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Timing of antenatal care initiation, contact frequency, and adverse maternal and perinatal outcomes at a district hospital in Zanzibar, Tanzania: an analytical cross-sectional study

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Research Article

Keywords: antenatal care, booking timing, contact frequency, maternal outcomes, perinatal outcomes, Zanzibar, Tanzania

Posted Date: August 27th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10704991/v1

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Additional Declarations: No competing interests reported.

Abstract

Background.

WHO recommends at least eight antenatal care (ANC) contacts, beginning in the first trimester. In sub-Saharan Africa late booking is common, but facility-level evidence linking ANC timing and contact frequency to maternal and perinatal outcomes remains limited, and data from Zanzibar are scarce. We examined whether trimester of ANC initiation and contact frequency were independently associated with adverse maternal and perinatal outcomes.

Methods.

We conducted an analytical cross-sectional study of 271 postpartum women delivering at Kivunge District Hospital, Unguja Island, between February and May 2026, recruited consecutively. Booking was classified as first (≤ 12 weeks), second (13–27) or third (≥ 28) trimester, and contact frequency as < 4, 4–7 or ≥ 8. Pre-specified composite outcomes—adverse maternal (anaemia, pre-eclampsia, gestational diabetes, haemorrhage, or caesarean delivery) and adverse fetal (birthweight < 2500 g, 5-minute Apgar < 7, any neonatal complication, or perinatal death)—were derived from recorded clinical components. Associations were assessed with χ^2 tests and multivariable logistic regression, using Firth penalised regression for the fetal model.

Results.

Of 271 women, 256 (94·5%) attended ANC: 69 (25·5%) booked in the first trimester, 119 (43·9%) in the second and 68 (25·1%) in the third; only 17 (6·3%) achieved eight contacts (percentages of the full recruited sample, N = 271). Adverse maternal outcomes occurred in 150 (55·4%) and adverse fetal outcomes in 134 (49·4%). Adverse fetal outcomes rose from 29·0% and 40·3% in first- and second-trimester bookers to 79·4% in the third (χ^2=39·69, p < 0·001). After adjustment, third-trimester booking remained strongly associated with adverse fetal outcome (aOR 6·27, 95% CI 2·69–15·35; p < 0·001), as did fewer than eight contacts (aOR 5·64; p = 0·022), whereas second-trimester booking did not differ from first (aOR 1·22; p = 0·566). For adverse maternal outcomes, documented pregnancy complications were the dominant independent predictor (aOR 3·84, 95% CI 2·13–6·92), while booking timing was not. Findings were consistent when caesarean delivery was excluded from the maternal composite.

Conclusions.

In this Zanzibari district hospital, third-trimester ANC initiation was associated with six-fold higher odds of adverse perinatal outcomes, whereas second-trimester booking was indistinguishable from first-trimester booking—a threshold-like rather than graded pattern. Prioritising prevention of third-trimester

initiation may be a more attainable programme goal than an eight-contact target met by fewer than 7% of women.

Introduction

Antenatal care is a central platform for reducing maternal and newborn mortality. Structured contacts with skilled providers permit early detection of complications, delivery of preventive interventions such as iron–folic acid supplementation and malaria prophylaxis, birth preparedness counselling, and timely referral. In 2016 WHO revised its guidance, recommending a minimum of eight ANC contacts—up from four focused visits—with the first contact in the first trimester.

Early initiation matters because it defines the window in which screening for anaemia, hypertensive disorders and fetal growth restriction can still alter the course of pregnancy, and because it is a practical prerequisite for accumulating the recommended number of contacts. Across sub-Saharan Africa, however, first-trimester booking remains uncommon, reflecting delayed recognition of pregnancy, transport and cost barriers, and social norms around early disclosure.

Most published work in the region reports ANC coverage and its determinants; comparatively few studies quantify the association between the timing of initiation and clinically important outcomes within a defined delivery population, and evidence from Zanzibar is particularly limited. We therefore determined the distribution of ANC booking timing and contact frequency among women delivering at a district hospital on Unguja Island, and examined whether timing and frequency were independently associated with adverse maternal and fetal outcomes.

Methods

Study design and setting

We conducted an analytical cross-sectional study at Kivunge District Hospital, a public district-level facility in North A District (Kaskazini A), Unguja Island, Zanzibar, Tanzania. Data were collected between February and May 2026.

Zanzibar is a semi-autonomous archipelago of approximately 1·98 million people (2022 census) with a three-tier public health system: primary health care units and centres, district hospitals at secondary level, and Mnazi Mmoja Hospital in Stone Town as the national referral hospital. Maternity provision is highly centralised: Mnazi Mmoja conducts more than 12,000 deliveries annually and accounts for roughly 30% of all facility deliveries in Zanzibar. District hospitals, several of which have been commissioned or upgraded only recently, provide the secondary tier that serves populations outside the urban west.

Within this system, Kivunge District Hospital is the district-level facility for Kaskazini A, a predominantly rural district with a population of 157,369 (2022 census), and the principal provider of comprehensive

maternity and emergency obstetric and newborn care in the rural north of Unguja. Approximately 200 births occur each month in its catchment area. Before the upgrading of its maternity unit, women developing obstetric complications faced a journey of about one hour to Mnazi Mmoja Hospital. The facility therefore serves a defined and geographically bounded catchment population rather than a self-selected referral stream, which supports interpretation of these data as broadly representative of facility deliveries in rural northern Unguja — while acknowledging that it is not representative of Zanzibar as a whole, where the urban referral hospital dominates delivery volume.

Participants

Postpartum women admitted to the postnatal ward during the study period were recruited consecutively. Inclusion required delivery at the facility during the study window, admission to the postnatal ward, accessible ANC records or the ability to recall ANC attendance, and written informed consent. Women in active labour at approach, those too unwell to participate, those with documented cognitive impairment affecting consent, and those declining enrolment were excluded.

A total of 271 postpartum women meeting these criteria were recruited consecutively during the study period and constitute the analysis population. Participant flow, including women who attended no antenatal care and those with incomplete data for the multivariable models, is summarised in Supplementary File 2 (Figure S1).

Sample size

The minimum sample was derived from the Cochran single-proportion formula ($n = Z^2p(1 - p)/d^2$) using an early-booking prevalence of 22·9% reported from the Kilimanjaro Region of Tanzania, a 95% confidence level and a 5% margin of error, giving a minimum of 271 participants. Consecutive recruitment during the fixed study period yielded 271 participants, meeting this minimum. Because the formula powers estimation of a proportion rather than regression comparisons, the number of outcome events per predictor is reported alongside each model.

Variables and definitions

Primary exposure. Trimester of first ANC contact: first (≤ 12 completed weeks), second (13–27 weeks) or third (≥ 28 weeks), with first trimester as the reference category. In view of the non-linear pattern observed (Results), the three categories were retained in multivariable models rather than collapsed into a single late-booking indicator.

