Uptake of antenatal care in high HIV-prevalence settings: Results from three population-based surveys in South Africa

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Background. Despite substantial progress in reducing pregnancy-related preventable morbidity and mortality, these remain unacceptably high in developing countries. In 2016, the World Health Organization (WHO) revised recommendations for antenatal care (ANC) from a 4-visit model to a minimum of 8 ANC contacts to reduce perinatal mortality further and improve women's experience of care. The guidelines also recommend that the first ANC visit (ANC-1) should occur during the first trimester.

Objectives. To describe the uptake of routine ANC and its associated factors in South Africa (SA) prior to the 2016 WHO recommendations, when the country recommended 4 ANC visits, to bring to light potential challenges in achieving the current recommendations.

Methods. Secondary data analyses were performed from 3 facility-based, cross-sectional national surveys, conducted to measure 6-week mother-to-child transmission of HIV and coverage of related interventions in SA. These surveys recruited mother-infant pairs attending selected public primary healthcare facilities for their infants' 6-week immunisation in 2010, 2011 - 2012 and 2012 - 2013. Quantitative questionnaires were used to gather sociodemographic and antenatal-to-peripartum information from Road to Health cards and maternal recall. The inclusion criteria for this secondary assessment were at least 1 ANC visit, the primary outcome being uptake of ≥4 ANC visits. A multivariable logistic regression model was used to: (*i*) identify maternal factors associated with ANC visits; and (*ii*) establish whether receiving selected ANC activities was associated with frequency or timing of ANC-1.

Results. Of the 9 470, 9 646 and 8 763 women who attended at least 1 ANC visit, only 47.5% (95% confidence interval (CI) 45.4 - 49.6), 55.6% (95% CI 53.2 - 58.0) and 56.7% (95% CI 54.3 - 59.1) adhered to ≥4 ANC visits, while 36.0% (95% CI 34.5 - 37.5), 43.5% (95% CI 42.0 - 45.1) and 50.8% (95% CI 49.3 - 52.2) attended ANC-1 early (before 20 weeks' gestation) in 2010, 2011 - 2012 and 2012 - 2013, respectively. Multiparity and lower socioeconomic status were significantly associated with non-adherence to the 4-visit ANC recommendation, while a later survey year, higher education, being married, >19 years old, HIV-positive, planned pregnancy and knowing how HIV is transmitted vertically were strongly related to ≥4 ANC visits. The number of women who received selected ANC activities increased significantly with survey year and ≥4 ANC visits, but was not associated with timing of ANC-1.

Conclusions. Despite increases in the uptake of ≥4 ANC visits and early ANC-1 rates between 2010 and 2013, these practices remain suboptimal. Adhering to ≥4 ANC visits improved coverage of selected ANC activities, implying that strengthening efforts to increase the uptake of ANC from at least 4 to 8, could improve overall outcomes.

The World Health Organization (WHO) estimates that ~830 women die daily from preventable causes related to pregnancy and childbirth, 99% of which occur in developing countries.[1] Women from rural areas and poor communities are most affected. Part of the 2030 Sustainable Development agenda is to reduce the global maternal mortality ratio (MMR) to <70 per 100 000 live births.[2] In South Africa (SA), MMR remains unacceptably high, at 138 per 100 000 live births (95% confidence interval (CI) 124 - 154).[3] SA is also home to the world's largest HIV epidemic, with ~7 million (95% CI 6.7 - 7.4) of the population living with HIV.[4] In SA, the highest HIV prevalence is seen among pregnant women (30.8%; 95% CI 30.0 - 31.6) aged 15 - 49 years attending public health facilities,[5] and an estimated 42% of all maternal deaths are associated with HIV infection.[6] This makes

the integration of HIV services into the routine antenatal care (ANC) programme critical – yet the intended improvement in outcomes due to integration is only possible if the uptake of basic ANC service delivery is optimal. The integrated ANC structure was adopted countrywide by 2010 and included other activities for maximising maternal and child health (MCH), such as screening for tuberculosis and syphilis, initiating the required treatment interventions, as well as early education of mothers regarding best infant-feeding practices.[7] ANC is therefore a preventive public health intervention to promote the wellbeing of all pregnant women and that of their expected babies.[8] It is an entry point for providing a unique opportunity to screen women for diseases, educate, treat or refer them for ongoing care, where required.

