rural areas were four times higher than among women residing in urban areas. In contrast, evidence in South Asia and Sub-Saharan Africa found that rural women had lower odds of receiving all the elements of maternal health services compared to urban women (7). This discrepancy is due to, in the study region, private health institutes were concentrated in urban area which provides maternal health services. As a result, once women confirmed their pregnancy and initiated ANC follow-up at public health facilities, then after, they switch to the private health institute. This argument is supported by women who obtained ANC in the private sector had nearly two times greater odds of receiving maternal health services compared with those who received care in the public sector (40). Moreover, this study didn't include private health sectors to measure the coverage of maternal health services utilization. Other reasons, in the rural areas, there are strong defaulter tracing mechanisms by HEW; they have a list of all pregnant women with their names in their catchment areas, and then follow the pregnant women up to the postnatal period during home visits.

The socio-economic status especially the household wealth index is strongly linked to a place of delivery. As the household wealth index increases, the uptake of institutional delivery service is also increases. This evidence is supported by different studies in Sub-Saharan Africa(29), Nigeria (21), Ethiopia (4), and EDHS 2016 (24). This is because the wealthier families can afford the direct and indirect costs associated with birth in the health facilities.

Individual-level factors on maternal health services

We found that information on maternal health services, history of pregnancy-related problems, history of stillbirth, and women decision-making power were statistically significant association with the recommended ANC visit (4th visit). Similarly, completing the recommended ANC visits, women's educational status, time of 1st ANC visit initiate, history of pregnancy-related problems, and history of stillbirths were statistically significant associations with skilled delivery services. Moreover, partner educational status, women's decision-making power, completing ANC 4th visits, time of 1st ANC visit initiated, iron and folic acid (IFA) supplementation during

pregnancy, skilled delivery services, and history of stillbirth were statistically significant association with the recommended PNC visits.

Health-seeking behavior may be influenced by health information offered to pregnant women on the issues of maternal health services. Besides, the odds of women receiving the recommended ANC visits among women who did have information on maternal health services were two times higher than women who didn't have information on maternal health services. This finding is similar to the study conducted in Ethiopia(4)and the Rural areas of Ethiopia(25).

The odds of completion of the whole ANC visits among women with a history of pregnancy-related problems during labour and a history of stillbirth were two times higher than women who belonged within their counterparts. This evidence is supported by a study done in Kombolcha (26). This is because prior bad experiences gave a big lesson for women on maternal health services which encouraged and motivated the women to consult the health professional during their subsequent pregnancies and also women will start ANC services early and receive the recommended ANC visits.

Women and partner decision-making powers have a significant role in the utilization of maternal health services. In line with these, the odds of using the recommended ANC visits among women who had decision-making power within the households were almost two times higher than women who had no decision-making power. This finding is consistent with the study done in Nigeria (21). This might be because, if the household resources are controlled by others and women have no power to decide on their resources, women will not have the freedom to access maternal health services whenever they need care. Autonomy may also be related to other variables such as women's education level, information on maternal health services, and urban residence, all of these parameters increase the likelihood of using maternal health services, particularly ANC services, which is an entry point of maternal health services.

Similarly, educational status of women has a significant effect on the utilization of institutional delivery services. This finding has been consistently supported by many other studies conducted in different parts of the World including Ethiopia (4, 21, 24, 26, 41). This positive correlation can be explained by the fact that educated women are more aware of the importance of medical

services to themselves and their newborns and also they have a more modern cultural perspective on utilization of maternal health services.

Provision of the recommended ANC visits during pregnancy and early initiation of ANC within the WHO recommended time significantly affected the use of institutional delivery services. These findings are supported by studies conducted in Ethiopia (41) and Nigeria (21). This may be because the women will be aware of the importance of institutional and skilled delivery services as they may be educate and counsel during the ANC session. Even though, women have got adequate information on maternal health services; the probability of utilizing maternal health services will be increased (32, 41, 42). Other evidence supported that use of ANC is one of the strongest determinants for the use of skilled delivery and institutional delivery services (21).

