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Original Article

Antenatal Care Visits and Adverse Pregnancy Outcomes at a Hospital in Rural Western Province, Rwanda

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In many economically developing countries, and especially in the rural regions of sub-Saharan African countries, there have been only limited investigations into the association between antenatal care (ANC) and adverse pregnancy outcomes. We obtained information on ANC and pregnancy outcomes between 2011 and 2016 from hospital files of pregnant women (n = 4,960) served at a rural hospital in Rwanda, and we examined the associations between their ANC visits and the adverse pregnancy and neonatal outcomes by using univariate and multivariate logistic regression models to estimate the odds ratios (ORs) and 95% confidence intervals (CIs). Most of the pregnant women had ≥ 4 ANC visits, but 39% (n = 1,911) did not have ≥ 3 visits before delivery. The prevalence of low birth weight (LBW) and that of preterm birth (PTB) were 12% and 9.9%, respectively. Compared to the women who attended only one ANC visit, those who attended ≥ 4 ANC visits had lower risks of LBW (OR 0.20; 95%CI: 0.11-0.36) and PTB (OR 0.28; 95%CI: 0.11-0.76). Frequent ANC visits were also associated with better postnatal outcomes of the newborns. Encouraging women to attend ANC visits before delivery can markedly reduce PTB-related and LBW-related complications, especially in resource-limited settings.

Key words: antenatal care, epidemiology, low birth weight, preterm birth, rural

Preterm birth (PTB) and low birth weight (LBW) present major public health challenges in economically developing countries. They are major determinants of perinatal survival and infant morbidity and mortality [1], not only in the immediate neonatal period but also in infancy, childhood, and adulthood [2, 3]. Of 5.942 million children under 5 years of age who died worldwide in 2015, PTB was the leading cause of death, accounting for 15.9% of decedents (1.055 million). LBW has contributed to 60-80% of all neonatal deaths [4]. Every year, an estimated 15 million babies are born preterm, and this number is rising, especially in economically developing countries. An estimated 18 million are newborn infants with LBW [1].

In 1994, the health system of Rwanda, a sub-Saharan country, was completely paralyzed by the horrific historical events of the Genocide against the Tutsi [5].

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Nevertheless, a steady and impressive reduction of the mortality rate in children under 5 years of age has been achieved in the two past decades, from 249 per 1,000 in 1994 to 50 per 1,000 in 2014-2015 [6,7]. The neonatal mortality rate has been declining to a lesser degree [6,8]. This observed positive decline can be explained in part by better access to health care and community-based maternal and newborn care [9-11]. Despite the positive progress, Rwanda, like many other sub-Saharan African nations, is still threatened by the increased prevalence of PTB and LBW [12]; the PTB rate has been estimated as 10% [13], and the estimated LBW rate is 7% [6]. Some studies in sub-Saharan Africa have indicated the incidence of LBW to be 13% in Ethiopia, 13% in east Africa, 14-15% for the entire Africa, and most of who are pre-term [14].

Antenatal care (ANC) is an important determinant in pregnancy outcomes, including both maternal and perinatal mortality [15]. Studies have shown that frequent use of this routine medical service during pregnancy has the potential to reduce the incidence of perinatal morbidity and mortality by treating medical conditions and identifying and reducing potential risks, thus helping women to address behavioral factors that contribute to poor pregnancy outcomes [16]. The correlation between derelict ANC and increased rates of adverse pregnancy outcomes was first demonstrated in the late 1940s [17]. The World Health Organization (WHO) recommends that all pregnant women with uncomplicated pregnancies should attend ≥4 ANC visits before their deliveries.

During ANC visits, women who might be at an increased risk of adverse pregnancy outcomes such as PTB and LBW can be identified and clinically supported for improved neonatal and postnatal outcomes [18,19]. Women with inadequate ANC [20] *(i.e.*, <50% of expected visits), had higher prevalence of PTB and LBW than those who had ≥4 ANC visits [17,19]. Another study found an increased risk of LBW, which has been associated with premature delivery, among women who made fewer ANC visits compared to women who made more than the recommended number of ANC visits during their pregnancies [21].