Secondary exposure. Number of ANC contacts, categorised per WHO 2016 as < 4 (inadequate), 4–7 (sub-optimal) and ≥ 8 (recommended minimum); modelled dichotomously as < 8 versus ≥ 8.

Outcomes. Two pre-specified composite outcomes were used. The adverse maternal composite was the presence of at least one of anaemia, pre-eclampsia, gestational diabetes mellitus, antepartum or postpartum haemorrhage, or caesarean delivery. The adverse fetal composite was at least one of birthweight < 2500 g, 5-minute Apgar score < 7, any documented neonatal complication, or perinatal death. Each composite was reconstructed directly from its recorded clinical components rather than from any single global assessment field, so that the outcome definition is explicit, auditable and reproducible from the primary record; where a global field and the component-level record disagreed, the components were treated as authoritative because they derive from documented clinical measurements.

Rationale for the composites. Composite endpoints are standard in maternal and perinatal research because individual adverse events are each relatively infrequent, and combining clinically related events of comparable importance increases statistical efficiency while capturing the spectrum of morbidity that ANC is intended to prevent. The components of each composite are recognised, guideline-defined contributors to maternal or perinatal morbidity and mortality, and each is plausibly linked to the timeliness and adequacy of antenatal care. Caesarean delivery was included in the maternal composite as a marker of intrapartum complication and operative intervention; because a proportion of caesareans are performed for reasons unrelated to maternal morbidity, its inclusion was examined directly in a pre-specified sensitivity analysis (below), so that the main and sensitivity analyses together bracket the effect of this definitional choice.

Operational definitions. Anaemia: haemoglobin < 11·0 g/dL. Pre-eclampsia: new-onset blood pressure ≥ 140/90 mmHg after 20 weeks with proteinuria or end-organ dysfunction, distinguished from chronic hypertension. Low birthweight: <2500 g regardless of gestational age. Covariates comprised maternal age, education, occupation, marital status, parity, residence, travel time to the facility, documented pregnancy complications and chronic conditions.

Data collection

Trained nurses and midwives administered a structured face-to-face questionnaire adapted from prior sub-Saharan African ANC research, translated into Kiswahili and back-translated to English to verify conceptual equivalence. Clinical outcomes reported at interview were cross-checked against ANC cards, maternity registers, delivery records and postnatal documentation; where sources conflicted, the medical record was treated as authoritative. Data collectors received structured training and completed questionnaires were reviewed daily by the principal investigator.

Statistical analysis

Categorical variables are summarised as counts and percentages, continuous variables as mean (SD) or median (IQR). Bivariate associations were assessed with Pearson χ^2 tests, and ordinal trend across categories with logistic regression on an ordinal score. Multivariable logistic regression included booking trimester, contact frequency, pregnancy complications, chronic conditions, employment,

education, travel time and maternal age. The maternal composite was frequent (136 events among 255 complete cases, giving roughly 15 events per predictor), so the maternal model was fitted by standard maximum likelihood. The fetal model was fitted by Firth penalised likelihood. Firth's method was chosen a priori because the fetal analysis involved a sparse exposure stratum — only 17 women attended eight or more contacts, among whom a single adverse fetal outcome occurred — a configuration that produces complete or near-complete separation and, under ordinary maximum likelihood, inflated or non-finite coefficients with unstable standard errors. Firth penalisation removes the first-order small-sample bias of maximum likelihood and yields finite, well-behaved estimates under separation; we report profile penalised-likelihood confidence intervals and likelihood-ratio p values, which are more reliable than Wald statistics in this setting. As a check, the maternal model was also refitted under Firth penalisation, with materially identical estimates. Multicollinearity was assessed by variance inflation factors (all < 2·0). Analyses used complete cases; the number analysed is reported for each model. The full recruited sample was 271 women throughout; no participant was removed from the study. Of the 256 women who attended ANC, one had a missing travel-time value, so complete data for the multivariable models were available for 255 of the 256 attendees. Analyses were conducted in Python 3·12 (statsmodels 0·14, SciPy 1·17, NumPy 2·4, pandas 3·0), with Firth penalised estimation implemented using a Newton–Raphson routine on the penalised score; significance was set at $p < 0·05$, two-tailed.

The maternal composite includes caesarean delivery, which is not invariably a marker of maternal morbidity. To quantify the influence of this definitional choice rather than treat it as an afterthought, we pre-specified a parallel analysis in which caesarean delivery was removed from the composite; the main and sensitivity analyses are reported together so that readers can judge the robustness of the maternal findings to the handling of caesarean section.

Ethics

The study was approved by the Zanzibar Health Research Ethics Committee (ZAHREC; reference ZAHREC/02/ST/APR/2026/121). Written informed consent was obtained from all participants; participation was voluntary and did not affect care. Identifiers were replaced with unique codes. Reporting follows the STROBE statement for cross-sectional studies (Supplementary File 1).

Results

Participant characteristics

The 271 participants had a mean age of 27·6 years (SD 7·5; range 16–52). Most were married (90·8%), had completed secondary education (62·0%) and lived in rural areas (86·3%); half were not in paid employment (50·2%). Median parity was 2 (IQR 1–3). Median travel time to the facility was 30 minutes (IQR 20–60), with 12·6% travelling more than 60 minutes. Documented pregnancy complications were present in 52·4% and chronic conditions in 9·6% (Table 1).

Table 1
Characteristics of participants (N = 271).

Variable	Category	n (%)
Age group (years)	< 20	33 (12·2)
	20–24	78 (28·8)
	25–29	68 (25·1)
	30–34	45 (16·6)
	≥ 35	47 (17·3)
Marital status	Married	246 (90·8)
	Widowed	11 (4·1)
	Single	8 (3·0)
	Divorced	6 (2·2)
Education	None	19 (7·0)
	Primary	40 (14·8)
	Secondary	168 (62·0)
	Tertiary	44 (16·2)
Occupation	Unemployed	136 (50·2)
	Employed	80 (29·5)
	Self-employed	55 (20·3)
Residence	Rural	234 (86·3)
	Peri-rural	37 (13·7)
Parity	0	24 (8·9)
	1	83 (30·6)
	2–4	105 (38·7)
	≥ 5	59 (21·8)
Travel time to facility	≤ 15 min	66 (24·4)
	16–30 min	80 (29·6)
	31–60 min	90 (33·3)
	> 60 min	34 (12·6)
Pregnancy complications	Yes	142 (52·4)

Variable	Category	n (%)
Chronic conditions	Yes	26 (9·6)

Travel time was missing for 1 participant; percentages for that variable use the available denominator. Percentages may not sum to 100 due to rounding.