Uptake of postnatal care service is directly related to partner education, which showed a positive influence on utilization of PNC services. This finding is consistent with other studies conducted in Ethiopia and abroad the nation (4, 21, 32). This is because educated husbands may have a better understanding of the benefit of PNC services and good communication with their wives and willingness to discuss the use of maternal health services. Moreover, women receiving the recommended ANC visits, timely initiation of ANC services and skilled delivery services are more likely to receive the recommended PNC visits. This evidence is strongly supported by systematic review and meta-analysis pooled results (43) and also other studies done in Nigeria (21) and Ethiopia (3, 4). Whereas, the odds of use of PNC services among women with a history of stillbirth are 49% times lower than women free of stillbirth history. This finding is consistent with the evidence in Lubumbashi City in the Democratic Republic of Congo (3). This is due to when women encountered with stillbirth, the chance of women going to the health facility for checkup purpose is poor and null. Another reason may be women have no confidence and motivation to treat and checkups themselves after the event of stillbirth.

Generalizability (External validity)

Since this study used a representative large number of sample size (2,198 study participants) randomly selected 51 kebeles, it can be generalized to Benishangul Gumuz Region having similar characteristics in population, socio-culture, access to and availability of health care and health services seeking behaviors.

Strength and limitations of the study

The strengths of this study were using a prospective follow-up study that helped to measure the cause and effect relationship, a large sample size that resulted in high power and precision for the multilevel analyses, and using advanced statistical models (multilevel logistic regression model) to handle clustering effects and identify factors at different levels for intervention purposes.

However, the limitation of this study was health facility data were collected by health workers who were liable to social desirability bias which might compromise the findings. In the region, fifteen medium clinics were providing maternal health services but the rest of the private health facilities did not provide maternal health services for the community. However, this study did not include private health facilities which might compromise the findings. Finally, some of the study participants (8.5%) were lost to follow-up which might have some deviation in the result.

Conclusion and Recommendation

The proportion of women, who attended antenatal care, received skilled delivery care, and postnatal care were low as compared with the national target. In this study, we found different individual-level factors that influenced the utilization of these services. Those factors were women and partner education, information on maternal health services, history of pregnancy-related problems for previous birth, history of stillbirth, ANC visit 4th, early initiation of 1st ANC visit, iron-folic acid supplementation during pregnancy, skilled delivery care and women decision making power. Among community-level factors, only place of residence and household wealth index had significantly influenced the utilization of maternal health services.

Therefore, this study strongly recommended that reinforcing women's autonomy, particularly household decision–making power, efforts are also needed to reinforce and improve the information given to pregnant women, as well as strengthen the communication system between the healthcare providers and the community, and participating within the community dialogues. This will contribute to raising awareness of women on safe motherhood initiatives, particularly ANC, institutional delivery, and PNC services in the study area.

Acknowledgments

We would like to thank Addis Ababa University, College of Health for providing ethical approval and supporting of this study. The authors would also want to express their gratitude to all of the pregnant women, data collectors, supervisors, and other individuals who contributed

directly or indirectly to the study success. Last but not least, we wish to express our gratitude to Miss Abebech Tefera, Miss Chaltu Argeta, Dr. Nigatu Disassa, and Assistant professor Atnafu Morka for their unwavering support.

