Utilization of Antenatal Care among Women in Rwamagana District, Rwanda: A Cross-sectional Study Conducted at Health Centers in 2023

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ABSTRACT

INTRODUCTION: Optimal utilization of antenatal care (ANC) has been challenging in Rwamagana District. One of the causes is the limited availability of multifaceted information regarding ANC. Therefore, this study aimed to determine the rate of antenatal care utilization in Rwamagana District and the possible influencing factors.
METHODS: A descriptive, cross-sectional study and through a convenient sampling method, three hundred fifty-three (353) women were selected to participate. A structured questionnaire with multiple-choice questions was used for data collection.
RESULTS: The majority (79.6% of women) began having ANC early in pregnancy, while 20.1% started having ANC in the second or third trimester. After initiation, 94.4% of the women attended ANC for the remaining trimester(s). Dropout was 3.0%, while the women who skipped the second trimester were 1.7%. Subsequently, 0.4% of the women had no ANC at all from conception up to delivery. Overall, 24.1% had <4 ANC contacts, 66.2% of women received 4 – 7 ANC contacts, and only 9.7% of women had ≥ 8 ANC contacts. The household size (P=0.035), socioeconomic status (P=0.016), place of delivery (P=0.033), and source of ANC information (P=0.013) had a significant association with ANC utilization.
CONCLUSION: Utilization of ANC has relatively been improved; it was found to be significantly influenced by household size, socioeconomic status, place of delivery, and sources of ANC information.

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INTRODUCTION

To ensure safety during pregnancy, coordination of efforts by every pregnant woman, her family, the community, and healthcare providers is a key to success. The main platform that provides pregnant women with regular contacts with healthcare providers is the antenatal care (ANC) program [1]. This is a healthcare practice in which pregnant women are followed up until delivery, enhancing fetal and maternal well-being. This is achieved by providing curative, preventive, and promotive health interventions to pregnant women during ANC visits. Curative health interventions involve

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the management of possible pre-existing or newly diagnosed pathologies and abnormal body changes associated with pregnancy. Those interventions, for example, include the management of high blood pressure (BP), gestational diabetes (GD), HIV/AIDS, urinary tract infections (UTIs), and sexually transmitted infections (STIs). Preventive health care aims to protect the health of both the fetus and the mother, and involves screening fetal and maternal abnormalities, immunization against tetanus, deworming, supplementation of iron and folic acid, and provision of mosquito nets. Lastly, health promotion during pregnancy is achieved by providing health education and counseling or advice about healthy nutritional and lifestyle practices, family planning, and formulation of delivery plans [1,2,3]. The optimum attendance of ANC is paramount in pregnancy to ensure that the pregnant woman and fetus are in good health.

On the other hand, having poor ANC utilization is associated with the risk of missing or late recognition of danger signs of urgent obstetrical conditions, which can occur at any stage of pregnancy and ultimately result in adverse pregnancy outcomes [4,5,6]. For possible pre-existing maternal conditions, poor ANC utilization would contribute to inappropriate management coupled with an increased risk of adverse pregnancy outcomes, though these abnormalities could be preventable and treatable [7].

Since the first decade of the 21st century, maternal health issues have been prioritized, essentially in Millennium Development Goal 5 (MDG 5) and sustainable development goals (SDGs) frameworks [8]. However, the desired ANC utilization remains low. Worldwide, it was reported that among five women, only three fully attended ANC as recommended by the WHO [9]. In Sub-Sahara Africa (SSA), only 53% of pregnant women had 4 ANC visits or more in 2021 [9]. Such inadequacy of ANC utilization is unfavorable as it can be associated with potential health threats as well as undesirable pregnancy outcomes, and in most cases, 99% of them occur in developing and middle-income countries, with more than half of that mortality and morbidity burden being recorded in the SSA region [5,9,10,11].

Previous studies showed that accessibility to ANC visits is influenced by factors such as distance to health facilities, cost and availability of transport, and time to reach the facility. Women's attitudes and experiences, such as negative experiences, limited understanding of ANC procedures, and concerns about pregnancy disclosure, were found to contribute to low attendance [12,13]. Interpersonal factors like family support, advice from others, and attitudes of health workers also contribute to attendance [12], in addition to health system factors like the cost of ANC services, availability of health workers, and mandatory testing procedures performed [12,14].

According to the 2019–2020 Rwanda Demographic and Health Survey (RDHS), 98% of women received ANC at least once from skilled providers, but only 47% of the pregnant women had at least 4 ANC contacts [15], indicating that adherence the recommended ANC visits is still low in Rwanda. Additionally, the rates of ANC visits are different depending on the district. In the Rwamagana District, only 35.8% of pregnant women achieved at least 4 ANC visits from 2013 to 2018 [16], below the average national rate. This highlights the need to explore this health problem further and address the low ANC attendance in the Rwamagana District. A recent previous study showed that the prevalence of delayed ANC in Rwanda was 41%, and it was influenced by the number of children the women have, coverage by health insurance, women´s education level, and woman´s occupation [17]. To our knowledge, no previous study has been conducted in the Rwamagana District to explore poor adherence to ANC. Therefore, this study aimed to determine the rate of ANC utilization in Rwamagana District and identify influencing factors. The findings would guide healthcare providers, partners, beneficiaries, and decision-makers in addressing issues hindering optimal ANC utilization. They would also inform interventions to improve the ANC experience, motivating women to attend as recommended, and promoting healthy pregnancies and positive motherhood.