ANC attendance, timing and frequency

Overall, 256 women (94·5%) attended at least one ANC visit and 15 (5·5%) attended none. Of the full recruited sample (N = 271), 69 (25·5%) booked in the first trimester, 119 (43·9%) in the second and 68 (25·1%) in the third. Median contact number was 4 (IQR 2–5); 116 (42·8%) attended fewer than four contacts, 123 (45·4%) attended four to seven, and only 17 (6·3%) reached eight or more (percentages of N = 271) (Fig. 1). Contact number declined markedly with later booking (median 5, 4 and 2 contacts for first-, second- and third-trimester bookers respectively; Kruskal–Wallis $p < 0·001$); no third-trimester booker achieved eight contacts.

Outcomes

At least one adverse maternal outcome occurred in 150 women (55·4%) and at least one adverse fetal outcome in 134 (49·4%). The commonest maternal components were anaemia (29·9%), caesarean delivery (25·1%), haemorrhage (18·5%), pre-eclampsia (17·7%) and gestational diabetes (10·0%). Among neonates, 43·5% had a documented complication, 29·5% a 5-minute Apgar below 7, 19·2% a birthweight under 2500 g, and 17·7% did not survive (Table 2).

Table 2
Prevalence of composite outcomes and their components (N = 271).

Outcome	n	%
Adverse maternal composite	**150**	**55.4**
Anaemia	81	29.9
Caesarean delivery	68	25.1
Haemorrhage	50	18.5
Pre-eclampsia	48	17.7
Gestational diabetes	27	10.0
Adverse fetal composite	**134**	**49.4**
Any neonatal complication	118	43.5
5-minute Apgar < 7	80	29.5
Birthweight < 2500 g	52	19.2
Perinatal death	48	17.7

Components are not mutually exclusive; a woman may contribute to more than one.

Booking trimester and outcomes

Adverse fetal outcomes increased sharply with later booking, from 29·0% among first-trimester bookers and 40·3% among second-trimester bookers to 79·4% among third-trimester bookers (χ^2=39·69, df = 2, p < 0·001). The pattern for adverse maternal outcomes was similar in direction but non-monotonic: 46·4%, 47·1% and 70·6% respectively (χ^2=11·35, df = 2, p = 0·003). In both cases the excess was concentrated in the third trimester, with second-trimester bookers closely resembling first-trimester bookers (Table 3, Fig. 2).

Table 3
Booking trimester and adverse outcomes (ANC attendees, n = 256).

Booking trimester	n	Adverse maternal n (%)	Adverse fetal n (%)
First (≤ 12 weeks)	69	32 (46·4)	20 (29·0)
Second (13–27 weeks)	119	56 (47·1)	48 (40·3)
Third (≥ 28 weeks)	68	48 (70·6)	54 (79·4)

Maternal χ^2=11·35, df = 2, p = 0·003; fetal χ^2=39·69, df = 2, p < 0·001. Trend across trimesters: maternal OR 1·64 per category (p = 0·005); fetal OR 3·04 per category (p < 0·001). The 15 women who attended no ANC

remain in the study sample (N = 271) but have no trimester-of-booking value and so are not shown in this table.

The 15 women who attended no ANC at all experienced the highest event rates of any group (93·3% adverse maternal, 80·0% adverse fetal, versus 53·1% and 47·7% among attendees). They remain part of the full analytic sample (N = 271) and are described separately here; they have no defined value for trimester of booking, so they do not appear in the trimester-stratified analyses in Table 3 and Fig. 2.

Contact frequency and outcomes

Adverse outcomes fell steadily as contact number rose. Among women with fewer than four contacts, 62·9% had an adverse maternal and 59·5% an adverse fetal outcome, compared with 41·2% and 5·9% respectively among the 17 women achieving eight or more (maternal χ^2=8·30, p = 0·016; fetal χ^2=19·82, p < 0·001) (Table 4, Fig. 3). Only one adverse fetal outcome occurred in the ≥ 8-contact group, so estimates involving this stratum are imprecise.

Table 4
Number of ANC contacts and adverse outcomes (n = 256).

Contacts	n	Adverse maternal n (%)	Adverse fetal n (%)
< 4 (inadequate)	116	73 (62·9)	69 (59·5)
4–7 (sub-optimal)	123	56 (45·5)	52 (42·3)
≥ 8 (WHO minimum)	17	7 (41·2)	1 (5·9)

Maternal χ^2=8·30, p = 0·016; fetal χ^2=19·82, p < 0·001. Trend: maternal OR 0·56 per category (p = 0·006); fetal OR 0·39 per category (p < 0·001).

Multivariable analysis

In the adjusted fetal model (Firth penalised; 255 complete cases, 122 events), third-trimester booking remained strongly associated with adverse fetal outcome relative to first-trimester booking (aOR 6·27, 95% CI 2·69–15·35; p < 0·001), as did fewer than eight contacts (aOR 5·64, 95% CI 1·25–53·86; p = 0·022). Second-trimester booking did not differ from first-trimester booking (aOR 1·22, 95% CI 0·63–2·40; p = 0·566). No sociodemographic variable, including maternal age, was independently associated with fetal outcome (Table 6).

In the adjusted maternal model (255 complete cases, 136 events), documented pregnancy complications were the dominant independent predictor of adverse maternal outcome (aOR 3·84, 95% CI 2·13–6·92; p < 0·001); employment showed a borderline association (aOR 1·68, 95% CI 0·97–2·90; p = 0·063) and chronic conditions did not reach significance after adjustment (aOR 2·18, 95% CI 0·76–6·23; p = 0·147). Neither booking trimester, contact frequency nor maternal age retained significance (Table 5).

Table 5
Multivariable logistic regression — adverse maternal composite (n = 255; 136 events).

Variable	cOR (95% CI)	p	aOR (95% CI)	p
Second trimester (vs first)	1·03 (0·57–1·86)	0·928	0·79 (0·39–1·57)	0·500
Third trimester (vs first)	2·77 (1·37–5·61)	0·005	1·31 (0·56–3·07)	0·527
ANC contacts < 8 (vs ≥ 8)	1·68 (0·62–4·55)	0·311	2·08 (0·62–6·98)	0·235
Pregnancy complications	4·02 (2·42–6·68)	< 0·001	3·84 (2·13–6·92)	< 0·001
Chronic conditions	2·95 (1·14–7·60)	0·025	2·18 (0·76–6·23)	0·147
Employment (vs unemployed)	1·37 (0·85–2·22)	0·198	1·68 (0·97–2·90)	0·063
Low education	1·13 (0·63–2·02)	0·691	0·94 (0·48–1·85)	0·863
Travel time > 60 min	1·55 (0·73–3·27)	0·253	1·18 (0·50–2·80)	0·705
Maternal age (per year)	1·02 (0·99–1·05)	0·249	1·03 (0·99–1·07)	0·127

cOR, crude odds ratio; aOR, adjusted odds ratio. McFadden pseudo-R^2=0·114. Reference categories: first-trimester booking; ≥8 contacts; no complications; no chronic conditions; unemployed; secondary/tertiary education; ≤60 min.