List of abbreviations

ANC: Antenatal Care
AOR: Adjusted Odds Ratio
BF: Breast Feeding
BGRS: Benishangul Gumuz Regional State
CI: Confidence Interval
EDHS: Ethiopia Demographic and Health Survey
GA: Gestational Age
HF: Health Facility
ICC: Intra-class Correlation
IFA: Iron Folic Acid
IGA: Income Generating Activities
IRB: Institutional Review Board
LR: Log-Likelihood
MCH: Maternal and Child Health
MHS: Maternal Health Service
MPDSR: Maternal and Perinatal Death Surveillance Response
NGO: Non-Governmental Organization
PCA: Principal Component Analysis
PNC: Postnatal Care
SMI: Safe Motherhood Initiative
SPH: School of Public Health
SRMA: Systematic Review and Meta-analysis
TT: Tetanus Toxoid
VIF: Variance Inflation Factors

Authors' contributions

MA conceived and designed the study. Then after, data was collected, analyzed, interpreted, and wrote the whole document. *AW and GT* were critically commenting on the whole document and genuinely guide the whole work. All authors read and approved the final manuscripts.

Funding

This study was funded by Addis Ababa University.

Competing interests

The authors declare that they have no competing interests.

Patient consent for publication

Not required

Ethics approval and consent to participate

Ethical approval was obtained from the Research Review and Ethics Committee (REC) of the School of Public Health, Addis Ababa University with protocol number SPH/3089/011, and the Institutional Review Board (IRB) of the College of Health Sciences of Addis Ababa University with the protocol number 048/19/SPH. Necessary permission letters were obtained from Regional Health Bureau and respective all local districts. Confidentiality was maintained by

avoiding any identities from the questionnaire. Before starting actual data collection, written and verbal consent was obtained from each study subject.

Data availability statement

All data relevant to the study are included in the article.

References

1. Central Statistical Agency (CSA), Ethiopia, ICF. Ethiopia Demographic and Health Survey. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.: The DHS Program ICF Rockville, Maryland, USA; 2016.
2. Central Statistical Agency (CSA), Ethiopia, editors. Ethiopia Demographic and Health Survey2011; Addis Ababa: The DHS Program ICF Rockville, Maryland, USA.
3. Abel Ntambue ML, Françoise Malonga K, Dramaix-Wilmet M, Donnen P. Determinants of maternal health services utilization in urban settings of the Democratic Republic of Congo, a case study of Lubumbashi City. BMC Pregnancy Childbirth. 2012;12(66).
4. Tarekegn SM, Lieberman LS, Giedraitis V. Determinants of maternal health service utilization in Ethiopia: Analysis of the 2011 Ethiopia Demographic and Health Survey. 2014;14(161).
5. Balla YY, Data T, Lindtjorn B. Maternal and neonatal mortality in rural south Ethiopia:Outcomes of Community-Based Birth Registration by Health Extension Workers. 2015;10(3).
6. Singh K, Story WT, Moran AC. Assessing the Continuum of Care Pathway for Maternal Health in South Asia and Sub-Saharan Africa. Maternal and child health journal. 2016;20(2):281-9.
7. Singh K, Story WT, Moran AC. Assessing the Continuum of Care Pathway for Maternal Health in South Asia and Sub-Saharan Africa. Matern Child Health J. 2016;20(2):281-9.
8. Sarker BK, Rahman M, Rahman T, Rahman T, Khalil JJ, Hasan M, et al. Status of the WHO recommended timing and frequency of antenatal care visits in Northern Bangladesh. PLOS ONE. 2020;15(11):e0241185.
9. Iqbal S, Maqsood S, Zakar R, Zakar MZ, Fischer F. Continuum of care in maternal, newborn and child health in Pakistan: analysis of trends and determinants from 2006 to 2012. BMC Health Serv Res. 2017;17(1):189.
10. Kikuchi K, Yasuoka J, Nanishi K, Ahmed A, Nohara Y, Nishikitani M, et al. Postnatal care could be the key to improving the continuum of care in maternal and child health in Ratanakiri, Cambodia2018. e0198829 p.
11. Sakuma S, Yasuoka J, Phongluxa K, Jimba M. Determinants of continuum of care for maternal, newborn, and child health services in rural Khammouane, Lao PDR. 2019;14(4):e0215635.
12. Wang W, Hong R. Levels and determinants of continuum of care for maternal and newborn health in Cambodia-evidence from a population-based survey. BMC Pregnancy Childbirth. 2015;15:62.
13. Balakrishnan R, Gopichandran V, Chaturvedi S, Chatterjee R, Mahapatra T, Chaudhuri I. Continuum of Care Services for Maternal and Child Health using mobile technology - a health system strengthening strategy in low and middle income countries. BMC Med Inform Decis Mak. 2016;16:84.
14. Carvajal-Aguirre L, Amouzou A, Mehra V, Ziqi M, Zaka N, Newby H. Gap between contact and content in maternal and newborn care: An analysis of data from 20 countries in sub-Saharan Africa. J Glob Health. 2017;7(2):020501.
15. Muchie KF. Quality of antenatal care services and completion of four or more antenatal care visits in Ethiopia: a finding based on a demographic and health survey. BMC Pregnancy and Childbirth. 2017;17(1).