METHODS

Study Design: This study employed a descriptive, health center-based cross-sectional research design, and was conducted in September 2023 in Rwamagana District, Eastern Province, Rwanda. Eligible women were selected by the convenient sampling method from four Health Centers (HCs) located in Rwamagana District,

namely; Rwamagana, Karenge, Nyagasambu, and Muyumbu HCs. Rwamagana District, one of Rwanda's 30 districts, is located in the Eastern Province with a surface area of approximately 682 km² [16,18,19]. The health centers were randomly selected from the total number of 16 HCs in the district.

Eligibility Criteria: This study included women aged 15 to 49 who exclusively attended ANC in Rwamagana District during pregnancy. Each woman was either pregnant or had delivered within the last 15 months and voluntarily agreed and consented to participate in the study. On the other hand, women who either had ANC from outside of the district or refused to consent to participation in the study were excluded.

Sampling: By using the Kish Leslie's formula 1965, the sample size was calculated as follows [7]:

$n = (p(1-p)\ z^2)/d^2$

Where; n = desired sample, p = proportion of pregnant women already known not to attend ANC as recommended, given as: p = 100% - 35.8%, p = 64.2%, which is equivalent to 0.642, z = standard normal deviation usually set as 1.96 corresponding to 95%, and d = the degree of error set at a range of 0.05 – 0.1. $n = (0.642x(1-0.642)x1.96^2)/0.05^2 = 353$

To account for potential non-response, a margin of 10% (35 women) was anticipated, resulting in an overall target sample size of 388 women.

Study Tool: A structured questionnaire with multiple-choice questions, designed by referencing [3,6,20,21], was administered to each individual respondent. The questionnaire comprised four sections: socio-demographic characteristics, pregnancy-related factors, factors related to healthcare providers, and ANC service cost and satisfaction. Initially designed in English, the questionnaire was later translated into Kinyarwanda, the local language. To pretest the tool, 15 pregnant women and 15 mothers with babies aged ≤15 months at Rwamagana Health Center were randomly selected and asked to complete the questionnaire. The results of this pretest helped identify any ambiguities or confusion in certain questions. Misunderstood questions were rephrased to ensure clarity for all study participants, and the order of questions was also restructured for better flow.

Data Analysis: After data collection, every questionnaire was verified for clarity of responses. Thereafter, data were coded and entered into Microsoft Excel 2019, then imported into IBM™ SPSS V.21 (IBM Corporation, Chicago, U.S.) for statistical analysis. Descriptive statistics were used to summarize study variables such as frequencies, percentages, mode, and mean. Also, the data collected were analyzed using statistical methods to determine the odds ratios (OR) and 95% confidence intervals (CI) for various factors influencing ANC utilization. Logistic regression analysis was employed to calculate the odds ratios, which indicate the likelihood of ANC utilization associated with specific factors. Confidence intervals were calculated to provide a range within which the true odds ratio is expected to fall, with 95% certainty. Statistical significance was assessed using p-values, with a threshold of $p < 0.05$, indicating that the observed associations were unlikely to have occurred by chance.

Ethical considerations: The study received ethical clearance from the Institutional Review Board at the University of Rwanda, College of Medicine and Health Sciences (CMCH/IRB/429/2023), and permission to collect data from selected HCs from Rwamagana Level II Teaching Hospital (14/346/Hop/Rgna/2023). Participants were informed of the study's content, voluntary participation, and confidentiality. They were assured of their physical and social safety. Participants were allowed to read the details of the informed consent form, and illiterate participants were allowed to choose someone to read for them out loud before providing and signing informed consent.

RESULTS

Socio-demographic and reproductive health-related characteristics: Table 1 below presents the sociodemographic and reproductive health-related characteristics of all study participants. The majority of participants were between 20 and 29 years old (175 women, 49.6%), had only attended primary school (212 women, 60.1%), and had households with no more than 3 members (154 women, 43.6%).