Studies have shown that adequate antenatal attendance has a potential for improving perinatal outcomes.[9,10] Good-quality ANC and women's positive experiences of care are likely to improve adherence to recommended ANC contacts and subsequently result in positive pregnancy outcomes.[11] Uptake of ≥4 ANC visits has been shown to increase the chances of receiving proper antenatal screening, high-quality care, including delivery by skilled birth attendants,[12] and risk reduction of stillbirths and preterm births.[13,14] In line with these findings, the WHO, in 2016, revised its recommendations on ANC uptake from a target of 4 ANC visits to a new target of 8 ANC visits for all pregnant women.[11] This revision also followed the need to support set goals to eliminate vertical HIV transmission.[15] Delayed ANC booking after 12 weeks' gestation, together with infrequent ANC visits, especially in the third trimester of pregnancy, has been associated with poor perinatal outcomes, such as maternal mortality, stillbirths and neonatal deaths[16-19] due to the increased likelihood of missed opportunities for preventive treatment and care.[20] The WHO and the National Department of Health (NDoH) guidelines recommend that the first antenatal contact should occur during the first 12 weeks of gestation.[11,21] However, several contextual factors influence women's utilisation of maternal healthcare services. These include unplanned pregnancy,[16,22,23] parity,[24] fear of HIV testing and stigmatisation,[16,22] maternal socioeconomic status,[25,26] including lack of confidentiality,[27] and poor health-worker attitudes.[28,29]

The aim of this analysis was to determine the uptake of recommended routine basic ANC, i.e. ≥4 ANC visits, using secondary data from three national, population-based surveys (2010, 2011 - 2012 and 2012 - 2013) conducted in SA. Secondary objectives were to determine factors associated with adhering to ≥4 ANC visits and to assess whether better uptake of such visits increases coverage of selected key ANC services. This would highlight factors that potentially need attention to enable the country to meet the current WHO recommendations for a minimum of 8 ANC contacts.

Methods

Design
We analysed data collected as part of three facility-based, cross-sectional, national SA prevention of mother-to-child transmission of HIV (SAPMTCT) surveys, conducted in 2010 (June - December), 2011 - 2012 (August - March) and 2012 -2013 (October - May). These surveys aimed to measure the risk of MTCT at 4 - 8 weeks' postpartum and coverage of key prevention of MTCT with regard to HIV interventions.[30,31]

All caregiver-infant pairs visiting selected public primary healthcare clinics and community healthcare centres for their infants' 6-week immunisation during the study periods were approached to participate in the surveys. A multistage probability proportional to size sampling frame was set up nationally and facilities were randomly selected from this frame to provide the desired number of participants (methods for the three SAPMTCT surveys are described in detail by Goga et al.).[30] The sample was representative of national and provincial level estimates of the primary outcome. The data used for this secondary analysis were obtained from the survey interviews. Briefly, electronic questionnaires loaded on low-cost mobile phones using the Mobile Researcher software management solution (mobenzi.com, SA) were administered by trained field workers (registered nurses) by interviewing mothers or caregivers. These interviews lasted 30 - 45 minutes, during which data were collected from maternal recall and Road to Health cards. Quantitative information on sociodemographics, antenatal and obstetric factors, and other maternal and infant health status indicators were gathered.

Sample sizes for this secondary analysis consisted of 9 470, 9 646 and 8 763 women who adhered to at least 1 antenatal visit in 2010, 2011 - 2012 and 2012 - 2013, respectively.

Main outcome measures
The primary outcome variable for this study was the self-reported number of ANC visits during the most recent pregnancy, presented here as a binary variable of at least 4 ANC visits (adherence) or no visits (non-adherence). This outcome was related to the 2002 WHO recommendation of at least 4 ANC visits during pregnancy,[32] which was used in SA during the survey periods.