Table 6
Multivariable Firth penalised logistic regression — adverse fetal composite (n = 255; 122 events).

Variable	cOR (95% CI)	p	aOR (95% CI)	p
Second trimester (vs first)	1·66 (0·88–3·13)	0·120	1·22 (0·63–2·40)	0·566
Third trimester (vs first)	9·45 (4·31–20·72)	< 0·001	6·27 (2·69–15·35)	< 0·001
ANC contacts < 8 (vs ≥ 8)	16·41 (2·14–125·69)	0·007	5·64 (1·25–53·86)	0·022
Pregnancy complications	1·90 (1·17–3·09)	0·009	1·10 (0·61–1·96)	0·741
Chronic conditions	1·22 (0·54–2·73)	0·637	1·03 (0·38–2·79)	0·956
Employment (vs unemployed)	1·14 (0·71–1·84)	0·585	1·20 (0·70–2·06)	0·516
Low education	0·90 (0·51–1·61)	0·730	0·72 (0·37–1·40)	0·335
Travel time > 60 min	1·33 (0·65–2·75)	0·436	1·02 (0·43–2·40)	0·972
Maternal age (per year)	0·97 (0·94–1·00)	0·083	0·97 (0·94–1·01)	0·124

Adjusted estimates from Firth penalised likelihood with profile penalised-likelihood confidence intervals and likelihood-ratio p values. The wide interval for contact frequency reflects a single adverse fetal outcome among 17 women with ≥ 8 contacts. Maternal age is modelled per one-year increment. Reference categories otherwise as in Table 5.

Sensitivity analysis

The maternal composite as defined (including caesarean delivery) identified documented pregnancy complications as the dominant predictor. Because caesarean delivery is not invariably a marker of maternal morbidity, we examined this definitional choice directly in the pre-specified sensitivity analysis: refitting the model with caesarean removed (133 events, 49·1%) left the conclusions unchanged and, if anything, strengthened the principal signal — pregnancy complications remained dominant (aOR 4·88, 95% CI 2·70–8·82; p < 0·001), booking trimester remained non-significant (third vs first aOR 1·41, 95% CI 0·61–3·30; p = 0·423), and fewer than eight contacts was borderline (aOR 3·63, 95% CI 0·96–13·76; p = 0·058). The main and sensitivity analyses therefore agree, indicating that the maternal findings are not an artefact of including caesarean section in the composite.

Discussion

In 271 women delivering at a Zanzibari district hospital, only about one in four attending ANC booked within the first trimester and fewer than one in fourteen achieved the eight contacts recommended by WHO. Third-trimester initiation was independently associated with roughly six-fold higher odds of an adverse fetal outcome, and this association persisted after adjustment for pregnancy complications, chronic conditions, maternal age and other sociodemographic factors. By contrast, second-trimester booking was statistically indistinguishable from first-trimester booking. As the design is cross-sectional, these are associations rather than causal effects.

This threshold pattern is the study's principal finding and has a direct programmatic reading. The excess risk was concentrated among women presenting after 28 weeks, rather than distributed evenly across a gradient from early to late booking. This suggests that shifting women from third- to second-trimester booking could be associated with much of the available benefit, even where first-trimester attendance remains difficult to achieve — a hypothesis that warrants prospective evaluation.

Booking timing in regional context

The first-trimester booking rate of 25·5% falls below the pooled sub-Saharan African estimate of 37·2% derived from 86 studies across 19 countries (n = 224,317), and within the wide continental range of 13·7% (South Africa) to 69·1% (Liberia). Globally, early-ANC coverage follows a steep income gradient, exceeding 80% in high-income countries but reaching only 52% in lower-middle-income and 24% in low-income settings (Table 7). Coverage in this setting is thus consistent with, rather than exceptional among, low-income sub-Saharan populations.

Table 7
Early / first-trimester ANC coverage in comparable settings (context).

Setting	Early-ANC coverage	Source
Kivunge District Hospital, Zanzibar (this study; N = 271)	25·5%	This study
Tanzania — national (2022 TDHS; n = 4,243)	34·0% (95% CI 32·0–36·0)	Mahiti et al. 2025
Sub-Saharan Africa — pooled (86 studies, 19 countries; n = 224,317)	37·2% (95% CI 33·3–41·0)	Abdo et al. 2023
Sub-Saharan Africa — pooled, updated estimate	38·0% (95% CI 37·8–38·2)	Akinola et al. 2026
Range across African countries (updated)	14·5% (Mozambique) – 68·6% (Liberia)	Akinola et al. 2026
Western Ethiopia — facility-based, multi-centre (2023; n = 414)	43·2% (56·8% booked late; 95% CI 51·9–61·5)	Amsalu et al. 2025
Low-income countries (global, 2013)	63·7%	Gage et al. 2025
High-income countries (global, 2013)	> 80%	Gage et al. 2025

Definitions of the early-ANC window (≤ 12 vs < 14 weeks) and data sources (facility records, DHS, modelled estimates) differ across sources; comparisons are indicative rather than exact.

Comparison with regional evidence

Both coverage indicators in this cohort sit below regional benchmarks. First-trimester booking (25·5%) is below the pooled sub-Saharan African estimate of 37·2%, and the proportion achieving eight contacts (6·3%) is well below the 14·5% pooled across ten sub-Saharan countries in recent Demographic and Health Surveys. Zanzibar's northern rural district is therefore not merely below the WHO target but below the regional average on both dimensions simultaneously (Table 8).

The magnitude of the associations reported here exceeds those from population-based analyses. Pooled DHS data across ten sub-Saharan countries found that eight or more contacts reduced the odds of low birthweight by roughly one third (aOR 0·68), whereas the present analysis found fewer than eight contacts associated with a roughly six-fold increase in the odds of the adverse fetal composite (aOR 5·95). Several factors plausibly account for this difference and should temper direct comparison. First, the outcome differs: a composite spanning birthweight, Apgar score, neonatal complications and perinatal death will move more than birthweight alone. Second, a facility delivery population is enriched for obstetric pathology relative to a household survey. Third, the reference stratum here is small (17 women, one event), inflating the point estimate and widening its interval. Fourth, DHS analyses rely on

maternal recall and typically exclude stillbirths, attenuating measured associations. The consistent direction across these very different designs is more informative than the difference in magnitude.

A further contrast concerns study focus rather than findings. Much of the sub-Saharan literature on ANC timing examines the determinants of late booking — knowledge, parity, pregnancy intention, distance — rather than its consequences for mother and newborn. Studies that do link ANC to outcomes have generally examined contact number rather than timing, and single outcomes rather than composites. Analyses that place trimester of initiation alongside contact frequency within a defined delivery population, as here, remain uncommon, which is where this study's contribution lies.

.**Table 8.** Coverage and outcome associations in comparison with regional evidence.