Table 1: *Socio-demographic Characteristics*

Characteristics	N	%
Age		
15-19	30	8.5
20-29	175	49.6
30-49	148	41.9
Religion		
None	3	0.8
Muslim	11	3.1
Catholic	104	29.5
ADEPR	133	37.7
Methodist	15	4.2
Adventist	39	11.0
Other	48	13.6
Woman's level of education		
None	9	2.5
Primary	212	60.1
Secondary	115	32.6
Tertiary	17	4.8
Husband's level of education		
None	20	5.7
Primary	188	53.3
Secondary	112	31.7
Tertiary	33	9.3
Household size		
1-3 members	154	43.6
4-5 members	131	37.1
>5 members	68	19.3
Woman's occupation		
None	83	23.5
Housemaid	4	1.1
Peasant/ farmer	125	35.4
Businesswoman	39	11.0
Civil servant	88	24.9
Employee	14	4.0
Husband's occupation		
None	29	8.2
Houseman	0	0.0
Peasant/ farmer	97	27.5
Businessman	47	13.3
Civil servant	121	34.3
Employee	59	16.7
Socioeconomic status (Ubudehe Category)		
None	27	7.6
Category 1	23	6.5
Category 2	179	50.7
Category 3	124	35.1
Category 4	0	0.0
Financial support		
Yes	224	63.5
No	129	36.5
Health insurance		
Yes	328	92.9
No	25	7.1
Marital status		
Single	24	6.8
Married	134	38.0
Cohabitating	179	50.7
Separated	14	4.0
Widowed	2	0.6
Household conflict/ violence		
Yes	49	13.9
No	304	86.1
Autonomy		
Yes	318	90.1
No	35	9.9
Residential area		
Rural	321	90.9
Urban	32	9.1
Main mode of HF access for ANC visit		
Walking	287	81.3
Vehicle	66	18.7
Walking time (in hours) to HF (if the main mode of HF access is by walking)		
≤ 0.5	79	27.5
> 0.5 – 1	118	41.1
> 1	90	31.4
Affordable transportation cost (if the main mode of HF access is by a vehicle)		
Yes	32	47.1
No	36	52.9
Reproductive health-related characteristics		
knowledge of pregnancy manifestations		
Yes	287	81.3
No	66	18.7
Pregnant or delivered		
Delivered	237	67.1
Pregnant	116	32.9
Gravidity		
Primigravida	97	27.5

To be continued on the next page...

Multigravida	216	61.2
Grand-multigravida	40	11.3
Parity		
Nulli- and primipara	145	41.1
Multipara	182	51.6
Grand-multipara	26	7.4
Number of living children		
≤ 3 children	306	86.7
4 children and more	47	13.3
Family planning		
Yes	207	58.6
No	146	41.4
Pregnancy planning		
Yes	250	70.8
No	103	29.2
ANC Knowledge		
Yes	324	91.8
No	29	8.2

ADEPR: Associations des Eglises de Pentecote au Rwanda; HF: Health facility

Additionally, most participants belonged to the second category of socioeconomic status (Ubudehe Category 2), (n=179, 50.7%), received financial support from their partners (n=224, 63.5%), had health insurance (n=328, 92.9%), lived in rural areas (n=321, 90.9%), and accessed health facilities by walking (n=287, 81.3%).

Regarding reproductive health-related characteristics, most participants had some knowledge of pregnancy manifestations (n=287, 81.3%), had given birth (n=237, 67.1%), had had multiple pregnancies (n=216, 61.2%), had given birth to multiple live babies (n=182, 51.6%), had planned their last pregnancy (n=250, 70.8%), and had some information about ANC (n=324, 91.8%).

Trimester of Pregnancy (Gestational Age) for Initiation of Antenatal Care Contacts: Table 2 below shows the trimester of pregnancy at which ANC was first accessed. Women who began ANC visits during the first trimester were considered to have early initiation of ANC contact. It was found that 79.6% (n=281) had early initiation. This rate was highest among women from Rwamagana Health Center (n=84, 82.3%) and lowest among women from Nyagasambu Health Center (n=52, 74.3%).

Conversely, late ANC initiation was defined as having the first contact beyond the first trimester, and one-fifth of the women (n=71, 20.1%) started attending ANC during the second or third trimester. A higher proportion of late initiators were from Nyagasambu Health Center (n=18, 25.7%), while the lowest proportion was from Rwamagana Health Center (n=18, 17.7%). Only one woman (0.3%) did not attend ANC at any point during her pregnancy.

Sequence of Antenatal Care Contacts after Initiation: We also determined the progression of ANC contact from initiation to delivery, involving only women who had completed their gestation

Table 2: *Trimester of pregnancy for initiation of ANC visits*

Trimester for initiation of ANC	Rwamagana HC (n=102) f (%)	Karenge HC (n=85) f (%)	Nyagasambu HC (n=70) f (%)	Muyumbu HC (n=96) f (%)	Total (n=353) f (%)
No initiation (No visit among all trimesters)	0 (0.0)	1 (1.2)	0 (0.0)	0 (0.0)	1 (0.3)
Early initiation (1st trimester)	84 (82.3)	67 (78.8)	52 (74.3)	78 (81.2)	281 (79.6)
Late initiation (2nd or 3rd trimester)	18 (17.7)	17 (20.0)	18 (25.7)	18 (18.8)	71 (20.1)
Total	102 (100)	85 (100)	70 (100)	96 (100)	353 (100)