The secondary outcome was defined as receiving 3 ANC services expected to be offered to all women attending routine ANC and was included in the survey questionnaires. We used receipt of all 3 ANC interventions (i.e. syphilis serology screening, HIV testing or confirmation of HIV-positive status, and infant feeding counselling), which are part of the standard of care during pregnancy,[33] as a proxy for adequate coverage of basic ANC. We investigated whether adequate coverage (receipt) of basic ANC services was met when there was adherence to the recommended number of ANC visits and/or when the first ANC visit (i.e. ANC-1) was booked early (i.e. before 20 weeks' gestation), adjusting for survey year and self-reported prenatal HIV status. An upper margin of 20 weeks for the ANC-1 visit timing was used, based on evidence that the SA national average for an ANC-1 visit before 20 weeks was persistently <50% between 2005 and 2012.[34]

Independent variables
We sought to identify which user factors were associated with ANC visit adherence. These included socioeconomic status (SES), maternal self-reported prenatal HIV status and highest education level achieved. We used principal component analysis to derive an index for SES from information about household commodities.

Statistical analysis
For approximately one-third (n=8 791/27 879) of participants there was missing information on the outcome variable (i.e. either did not know or chose not to answer). To adjust for missing data in the primary outcome, participants for whom there were complete data were weighted for the probability of being missing (inverse probability weighting). Therefore, we fitted a predictive logistic model for being missing on the outcome variable, which included all other variables. The survey weight was then multiplied by the inverse of the probability of being missing on the outcome variable, and the augmented weight was then applied in the analysis. Participants with complete data therefore represented those with missing data in the analysis.

A logistic regression model with a domain analysis of those with complete information on the outcome variable (i.e. the number of ANC visits provided), was then fitted to assess the associations of the predictor variables, with ANC uptake across all three survey periods. The reference group for the primary outcome included clients with 1 - 3 ANC visits (non-adherent). To keep the survey structure of the data intact, an unknown category was created for secondary variables, where some data were missing.

For the secondary outcome, a multivariable logistic regression model was used to examine the association between the proxy coverage of basic ANC services and ANC visit adherence, as well as early ANC-1, adjusted for self-reported prenatal HIV-positive status and survey year. All analyses were weighted for survey sample ascertainment, and the sampling strata (a combination of province

and facility size) were also specified to account for intrastratum dependence and geographical variation.

Ethical approval

The protocols were approved by the South African Medical Research Council (SAMRC) (ref. no. EC09-002) and the US Centers for Disease Control and Prevention (CDC). Written informed consent was obtained from each eligible mother or caregiver (all referred to hereafter as caregivers).

Results

Sociodemographic characteristics of the study population

Sample ascertainment in the overall surveys (2010, 2011 - 2012 and 2012 - 2013) has been reported elsewhere.[30] The sample used for

this analysis comprised 97 - 99% of the final attained survey datasets. Table 1 shows that about three-quarters of mothers were single, with a mean age of 26 years, and had achieved at least a secondary level of education. Nearly 40% of mothers reported their recent pregnancy to have been planned.

Significant differences in proportions between survey years were apparent for education ($p<0.001$), other family members as a source of income ($p=0.004$), having no income ($p=0.009$), mean number of children ($p=0.02$), knowledge of modes of MTCT ($p<0.001$) and SES allocation ($p=0.004$) (Table 1). Of these, clear increasing trends from 2010 to 2011 to 2013 were observed for acquiring secondary or tertiary education.

Utilisation and coverage of basic antenatal care services

The summary of uptake of ANC, timing of ANC-1 and receiving basic ANC services for mothers are presented in Table 2. Adherence

Table 1. Sociodemographic and biomedical characteristics of mothers enrolled in the three SAPMTCT surveys, 2010, 2011 - 2012 and 2012 - 2013