Many studies conducted in economically developed and developing countries have shown beneficial effects of ANC on the rates of PTB and LBW [22-25]. Nevertheless, in sub-Saharan Africa, and especially in rural settings in sub-Saharan countries, few studies have examined the association between ANC attendance and the rates of PTB and LBW. We thus designed the present study to examine the relationship between the number of ANC visits and adverse pregnancy outcomes, specifically PTB and LBW, in a typical sub-Saharan African hospital in rural Rwanda.

Participants and Methods

Study site. The study was conducted at Mibilizi Hospital (2°34'03.6"S, 28°57'12.0"E), Rusizi District, Western Province in Rwanda (Fig. 1). The hospital catchment area has 277,452 residents [5], accounting for two-thirds of the entire Rusizi District population.

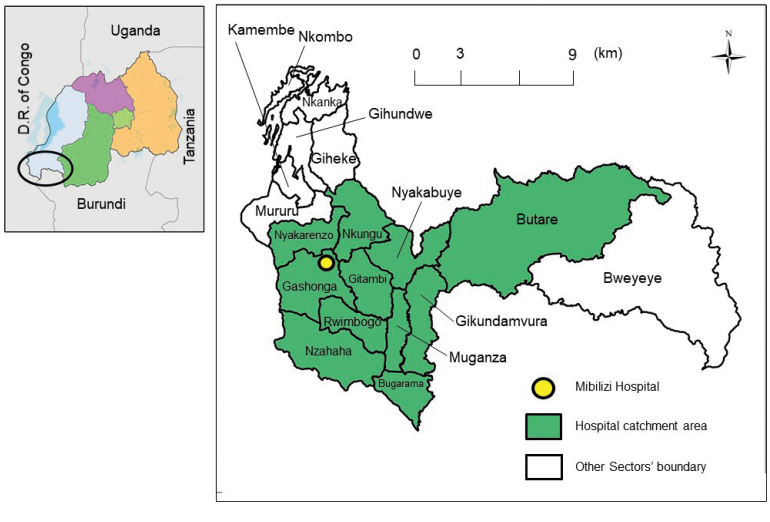

Fig. 1 Geographical location of Mibilizi Hospital. The *upper left* shows the entire map of Rwanda (*colored*) and surrounding countries. The area around Mibilizi Hospital is enlarged and shown at *right*. Eleven sectors of the catchment area are colored *green*. The hospital's location is shown by the *yellow circle*.

The hospital is among the busiest in the region because it receives all maternal cases transferred from 11 of the 18 health centers of the entire district. This hospital, which has a poor neonatal and maternal infrastructure and no gynecologist or neonatologist, is located at approx. 178 km from the nearest referral hospital. Such a long distance might affect the survival rate of preterm and low-birth-weight newborns [26].

Because of its location, Mibilizi Hospital can be regarded as a typical sub-Saharan African rural hospital in a mountainous area, which renders accessibility to health services difficult. The hospital catchment area is close to the borders of 2 countries, The Democratic Republic of Congo (DRC) and Burundi, making the area a busy hub for daily work. This is an important factor that gives the hospital the unique attribute of receiving many patients, including pregnant women seeking prenatal or postnatal care services, while being challenged by public health issues such as infectious diseases.

Study participants. Using the maternity case files, we obtained the information related to all births at the maternity department of Mibilizi Hospital during a recent 6-year period (2011-2016). The information had been reported by midwives, nurses, and physicians at the time of admission of each pregnant woman to the ward for delivery or immediately after delivery. From these case files, four pre-trained data collectors extracted necessary information using a pre-coded case abstraction computer spreadsheet under close supervision. The following data were obtained: the mother's characteristics, *i.e.*, age, parity, marital status, presence/absence of earlier cesarean section, delivery mode, pregnancy type, living area, and the number of ANC visits attended, and the newborn's characteristics: sex, birth weight, gestational age, and neonatal outcome.

Of the total 6,529 births from the maternity case files, 319 births without information related to neonatal outcomes and stillbirths were excluded. We further excluded births without information related to the number of ANC visits (n = 1,250), leaving the data of 4,960 births used for the analyses. These participants were geographically distributed among 11 sectors of the Mibilizi Hospital catchment area, as shown in Fig. 2. These sectors have similar economic conditions. According to the Fifth Integrated Household Living Survey (EICV5) published in 2017, 12.8% of the population of all sectors of the Mibilizi Hospital zone fall under the extreme poverty category.