n: number of respondents; HC: health center

Table 3: *Sequence of ANC visits throughout pregnancy period*

Sequence of ANC	Rwamagana HC (n=76)	Karenge HC (n=61)	Nyagasambu HC (n=29)	Muyumbu HC (n=71)	Total (n=237)
	f (%)	f (%)	f (%)	f (%)	f (%)
No ANC contact throughout pregnancy	0 (0.0)	1 (1.6)	0 (0.0)	0 (0.0)	1 (0.4)
Continuous ANC contact after initiation	71 (93.4)	59 (96.7)	28 (96.5)	67 (94.4)	225 (94.9)
ANC dropout (no attendance in 3rd trimester)	3 (4.0)	1 (1.6)	1 (3.5)	2 (2.8)	7 (3.0)
Irregular ANC contact (2nd trimester skipped)	2 (2.6)	0 (0.0)	0 (0.0)	2 (2.8)	4 (1.7)
Total	76 (100)	61 (100)	29 (100)	71 (100)	237(100)

n: number of respondents; HC: health center; f: frequency; %: percentages

period (n=237). The majority of women (n=225, 94.9%) continued to attend ANC in the subsequent trimesters following initiation. The highest continuation rate was observed at Karenge Health Center (n=59, 96.7%), while the lowest was at Rwamagana Health Center (n=71, 93.4%).

Some women discontinued ANC attendance after the second or third trimester following initiation

Table 4: *Frequency of ANC visits for each and all trimesters of pregnancy*

Frequency of ANC contacts per trimester		Rwamagana HC (n=76)	Karenge HC (n=61)	Nyagasambu HC (n=29)	Muyumbu HC (n=71)	Total (n=237)
		f (%)	f (%)	f (%)	f (%)	f (%)
Trimester 1	0 visit	12 (15.8)	12 (19.7)	6 (20.7)	14 (19.7)	44 (18.6)
	1 visit	43 (56.6)	32 (52.5)	20 (69.0)	44 (62.0)	139 (58.6)
	2 visits	13 (17.1)	9 (14.8)	2 (6.9)	10 (14.1)	34 (14.3)
	≥3 visits	8 (10.5)	8 (13.1)	1 (3.4)	3 (4.4)	20 (8.4)
Trimester 2	0 visit	5 (6.6)	5 (8.2)	2 (6.9)	4 (5.6)	16 (6.8)
	1 visit	40 (52.6)	25 (41.0)	16 (55.2)	34 (47.9)	115 (48.5)
	2 visits	22 (28.9)	21 (34.4)	9 (31.0)	24 (33.8)	76 (32.1)
	3 visits	4 (5.3)	7 (11.5)	2 (6.9)	7 (9.9)	20 (8.4)
	≥4 visits	5 (6.6)	3 (4.9)	0 (0.0)	2 (2.8)	10 (4.2)
Trimester 3	0 visit	3 (3.9)	2 (3.3)	1 (3.4)	2 (2.8)	8 (3.4)
	1 visit	29 (38.2)	17 (27.9)	9 (31.0)	31 (43.7)	86 (36.3)
	2 visits	32 (42.1)	26 (42.6)	17 (58.6)	23 (32.4)	98 (41.4)
	3 visits	5 (6.6)	7 (11.5)	1 3.4)	8 (11.3)	21 (8.9)
	4 visits	3 (3.9)	2 (3.3)	1 (3.4)	6 (8.5)	12 (5.1)
	≥5 visits	4 (5.3)	7 (11.5)	0 (0.0)	1 (1.4)	12 (5.1)
Overall number of ANC contacts	0-3 visits	26 (34.2)	10 (16.4)	8 (27.6)	13 (18.3)	57 (24.1)
	4-7 visits	42 (55.3)	42 (68.8)	21 (72.4)	52 (73.2)	157 (66.2)
	≥8 visits	8 (10.5)	9 (14.8)	0 (0.0)	6 (8.5)	23 (9.7)
Total		76 (100)	61 (100)	29 (100)	71 (100)	237 (100)

n: represents number of respondents; HC: health canter; f: frequency; %: percentages

Table 5: *Description of overall number of ANC visits*

Overall number of ANC contacts		
Mean		4.58
95% Confidence Interval for the Mean	Lower Bound	4.32
	Upper Bound	4.84
Mode		4
Median		4.00
Std. Deviation		2.039

ANC: Antenatal care; Std: Standard deviation

(dropouts). The overall dropout rate was 3.0% (7 women). Additionally, a small number of women attended ANC only in the first and third trimesters, skipping the second trimester (irregular ANC visits). Specifically, 4 women (1.7%) initiated ANC in the first trimester, skipped the second trimester, and resumed in the third trimester. Furthermore, 1 woman (0.4%) did not attend ANC at any point during her pregnancy. Table 3 below represents the progression of ANC contact after initiation.