Characteristics	2010, mean (95% CI) (N=9 470)	2011 - 2012, mean (95% CI) (N=9 646)	2012 - 2013, mean (95% CI) (N=8 763)	p-value
Age, years	26.0 (25.8 - 26.1)	26.1 (25.9 - 26.2)	26.3 (26.2 - 26.5)	0.227
Education level				
None	2.0 (1.7 - 2.4)	1.5 (1.2 - 1.7)	1.1 (0.9 - 1.3)	<0.001
Primary	15.1 (14.1 - 16.2)	13.4 (12.5 - 14.4)	13.4 (12.5 - 14.4)	
Secondary	77.7 (76.4 - 79.0)	79.4 (78.2 - 80.6)	79.7 (78.7 - 80.8)	
Tertiary	5.2 (4.5 - 5.9)	5.7 (5.0 - 6.5)	5.8 (5.2 - 6.4)	
Marital status				
Single	74.3 (72.6 - 75.9)	73.9 (72.2 - 75.5)	75.4 (74.1 - 76.7)	0.739
Married	19.7 (18.6 - 20.8)	19.9 (18.8 - 21.1)	18.8 (17.8 - 19.9)	
Other	6.1 (4.9 - 7.5)	6.3 (5.0 - 7.8)	5.9 (5.1 - 6.8)	
Ethnicity				
Black	92.8 (91.7 - 93.8)	92.5 (91.3 - 93.6)	93.0 (91.9 - 94.0)	0.122
White	0.6 (0.4 - 0.9)	0.5 (0.3 - 0.8)	0.3 (0.2 - 0.5)	
Coloured	6.0 (5.2 - 7.1)	6.6 (5.6 - 7.7)	6.3 (5.4 - 7.5)	
Indian	0.4 (0.2 - 0.8)	0.4 (0.2 - 0.8)	0.2 (0.1 - 0.5)	
Other	0.2 (0.1 - 0.3)	0.1 (0.1 - 0.2)	0.1 (0.1 - 0.2)	
Source of income				
Own employment	17.1 (16.1 - 18.1)	17.5 (16.5 - 18.5)	18.3 (16.9 - 19.8)	0.281
Child support grant	14.6 (13.5 - 15.9)	15.3 (14.1 - 16.6)	16.8 (15.3 - 18.4)	0.065
Disability grant	1.8 (1.5 - 2.2)	2.1 (1.8 - 2.4)	2.0 (1.7 - 2.4)	0.572
Partner/husband/ex-husband	62.1 (60.5 - 63.6)	62.0 (60.3 - 63.6)	60.5 (58.8 - 62.2)	0.316
Other family member	33.9 (32.3 - 35.5)	34.8 (33.3 - 36.4)	31.4 (29.7 - 33.1)	0.004
None	0.5 (0.3 - 0.6)	0.2 (0.1 - 0.3)	0.4 (0.3 - 0.5)	0.009
SES groups				
Highest	27.5 (25.9 - 29.2)	28.2 (26.5 - 30.0)	27.6 (25.7 - 29.6)	0.004
Second highest	21.0 (19.9 - 22.1)	21.2 (20.0 - 22.5)	24.1 (22.7 - 25.5)	
Low	23.3 (21.9 - 24.7)	23.5 (21.9 - 24.7)	22.5 (21.1 - 24.0)	
Lowest	28.2 (26.3 - 30.3)	27.3 (25.3 - 29.4)	25.8 (23.8 - 27.9)	
Children (mean n)	2.0 (2.0 - 2.1)	2.1 (2.1 - 2.1)	2.1 (2.1 - 2.1)	0.020
Had planned pregnancy	39.2 (37.6 - 40.8)	38.4 (36.9 - 39.9)	39.2 (37.7 - 40.7)	0.450
Knowledge of MTCT modes				
Know breastfeeding	77.5 (75.3 - 79.6)	82.5 (80.5 - 84.3)	84.0 (82.6 - 85.2)	<0.001
Know pregnancy	58.0 (55.6 - 60.5)	74.8 (72.7 - 76.7)	70.1 (67.6 - 72.6)	<0.001
Know childbirth	59.2 (56.5 - 61.9)	71.5 (69.4 - 73.6)	67.9 (65.3 - 70.4)	<0.001
Know all 3 MTCT modes	44.5 (41.5 - 47.6)	62.8 (60.1 - 65.4)	59.6 (56.7 - 62.4)	<0.001
Maternal HIV status – self reported prenatal				
HIV-positive	30.0 (28.9 - 31.1)	30.2 (29.1 - 31.3)	32.0 (31.0 - 33.1)	0.069

SAPMTCT = South African prevention of mother-to-child transmission; CI = confidence interval; SES = socioeconomic status; MTCT = mother-to-child transmission.

to the recommended ≥4 ANC visits was very low in 2010, but increased over time. In 2012 - 2013, 50.8% (95% CI 49.3 - 52.2) of mothers presented for ANC-1 before 20 weeks' gestation compared with 36.0% (95% CI 34.5 - 37.5) and 43.5% (95% CI 42.0 - 45.1) in 2010 and 2011 - 2012, respectively (*p*<0.001).

