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The impact of implementing the 2016 WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience on perinatal deaths: an interrupted time-series analysis in Mpumalanga province, South Africa

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ABSTRACT

Objectives To investigate if the implementation of the 2016 WHO Recommendations for a Positive Pregnancy Experience reduced perinatal mortality in a South African province. The recommendations were implemented which included increasing the number of contacts and also the content of the contacts.

Methods Retrospective interrupted time-series analysis was conducted for all women accessing a minimum of one antenatal care contact from April 2014 to September 2019 in Mpumalanga province, South Africa. Retrospective interrupted time-series analysis of province level perinatal mortality and birth data comparing the pre-implementation period (April 2014–March 2017) and post-implementation period (April 2018–September 2019). The main outcome measure was unadjusted prevalence ratio (PR) for perinatal deaths before and after implementation; interrupted time-series analyses for trends in perinatal mortality before and after implementation; stillbirth risk by gestational age; primary cause of deaths (and maternal condition) before and after implementation.

Results Overall, there was a 5.8% absolute decrease in stillbirths after implementation of the recommendations, however this was not statistically significant (PR 0.95, 95% CI 0.90% to 1.05%; p=0.073). Fresh stillbirths decreased by 16.6% (PR 0.86, 95% CI 0.77% to 0.95%; p=0.003) while macerated stillbirths (p=0.899) and early neonatal deaths remained unchanged (p=0.499). When stratified by weight fresh stillbirths >2500 g decreased by 17.2% (PR 0.81, 95% CI 0.70% to 0.94%; p=0.007) and early neonatal deaths decreased by 12.8% (PR 0.88, 95% CI 0.77% to 0.99%; p=0.041). The interrupted time-series analysis confirmed a trend for decreasing stillbirths at 0.09/1000 births per month (−0.09, 95% CI −1.18 to 0.01; p=0.059), early neonatal deaths (−0.09, 95% CI −0.14 to 0.04; p=<0.001) and perinatal mortality (−1.18, 95% CI −0.27 to −0.09; p<0.001) in the post-implementation period. A decrease in stillbirths, early neonatal deaths or perinatal mortality was not observed in the pre-implementation period. During the period when additional antenatal care contacts were implemented (34–38 weeks), there was a decrease in stillbirths of 18.4%

Key questions

What is already known?

► Antenatal care is a public health strategy known to prevent maternal and perinatal mortality; however the optimal timing of contacts and content of each contact are still unclear.
► In 2016 the WHO published new antenatal care recommendations (2016 WHO Recommendations on a Positive Pregnancy Experience) of which one focus was an increased number of routine contacts with healthcare providers during pregnancy (eight routine contacts; increased from four routine contacts).
► South Africa was the first country to implement these new recommendations.
► It is unknown if the 2016 WHO Recommendations are successful in decreasing perinatal mortality.

What are the new findings?

► Our study indicates that the implementation of the 2016 WHO Recommendations has been successful in decreasing perinatal mortality in Mpumalanga province, of South Africa, particularly due to hypertensive-related causes.

What do the new findings imply?

► This evidence provides support for the upscaling of the 2016 WHO Recommendations on a Positive Pregnancy Experience in South Africa and implementation in other low-income to middle-income countries.
► Future implementation of the recommendations should plan for the increase in the number of pregnancies with hypertension detected to ensure that the benefit of the recommendations is optimised.

(risk ratio (RR) 0.82, 95% CI 0.73% to 0.91%, p=0.0003). In hypertensive disorders of pregnancy, the risk of stillbirth decreased in the post-period by 15.1% (RR 0.85; 95% CI 0.76% to 0.94%; p=0.002).

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Conclusion The implementation of the 2016 WHO Recommendations for a Positive Pregnancy Experience may be an effective public health strategy to reduce stillbirths in South African provinces.

INTRODUCTION

Across the world 2.6 million stillbirths occur every year of which 98% occur in low-income to middle-income settings.[1] A recent analysis in South Africa found 58.3% of all perinatal deaths occur in the antepartum period.[2] It is estimated that two-thirds of perinatal deaths are preventable with low-cost and low-technology interventions that can be implemented in low/middle-income countries (LMICs).[3] Part of this strategy includes the provision of quality antenatal care (ANC).[4] The correct timing and frequency of ANC contacts is particularly important in preventing avoidable deaths in LMICs where resources are limited.[1]

Due to ANC being a central component to stillbirth prevention, in 2016 the WHO reviewed and published recommendations on the number and timing of ANC contacts. The new WHO Recommendations on a Positive Pregnancy Experience recommend a schedule of eight routine contacts at <12, 20, 26, 30, 34, 36, 38 and 40 weeks.[5] The new ANC schedule contains additional contacts as compared with the previous WHO antenatal recommendations of at least four contacts published in 2001. This was in response to recent evidence in favour of a schedule of (*at least*) eight routine contacts for women.[6–11] The evidence included a Cochrane review and epidemiological evidence demonstrating that eight ANC contacts decrease stillbirth as compared with five or fewer in LMIC settings,[6–8] as well as other evidence in favour of additional contacts such as improved communication and support for pregnant women.[9–11] The 2016 WHO Recommendations on a Positive Pregnancy Experience target additional contacts in the third trimester after two studies found an approximate 30% increased stillbirth risk during the third trimester when ANC contacts were not scheduled.[7 8] One of these studies, based in South Africa, found an increase in stillbirth risk at 38 weeks after a 6-week period of no ANC.[8] In particular, the new WHO recommendations aim to elicit a reduction in deaths due to hypertension, of which a substantial proportion of deaths are attributed[12] and could be reduced with greater ANC contact to increase detection and improve management of hypertensive disorders of pregnancy.[8]

South Africa was the first country to implement the new ANC recommendations adopting a routine ANC schedule of eight contacts from 1st of April 2017, providing an opportunity to examine the impact of the new recommendations on perinatal mortality, stillbirth risk across pregnancy and cause of death.