16. Ftwi M, Gebretsadik GG-e, Berhe H, Haftu M, Gebremariam G, Tesfau YB. Coverage of completion of four ANC visits based on recommended time schedule in Northern Ethiopia: A community-based cross-sectional study design. PLOS ONE. 2020;15(8):e0236965.
17. Tizazu MA, Sharew NT, Mamo TR, Zeru AB, Asefa EY, Amare NS. Completing the Continuum of Maternity Care and Associated Factors in Debre Berhan Town, Amhara, Ethiopia, 2020. 2021;14:21-32.
18. Emiru AA, Alene GD, Debelew GT. Women's retention on the continuum of maternal care pathway in west Gojjam zone, Ethiopia: multilevel analysis. BMC Pregnancy Childbirth. 2020;20(1):258.
19. Haile D, Kondale M, Andarge E. Level of completion along continuum of care for maternal and newborn health services and factors associated with it among women in Arba Minch Zuria woreda, Gamo zone, Southern Ethiopia: A community based cross-sectional study. 2020;15(6):e0221670.
20. Haftu A, Hagos H, Mehari MA, B GH. Pregnant women adherence level to antenatal care visit and its effect on perinatal outcome among mothers in Tigray Public Health institutions, 2017: cohort study. BMC Res Notes. 2018;11(1):872.
21. Tukur Dahiru OMO. Determinants of antenatal care, institutional delivery and postnatal care services utilization in Nigeria. PanAfrican Medical Journal. 2015.
22. Srivastava A, Mahmood S, Mishra P, Shrotriya V. Correlates of Maternal Health Care Utilization in Rohilkhand Region. June 2014;4(3).
23. G Anil Kumar RD, Priyanka Chaman, Priyanka Singh and Lalit Dandona. A population-based study of neonatal mortality and maternal care utilization in the Indian state of Bihar. 2014;14(357).
24. Agency CS, editor Ethiopia Demographic and Health SurveyOctober, 2016; Addis Ababa: The DHS Program ICF Rockville, Maryland, USA.
25. Araya Medhanyie MS, Yohannes Kifle, Nikki Schaay, David Sanders, Roman Blanco,Dinant GeertJan and Yemane Berhane. The role of health extension workers in improving utilization of maternal health services in rural areas in Ethiopia: a cross sectional study. 2012;12(352).
26. Desalew Zelalem Ayele BB, Kedir Teji and Desalegn Admassu Ayana. Factors Affecting Utilization of Maternal Health Care Services in Kombolcha District, Eastern Hararghe Zone, Oromia Regional State, Eastern Ethiopia. October 2014;2014 (Article ID 917058, 7 pages).
27. Tsegay Y, Gebrehiwot T, Goicolea I, Edin K, Lemma H, Sebastian MS. Determinants of antenatal and delivery care utilization in Tigray region, Ethiopia: a cross-sectional study. International Journal for Equity in Health. 2013;12(1):30.
28. Mohan D, LeFevre AE, George A, Mpembeni R, Bazant E, Rusibamayila N, et al. Analysis of dropout across the continuum of maternal health care in Tanzania: findings from a cross-sectional household survey. Health Policy Plan. 2017;32(6):791-9.
29. De Graft-Johnson J, Kerber K, Tinker A. The maternal, newborn and child health continuum of care: Opportunities for Africa's newborns. Partnership for Maternal, Newborn and Child Health. 2011;2006:23–36.
30. Taylor E. Hurst KS, Manasa Patna, Atul Gawande and Lisa R. Hirschhorn. Demand-side interventions for maternal care: evidence of more use, not better outcomes. 2015;15(297).
31. Shibanuma A, Yeji F, Okawa S, Mahama E, Kikuchi K, Narh C, et al. The coverage of continuum of care in maternal, newborn and child health: a cross-sectional study of woman-child pairs in Ghana. BMJ Glob Health. 2018;3(4):e000786.
32. Britta C. Mullany SBaMJH. The impact of including husbands in antenatal healtheducation services on maternal health practices inurban Nepal: results from a randomized controlled trial. July, 2006;22(2, 2007).
33. Federal Democratic Republic of Ethiopia Central Statistical Agency. Population Projection of Ethiopia for All Regions At Wereda Level from 2014 – 2017. 2013.
34. Wang W, Hong R. Completing the continuum of care for maternal and newborn health in Cambodia: Who drops out? Calverton, Maryland, USA: ICF International, 2013.