Antenatal care (ANC) visits. We used the number of ANC visits as an exposure (*i.e.*, independent) variable, irrespective of the timing of the visits' commencement during pregnancy. ANC services in Rwanda are provided mainly at health centers (HCs), and each sector has one HC. The obstetrical examination is performed by a midwife or nurse, but other care such as anthropometric measurements and/or nutritional education is provided by a trained senior social worker. There is no ultrasound performed at this level.

In the first trimester, various services and care are provided, such as a urine test to confirm pregnancy and to rule out any possible sexually transmitted infection,

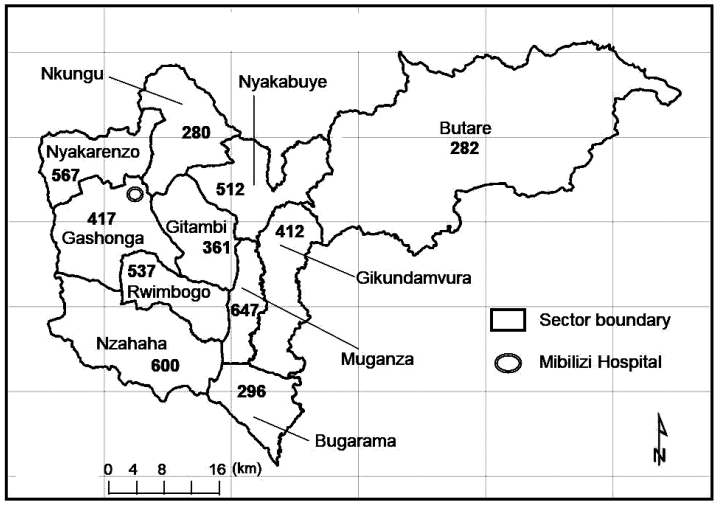

Fig. 2 Geographic distribution of the number of participants. The numbers in each sector are shown on the map of the Mibilizi Hospital catchment area.

a blood pressure check, an HIV test, anthropometric measurements, and psychosocial counseling. The same routine continues until the third trimester, and each time the woman visits the HC, she is also given iron/folic acid and advised to maintain a balanced diet. If there is any sign of preterm delivery, she is transferred to a hospital.

Most of the women in their second trimester visit a hospital, where a physician performs an ultrasound to confirm the age of the pregnancy, determine whether it is a multiple pregnancy, detect common abnormalities, and confirm the sex of the fetus. Because the hospital does not offer routine ANC services, we obtained this information from the ANC card (a card given to every pregnant woman on her first visit for ANC at the health center. The ANC card contains records of procedures, education, and examination findings during the woman's visits to the health center), and it is presented by a pregnant woman admitted for delivery at a hospital. Upon her admission to the maternity department, the card's information is copied by a physician or a qualified midwife.

The WHO and the Rwanda government recommend a regimen of ≥4 ANC visits (one visit during each trimester of gestation and a visit immediately preceding delivery) for women without pregnancy-related complications or other risk factors. According to the Rwanda demographic and health survey of 2014-2015, nearly all mothers (99%) attended ≥1 antenatal care visit(s), regardless of the timing. Due to this general propensity for ANC attendance, coupled with the fact that ANC was free in Rwanda by 2017, the number of non-attenders among our participants was very low. We thus categorized the number of ANC visits as follows: 1, 2, 3, and ≥4 visits for ANC services.

Data analysis. After conducting a descriptive analysis separated by the ANC visits, we examined the association between the number of ANC visits and each of LBW and PTB by using logistic regression models (simple and multiple) with the ANC visit category of "one visit" as a reference. After estimating crude odds ratios (ORs) and their 95% confidence intervals (CIs), we adjusted for potential confounders. The confounders were maternal age (categorical: <20, 20-24, 25-29, 30-34, and ≥35 years), parity (categorical: none, one child, and ≥2 children), marital status (dichotomous: divorced/single and married), previous cesarean section (dichotomous: none and ≥1 time), type of pregnancy (dichotomous: singleton and multiple), mode of delivery (dichotomous: cesarean section and normal delivery), living area (categorical: sector <5 km from the hospital, sector 5-10 km from the hospital, and sector located >10 km from the hospital), and sex of the newborn (dichotomous).