The aim of this study was to examine if the new recommendations were successful in reducing perinatal mortality in one South African province.

METHODS

Study design

An interrupted time-series study design was conducted using province-level perinatal mortality data from the Perinatal Problem Identification Program (PPIP). Mandatory reporting of all perinatal deaths including primary cause of death is required in South Africa. PPIP captures births and deaths in all public health facilities from primary level through to tertiary level. Mpumalanga province was chosen for this analysis as it is the province with the most rigorous auditing of maternal and perinatal deaths. The 2016 WHO Recommendations on a Positive Pregnancy Experience were implemented from 1st of April 2017. We allowed for a 12-month implementation period between 1st of April 2017 and 31st of March 2018, based on the rationale that it would take approximately 6 months to upscale the intervention across the province and an additional 6 months for the first women accessing ANC to begin delivering their infants. The pre-period was 1st of April 2014 to 31st of March 2017 (36 months) and the post-period was 1st of April 2018 to 30th of September 2019 (18 months). We evaluated stillbirths and early neonatal deaths (>1000 g) in women who had accessed any ANC, before and after the implementation period. We also examined stillbirth risk across pregnancy, primary cause of death and maternal condition before and after implementation.

Implementation

After some unease was expressed by South African clinicians using the reduced antenatal contact model,[13] a working group was established by the National Department of Health (NDoH) to review ANC in South Africa. The working group's report was submitted to the NDoH and was supported by the release of the WHO Recommendations. The Minister of Health accepted a new ANC package (called Basic Antenatal Care Plus—BANC Plus) put forward at the National Health Council on 24th of November 2016 and instructed the members of the executive council to implement BANC Plus starting 1st of April 2017. BANC Plus supported the WHO recommendation to increase routine ANC contacts for all women to >12, 20, 26, 30, 34, 36, 38, 40 weeks. Prior to the implementation of BANC Plus, the routine ANC schedule across South Africa consisted of five contacts at 20, 26, 32, 38, 41 weeks (except Western Cape which had more frequent contacts). The South African Medical Research Council Maternal and Infant Health Care Strategies unit played an integral role in adapting the recommendations for the South African clinical context.[14] In addition to the increase in the number of contacts, the content of each contact was changed. The antenatal checklist to be completed after every contact was adapted so that the examinations, investigations and interventions that needed to be done at the contact were listed. Introducing BANC Plus was about changing the way ANC was carried out. In South Africa women access ANC at the primary health clinic (PHC) level and are up-referred if they are

identified as high risk using a predefined set of criteria including conditions such as fetal growth restriction and hypertension. One of the intended focus points was to increase the detection and management of hypertension which is the leading cause of direct maternal mortality and responsible for a large proportion of perinatal deaths in South Africa (accounting for 14.8% of all maternal deaths and ~19% of perinatal deaths).[12 15] The BANC Plus Guidelines and WHO Recommendations for a Positive Pregnancy Experience can be viewed in full here.[5]

During the month of April 2017, the demand for ANC was generated by radio adverts to promote the increased number of antenatal contacts, women on the MomConnect app were informed of the new contacts and all women currently accessing ANC given the new information. Supply was catered for by workshops being held in every district in South Africa explaining the new package and information was sent to midwives on their social media forum. There were no additional human resources needed and the only extra resource was printing the new antenatal checklists, so the costs were minimal. South Africa has an extensive network of primary care clinics, and they are not busy all of the time often in the afternoons there are no patients to be seen, so there was capacity to manage the extra contacts. BANC Plus workshops were held in the three districts of Mpumalanga in February and March 2017 with doctors and midwives from the hospitals and primary care clinics attending. At-scale implementation started on 1st of April 2017.

A subanalysis of four catchment areas across South Africa (Springs, Upington, Mafikeng and Thohoyandou) between March 2017 (beginning of at-scale implementation) and March 2018 (after transition) showed an increase in the proportion of women who had accessed six contacts or more (from 36.5% to 61.0%) and women who accessed eight contacts or more (from 4.6% to 24.5%).[16]