Receipt of individual activities used in this study to define a proxy for basic ANC service coverage differed significantly between years, showing an improvement from 2010 to 2011 - 2012. Therefore, significant differences were observed in reported receiving of HIV testing, infant-feeding counselling and syphilis-screening rates between the survey years. Coverage of ANC HIV testing was highest for all survey periods and that of syphilis testing was lower by at least 20% (*p*<0.001).

Factors associated with antenatal care visit adherence
There were significantly higher odds for women to have adhered to the recommended ANC visits in 2011 and 2012 - 2013 than in 2010 (Table 3). Women aged ≥20 years had significantly higher odds for adhering to ≥4 ANC visits than adolescent mothers (<20 years old). Women with secondary or tertiary education were significantly more likely to adhere to ≥4 ANC visits than those with primary education. Married women had significantly higher odds of being ANC-visit adherent than single women. Women who had planned pregnancies had an adjusted odds ratio (aOR) 1.40 (95% CI 1.30 - 1.51) for ≥4 ANC visits than those with unplanned pregnancies (*p*<0.001). Lower SES and higher parity were associated with non-adherence to ANC visit uptake. As women's parity increased to ≥2 children, the odds ratio (OR) of ANC visit adherence decreased significantly. Those who self-reported an HIV-positive status prenatally or knew how HIV was transmitted vertically, also had better odds of ANC visit adherence.

Relationship between uptake and receipt of adequate basic antenatal care
Results from a multivariable logistic regression (Table 4) show that in the 2011 - 2012 and 2012 - 2013 surveys, the odds of receiving adequate basic ANC service activities were significantly higher than in 2010, and were particularly higher for women who were ANC visit adherent than for those who were not. The timing of the ANC-1 visit was not associated with receiving adequate basic ANC services (*p*=0.358). Women who did not know their gestational age at ANC-1, had significantly lower odds (OR 0.62 (95% CI 0.47 - 0.80); *p*<0.001) for receiving an adequate basic ANC service than those who had an early ANC-1. The model was adjusted for self-reported prenatal maternal HIV status.

Discussion
We report our findings on the uptake of the recommended (pre-2016) ≥4 basic ANC visits and factors associated with ANC visit adherence, and describe the coverage and receipt of basic ANC service activities, from three national, population-based surveys (2010, 2011 - 2012 and 2012 - 2013) in SA. Overall, our findings show a relatively modest increase (9.2%) in the uptake of ≥4 ANC visits between 2010 and 2012 - 2013. The highest improvement was observed between the 2010 and 2011 surveys (8.1%). The improvement during the 2012 - 2013 survey (16 months after the PMTCT guideline change to option A) could be attributed to the impact of focused attention and robust community mobilisation by the SANDoH following the PMTCT policy guideline change. We found that the average uptake of ≥4 ANC visits remained suboptimal (53.3%). This is concerning, given the reviews indicating increased fetal deaths among women adhering to ≥4 ANC visits, but who were less satisfied.[35] To this effect, in April 2017, SA adopted the 2016 WHO recommendation to move from a 4-focused ANC visit model to a minimum of 8 antenatal

Table 2. Temporal trends in ANC utilisation and basic ANC service activities (2010, 2011 - 2012, 2012 - 2013)