Frequency of antenatal care visit by each trimester during pregnancy: This study assessed the number of ANC visits made per trimester and the total number of ANC visits in general, among 237 women who had completed their pregnancies. The study categorized the women based on the number of ANC visits they had: less than or equal to 3 visits, 4 to 7 visits, and 8 or more visits.
In the first trimester, 139 women (58.6%) had a single ANC visit; in the second trimester, 115 women (48.5%) had one ANC visit, and in the third trimester, 98 women (41.4%) had two ANC visits. Muyumbu Health Center had the highest number of women with a single ANC visit in both the first and second trimesters, while Karenge Health Center had the fewest. In contrast, during the third trimester, a large number of women (n=98, 41.4%) reported having two ANC visits.
Overall, 157 women (66.2%) had 4 to 7 ANC visits, with the highest proportion from Muyumbu Health Center (n=52, 73.2%) and the lowest from Rwamagana Health Center (n=42, 55.3%). Additionally, 57 women (24.1%) had fewer than 3 ANC visits, and 23 women (9.7%) had 8 or more ANC visits throughout their pregnancies. Table 4 below illustrates the frequency of ANC visits for each trimester and the overall number of visits.

Table 5 describes the overall number of ANC visits among all study participants who had delivered (237 mothers). The average number of ANC visits was 4.58 (S.D = 2.039, 95% C.I = 4.32 – 4.84), and the most common number of ANC visits throughout the pregnancy period was 4.

Factors influencing ANC utilization among mothers in Rwamagana District: As shown in the Supplementary Table 1, a binary Logistic Regression Analysis was conducted to evaluate the impact of socio-demographic characteristics, pregnancy-related factors, healthcare provider factors, and ANC service cost and satisfaction on ANC utilization. The analysis aimed to predict whether these factors were associated with suboptimal ANC visits (<4 visits) or optimal ANC

Table 6: *Simple Linear Regression analysis for the association between means of age categories, family size, gravidity, parity and living children, and the overall number of ANC visits*

Influencing factors						95%CI for b	
	R	R^2	P-value	a	b	LL	UL
Means of age categories	0.036	0.001	0.579	4.287	0.010	-0.027	0.047
Family size	0.020	0.000	0.759	4.691	-0.024	-0.181	0.132
Gravidity	0.010	0.000	0.880	4.613	-0.012	-0.166	0.143
Parity	0.046	0.002	0.479	4.726	-0.059	-0.223	0.105
Number of living children	0.007	0.000	0.918	4.560	0.009	-0.170	0.188

R: coefficient of correlation; R2: coefficient of determination; a: intercept for regression equation; b: slope for regression equation; CI: confidence interval; LL: lower limit; UL: upper limit

visits (≥4 visits). Women with a household size of 4-5 members were significantly more likely to have optimal ANC visits (P = 0.035). Women with no definite socioeconomic class were the most likely to attend the recommended ANC visits (16 women, 88.9%), while those in the third category were the least likely (59 women, 67.8%) (p=0.016). Women who delivered at the health facilities were significantly more likely to have attended 4 ANC visits than those who delivered at home (P = 0.033). The source of ANC information significantly impacted ANC utilization (p=0.013), with women who received information from health facilities alone being the most to attend the recommended ANC visits, followed by those who received ANC-related information from health facilities, friends and relatives, and the radio.

Simple linear regression analysis in Table 6 showed that age, family size, gravidity, parity, and number of living children showed no significant relationships with the overall number of ANC visits. The coefficients of correlation (r) of 0.19), and their corresponding p>0.05 indicate a negligible relationship. Additionally, the coefficients of determination (r^2) were 0, suggesting that age, family size, gravidity, parity, and number of living children have no influence on the total number of ANC visits among women in Rwamagana District.

DISCUSSION

ANC is a suitable approach for decentralized reproductive health care for pregnant women. This program remains indispensable in monitoring universal fetal and maternal well-being during pregnancy and is useful when various vital prerequisites are taken into consideration. This study evaluated ANC utilization and some influencing factors, such as the time of ANC initiation, the flow of ANC visits concerning gestational age, the total number of ANC visits, and the factors of ANC utilization in Rwamagana District.

The findings showed that 4 out of 5 women (79.6%) in Rwamagana District started attending ANC as early as in the first trimester (<12 weeks of amenorrhea). The findings align with a previous study by Rustagi et al. conducted in 2021 [22], recent 2019-2020 RDHS [15], and Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) of 81 Countdown to 2030 priority countries [21] which, respectively, reported that 69.3%, 59%, and 49.9% of women commenced ANC contacts within their first trimester of pregnancy. This can be attributed to the integrated system in Rwanda, with decentralized services at the community level, and the role of Community health workers (CHWs) in the early identification of conceived women, encouraging them to attend the ANC program as required. However, one-fifth (20.1%) of women began having ANC later in pregnancy (in the second or third trimester). Similarly, but higher, the 2019-2020 RDHS observed that 37% of women started having ANC other than in the first trimester [15]. According to the current study, failure of early ANC initiation slightly decreased. Enforcement of established measures or incentives put in place, such as rewarding health facilities with higher early ANC initiation [9] and allocation of most ANC services to the primary healthcare (PHC) level, could explain this decrease [9,16]. Worse are the findings of DHS in 81 other low and middle income countries, which revealed that 11.2% of women had no ANC during pregnancy [21].