Statistical analysis

Province-level data were extracted for each month during the study period for livebirths (birth weight (g), mother attended ANC (y/n), maternal condition) and perinatal deaths (birth weight (g), gestational age at birth (weeks), mother attended ANC (y/n), primary cause of death, maternal condition). Maternal condition was classified as: healthy mother, coincidental conditions, medical/surgical disorders, non-pregnancy-related infections, extrauterine pregnancy, pregnancy-related sepsis, obstetric haemorrhage, hypertension. Descriptive analyses were performed to compare stillbirth and early neonatal death period prevalence in the pre-implementation and post-implementation period as well as cause of death (including maternal condition). In addition, the number of stillbirths (fresh, macerated), early neonatal deaths (0–7 days) and perinatal death were calculated per 1000 births for each month of the study period. Interrupted time-series analyses (ordinary least square regression) with Newey-West SEs were

used to examine trends in perinatal deaths, stillbirths and early neonatal deaths before and after implementation. Six months post-implementation of the guidelines was used as the start of the post-implementation period to allow women becoming pregnant under the new recommendations to give birth. Interrupted time-series analyses are useful when population-level outcomes (eg, deaths per 1000 births) are calculated over time with statistical regression modelling used to examine how trends in outcomes are impacted by a population-level exposure occurring in a well-defined period (in this case, implementation of the 2016 WHO Recommendations for a Positive Pregnancy Experience/BANC Plus on 1st of April 2017).[17] In this way, any disruptions to the underlying trends in the outcome over time can be examined. Three assumptions were confirmed prior to conducting the interrupted time-series analyses including (a) the pre-trend was linear (examined visually), (b) characteristics of the study population remain unchanged over the study period, (c) there is no comparator against which to adjust the results for changes that should not be attributed to the intervention.[17] The analyses were conducted using StataMP V.15, making use of the ITSA command for the interrupted time-series analysis.

Stillbirth risk across pregnancy was compared before and after implementation using Yudkin's method of stillbirth risk calculation (known at the fetuses-at-risk approach) as in our previous analyses.[8 18] This approach considers the number of fetuses still in-utero as the population at risk. There was no information available on the gestational age of livebirths for all women across Mpumalanga province. Therefore, gestational age at birth for livebirths in one subdistrict (Mamelodi subdistrict) was used to estimate the number of livebirths at each gestational age across Mpumalanga province. (1) The proportion of live births in each birth weight category (500–999 g; 1000–1499 g; 1500–1999 g; 2000–2499 g; ≥2500 g) for Mpumalanga was compared with the proportion of live births in each birth weight category for Mamelodi. There were no significant differences in the proportion of live births occurring in each birth weight category between Mpumalanga and Mamelodi. (2) The distribution of live births across gestation from Mamelodi was plotted, that is, the proportion of all live births for Mamelodi that occurred at each gestational age (eg, at 26 weeks 0.49% of infants were born, at 38 weeks 17.67% of infants were born). (3) The proportion of live births at each gestational age in Mamelodi was applied to the number of known births in Mpumalanga (eg, at 26 weeks 0.49% of infants were born, at 38 weeks 17.67% of infants were born). (4) Sensitivity analysis was conducted as outlined below. At each gestational age stillbirth risk was calculated using the number of stillbirths (as the numerator) divided by the total number of unborn fetuses and expressed as the number of stillbirths per 1000 fetuses still in-utero.

Table 1 Clinical characteristics of study population (>1000 g) in pre-implementation and post-implementation period (pre: n=216 030 births; n=5043 perinatal deaths; post: 111 526 births; n=2486 perinatal deaths)

Characteristic	Pre-implementation period		Post-implementation period	
	Live births, n (%)	Perinatal deaths, n (%)	Live births, n (%)	Perinatal deaths, n (%)
Pregnancy				
Single pregnancy	213 222 (98.7)	3636 (72.1)	110 076 (98.7)	1738 (69.9)
Multiple pregnancy	2808 (1.3)	237 (4.7)	1450 (1.3)	142 (5.7)
Unknown/missing	0 (0.0)	1170 (23.2)	0 (0.0)	606 (24.4)
Parity				
Primipara	69 993 (32.4)	1427 (28.3)	34 462 (30.9)	654 (26.3)
Multipara	131 994 (61.1)	2274 (45.1)	70 261 (63.0)	1139 (45.8)
Grand multipara	9721 (4.5)	247 (4.9)	5911 (5.3)	142 (5.7)
Unknown/missing	4322 (2.0)	1095 (21.7)	892 (0.8)	551 (22.2)
Birth method				
Normal vaginal	171 096 (79.2)	N/A	86 433 (77.5)	N/A
Assisted vaginal	1512 (0.7)	N/A	1004 (0.9)	N/A
C-section	39 533 (18.3)	N/A	22 305 (20.0)	N/A
Unknown/missing	3889 (1.8)	N/A	1784 (1.6)	N/A
Maternal age (years)				
<18	18 147 (8.4)	449 (8.9)	8253 (7.4)	167 (6.7)
18–19	23 115 (10.7)	373 (7.4)	11 041 (9.9)	191 (7.7)
20–34	150 789 (69.8)	3671 (72.8)	79 072 (70.9)	1832 (73.7)
35+	23 979 (11.1)	550 (10.9)	13 160 (11.8)	296 (11.9)
HIV				
Positive	71 290 (33)	1372 (27.2)	36 357 (32.6)	659 (26.5)
Negative	142 148 (65.8)	2395 (47.5)	74 611 (66.9)	1181 (47.5)
Unknown/missing	2592 (1.2)	1276 (25.3)	558 (0.5)	646 (26)

N/A, not available.