LBW (birth weight <2,500 g) and PTB (gestational age <37 weeks) were defined as described previously [30]. The gestational age was inferred from the mother's last menstrual period. We also examined detailed categories for birth weight and gestational age, where we estimated adjusted ORs in a comparison with normal birth weight (*i.e.*, ≥2,500 g) or term birth (gestational age ≥37 weeks).

We also examined the associations between the number of ANC visits and the postnatal outcomes of the newborns (discharged alive vs. died or transferred to the neonatal intensive care unit (NICU) and between pregnancy outcomes and postnatal outcomes.

Statistical analyses were conducted using Stata MP software ver. 13.0 (StataCorp., College Station, TX, USA). *P*-values <0.05 were considered significant.

Ethical approval. The study was approved by the review boards of Nagasaki University Institute of Tropical Medicine (No. 170209163), the National Health Research Committee-NHRC of the Rwanda Ministry of Health (No. NHRC/2017/PROT/009), and the University of Rwanda (No. 233/CMHS-IRB/2018).

Results

The baseline maternal and newborn characteristics are summarized in Table 1. Irrespective of age group, the majority of the mothers attended four or more ANC visits, but the other approx. 39% (n=1,911) of the participants did not comply with the WHO and Rwanda Government recommendation (*i.e.*, ≥4 visits). Among the mothers who had attended 4 or more ANC visits, the largest age group was 25-30 years old (31.7%, n=966). Young mothers (<20 years old) and old mothers (≥35 years old) made fewer ANC visits: 3% (n=91) and 16.3% (n=496), respectively. For the total population, the prevalence of LBW was 12.2% (n=605) and that of and PTB was 9.9% (n=325). The cesarean section rate was high among the women who attended ≥4 ANC visits at 58.2% (n=1,770); the vaginal delivery rate in the total population was 41.8% (n=1,270).

The prevalence of LBW decreased as the number of

Table 1 Maternal and newborn characteristics of the participants according to the number of antenatal care (ANC) visits (n=4,960)

	No. of ANC visits				
	Total (n=4,960)	1 visit (n=78)	2 visits (n=439)	3 visits (n=1,394)	≥4 visits (n=3,049)
Mother's characteristics					
Age, n (%)					
<20 years	166 (3.35)	7 (8.97)	14 (3.2)	54 (3.88)	91 (2.99)
20 to <25 years	1,246 (25.15)	23 (29.49)	104 (23.74)	333 (23.91)	786 (25.81)
25 to <30 years	1,477 (29.81)	19 (24.36)	109 (24.89)	383 (27.49)	966 (31.72)
30 to <35 years	1,173 (23.68)	13 (16.67)	119 (27.17)	335 (24.05)	706 (23.19)
≥35 years	892 (18.01)	16 (20.51)	92 (21)	288 (20.67)	496 (16.29)
Maternal parity, n (%)					
Nulliparous	1,655 (33.47)	23 (29.49)	83 (18.91)	392 (28.18)	1,157 (38.1)
Primiparous	1,029 (20.81)	24 (30.77)	110 (25.06)	312 (22.43)	583 (19.2)
Multiparous (≥2)	2,261 (45.72)	31 (39.74)	246 (56.04)	687 (49.39)	1,297 (42.71)
Marital status, n (%)					
Divorced/single	368 (7.64)	11 (14.86)	38 (8.86)	111 (8.16)	208 (7.05)
Married	4,447 (92.36)	63 (85.14)	391 (91.14)	1,249 (91.84)	2,744 (92.95)
Previous cesarean section, n (%)					
None	3,148 (66.48)	51 (71.83)	225 (54.35)	821 (61.45)	2,051 (70.38)
More than 1 time	1,587 (33.52)	20 (28.17)	189 (45.65)	515 (38.55)	863 (29.62)
Type of pregnancy, n (%)					
Singleton	4,643 (93.63)	72 (92.31)	393 (89.52)	1,288 (92.4)	2,890 (94.82)
Multiple (twin & triplet)	316 (6.37)	6 (7.69)	46 (10.48)	106 (7.6)	158 (5.18)
Mode of delivery, n (%)					
Cesarean section	2,912 (58.9)	35 (44.87)	278 (63.62)	829 (59.68)	1,770 (58.22)
Vaginal delivery	2,032 (41.1)	43 (55.13)	159 (36.38)	560 (40.32)	1,270 (41.78)
Living area (Sector), n (%)					
<5 km from the hospital	1,236 (25.17)	33 (43.42)	123 (28.47)	332 (24.18)	748 (24.69)
5–10 km from the hospital	1,223 (24.9)	12 (15.79)	104 (24.07)	353 (25.71)	754 (24.88)
>10 km from the hospital	2,452 (49.93)	31 (40.79)	205 (47.45)	688 (50.11)	1,528 (50.43)
Newborn characteristics					
Sex, n (%)					
Male	2,615 (52.77)	43 (55.13)	243 (55.48)	740 (53.12)	1,589 (52.17)
Female	2,340 (47.23)	35 (44.87)	195 (44.52)	653 (46.88)	1,457 (47.83)