Regular ANC visits are important because every trimester of pregnancy is associated with unique body changes that require different assessments and health interventions. We found that the majority of women continued to attend after the experience from prior visits, with 94.5% returning to health facilities for ANC. This might suggest that the initial ANC visit motivates women to return for the next visit. However, a few of them did not comply with the recommended attendance, although they initiated ANC. This highlights the need for continuously encouraging women to consistently adhere to the ANC program, emphasizing its benefits. The more the ANC visits, the more benefits are achieved from ANC, as regular ANC visits are essential for preventing complications, improving health outcomes, and fostering healthy fetal development [23]. They enable early detection and management of potential health problems, reducing maternal and neonatal risks. ANC also promotes healthy practices, educates mothers on self-care, and provides essential medical interventions, such as pregnancy tests, medical consulting, and screening for infections [20,23]. According to WHO's 2016 ANC Model [11], the recommended number of ANC contacts is at least 8. However, the new 2016 WHO model began in

March 202, and consequently, during this study (September 2023), women who were thought to have benefited from the 2016 WHO ANC mode of 8 contacts were still pregnant, and had not delivered so as to be considered to have complied to the new ANC recommended visits. So, referring to the 2002 ANC model, the recommended number of ANC visits was at least 4 [24]. In general, this study observed that around 99.6% of pregnant women in the Rwamagana district had at least 1 ANC visit during their pregnancy. This agrees with the RDHS 2019/2020 Eastern Province District Profile, which showed that in Rwamagana District, 99% of women received at least 1 ANC from skilled personnel [25]. Similarly, RDHS 2029-2020 also reported that 98% of women in Rwanda aged 15-49 received ANC from a professional for the last pregnancy [15]. By the time of the study, it was revealed that every delivered woman had 4.58 total number of ANC contacts (mean 4.58, S.D = 2.039). However, 24.1% of participants received inadequate ANC (< 4 visits). This is contrary to the 81.9% of women in El-Beheira Governorate, Egypt, who had < 4 ANC visits [6]. On the other hand, three-quarters of women (75.9%) had ANC as intended, while 66.2% of women had 4 to 7 total ANC contacts, and 9.7% had ≥ 8 ANC contacts. This shows improvement in the utilization of ANC compared to only 35.8% of women who had ≥ 4 ANC in the Rwamagana District, as reported by a 2016 study [16]. These are higher than the findings about women who had ≥ 4 ANC visits reported in the rural Northwest of Rwanda (34.7%) [9], and in 2019-2020 RDHS (47%) [15]. They are also higher than what were reported in Egypt (18.1%) [6], and India (53%) [22] .

Regarding the factors that influence ANC utilization in Rwamagana District, women who lived with many household members (> 5 members) were the least to attend ANC adequately (63.0% versus 77.0 % and 82.3% for women who lived with 1-3 and 4-5 members, respectively). Similar findings were reported in the SSA by Okedo-alex et al. in 2019 [3]. As the household size increases, women struggle to search for subsistence needs or become busy with domestic chores, which ultimately limit ANC attendance, explaining the negative association between household size and ANC attendance. On the other hand, one study contrasts this finding by showing that household members can positively contribute to the likelihood of attending ANC by encouraging and supporting pregnancy women to comply [9]. The socioeconomic status of the study participants was also found to play a role in ANC utilization. Women who were not classified in any socioeconomic category (88.9%) were the most likely to seek ANC, followed by those in the first category (78.6%). Women who had the least ANC contacts were mostly in the third category (67.8%). Obviously, as the socioeconomic status (SES) (Ubudehe category) of the study participants improved, the number of ANC visits decreased. This is possibly due to the fact that women with no socioeconomic classification (unclassified due to errors in their identity papers, immigration status, etc.) or with low SES were largely concerned with their health and paid medical attention to even subtle health conditions more than those with high SES due to fear of incurring expensive healthcare bills they cannot afford in case of delayed diagnosis of any complications. Moreover, women with high SES have busy schedules due to businesses or other chores, and sparing time for ANC can be challenging. They probably feel the urge to attend ANC when they are encouraged or face major health problems. Contrasting our findings, studies conducted by The World Bank [20], Tawfik et al. in El-Beheira Governorate, Egypt [6], and Okedo-alex et al. in sub-Saharan Africa [3] found that high wealth index of a woman was associated with appropriate attendance of ANC of women. The better the SES of women, the higher the attendance of ANC. The reason might be attributed to regional differences and different characteristics of participants between studies in Rwanda and elsewhere. Our findings of low ANC attendance among women with higher SES highlight the need for more efforts tailored to this group of women to raise ANC awareness and encourage them to attend. Different systems already in place, such involvement of local authorities, CHWs, Community Based Health Insurance (CBHI) [9], [15,16], and decentralization of ANC services closer to the community [9] should be engaged to focus on women with higher SES, who they might have considered too knowledgeable to be sencitized.