Patient and public involvement

No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for design or implementation of the study. No patients were asked to advise on interpretation or writing up of results.

RESULTS

Characteristics of the study population are presented in table 1. The characteristics of the study population remained similar between the pre-implementation and post-implementation periods for multiple pregnancies, parity, birth method, maternal age and HIV serology.

Pre–post comparison

Overall there was a decrease in stillbirths of 5.8%, from 15.5 per 1000 births to 14.5/100, however not statistically significant (p=0.073) (table 2). Fresh stillbirths decreased significantly by 14.5% (p=0.003) from 5.3/1000 to 4.5/1000. When stratified by weight, fresh stillbirths >2500 g decreased by 18.9% (from 2.9/1000 to 2.4/1000) while the 1000–2500 g weight group did not decrease

significantly (pre: 21.5/1000 to 19.9; p=0.290). There was no change in macerated stillbirths. Early neonatal deaths decreased by 12.8% in the >2500 g weight group (from 3.9/1000 to 3.4/1000; p=0.041).

Interrupted time-series analysis

The interrupted time-series analysis revealed a trend for decreasing stillbirths (p=0.059), early neonatal deaths (p<0.001) and perinatal mortality (p<0.001), occurring after implementation, which was not present before the implementation (figure 1 and table 3). When examining fresh and macerated stillbirths separately, there was a decline after implementation for both categories but these were not statistically significant (p=0.156 and p=0.216, respectively) (figure 1). Results from the interrupted times-series analysis are presented in table 3.

Stillbirth risk by gestational age

During the period when additional ANC contacts were implemented (34–38 weeks), there was a decrease in stillbirth risk of 18.4% (relative risk (RR) 0.82, 95% CI 0.73% to 0.91%, p=0.0003) (figure 2). The number needed to

Table 2 Stillbirths and early neonatal deaths in the pre-implementation and post-implementation period (n=221 078 pre-period; n=114 012 post-period)

	Prevalence pre-period (deaths per 1000 births)	Prevalence post-period (deaths per 1000 births)	% decrease	Prevalence ratio (95% CI); p value
Stillbirth	15.5	14.6	5.8	0.948 (0.895 to 1.005); 0.073
Fresh stillbirth	5.3	4.5	16.6	0.855 (0.771 to 0.949); 0.003
Macerated stillbirth	10.2	10.1	1.0	0.995 (0.927 to 1.068); 0.899
Early neonatal death	7.4	7.2	2.7	0.972 (0.894 to 1.056); 0.499
Stillbirth 1000–2500 g	77.1	76.4	1.0	0.992 (0.992 to 1.064); 0.812
Fresh stillbirth	21.5	19.9	8.0	0.927 (0.805 to 1.067); 0.290
Macerated stillbirth	55.5	56.4	−1.5	1.015 (0.934 to 1.104); 0.721
Early neonatal death 1000–2500 g	31.4	33.8	−7.5	1.075 (0.963 to 1.199); 0.199
Stillbirth 2500+ g	6.5	6	7.7	0.925 (0.840 to 1.019); 0.115
Fresh stillbirth	2.9	2.4	17.2	0.811 (0.697 to 0.944); 0.007
Macerated stillbirth	3.6	3.7	−2.7	1.016 (0.896 to 1.153); 0.802
Early neonatal death 2500+ g	3.9	3.4	12.8	0.876 (0.772 to 0.995); 0.041

treat (NNT) analysis revealed that for every 3427 (95% CI 2223 to 7476) women who accessed the new ANC model, one stillbirth would be prevented. When examining fresh stillbirths there was a decreased risk in the post-implementation period of 56.9% at 34 weeks (RR 0.43, 95% CI 0.23% to 0.81%; p=0.085) although not statistically significant, 48.5% at 36 weeks (RR 0.51, 95% CI 0.31% to 0.84%; p=0.008) and 35.5% at 38 weeks (RR 0.65, 95% CI 0.48% to 0.86%; p=0.003). This was followed by an increased risk of fresh stillbirth of 60.0% of the post-period at 40 weeks (RR 1.60, 95% CI 1.12% to 2.31%; p=0.008). There were no statistically significant decreases in macerated stillbirths between the pre-period and post-period during gestations where additional ANC contacts were scheduled. At 26 weeks' gestation there was a significant decrease of 61% in macerated stillbirth risk (RR 0.39, 95% CI 0.16% to 0.95%; p=0.038) and at 31 weeks there was an increase in macerated stillbirth risk of 70% (RR 1.7, 95% CI 1.12% to 2.58%; p=0.012).

Sensitivity analysis

As live birth data were derived from the Mamelodi subdistrict rather than Mpumalanga province, we conducted a sensitivity analysis to ensure that the use of live birth data from Mamelodi was a reasonable and valid approach. A series of hypothetical changes to the distribution of live births across gestational age were implemented and the impact on the risk estimates was assessed. There were no significant differences between the proportion of live births by weight categories (1000–1499 g, 1500–1999 g, 2000–2499 g and ≥2500 g) between Mamelodi and Mpumalanga. The largest difference in the proportion of live births occurring in a single weight category was 2.1% between Mpumalanga and the Mamelodi subdistrict for the 2000–2499 g category. Therefore, sensitivity analysis was performed by adjusting the proportion of live births

at each gestational age by 5%. This was repeated with a decrease of 5%. There were no significant differences in stillbirth risk before adjustment and after adjustment at any gestational age with these increases/decreases implemented. The greatest change in stillbirth risk was 7.6% at 37 weeks' gestation (stillbirth risk changed from 0.777 (95% CI 0.606 to 0.997; p=0.048) to 0.702 (95% CI 0.054 to 0.091; p=0.005)). It was concluded that even if there was a difference in the distribution of live births at any gestational age at 2.5 times the variation observed in our data, it would be unlikely for any large changes to occur to our risk estimates.