Note: There were 6 missing data points on maternal age, 17 on parity, 185 for marital status, 302 for previous caesarean section, 1 for type of pregnancy, 16 for the mode of delivery, 61 for the living area (sector), and 6 for new-born sex.

visits for ANC increased, from 33.3% in the reference group (a single ANC visit) to 8.5% in the group who made ≥4 visits for ANC (Table 2). Even after adjusting for potential confounders, the association of LBW and the number of ANC visits remained: the adjusted OR was 0.20 (95%CI: 0.11-0.36) for ≥4 visits. This was also the case with the other birthweight categories.

Table 3 presents the crude and adjusted ORs for the association between the number of ANC visits and preterm birth. Attending frequent (*i.e.*, ≥4) ANC visits was associated with a reduced risk of PTB, and the same tendency was observed for the other gestational age categories.

Consistent with pregnancy outcomes, attending frequent ANC visits was associated with better postnatal outcomes of newborns (Table 4). Adverse pregnancy outcomes (*i.e.*, LBW and PTB) were associated with poorer postnatal outcomes of newborns (Table 5).

Discussion

We examined the relationship between ANC visits and adverse pregnancy outcomes (PTB and LBW) in a typical sub-Saharan African rural hospital of Rwanda. Our findings indicate that ≥3 visits for ANC were associated with lower risks of LBW and PTB and a reduced

Table 2 Odds ratios[a] and 95%CIs for the association between ANC visits and obstetric outcomes (birth weight [BW])

	No. of ANC visits			
	1 visit	2 visits	3 visits	≥4 visits
Low birth weight				
BW <2,500 g				
Prevalence (%)	33.33	24.66	15.21	8.50
Crude OR	1 (ref.)	0.65 (0.39–1.1)	0.36 (0.22–0.59)	0.19 (0.11–0.3)
Adjusted OR[b]	1 (ref.)	0.7 (0.38–1.31)	0.41 (0.22–0.73)	0.2 (0.11–0.36)
BW <2,000 g				
Prevalence (%)	18.75	14.06	3.75	0.99
Crude OR	1 (ref.)	0.71 (0.36–1.41)	0.17 (0.08–0.34)	0.04 (0.02–0.09)
Adjusted OR[b]	1 (ref.)	0.6 (0.26–1.43)	0.13 (0.06–0.08)	0.03 (0.01–0.08)
BW <1,500 g				
Prevalence (%)	11.86	8.59	0.42	0.14
Crude OR	1 (ref.)	0.69 (0.29–1.67)	0.03 (0.01–0.1)	0.01 (0–0.04)
Adjusted OR[b]	1 (ref.)	0.56 (0.18–1.74)	0.03 (0.01–0.12)	0.01 (0–0.03)
BW *<1,000* g				
Prevalence (%)	5.45	2.65	0.08	0.04
Crude OR	1 (ref.)	0.47 (0.12–1.8)	0.01 (0–0.14)	0.01 (0–0.06)
Adjusted OR[b]	1 (ref.)	0.25 (0.04–1.46)	0.01 (0–0.11)	0.01 (0–0.08)

[a]Crude and adjusted ORs were estimated by comparing with normal birth weight (*i.e.*, ≥2,500 g).
[b]Adjusted for maternal age, parity, marital status, previous cesarean section, type of pregnancy, mode of delivery, living area, and sex of new-born.