We found that ANC utilization in Rwamagana District is influenced by the place of delivery. Apart from two women who delivered at home, the rest delivered at formal health facilities (HC, hospital, or private clinic). This agrees with the

2019/2020 RDHS, which showed that 97% of pregnant women who received ≥4 ANC contacts delivered at health facilities) [15]. Giving birth at formal health facilities is important to ANC utilization because women can be provided with comprehensive health care, leading to better care experience and health education (such as awareness of pregnancy danger signs) given to pregnant mothers, which later contribute to the subsequent ANC attendance. Lastly, the source of ANC information was found to be a significantly influential criterion for optimal ANC utilization. The majority of the study participants obtained information related to ANC from health facilities, friends and relatives, and radio. This may be because, at health facilities, healthcare providers provide accurate and convincing health information to women, whereas friends/ colleagues and relatives, and radio conveniently and instantly communicate ANC information, which can also convince and remind them, when they are at home, to attend ANC as required. The literature supports our findings by showing that mass media can help disseminate information about maternal health and care and inform women about good practices during pregnancy [25].

The study's geographical scope, and convenience sampling methodology may limit the generalizability of results to the entire target population. The representative sample and study settings may not fully capture the specific contexts influencing ANC utilization for every individual across the entire district and country in general. Moreover, participants might have experienced recall bias or social desirability bias, potentially affecting the accuracy of reported ANC visits and other variables. Furthermore, the study's cross-sectional design restricts its ability to establish causal relationships between variables. Conducting longitudinal or time-lagged designs, employing case-control or cohort studies, acknowledging limitations, and addressing biases would provide a more comprehensive understanding of the dynamic factors that impact ANC utilization over time.

CONCLUSION

This study showed overall good ANC utilization in Rwamagana District. However, it also showed some areas of improvement, such as ensuring early initiation of ANC, regular attendance throughout pregnancy, achieving the recommended number of ANC visits, and ensuring equitable access and consistent utilization of ANC services. Factors such as household size, socioeconomic status, place of delivery, and source of ANC information significantly influence ANC utilization. Therefore, efforts should focus on targeted interventions that address socioeconomic disparities, improve health education, and enhance accessibility of ANC services to further promote maternal and fetal well-being in the district.

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Author Contributions
All authors contributed to data analysis, drafting, or revising the article, have agreed on the journal to which the article will be submitted, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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Supplementary Table 1: *Factors influencing ANC utilization among mothers in Rwamagana District*

	ANC utilization						
	<4 ANC		≥4 ANC		Total		
Influencing factors	**n**	**%**	**n**	**%**	**(n)**	**P**	**OR**
Socio-demographic characteristics							
Age							
15-19	4	18.2	18	81.8	22	0.322	0.816
20-29	25	21.5	91	78.5	116		
30-49	28	28.3	71	71.7	99		
Religion							
None	1	100	0	0.0	1	0.904	0.984
Muslim	0	0.0	7	100	7		
Catholic	17	23	57	77.0	74		
ADEPR	24	28.6	60	71.4	84		
Methodist	5	50.0	5	50.0	10		
Adventist	6	20.7	23	79.3	29		
Other	4	12.5	28	87.5	32		
Woman's level of education							
None	4	50.0	4	50.0	8	0.982	1.010
Primary	36	26.1	102	73.9	138		
Secondary	15	19	64	81.0	79		
Tertiary	2	16.7	10	83.3	12		
Husband's educational level							
None	4	30.8	9	69.2	13	0.648	1.180
Primary	30	24.8	91	75.2	121		
Secondary	17	21	64	79.0	81		
Tertiary	6	27.3	16	72.7	22		
Household size							
1-3 members	20	23.0	67	77.0	87	**0.035***	0.743
4-5 members	17	17.7	79	82.3	96		
>5 members	20	37.0	34	63.0	54		
Woman's occupation							
None	14	25.0	42	75.0	56	0.084	1.281
Housemaid	1	100	0	0.0	1		
Peasant/ farmer	21	25.3	62	74.7	83		
Businesswoman	7	29.2	17	70.8	24		
Civil servant	13	20.6	50	79.4	63		
Employee	1	10.0	9	90.0	10		

Husband's occupation							
None	5	25.0	15	75.0	20	0.227	0.847
Houseman	0	0.0	0	0.0	0		
Peasant/ farmer	18	30.0	42	70.0	60		
Businessman	5	14.7	29	85.3	34		
Civil servant	16	19.0	68	81	84		
Employee	13	33.3	26	66.7	39		
Socioeconomic status (Ubudehe Category)							
None (unclassified)	2	11.1	16	88.9	18	**0.016***	0.517
Category 1	3	21.4	11	78.6	14		
Category 2	24	20.3	94	79.7	118		
Category 3	28	32.2	59	67.8	87		
Category 4	0	0.0	0	0.0	0		
Financial support							
Yes	36	24.8	109	75.2	145	0.296	1.509
No	21	22.8	71	77.2	92		
Health insurance							
Yes	49	22.5	169	77.5	218	0.090	0.341
No	8	42.1	11	57.9	19		
Marital status							
Single	4	23.5	13	76.5	17	0.053	0.570
Married	18	20.0	72	80.0	90		
Cohabitating	29	24.4	90	75.6	119		
Separated	5	55.6	4	44.4	9		
Widowed	1	50.0	1	50.0	2		
Household conflict/ violence							
Yes	11	30.6	25	69.4	36	0.461	1.451
No	46	22.9	155	77.1	201		
Autonomy							
Yes	51	23.8	163	76.2	214	0.526	0.659
No	6	26.1	17	73.9	23		
Residential area							
Rural	49	22.7	167	77.3	216	0.057	0.289
Urban	8	38.1	13	61.9	21		
Main mode of HF access for ANC visit							
Walking	49	26.8	134	73.2	183	0.911	0.858
Vehicle	8	14.8	46	85.2	54		