Causes of death

Overall there was a decrease in all primary causes of death (per 1000 births) in the post-implementation period except for fetal anomalies and infections which increased marginally (table 4). In hypertensive disorders of pregnancy (severe pre-eclampsia and eclampsia) the risk of stillbirth (due to complications of hypertension) decreased significantly in the post-period by 15.1% (RR 0.85; 95% CI 0.77% to 0.94%; p=0.002; pre: 264.5 stillbirths/1000 hypertensive disorders of pregnancy; post: 224.5 stillbirths/1000). The NNT analysis showed that for every 25 women with severe hypertension detected using the new ANC schedule, 1 stillbirth is averted (95% CI 15.33 to 67.91). The risk of death due to antepartum haemorrhage (APH) did not change between the pre-period and post-period (RR 0.93; 95% CI 0.82 to 1.06 p=0.272). Within the APH category, abruptio placentae decreased from 1.9/1000 births to 1.3/1000 births. The proportion of perinatal deaths with a maternal complication decreased in the post-implementation period from 55.2% to 53.4% (table 5). Figure 3 shows causes of death by gestational age.
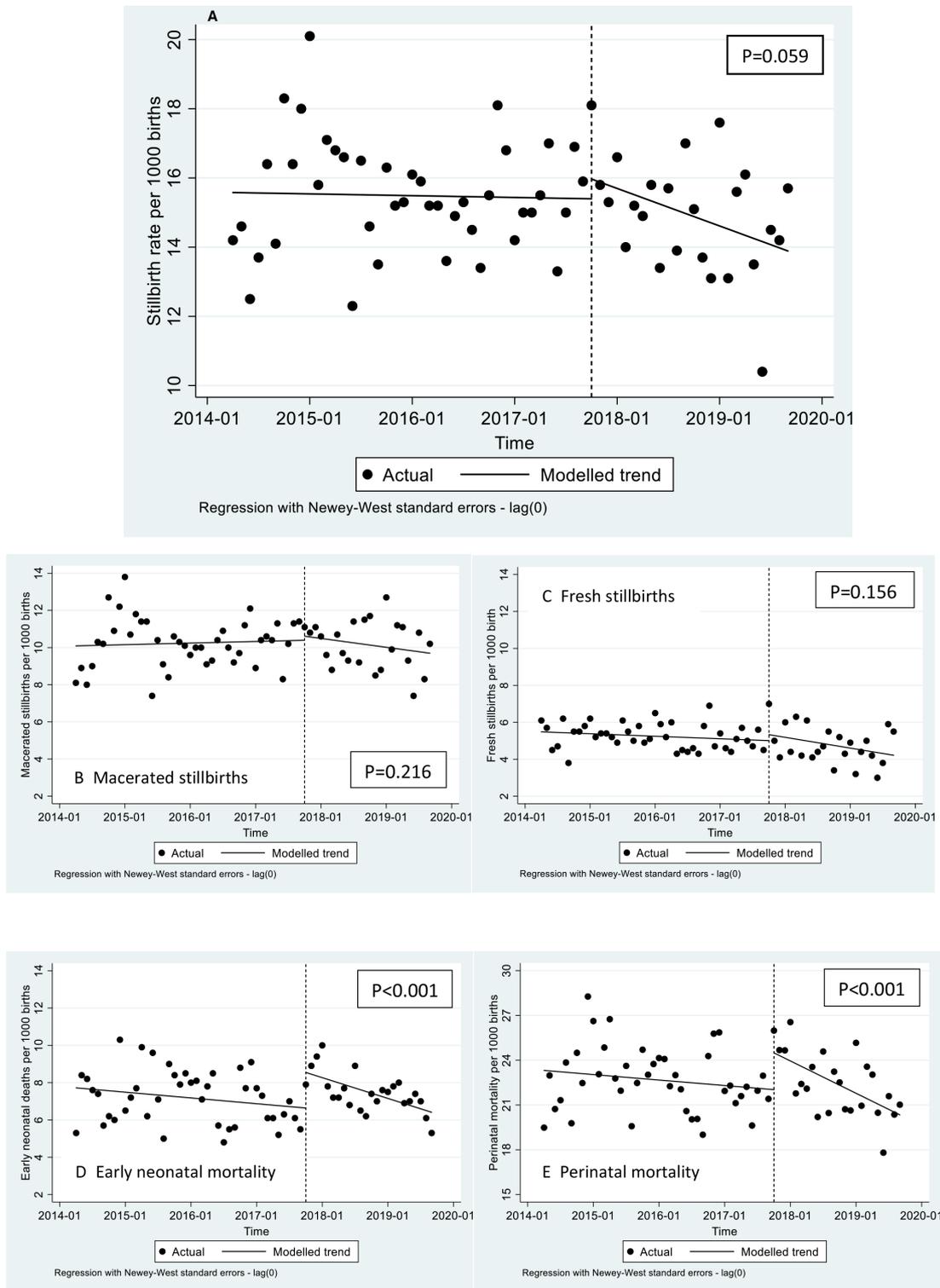
Figure 1 Interrupted time-series analysis for stillbirth (A), macerated stillbirth (B), fresh stillbirth (C), early neonatal mortality (D), perinatal mortality (E). Dotted line is 6 months post-implementation of guidelines (ie, women who accessed new antenatal care started to give birth).