Source	Setting / design	Measure	Estimate
This study	Kivunge District Hospital, Zanzibar; cross-sectional, N = 271	First-trimester booking	**25·5%**
Abdo et al. 2023	86 studies, 19 African countries; meta-analysis, n = 224,317	First-trimester booking	37·2%
This study	As above	≥ 8 ANC contacts	**6·3%**
Weyori et al. 2022	DHS, 10 sub-Saharan countries; n = 33,585	≥ 8 ANC contacts	14·5%
This study	As above	3rd vs 1st trimester → adverse fetal composite	**aOR 6·27 (2·69–15·35)**
This study	As above	< 8 vs ≥ 8 contacts → adverse fetal composite	**aOR 5·64 (1·25–53·86)**
Weyori et al. 2022	As above	≥ 8 vs < 8 contacts → low birthweight	aOR 0·68 (0·56–0·82)

aOR, adjusted odds ratio. Outcome definitions differ across sources (composite adverse fetal outcome here versus low birthweight alone in pooled DHS analyses), so estimates are not directly interchangeable; the table is intended to situate magnitude and direction rather than to provide a formal comparison.

Contact frequency

Only 6·3% of women met the eight-contact benchmark, and the shortfall was structurally linked to late booking: median contact number fell from five among first-trimester bookers to two among third-trimester bookers, and no woman presenting in the third trimester achieved eight contacts. Fewer than eight contacts was independently associated with adverse fetal outcome, but the estimate rests on a single event among 17 women in the reference stratum and must be read as imprecise. Because timing and frequency are entangled by design — late booking mechanically limits the number of achievable contacts — their independent contributions cannot be fully separated in these data, and the two should be interpreted jointly rather than as competing explanations. From a programmatic standpoint, timing

may be a practical precondition for adequate contact frequency: efforts to raise the number of contacts without addressing late initiation are unlikely to succeed in this setting, whereas strategies that promote earlier booking could plausibly improve both dimensions together.

Maternal outcomes and other predictors

For maternal outcomes, documented pregnancy complications dominated (aOR 3·84) and booking timing lost significance after adjustment. Two readings are plausible and cannot be distinguished in a cross-sectional design: complications may lie on the pathway between late presentation and maternal morbidity, or women who develop complications may present or be referred earlier, attenuating the apparent association with timing. Employment showed a borderline positive association with adverse maternal outcome (aOR 1·68, p = 0·063); if real, it may reflect residual confounding by care-seeking, referral or documentation patterns rather than a causal effect, and it warrants dedicated investigation rather than causal interpretation.

The absence of an independent association between booking trimester and the maternal composite does not diminish the clinical importance of the fetal findings. It may indicate that, in this setting, the burden associated with delayed ANC falls principally on fetal and neonatal wellbeing, plausibly through missed opportunities for early detection and management of conditions affecting fetal growth, oxygenation and survival.

Implications for policy and practice

These findings are consistent with a dual-indicator approach to monitoring ANC performance in comparable settings: tracking both first-trimester booking and the proportion of pregnancies booked before 28 weeks. The latter may be a more attainable short-term target where first-trimester attendance remains low, while still capturing the stratum in which adverse perinatal outcomes were most concentrated. Community-based strategies to promote early pregnancy recognition, together with efforts to reduce transport, cost and social barriers to early attendance, are plausible priorities for improving these indicators; their effect on outcomes would need to be confirmed prospectively.

Strengths and limitations

Strengths include a consecutively recruited sample large enough to estimate adjusted associations with reasonable precision, retention of the three-category exposure rather than a collapsed late-booking indicator, verification of outcomes against facility records, adjustment for maternal age and other potential confounders, penalised estimation for the fetal model, and a pre-specified sensitivity analysis excluding caesarean delivery.

Limitations warrant emphasis. The cross-sectional design precludes causal inference and cannot establish that late booking preceded the conditions with which it is associated. Restriction to facility-based deliveries excludes women delivering at home, limiting generalisability to the wider pregnant population. Gestational age at booking may be misclassified where dating relied on last menstrual

period rather than ultrasound. The composite outcomes aggregate conditions of differing severity, and the ≥ 8-contact stratum contained only 17 women and a single adverse fetal outcome, so estimates involving it are imprecise. Booking timing and contact number are structurally entangled, and their independent contributions cannot be fully separated. The modest sample size limits power for the smallest strata. Finally, the data derive from a single facility over a four-month period.

Conclusion

In this Zanzibari district hospital, third-trimester ANC initiation was independently associated with roughly six-fold higher odds of adverse perinatal outcomes, whereas second-trimester initiation was indistinguishable from first-trimester initiation. Combined with an eight-contact target achieved by fewer than 7% of women, this suggests that programme effort in comparable settings may be better directed at preventing third-trimester presentation — through community-based early pregnancy identification and reduction of facility-level access barriers — than at a contact count that remains far out of reach. Monitoring the proportion of pregnancies booked before 28 weeks, alongside first-trimester booking, would provide an attainable and clinically meaningful indicator of programme performance.

Declarations

Ethics approval and consent to participate. Approved by the Zanzibar Health Research Ethics Committee (ZAHREC; reference ZAHREC/02/ST/APR/2026/121). Written informed consent was obtained from all participants.

Availability of data and materials. The de-identified dataset and analysis code are available from the corresponding author on reasonable request.

Competing interests. The authors declare no competing interests.

Funding. This research received no external funding.

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All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Acknowledgements

The authors sincerely thank the management and staff of Kivunge District Hospital for their permission and support during the conduct of this study. We are grateful to the antenatal care clinic staff, maternity ward personnel, medical records department, and research assistants for their valuable contributions to data collection and quality assurance. We also acknowledge the dedication of the data collectors, whose efforts ensured the completeness and accuracy of the study data. Finally, we express our sincere appreciation to all women whose medical records contributed to this research and to advancing knowledge of antenatal care utilization and maternal and neonatal outcomes in Zanzibar.

References

1. Moshi TJ, Kibusi SM, Bwire DB, Lilungulu A. The effectiveness of interactive mobile health technologies in improving antenatal care service utilization in Dodoma Region, Tanzania: a quasi-experimental study. PLoS Digit Health. 2023;2:e0000321. 10.1371/journal.pdig.0000321.
2. Kimario AD, Gibore NS, Ngowi AF, Masika GM. Antenatal care services utilization and their associated factors among postnatal women in Dodoma city: a cross-sectional study. BMC Pregnancy Childbirth. 2025;25(1):276. 10.1186/s12884-024-07118-2. . PMID: 40082813; PMCID: PMC11905713.
3. Sserwanja Q, Musaba MW, Kamara K, Mutisya LM, Mukunya D. Status of the latest 2016 World Health Organization recommended frequency of antenatal care contacts in Sierra Leone: a nationally representative survey. BMC Health Serv Res. 2022;22:1165. 10.1186/s12913-022-08594-y.
4. Di Martino DD, Avagliano L, Ferrazzi E, Fusè F, Sterpi V, Parasiliti M, Stampalija T, Zullino S, Farina A, Bulfamante GP, Di Maso M, D'Ambrosi F. Hypertensive Disorders of Pregnancy and Fetal Growth Restriction: Clinical Characteristics and Placental Lesions and Possible Preventive Nutritional Targets. Nutrients. 2022;14(16):3276. 10.3390/nu14163276. . PMID: 36014782; PMCID: PMC9414322.
5. Tousty P, Fraszczyk-Tousty M, Golara A, Zahorowska A, Sławiński M, Dzidek S. Screening for Preeclampsia and Fetal Growth Restriction in the First Trimester in Women without Chronic

Hypertension. J Clin Med. 2023;12(17):5582. 10.3390/jcm12175582. . PMID: 37685649; PMCID: PMC10488103.