	2010, %* (95% CI) (*N*=9 470)	2011 - 2012, %* (95% CI) (*N*=9 646)	2012 - 2013, %* (95% CI) (*N*=8 763)	*p*-value
ANC visits, *n*				
<4 (non-adherence)	18.8 (17.6 - 20.1)	16.2 (15.0 - 17.4)	14.5 (13.4 - 15.6)	<0.001
≥4 (adherence)	47.5 (45.4 - 49.6)	55.6 (53.2 - 58.0)	56.7 (54.3 - 59.1)	
Unknown†	33.7 (31.4 - 36.2)	28.2 (25.7 - 30.9)	28.9 (26.5 - 31.4)	
Timing of ANC-1 visit, weeks				
<20 (early)	36.0 (34.5 - 37.5)	43.5 (42.0 - 45.1)	50.8 (49.3 - 52.2)	<0.001
≥20 (late)	46.9 (45.2 - 48.6)	42.7 (41.2 - 44.3)	42.3 (40.8 - 43.7)	
Unknown	17.1 (15.3 - 19.0)	13.7 (11.9 - 15.8)	7.0 (6.1 - 7.9)	
Basic ANC service activities				
Syphilis screening done	66.4 (63.1 - 69.6)	76.2 (73.9 - 78.5)	70.2 (67.6 - 72.6)	<0.001
Infant feeding counselling	83.6 (82.0 - 85.1)	89.5 (88.2 - 90.6)	92.1 (91.3 - 92.9)	<0.001
Tested for HIV last pregnancy	98.3 (98.0 - 98.5)	95.5 (94.5 - 96.4)	98.8 (98.5 - 99.1)	<0.001
Receipt of all 3 measures of basic ANC service				
Among all women	55.9 (52.9 - 58.8) (*n*=9 470)	67.7 (65.1- 70.2) (*n*=9 646)	65.4 (62.8 - 67.8) (*n*=8 763)	<0.001
Among those with ≥4 visits	57.0 (53.5 - 60.5) (*n*=4 432)	68.9 (65.6 - 71.9) (*n*=5 413)	67.8 (64.8 - 70.6) (*n*=4 837)	<0.001
Among those with <4 visits	53.4 (48.5 - 58.2) (*n*=1 603)	64.5 (60.8 - 68.0) (*n*=1 534)	57.9 (53.9 - 61.8) (*n*=1 269)	<0.001
Among clients who booked ANC early (ANC-1 <20 weeks' pregnant)	58.8 (56.0 - 61.6) (*n*=3 726)	70.3 (67.6 - 72.9) (*n*=4 276)	67.0 (64.2 - 69.8) (*n*=4 461)	<0.001
Among clients who booked ANC late (ANC-1 at ≥20 weeks' pregnant)	55.5 (51.6 - 59.3) (*n*=4 196)	70.6 (67.6 - 73.5) (*n*=4 042)	66.2 (63.2 - 69.0) (*n*=3 626)	<0.001

ANC = antenatal care; CI = confidence interval; ANC-1 = first antenatal care visit.
*All percentages are weighted for survey sampling.
†Data excluded from the regression analyses and appropriate weights used to further adjust for missing information on the outcome variable; *p*-value is from a χ² test.

contacts.[36] Therefore, understanding the factors associated with ANC visit adherence will assist in guiding efforts towards meeting the new ANC policy guideline.

Our study findings on adherence to ≥4 ANC visits are consistent with the reported global rate of 55% (*n*=40). Wang *et al.*,[37] analysing Demographic and Health Survey (DHS) data (1990 - 2009) from 38 countries, reported >80% coverage for at least 1 antenatal visit, whereas >50% of all pregnant women adhered to ≥4 antenatal visits. However, in the latter analysis, SA was not included among the 21 sub-Saharan African (SSA) countries.[37] This finding could support a hypothesis that the majority of pregnant women prioritise attending ANC once to enable them to deliver in a hospital.[22,38,39] One-third of our study participants did not know or chose not to disclose the number of ANC visits. It is plausible that these women attended fewer than the recommended number of visits.

We found that 36.0 - 50.8% of women in our study attended an ANC-1 visit before 20 weeks. This finding supports previous findings in SSA, which reported early ANC booking rates <50%[16,40] and delayed booking up to the third trimester.[41] It is, however, encouraging to observe that in our study ANC booking rates before 20 weeks increased over time, which is comparable with rates in the SA District Health Information Software (DHIS) between 2010/2011and 2013/2014.[41] Haddad *et al.*[22] found that, despite women being aware of the recommendation to book ANC-1 early, most booked 7 weeks later than 20 weeks' gestation.