DISCUSSION
Statement of principal findings/context of other studies

There was an overall decrease in stillbirths, fresh stillbirths and early neonatal deaths in our South African provincial study population after the implementation of the 2016 WHO Recommendations for a Positive Pregnancy Experience. During the pregnancy period when additional ANC contacts were scheduled (34–38 weeks), stillbirths decreased by one-fifth. In hypertensive disorders of pregnancy, which the new recommendations target, there was a decreased risk of stillbirth by 15% in the post-implementation period. This evidence suggests

Table 3 Interrupted time-series analysis for perinatal mortality rate in the pre-implementation period and post-implementation period (n=410 088 births; n=9256 deaths)

	Pre-period			Post-period		
	Coefficient	95% CI	P value	Coefficient	95% CI	P value
All neonates						
Stillbirth	−0.004	−0.048 to 0.040	0.846	−0.090	−0.184 to 0.004	0.059
Fresh	−0.011	−0.029 to 0.006	0.199	−0.049	−0.116 to 0.019	0.156
Macerated	0.007	−0.030 to 0.044	0.698	−0.040	−0.104 to 0.024	0.216
Early neonatal	−0.026	−0.059 to 0.008	0.131	−0.093	−0.142 to 0.044	<0.001
Perinatal mortality	−0.031	−0.087 to 0.025	0.278	−0.181	-0.271, to 0.090	<0.001
Stillbirth with HT	−1.966	−4.109 to 0.176	0.071	−0.426	−3.390 to 2.539	0.775
Birth weight 1000–2500 g						
Stillbirth	0.023	−0.232 to 0.277	0.859	−0.402	−1.193 to 0.3891	0.314
Fresh	0.077	−0.068 to 0.222	0.292	−0.265	-0.634 to 0.104	0.156
Macerated	−0.055	−0.264 to 0.153	0.598	−0.136	−0.686 to 0.414	0.623
Early neonatal	−0.055	−0.226 to 0.116	0.525	−0.377	-0.698 to 0.056	0.022
Perinatal mortality	−0.033	−0.300 to 0.235	0.808	−0.777	−1.595 to 0.040	0.062
Birth weight 2500+ g						
Stillbirth	−0.012	−0.048 to 0.025	0.519	−0.005	−0.067 to 0.057	0.870
Fresh	−0.025	-0.040, to 0.011	0.001	−0.007	−0.056 to 0.042	0.785
Macerated	0.013	−0.015 to 0.041	0.354	0.002	−0.045 to 0.048	0.940
Early neonatal	−0.026	-0.049 to 0.003	0.027	−0.035	−0.084 to 0.014	0.159
Perinatal mortality	−0.038	−0.085 to 0.009	0.110	−0.038	−0.107 to 0.031	0.273

HT, hypertension.

that the new recommendations are meeting their objectives to reduce perinatal mortality and reduce preventable deaths due to hypertension.

Our study is the first to examine the impact of the 2016 WHO Recommendations for a Positive Pregnancy Experience on perinatal mortality. In the current study, no declines in perinatal mortality were observed across the pre-implementation period, consistent with South Africa's national reporting of perinatal mortality.[19] However, after implementation, a decline in stillbirths was initiated (at a rate of 9 stillbirths prevented per 100 000 births
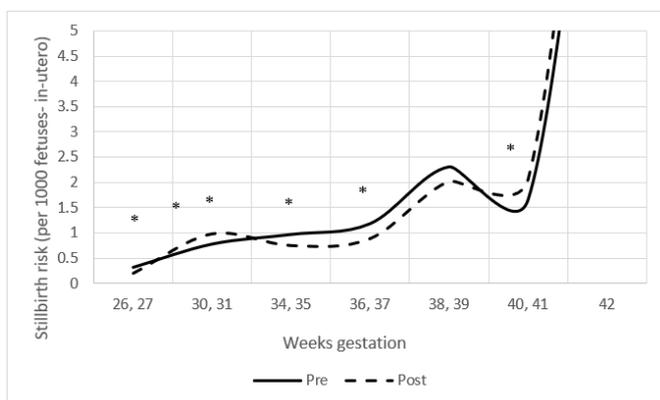
Figure 2 Stillbirth risk by pregnancy gestation (weeks), pre n=145 149, post n=76 270, *p<0.05 between pre-implementation and post-implementation groups.