6. Abdo R, Demelash M, Seid AM, Mussema A. First trimester antenatal care contact in Africa: a systematic review and meta – analysis of prevalence and contributing factors. BMC Pregnancy Childbirth. 2023;23:742. 10.1186/s12884-023-06034-1.
7. Sibanda S, Khozah MY, Moyo PL. Lived Experiences of Pregnant Women Regarding Late Antenatal Care Bookings: A Phenomenological Study in Mangwe District, Zimbabwe. Inquiry. 2026 Jan-Dec;63:469580261444288. doi: 10.1177/00469580261444288. Epub 2026 Apr 24. PMID: 42028915; PMCID: PMC13125842.
8. Tafere TZ, Demissie KA, Teshale G, Tiruneh MG, Dellie E, Geberu DM, Hagos A, Worku N, Jejaw M. Multilevel analysis of late antenatal care booking and its predictors among pregnant women in extremely high and very high maternal mortality sub-Saharan African countries: evidence from recent demographic and health surveys data. BMC Pregnancy Childbirth. 2025;25(1):656. 10.1186/s12884-025-07789-5. . PMID: 40468242; PMCID: PMC12139056.
9. Gebrekidan AY, Woldegeorgis BZ, Kassie GA, Haile KE, Abrha AT, Asnake AA, Asgedom YS. Effective coverage of antenatal care and associated factors among pregnant women in Tanzania: a multilevel analysis. Front Glob Womens Health. 2025;6:1477666. 10.3389/fgwh.2025.1477666. . PMID: 40896113; PMCID: PMC12394477.
10. Olapeju B, Bride M, Wamala M, Atobrah D, Lee EH, Hendrickson ZM. Antenatal care and breastfeeding practices in Sub-Saharan Africa: an analysis of demographic and health surveys. BMC Pregnancy Childbirth. 2025;25(1):1–12. 10.1186/s12884-025-07188-w.
11. Mahiti GR, Chombo S, Luoga P. Socio-demographic correlates of booking antenatal care in first trimester among pregnant women in Tanzania. Insights from Tanzania demographic health survey 2022. Front Reprod Health. 2025;7:1669621. 10.3389/frph.2025.1669621. . PMID: 41234245; PMCID: PMC12605227.
12. Ngowi AF, Shirima L, Ngalesoni F, Frumence G. Determinants of Focused Antenatal Care Utilization Among Women in Simiyu Region Tanzania. SAGE Open Med. 2023;11. 10.1177/23779608231170728.
13. Tchibozo EMC, Gado TAA, Sonou YCH, Amidou SA, Lacroix P, Houinato DS, Bezanahary H. Late initiation of antenatal care and its associated factors among pregnant women in Benin: a facility based cross-sectional study. BMC Pregnancy Childbirth. 2025;25(1):1008. 10.1186/s12884-025-08170-2. . PMID: 41044497; PMCID: PMC12495766.
14. Pattanamanee J, Chawanpaiboon S. Adverse maternal and neonatal outcomes in extremely young mothers (≤ 17 years) versus women aged 20–35 years: a retrospective cohort study in Thailand.Midwifery. 2026;157:104771. 10.1016/j.midw.2026.104771
15. Mirieri H, Nduati R, Dawa J, Okutoyi L, Osoro E, Mugo I, et al. Risk factors of adverse birth outcomes among a cohort of pregnant women in Coastal Kenya, 2017–2019. BMC Pregnancy Childbirth. 2024;24(1):127. 10.1186/s12884-024-06320-6. . PMID: 38347445; PMCID: PMC10860222.

16. Hasan T, Mohan D, Ghosh D. Prevalence and risk factors for anaemia during pregnancy in Sylhet district of Bangladesh: a cohort study. J Glob Health. 2026;16:04367. 10.7189/jogh.16.04367.
17. Lyoba WB, Mpambije CJ, Mwakatoga JD. Unlock the drivers of early ANC visits among pregnant women in Kasulu town council, Tanzania: an institutional cross-sectional study. Reprod Health. 2025;22(1):187. 10.1186/s12978-025-02162-3. . PMID: 41053705; PMCID: PMC12502604.
18. Sibanda S, Khozah MY. Determinants of Late Antenatal Care Bookings Among Pregnant Women in Mangwe District, Zimbabwe : A Quantitative Cross-Sectional Study. SAGE Open Med. 2026;14. 10.1177/20503121261430430.
19. Moloro AH, Ebrahim OA. Time to initiation of antenatal care and its predictors among pregnant women across 35 sub-Saharan African countries (2011–2024): A multilevel mixed-effects acceleration failure time model of multination population survey data. Reprod Health. 2026;23:112. https://doi.org/10.1186/s12978-026-02335-8.
20. Zeleke A, Liyew AM, Tesema GA, Alamneh TS, et al. Timely initiation of antenatal care and its associated factors among pregnant women in sub-Saharan Africa: a multicountry analysis of Demographic and Health Surveys. PLoS ONE. 2022;17:e0262411. 10.1371/journal.pone.0262411.
21. Amsalu AA, Yalew AW. Prevalence and determinants of late first antenatal care initiation in western Ethiopia: findings from a multicentre cross-sectional study. Front Public Health. 2025. 10.3389/frph.2025.1551706.
22. Wolderufael TS, Areda TB, Ganebo UW, Gebreyesus FF. Determinants of late initiation for first antenatal care visit among pregnant women in public health institutions, Dale District, Southern Ethiopia: unmatched case-control study. Sci Res. 2020;8(2):31–8. 10.11648/j.sr.20200802.11.
23. Gage A, Conrad M, Knight M, Banke-Thomas A, Bintz C, Bienhoff K et al. Measuring antenatal care timing and content: a systematic analysis of trends. Lancet Glob Health. 2023;11:702–713.2026;14(5):e702-e713. 10.1016/S2214-109X(26)00010-0. Epub 2026 Apr 15. PMID: 41999716; PMCID: PMC13106046.
24. Lukwago SL, Adam E, Marvin A, Kizito K, Wani S, Kasibante S, et al. Compliance with the WHO-recommended eight antenatal care contacts schedule among postpartum mothers in eastern Uganda: a cross-sectional study. PLoS ONE. 2024;19:e0314769. 10.1371/journal.pone.0314769.
25. Wakjira GI, Solbana LK, Digilu YG, Tafese ZT, Gindaba BG, Boru JD, Efa BW. Compliance with ≥ 8 antenatal care contacts and its associated factors among postnatal women attending public health facilities in Nekemte town, Western Ethiopia: a cross-sectional study. BMC Pregnancy Childbirth. 2025;25(1):1058. 10.1186/s12884-025-08223-6. . PMID: 41068601; PMCID: PMC12512450.
26. Abebaw N, Negesse Y, Begashw A. Prevalence and associated factors of eight antenatal care contacts among mothers who gave birth in Shebel Berenta District, East Gojjam Zone, northeast Ethiopia, 2024. Front Public Health. 2025. 10.3389/frph.2025.1531380.
27. Osei F, Konadu E, Addai-Manu H, Kwabena J, Serwah E, Ibrahim N, et al. Effect of completing eight or more antenatal care contacts on adverse pregnancy outcomes in a district hospital in Ghana: a