Table 3 Odds ratios[a] and 95%CIs for the association between ANC visits and obstetric outcomes (preterm birth)

	No. of ANC visits			
	1 visit	2 visits	3 visits	≥4 visits
Preterm delivery				
GW <37 weeks				
Prevalence (%)	21.62	22.28	17.5	5.80
Crude OR	1 (ref.)	1.03 (0.44–2.44)	0.76 (0.44–1.71)	0.22 (0.1–0.5)
Adjusted OR[b]	1 (ref.)	1.23 (0.46–3.27)	0.99 (0.39–2.48)	0.28 (0.11–0.71)
GW <36 weeks				
Prevalence (%)	21.6	15.9	12.1	3.6
Crude OR	1 (ref.)	0.68 (0.28–1.65)	0.5 (0.22–1.12)	0.13 (0.06–0.3)
Adjusted OR[b]	1 (ref.)	0.86 (0.32–2.38)	0.68 (0.27–1.75)	0.16 (0.06–0.41)
GW <34 weeks				
Prevalence (%)	13.50	9.20	3.50	1.3
Crude OR	1 (ref.)	0.65 (0.22–1.89)	0.23 (0.09–0.64)	0.08 (0.03–0.23)
Adjusted OR[b]	1 (ref.)	0.74 (0.22–2.54)	0.28 (0.09–0.88)	0.09 (0.03–0.28)

[a]Crude and adjusted ORs were estimated by comparison with term birth (gestational age ≥37 weeks).
[b]Adjusted for maternal age category, parity, marital status, previous cesarean section, type of pregnancy, mode of delivery, living area, and sex of newborn. GW, gestational weeks; NICU, neonatal intensive care unit.

risk of poor newborn outcomes. These findings might be useful for developing new approaches and activities for the improvement of maternal and newborn health services in similar settings. Although hospital-based, our study results may reflect the circumstances of the entire region. For that reason, the generalization of the results to pregnant women in the region might be justified.

Table 4 Odds ratios[a] and 95%CIs for the association between ANC visits and postnatal outcomes (died or admitted to NICU)

	No. of ANC visits			
	1 visit	2 visits	3 visits	≥4 visits
Postnatal outcomes				
Prevalence (%)	18.0	13.4	6.0	3.6
Crude OR	1 (ref.)	0.71 (0.37–1.35)	0.29 (0.16–0.54)	0.17 (0.09–0.31)
Adjusted OR[b]	1 (ref.)	0.72 (0.36–1.47)	0.32 (0.16–0.64)	0.18 (0.09–0.35)

[a]Crude and adjusted ORs were estimated by comparing with new-borns discharged alive within 24 h post-natal without admission to the NICU.
[b]Adjusted for maternal age category, parity, marital status, previous cesarean section, type of pregnancy, mode of delivery, living area, and sex of new-born.

Table 5 Association between pregnancy outcomes (LBW and PTB) and newborn outcomes

	Pregnancy outcomes, n (%)					
	Low Birthweight			Preterm Birth		
	Yes (n=605)	No (n=4,352)	*p*-value	Yes (n=325)	No (n=2,930)	*p*-value
Newborn outcome, (n, %)			0.0001*			0.0001*
Discharged alive	465 (76.9)	4,226 (97.1)		290 (89.2)	2,831 (96.6)	
Transferred to NICU	130 (21.5)	109 (2.5)		33 (10.2)	89 (3.04)	
Died within 24 h after birth	10 (1.7)	17 (0.4)		2 (0.6)	10 (0.3)	

*$p<0.05$, Chi-square test. NICU, neonatal intensive care unit; LBW, low birthweight; PTB, preterm birth.

Data recorded by skilled health professionals (physicians, midwives, and general nurses) were obtained from hospital records at a large hospital serving as a transfer center for 11 health centers across the district. The analysis was conducted on a large sample (>6,000 deliveries) over a long period. To the best of our knowledge, this report is the first of a study conducted to explore the specific association between ANC visits and adverse pregnancy and newborn outcomes in a rural setting in Rwanda. The rate of delivery at home in this region is very low (<1%) [28]; almost all women deliver at health facilities. The hospital serves 277,452 individuals in a population of >400,000 across the entire region, and thus our findings can be expected to provide a reliable representation of the region.