each month). These findings are consistent with previous evidence suggesting that more frequent ANC contacts decrease perinatal mortality.[6–8] A Cochrane review (2015) found that in LMICs, perinatal mortality was significantly higher in reduced ANC contact groups receiving five or fewer contacts compared with standard ANC contacts.[6] The timing of contacts and risk of stillbirth have been examined in two studies. A secondary analysis of the WHO Antenatal Care Trial found an increased relative risk of fetal death of 27% between 32 and 36 weeks' gestation in populations with reduced ANC schedules.[7] Our previous work from South Africa also found an increase in stillbirth risk at 38 weeks after a 6-week period of no ANC.[8] The Cochrane review concluded that having only two or three contacts scheduled in the third trimester would not be sufficient to detect fetuses at risk or provide treatment to prevent stillbirth, thus contributing to the increased risk of perinatal death in the reduced ANC group.[6] Based on this evidence, 2016 WHO Recommendations for a Positive Pregnancy Experience targeted additional contacts in the third trimester.[7 8] Our analysis found a decrease in stillbirth risk specifically during the third trimester when the additional ANC contacts were scheduled (34–38 weeks), indicating that these targeted recommendations do reduce stillbirth in this high-risk period.

Table 4 Primary causes of perinatal deaths for the pre-implementation (n=5047) and post-implementation period (n=2486)

Primary cause of death	Pre-intervention		Post-intervention	
	n (%)	Per 1000 births	n (%)	Per 1000 births
Intrapartum asphyxia	1246 (24.7)	5.6	568 (22.8)	5.0
Unexplained intrauterine death	1233 (24.4)	5.6	608 (24.5)	5.3
Hypertensive disorders	968 (19.2)	4.4	470 (18.9)	4.1
Antepartum haemorrhage	587 (11.6)	2.7	302 (12.1)	2.6
Abruptio placentae	426 (8.4)	1.9	145 (5.8)	1.3
Spontaneous preterm labour	451 (8.9)	2.0	221 (8.9)	1.9
Fetal abnormality	273 (5.4)	1.2	156 (6.3)	1.4
Intrauterine growth restriction	79 (1.6)	0.4	55 (2.2)	0.5
Maternal disease	75 (1.5)	0.3	37 (1.5)	0.3
Infections	50 (1.0)	0.2	31 (1.2)	0.3
Other	85 (1.7)	0.4	38 (1.5)	0.3

One of the aims of the new ANC contact schedule was to target the detection and management of hypertension. Our results indicate that the 2016 WHO Recommendations for a Positive Pregnancy Experience were successful in starting to reduce deaths due to hypertension. No progress has been made in the last decade in reducing the maternal deaths or perinatal deaths due to hypertensive causes in South Africa, despite almost 75% of these deaths considered preventable.[12] The risk of stillbirth was reduced by 15% in hypertensive disorders of pregnancy when accessing the new ANC schedule with 1 stillbirth prevented for every 25 women with severe hypertension accessing the new ANC schedule. The decreases seen in fresh stillbirths between 34 and 38 weeks are also likely a reflection of the decrease in deaths due to hypertension which would manifest in fewer cases of abruptio placentae, consistent with our data showing an overall decrease in the number of deaths due to abruptio placentae. A well-accepted hypothesis for the increase in perinatal mortality observed in several studies between 32 and 36 weeks[7 8 15] is that these deaths are due to treatable and detectable conditions such as eclampsia and hypertension.[20] The overall decreases in

stillbirth risk for hypertensive disorders of pregnancy specifically during this period provide further support for this reasoning.

The effect of the new BANC Plus programme was an increased detection of hypertension, which led to the overloading of the local high-risk clinics. A published subanalysis of four catchment areas in South Africa with BANC Plus found that there was an increase in the detection of hypertension by 40%. This necessitated developing new systems to manage the women identified with hypertension, but these were only introduced into Mpumalanga in November 2019 (after the analysis in the current paper). This was attributed to the lack of ensuring the women with hypertension were seen by a healthcare professional with the appropriate skills and resources available.[14]

New strategies have recently been accepted by the NDoH to manage hypertensive disorders of pregnancy through the additional ANC contacts and the concept of 'next level of expertise', an innovative approach that promotes creating a functional 'next level of expertise' at the PHC level to increase accessibility to expert care for all women.[14] This presents an opportunity to have a

Table 5 Mother's health in perinatal deaths for the pre-implementation (n=5047) and post-implementation period (n=2486)

Mother's health	Pre-intervention		Post-intervention	
	n (%)	Per 1000 births	n (%)	Per 1000 births
No obstetric condition	2786 (55.2)	13.1	1327 (53.4)	12
Coincidental conditions	95 (1.9)	0.4	41 (1.7)	0
Medical and surgical disorders	211 (4.2)	1.0	137 (5.5)	1
Non-pregnancy-related infections	191 (3.8)	0.9	103 (4.1)	1
Extrauterine pregnancy	11 (0.2)	0.0	6 (0.2)	0
Pregnancy-related sepsis	39 (0.8)	0.2	12 (0.5)	0
Obstetric haemorrhage	570 (11.3)	2.7	304 (12.2)	3
Hypertension	1143 (22.6)	5.4	555 (22.3)	5
Other	1 (0.0)	0.0	1 (0.0)	0
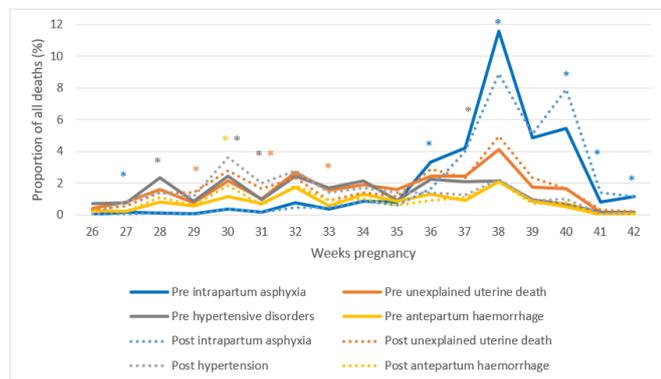
Figure 3 Proportion of deaths by gestation age. *P<0.05 between pre-period and post-period.