propensity score-matched and doubly robust analysis. Glob Epidemiol. 2026;11:100253. 10.1016/j.gloepi.2026.100253.

28. Gebeyehu FG, Geremew BM, Belew AK, Zemene MA. Number of antenatal care visits and associated factors among reproductive age women in Sub-Saharan Africa using recent demographic and health survey data from 2008–2019: A multilevel negative binomial regression model. PLOS Glob Public Health. 2022;2(12):e0001180. 10.1371/journal.pgph.0001180. . PMID: 36962803; PMCID: PMC10022079.
29. Agaba R, Ochola H, Muhwezi A, Murungi T, Namanya S, Lule D, et al. Compliance with WHO-recommended eight or more antenatal contacts and associated factors among women at primary health facilities in Mbarara District, Uganda. SAGE Open Med. 2026;14. 10.1177/20503121261464652.
30. Kase BF, Seifu BL, Mare KU, Shibeshi AH, Asebe HA, Gemeda K, Asmare ZA, Asgedom YS, Fente BM, Lombebo AA, Tebeje TM. Time to first antenatal care visit and its predictors among women in Kenya: Weibull gamma shared frailty model (based on the recent 2022 KDHS data). BMC Pregnancy Childbirth. 2025;25(1):50. 10.1186/s12884-025-07178-y. PMID: 39844082; PMCID: PMC11752801.
31. Hoque AM, Buckus S, Hoque M, Van Hal G. Deciphering the association between antenatal care visits and pregnancy outcomes in South Africa. Eur J Med Health Sci. 2022;4(3):175–81. 10.24018/ejmed.2022.4.3.1113.
32. Akinola O, Zimba R, Banda K, et al. A systematic review of implementation strategies to improve timely initiation of antenatal care among pregnant women in sub-Saharan Africa. J Public Health Afr. 2026;17(1):a1461. 10.4102/jphia.v7il.1461.

Figures

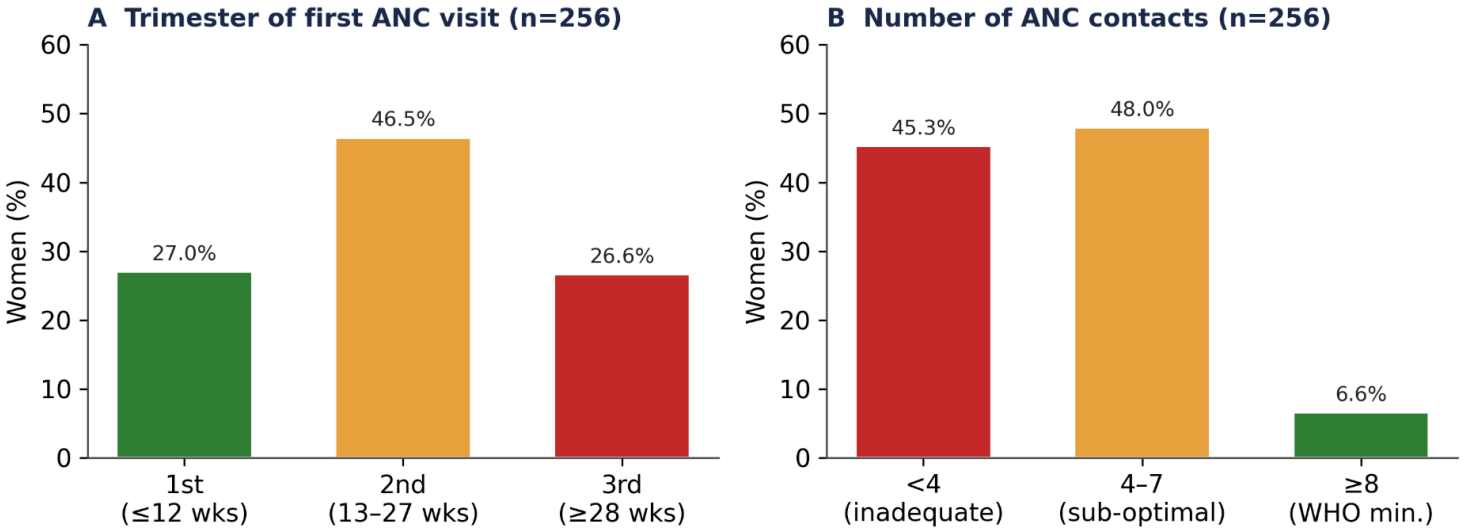


Figure 1

Trimester of first ANC visit (Panel A) and number of ANC contacts by WHO category (Panel B) among women who attended ANC (n=256). WHO, World Health Organization.