We found that pregnant women with tertiary and secondary education have higher odds of complying with recommended ANC. In line with our findings, Wang and Hong[25] found that in Cambodia, the odds of utilising ANC services were almost 5 times higher for women with secondary or higher education than for uneducated women. They also found that exposure to mass media and health insurance coverage increased the odds of attending ANC by 30% and 40%, respectively.[25] It is likely that education increases women's understanding of the benefits of ANC visits and results in a better income, which could positively influence ANC utilisation. Age and marital status are also associated with ANC visit adherence. The likelihood of adhering to ≥4 ANC visits increases by a factor of 1.3 - 1.5 as a woman's age increases to >20 years. Our study established that women who had previous experience of pregnancies were less likely to adhere to the ≥4 ANC visit recommendation. Similarly, Pell *et al.*[38] showed that timing and access to ANC were related to a woman's age and parity. The literature suggests that ANC utilisation by adolescents[42] and young unmarried women[26,43] can be hindered by poor healthcare worker attitudes and poor accessibility of antenatal clinics. These factors might have contributed to low ANC uptake in our study. In contrast, Wang *et al.*[37] found that mothers <20 years of age from SSA (excluding SA) and South/South-east Asia were more likely to report uptake of ≥4 ANC visits than older mothers.

The literature suggests that attitudes towards one's pregnancy can influence eagerness to attend ANC.[44] Similarly, we found that planned pregnancy and knowledge of modes of MTCT were strong predictors of ANC visit adherence. It would be logical for women whose pregnancies are planned and those who have information

Table 3. Factors associated with uptake of ≥4 ANC visits

Attendance of ≥4 ANC visits*	Model		
	Adjusted OR	95% CI	*p*-value
Survey year			
2010	1	-	-
2011 - 2012	1.33	1.19 - 1.47	<0.001
2012 - 2013	1.51	1.34 - 1.70	<0.001
Age group, years			
<20	1	-	-
20 - 34	1.30	1.16 - 1.46	<0.001
≥35	1.47	1.27 - 1.69	<0.001
Education			
Primary	1 .00	-	-
None	1.00	0.75 - 1.34	0.992
Secondary	1.20	1.08 - 1.33	0.001
Tertiary	1.60	1.31 - 1.96	<0.001
Unknown	1.73	0.33 - 9.01	0.517
Marital status			
Single	1	-	-
Married	1.23	1.11 - 1.36	<0.001
Other	0.93	0.78 - 1.10	0.411
SES			
Highest	1	-	-
High	0.83	0.75 - 0.92	<0.001
Low	0.84	0.75 - 0.94	0.002
Lowest	0.81	0.71 - 0.92	0.001
Planned pregnancy			
No	1	-	-
Yes	1.40	1.30 - 1.51	<0.001
Live children, *n*			
1	1	-	-
≥2	0.60	0.55 - 0.65	<0.001
HIV status (self-reported)			
Negative	1	-	-
Positive	1.34	1.24 - 1.45	<0.001
Knowledge of 3 modes of MTCT			
No	1	-	-
Yes	1.21	1.11 - 1.33	<0.001

ANC = antenatal care; OR = odds ratio; CI = confidence interval; SES = socioeconomic status; MTCT = mother-to-child transmission.
*Reference: 1 - 3 visits.