Compared to the findings of the Rwanda Demographic and Health Survey (R-DHS) conducted in 2014-2015 [6], our present analyses revealed both an apparent increase in the number of ANC sessions attended, *i.e.*, 61.5% (n=3,049) women attended four or more ANC visits, and higher prevalence of adverse pregnancy outcomes: 12% (n=605) for LBW and 10% (n=325) for PTB. The increase in the number of ANC visits occurred gradually. However, it is noteworthy that this prevalence is lower than that of neighboring sub-Saharan African countries such as Kenya [29], Ethiopia [30], and Uganda [31]. We also observed that young (<20 years old) and older women (≥35 years) attended fewer ANC visits than the women in the other age categories (Table 1). Possible reasons include some women's fear of being embarrassed at a health facility when they become pregnant at an early age (teenage pregnancy), or after being sexually harassed, raped, or forced into early sexual intercourse or a pregnancy at a late age (multiparous), or because the women had no experience with pregnancy. Our results are in agreement with the findings of studies indicating that young and old pregnant women were more prevalent than the average in groups of women who attended few or no ANC visits [6,32,33]. Therefore, women who are under 20 years old or ≥35 years old could be appropriate targets for advocacy and interventions that aim to maximize the number of ANC visits in Rwanda.

Our finding that the risks of LBW and PTB were

reduced among women who attended 4 or more ANC visits is consistent with the findings of studies conducted in the Gambia [34], Kenya [25], Ethiopia [35], Ghana [15], and elsewhere [36]. All have shown that women who attended ≥3 ANC visits have better pregnancy outcomes. In this study, however, the associations between 2 or 3 ANC visits and PTB were not statistically significant, and the confidence intervals were wider: OR 1.23, 95%CI 0.46-3.27 for 2 visits and OR 0.99, 95%CI 0.39-2.48 for 3 visits. This indicates that full compliance with the recommended 4 or more ANC visits is desirable to best protect against preterm delivery.

Moreover, our results show that, as the number of ANC visits increased, the risk of NICU admission or perinatal death decreased. These findings contradict the results of earlier studies, which suggested that the risks of NICU admission and perinatal death increase with the number of ANC visits [32, 37]. These earlier studies were adversely affected by under-reporting as a source of error because their data on the backgrounds of women not attending ANC visits, including gestational age, were collected at the time of birth. The most likely explanation for the decreased risks of PTB and LBW might be that a higher number of ANC visits during pregnancy provides greater opportunities to promote the good health of the mother and fetus/newborn and to promote parenting skills before and after childbirth.

It is important to note that this study was based on hospital and retrospective data collection, which might cause unexpected biases and shortcomings in obtaining a reliable index for an evaluation against the quality of ANC. For example, the only selected participants were women who had been admitted to the hospital. We did not have sufficient information about the reasons for admission apart from delivering. In earlier studies, such surveillance might have included already threatened premature labor, which is a potential risk factor of LBW and PTB [1, 38]. In addition, our study used hospital-file-based data, and for that reason, we were unable to include an evaluation of the Kotelchock index (concerning the proposed adequacy of the Prenatal Care Utilization Index), since the women present only their ANC cards indicating the number of visits they attended, without describing the accuracy and adequacy of services provided.

Another potential study limitation is tied to the determination of PTB based on the pregnancy duration. This duration was inferred from the last menstrual period (LMP) reported by the woman at her time of admission if not on her ANC card. Women might have recalled the LMP incorrectly and might thereby have affected our calculations, but one can readily assume that this was less likely because we tried to assess the duration with first or second-trimester ultrasound information provided in the women's files. In most cases, the range of error was small. The retrospective nature of our study limits the ability to draw any causal relation between ANC and the low prevalence of LBW and PTB. Clinical trials will be needed to address these issues.

In conclusion, PTB and LBW are concerns among women in the Rusizi District of Rwanda. ANC visits are associated with a reduced prevalence of LBW of PTB and better neonatal outcomes. Encouraging pregnant women who are <20 or ≥35 years old in particular to attend four or more antenatal care visits before their delivery could result in a marked reduction of the prevalence of LBW and PTB, thereby improving the postnatal outcomes and increasing the likelihood of survival among newborns in resource-limited settings such as rural regions in sub-Saharan Africa.

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