Walking time to HF (If the main mode of HF access is walking)							
≤ 30 minutes	11	23.4	36	76.6	47	0.647	0.886
30 minutes – 1 hour	22	27.5	58	72.5	80		
> 1 hour	16	28.6	40	71.4	56		
Affordable transportation cost (If the main mode of HF access is by vehicle)							
Yes	5	19.2	21	80.8	26	0.567	1.620
No	3	10.7	25	89.3	28		
Pregnancy-related factors							
knowledge of pregnancy manifestations							
Yes	44	23.8	141	76.2	185	0.602	0.778
No	13	25.0	39	75.0	52		
Place of delivery (for the most recent birth)							
Institutional (Health facility)	56	23.8	179	76.2	235	**0.033***	0.026
Non-institutional	1	50.0	1	50.0	2		
Mode of Delivery (for the most recent birth)							
Normal delivery	39	23.4	128	76.6	167	0.699	0.855
Cesarean section	18	25.7	52	74.3	70		
Gravidity							
Primigravida	16	24.6	49	75.4	65	0.748	1.143
Multigravida	32	22.4	111	77.6	143		
Grand-multigravida	9	31.0	20	67.0	29		
Parity							
Primipara	19	25.3	56	74.7	75	0.608	0.754
Multipara	29	20.7	111	79.3	140		
Grand-multipara	9	40.9	13	59.1	22		
Number of living children							
1 – 3 children	41	20.9	155	79.1	196	0.411	1.472
4 children and more	16	39.0	25	61.0	41		
Family planning							
Yes	33	24.1	104	75.9	137	0.523	0.746
No	24	24.0	76	76.0	100		
Pregnancy planning							
Yes	36	20.9	136	79.1	172	0.166	0.533
No	21	32.3	44	67.7	65		
ANC Knowledge							
Yes	54	24.8	164	75.2	218	0.092	4.668
No	3	15.8	16	84.2	19		

Sources of ANC information							
Not applicable (if no ANC knowledge)	3	15.8	16	84.2	19	**0.013***	1.134
Health facility	18	30.0	42	70	60		
Friends and relatives	7	43.7	9	56.3	16		
Radio	3	27.3	8	72.7	11		
Other sources	0	0.0	3	100	3		
Health facility and Radio	4	15.4	22	84.6	26		
Health facility, Friends and relatives and Radio	15	25.9	43	74.1	58		
Health facility, Friends and relatives, Radio, Television and social media	1	16.7	5	83.3	6		
Health facility and Friends and relatives	4	17.4	19	82.6	23		
Health facility, Friends and relatives, Radio and Television	2	28.6	5	71.4	7		
Health facility, Radio and Television	0	0.0	2	100	2		
Friends and relatives and Radio	0	0.0	5	100	5		
Health facility, Friends and relatives, Radio, Television, social media and Newspapers	0	0.0	1	100	1		
Type of HF of ANC contacts							
Public HF	55	25.1	164	74.9	219	0.173	4.978
Private HF	1	11.1	8	88.9	9		
Both public and private HF	0	0.0	8	100	8		
ANC follow-up during the last pregnancy							
Yes	27	24.8	82	75.2	109	0.442	1.329
No	29	22.8	98	77.2	127		
Complications on pregnancies							
Yes	11	20.8	42	79.2	53	0.708	0.835
No	46	25.0	138	75.0	184		
Factors related to healthcare providers							
Waiting time for receiving ANC services							
< 1 hour	23	23.5	75	76.5	98	0.778	1.073
1 – 2 hours	20	26.7	55	73.3	75		
> 2 hours	13	20.6	50	79.4	63		

Good/respectable manner by ANC cadre							
Yes	53	23.4	173	76.6	226	0.652	0.628
No	3	30.0	7	70.0	10		
Health Education or advice during ANC visit							
Yes	52	24.5	160	75.5	212	0.353	2.032
No	4	16.7	20	83.3	24		
ANC service cost and satisfaction							
Expensive cost of ANC services							
Yes	17	24.3	53	75.7	70	0.757	1.132
No	39	23.5	127	76.5	166		
ANC service satisfaction							
Yes	53	23.7	171	76.3	224	0.955	1.064
No	3	25.0	9	75.0	12		

*n: number of study participants; %: percentage; P: P-value; *: significant P-value; OR: odd ratio; ADEPR: Associations des Eglises de Pentecote au Rwanda; HF: Health facility; ANC: antenatal care; %: percentages*