Table 4. Relationship between uptake and coverage of basic ANC service activities

Received 3 v. <3 services (*N*=19 088)	Adjusted OR	95% CI	*p*-value
Survey year			
2010	1.00	-	-
2011 - 2012	1.65	1.38 - 1.98	<0.001
2012 - 2013	1.42	1.18 - 1.72	<0.001
ANC visits, *n*			
<4	1.00	-	-
≥4	1.30	1.18 - 1.42	<0.001
Timing of ANC-1 visit, weeks	1.00	-	
<20			-
≥20	1.04	0.96 - 1.12	0.358
Unknown	0.62	0.47 - 0.80	<0.001

ANC = antenatal care; OR = odds ratio; CI = confidence interval; ANC-1 = first antenatal care visit.
*Adequate basic routine ANC service (the 3 services used to define adequate basic ANC service are syphilis screening, infant-feeding counselling and HIV testing, all during pregnancy).

regarding pregnancy risks to be more inclined to adhere to the recommendation of ≥4 ANC visits. There is a positive association between household wealth and ANC visit adherence.[24,45] We found that women from high, low and lowest SES were significantly less likely to comply with recommended antenatal visits. It is possible that lack of income could have hindered those from low SES from attending ANC, as expected.

More than 30% of women reported that they did not receive adequate basic ANC services. This has serious implications for MCH outcomes, especially in a high HIV-prevalent setting such as SA. The odds of receiving adequate basic ANC were higher for women who were ANC-visit adherent than for those who were not. There was a lower coverage for syphilis screening (66 - 76%) than for HIV testing (>95%) across all three surveys. This difference could be due to: (i) women finding it easier to recall an HIV test than a syphilis screening test (especially if results for the latter were negative); and (ii) actual missed opportunities for syphilis screening. The WHO's global guidance for elimination of MTCT and syphilis emphasises the importance of effective antenatal screening and treatment for HIV and syphilis infections.[15] Our study found no difference between clients who booked early or late in each survey year with regard to receiving adequate basic ANC service activities, which suggests that all pregnant women receive the same level of care at ANC-1, irrespective of the gestational age at booking.

Significant improvements in uptake of ≥4 ANC visits and adequate basic ANC services in our study could be attributed to efforts by the NDoH, such as introducing policies and systems aimed at improving MCH outcomes during this period. These include: (i) the 2010 primary healthcare (PHC) re-engineering model, which introduced ward-based outreach teams; (ii) the 2010 - 2014 Negotiated Service Delivery Agreement; and (iii) the National Strategic Plan on HIV, sexually transmitted infections and tuberculosis 2012 - 2016.[46-48] It is clear from our results that lower uptake of ANC occurs among women who may be easier to reach in their community and home than in the clinic, i.e. the lesser educated and those in the lower SES rankings. Other low-income African countries, such as Malawi, have been successful in improving MCH care uptake by introducing well-established and formalised community outreach healthcare programmes.[49] Strengthening existing strategies, such as PHC re-engineering,[50] MomConnect[43] and integrating family planning with MCH care programmes, could optimise ANC visit uptake. The effective implementation of the National Adolescent and Youth Health Policy, which promotes 'dedicated clinic times' and a comprehensive package of services for 10 - 24-year olds, could improve women's positive pregnancy experiences and outcomes.[51]

Study strengths and limitations
We minimised recall bias by restricting interview questions to the women's last pregnancy and collecting data 4 - 6 weeks after delivery. However, the study had some limitations. Low to insignificant selection bias, as mothers of infants with adverse perinatal outcomes (stillbirths, neonatal deaths and newborns not surviving up to 6 weeks) were not included in the sample of the main study. We relied on mothers' self-reported information and only used the Road to Health cards to validate reported information. Even though the outcome variable was missing from nearly a third of the sample, it was missing completely at random, but we included a weight to account for these within each stratum, thus preserving the external validity of the sample; pregnancy outcomes were not assessed. Accurate information on urban/rural locality was not available for all facilities – hence it was not included. However, we acknowledge that locality has the potential

to affect uptake, possibly in terms of accessibility to facilities and consistent availability of resources.

Conclusions
Adequate ANC would offer an opportunity to reduce poor pregnancy outcomes and provide women with a positive pregnancy experience.[35] Therefore, as SA implements the model of a minimum of 8 ANC contacts, it is clear that the strengthening of co-ordination between in-facility and community-based interventions and integrating these services are necessary. Trained community-based and facility-based healthcare workers are needed to access and reach out to women who are at high risk, as defined by different sociodemographic contexts, to improve the timing and uptake of ANC. Further quantitative and qualitative research is required to determine ANC coverage rates, quality of care and impact of the model of 8 ANC visits and to explore associated factors.

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