significant impact in reducing deaths due to hypertensive-related causes and on stillbirth overall.

Strengths and weaknesses of the study

There are several limitations that must be considered when interpreting the findings of this study. One inherent limitation to pre–post study designs is the lack of a control. One cannot be certain the changes observed are due to the implementation of the recommendations, however this was the only intervention implemented for pregnant women in Mpumalanga during the study period. As the number of ANC contacts that each woman received was not recorded, this study adopted the assumption that women accessing care in the post-implementation period would have accessed BANC Plus as this programme was upscaled across the province. We aimed to mitigate this by including only women who had been recorded attending at least one ANC contact. Any effect estimates would be drawn towards the null and therefore our estimates likely underestimate the true impact of the intervention. For the analysis examining deaths due to hypertension, our denominator consisted only of women with severe hypertension leading to severe pre-eclampsia or eclampsia, therefore our risk estimates for hypertensive-related deaths will be overestimates when applied to pregnant women with hypertension of any severity. The analysis investigating stillbirth risk by gestational age used only women with known gestational age, therefore 43.2% of deaths were unable to be included in the analyses due to missing data. The deaths not included in the analysis were similar to those analysed in terms of maternal age, parity, syphilis serology and HIV serology. There were more missing data on single/multiple pregnancies in the uncertain group (missing 'certain' group n=0, 0.0%; missing in 'uncertain' group n=600, 31.8%). However, as our analysis included all pregnancies regardless of whether they were single/multiple or missing information on this variable, we do not expect these missing data to have a significant impact on our results.

One of the strengths of the current study that it was a 'real-life' reflection of the situation in South Africa and a 'natural experiment' removing the issues of selection and information bias present in previous randomised

controlled trials (RCTs). Due to the nature of the current study design using administrative province-level data, with an intervention occurring for all women (without the ability for individual manipulation), several potential threats to validity inherent to pre–post study designs are not applicable such as placebo, Hawthorne effect, testing, maturation and drop-out. Other potential threats inherent to pre–post study designs are not likely not to introduce significant bias such as history and reporting bias. Previous studies have been RCTs where complete blinding in trials of ANC is impossible, increasing the chance of selection or information bias. It has also been a challenge to avoid co-interventions in such trials as demonstrated with many ANC RCTs to date.[21]

Meaning of the study: possible explanations and implications for clinicians and policymakers

The trend towards a decrease of around 6% in stillbirths with the implementation of the new recommendations is similar in magnitude to the predicted impact of interventions that encourages women to fall asleep on their side in high-income countries of 6%.[22] In the Global Report on Preterm and Stillbirths, 10 interventions were identified to prevent stillbirth and preterm births in LMICs.[23] Nine of these interventions require quality ANC to deliver the intervention. Additional ANC contacts offer improved communication and support for pregnant women.[9–11] Additional contacts also result in increased detection of complications in pregnancy. Future implementation of the recommendations needs to ensure that plans are in place to manage with the increased number of women detected with complications. In Mpumalanga, had health system changes been put in place during the introduction of the new recommendations to manage women detected with hypertension, the impact of the intervention might have been greater.

Current prediction models show that if stillbirth rates continue to decrease at the current velocity in LMICs, it will take more than 160 years before a woman in Africa has the same chance of her baby being born alive as a woman in a high-income country.[1] Our analysis showed that for every 3427 women who accessed the new ANC model 1 third-trimester stillbirth would be prevented. This has the capacity to prevent approximately 288 stillbirths in South Africa each year. This would greatly expedite progress towards the stillbirth target of less than 12 per 1000 births per year which in absolute terms requires the prevention of 891 stillbirths per year in South Africa. The large number of avoidable stillbirths occurring in the third trimester and due to causes such as hypertension presents an opportunity to make a significant impact in reaching this target.[1]

The implementation of the 2016 WHO Recommendations for a Positive Pregnancy Experience appears to be an effective public health strategy to reduce stillbirths in the South African context. The increased number of ANC contacts increases the opportunity for improved communication and support for pregnant women[9–11]

and to detect and manage conditions such as hypertension. Ensuring adequate resources and planning for the increase in referrals for pregnancies where hypertension is detected would likely decrease perinatal mortality further. Other LMICs should consider the implementation of 2016 WHO Recommendations for a Positive Pregnancy Experience as a strategy to reduce perinatal mortality.

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Patient consent for publication Not required.

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