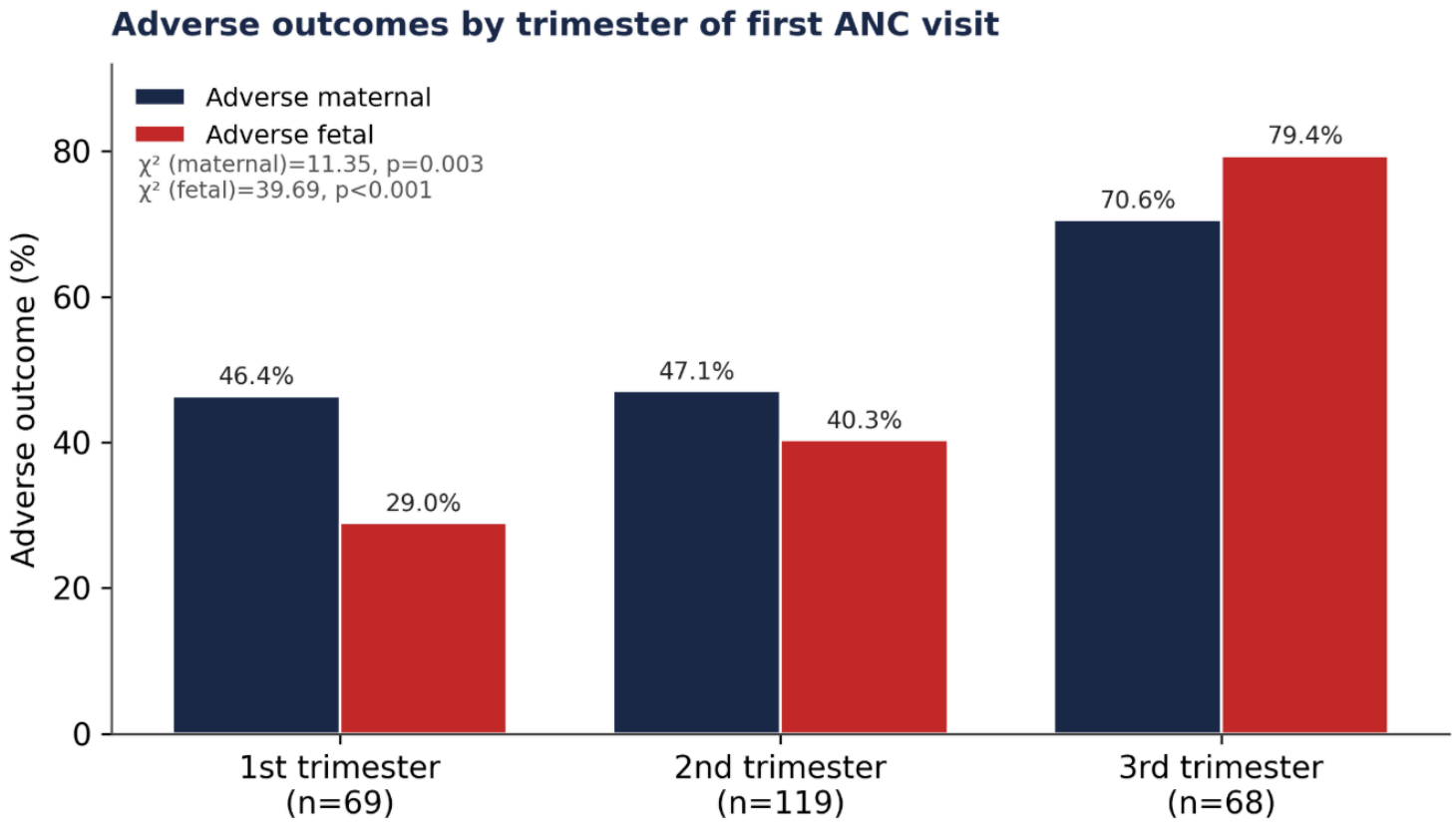


Figure 2

Adverse maternal and fetal outcomes by trimester of first ANC visit (n=256).

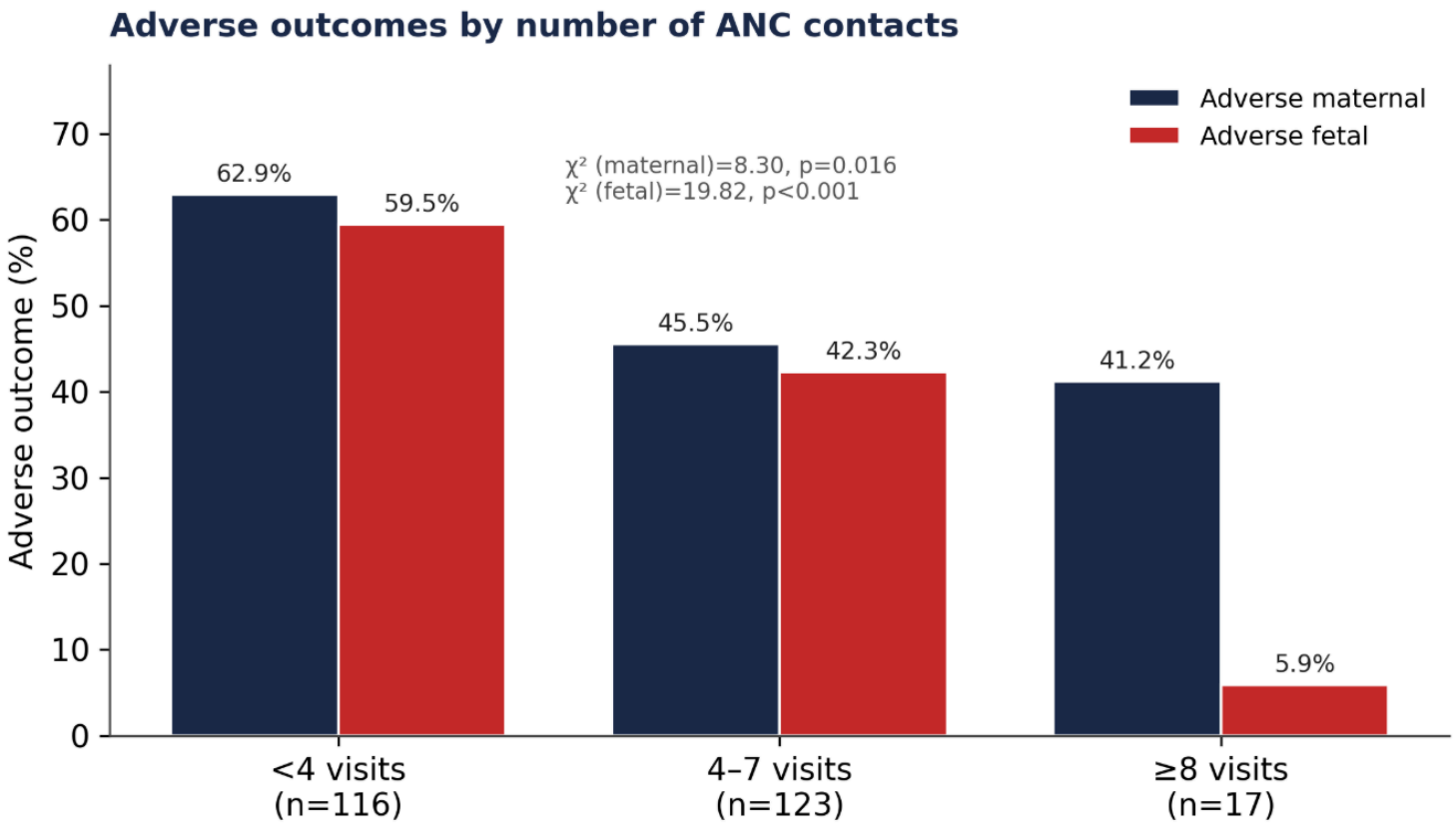


Figure 3

Adverse maternal and fetal outcomes by number of ANC contacts (n=256). The ≥8-contact group is small (n=17) and contained a single adverse fetal outcome; estimates for this stratum are imprecise.

Supplementary Files

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