35. Zelka MA, Yalew AW, Debelew GT. Effects of continuum of care in maternal health services on adverse birth outcome in Northwest Ethiopia: a prospective follow up study. Research Square; 2021.
36. Ethiopian Minisry of Health (MoH). National Technical Guidance For Mataernal and Perinatal Death Surveillance and Response (MPDSR). In: INSTITUE EPH, editor. 2017.
37. Agha S, Williams E. Maternal and Child Health Program Indicator Survey 2013, Sindh Province. MNCH Services Component, USAID/Pakistan MCH Program. Karachi, Pakistan: Jhpiego. 2013.
38. Debelew GT, Afework MF, Yalew AW. Determinants and causes of neonatal mortality in Jimma Zone, Southwest Ethiopia: a multilevel analysis of prospective follow up study. PLoS One. 2014;9(9):e107184.
39. Afulani PA. Determinants of stillbirths in Ghana: does quality of antenatal care matter? BMC Pregnancy Childbirth. 2016;16(1):132.
40. Dennis ML, Benova L, Abuya T, Quartagno M, Bellows B, Campbell OMR. Initiation and continuity of maternal healthcare: examining the role of vouchers and user-fee removal on maternal health service use in Kenya. Health Policy Plan. 2019;34(2):120-31.
41. Determinants of antenatal and delivery care utilization in Tigrary Region. 2013;12(30).
42. Muluwas Amentie MAaMa. Utilization of Institutional Delivery Care Services and Influencing Factorsamong Women of Child Bearing Age in Assosa District, Benishangul Gumuz Regional State, West Ethiopia. 2016;16(3).
43. Geremew AB, Boke MM, Yismaw AE. The Effect of Antenatal Care Service Utilization on Postnatal Care Service Utilization: A Systematic Review and Meta-analysis Study. Journal of pregnancy. 2020;2020:7363242.

Figure legends/caption

Figure- 2: Flow-diagram of the overall study process in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

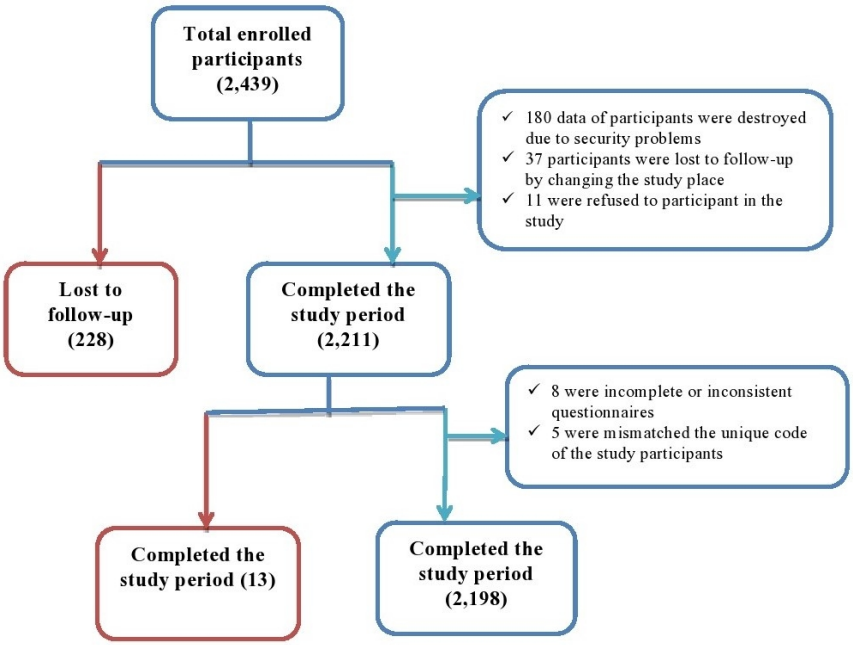

Figure- 1: Flow-diagram of the overall study process in Benishangul Gumuz Region, Northwestern Ethiopia, March 2020 – January 2021

307x250mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Indicated page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	*It is clearly indicated in the title and abstract. See on Title section, page 1 and abstract section, at page-2*
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	*It is properly described according to the guideline of journal and also the strengths and limitations of the study incorporate in the document. See page number 2 and 3*
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	*It is concisely formulated and stated in the introduction section. See page number 3 – 4.* *The rationality of the study is clearly described at the last paragraph under the section of introduction. Page - 4*
Objectives	3	State specific objectives, including any pre-specified hypotheses	*It is clearly formulated and indicated at the end of introduction section. See page number 4*
Methods			
Study design	4	Present key elements of study design early in the paper	*It is stated at page number 5*
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	*It is stated in the first section of methods part. See at page number 4 – 5*
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	*It is elaborated in detail. see at page number 5 – 6*
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	*NA*
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	*See at page number 7*
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*See at page number 7*
Bias	9	Describe any efforts to address potential sources of bias	*- It is stated clearly under subsection of data collection and quality control see page 7* *- It is also explained under subsection of data management and statistical modelling see at page 8*
Study size	10	Explain how the study size was arrived at	*See page number 5 – 6*

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	*See page number 7 – 8*
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	*See page number 8*
		(*b*) Describe any methods used to examine subgroups and interactions	*See page number 8*
		(*c*) Explain how missing data were addressed	*It was excluded from the final analysis*
		(*d*) If applicable, explain how loss to follow-up was addressed	*It was excluded from the final analysis*
		(*e*) Describe any sensitivity analyses	*NA*
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	*It was stated at page number 9*
		(b) Give reasons for non-participation at each stage	*It was stated at page number 9 and see figure – 1*
		(c) Consider use of a flow diagram	See page number – 9 and figure – 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	*It was stated at page number 9*
		(b) Indicate number of participants with missing data for each variable of interest	*It was clearly formulated under table 2 – 4*
		(c) Summarise follow-up time (eg, average and total amount)	*NA*
Outcome data	15*	Report numbers of outcome events or summary measures over time	*See page number 10, 11 and 12*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	*It was stated at page number 15 – 18*
		(*b*) Report category boundaries when continuous variables were categorized	See page number 17
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			

Key results	18	Summarise key results with reference to study objectives	See page number 19 – 23
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	See page number 23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	See page number 19 – 23
Generalisability	21	Discuss the generalisability (external validity) of the study results	See page number 23
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	See page number 25

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.