

BMJ Open Do women's empowerment and socioeconomic status predict the adequacy of antenatal care? A cross-sectional study in five South Asian countries

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ABSTRACT

Objectives Relative to the attention given to improving the measurement of adequacy of antenatal care (ANC) in South Asian (SA) region, the influence of women's empowerment and socioeconomic status (WESES) on adequate ANC services has hardly received any attention. This study aimed to investigate the present scenario of adequacy of ANC in SA and how its adequacy was associated with WESES.

Setting and participants Using the Demographic and Health Survey data set of five SA countries, that is, Afghanistan, Bangladesh, India, Nepal and Pakistan, 48 107 women were selected in this study who received at least one ANC component and had at least one live birth in the 3 or 5 years preceding the survey.

Analysis Multilevel logistic regression models were used to investigate the relationship between adequacy of ANC and WESES.

Results Only 30% women received adequate ANC in SA, ranging from 8.4% (95% CI 7.1% to 9.9%) in Afghanistan to 39.8% (95% CI 37.4% to 42.2%) in Nepal. The poor utilisation of adequate ANC services was most prevalent among the women residing in rural areas and that of poor families as well as low empowerment status in SA countries. Different levels of WESES, that is, highly empowered but poor (adjusted OR (AOR): 1.33; 95% CI 1.18 to 1.49), lowly empowered but rich (AOR: 2.07; 95% CI 1.84 to 2.32) and highly empowered and rich women (AOR: 3.07; 95% CI 2.75 to 3.43), showed significant positive association with adequate ANC services than the poor and low empowered women, after adjusting the potential covariates.

Conclusion As unsatisfactory level of adequate ANC services has been observed in SA region, this study suggests a nationwide comprehensive improvement of women's empowerment status as well as establishment of necessary healthcare centres in remote areas is essential to ensure long-term and sustainable adequacy of ANC services.

INTRODUCTION

Approximately 800 women die each day from complications in pregnancy and childbirth, and only South Asia (SA) accounts for about

Strengths and limitations of this study

- The approach of 'adequate ANC' estimation in this study allows the nationwide identification of women who received frequent, sufficient and appropriate care.
- This study can be used to show the existing gaps in coverage among different socioeconomic groups.
- This study considered the previous recommended antenatal care (ANC) visit (minimum four visits) rather than the WHO (2016) updated ANC guidance (minimum eight contacts), since Demographic and Health Survey data are only available for the previous recommendation.

20% of the total maternal deaths worldwide. In SA, while the maternal mortality ratio was 163 per 100 000 live births in 2017, strategies like effective and adequate antenatal care (ANC) provision can accelerate the aim of achieving Sustainable Development Goal-3 in the area of maternal mortality (ie, reduction of global maternal death to less than 70 per 100 000 live births).¹⁻³ Most of the complications during pregnancy, like haemorrhage, eclampsia, sepsis, embolism, other pre-existing medical disorders, etc, which have been the leading causes of deaths and disabilities among women of childbearing age across the world, are preventable with adequate and cost-effective maternity care and counselling during and after pregnancy period.^{2 4 5} Evidence suggests that women's use of adequate ANC had a strong association with a lower occurrence of preterm births, and ANC alone can reduce maternal mortality by 20%, given the good quality and regular attendance.^{6 7}

Adequacy of ANC is a conditional process where women receive recommended ANC visits and components from skilled ANC

providers.¹ It could be measured according to four dimensions of the healthcare process: access to the care, that is, well timed (first visit during the first 3 months of pregnancy); sufficient (at least four antenatal visits); delivered by skilled health personnel; and received with recommended ANC packages or contents.^{1 7 8} But, in 2017, only half of the pregnant women in SA received the recommended minimum of four ANC visits, which is lower than in sub-Saharan Africa.⁹ On the other hand, the WHO recommended ANC packages include physical examinations (weight, height, blood pressure measurement, fetal heartbeat assessment), laboratory investigations (urine and blood samples), preventive procedures (tetanus injection and iron supplementation) and provision of information or counselling on signs of pregnancy complications.⁸ However, there are enormous disparities in receiving adequate ANC among women in different geographic areas and socioeconomic groups.^{10–12} Recommended ANC visits and receiving good quality ANC mostly depend on several community and individual-level factors such as geographic location, proximity to health centres, women's empowerment and household status. Previous studies reported that the likelihood of receiving good ANC was higher among women of rich household status in SA.^{10 11 13} In particular, a previous study illustrated that highly empowered women from low and middle-income countries were positively associated with good quality maternal care during pregnancy.¹² Nevertheless, women's educational level and earning status could not secure their healthcare decision-making autonomy because of the poor socioeconomic status (SES) of their households.¹⁴ So, there might be a hidden relationship of women's empowerment and socioeconomic status (WESES) (ie, lowly empowered but rich, highly empowered but poor, medium empowered but poor, etc) with the adequacy of ANC; however, such evidence in SA countries is lacking.

Most of the previous studies^{10 11 13} were country specific and focused on either the contact coverage or on the content of ANC. However, none of those earlier studies comprehensively combined the conditional indices (ie, women who received recommended comprehensive care and coverage in all indicators) to measure and depict the whole picture of the adequacy of ANC services in SA. Thus, our study aimed to investigate the present scenario of the adequacy of ANC in SA and how adequacy is associated with WESES.

METHODOLOGY

Data sources

We used the nationally representative most recent Demographic and Health Survey (DHS) data from five SA countries—Afghanistan, Bangladesh, India, Nepal and Pakistan. The DHS surveys gather data on a range of population health indicators with a strong focus on maternal and child health in low and middle-income countries and comparable across countries. Women of

reproductive age (15–49 years) without necessary ANC information and missing information on covariates were excluded from this study. Finally, 48 107 women were used in this cross-sectional study who received at least one ANC component and had at least one live birth in the 3 or 5 years preceding the survey (online supplemental appendix table 1).

Regarding the ethical aspects of the DHS survey, details of administrative procedures, training, sampling strategies and methodology of DHS have been described elsewhere.^{15 16} Because of the publicly available nature of DHS data with no identifying information, it was reviewed¹⁷ but exempted from ethics review approval by the Institutional Review Board at the first author's affiliation.

Patient and public involvement

Patients and the public were not involved in the development of research questions, design of the study, recruitment, and conduct of the study, or dissemination of the study results.

Outcome variable

The outcome variable of this study was the 'adequacy of antenatal care' which is the combination of (A) ANC coverage of at least one visit (ANC1), (B) intensity of ANC (ANC4), and (C) receipt of components of care. The ANC coverage (ANC1) was defined as the proportion of women who had at least one ANC visit with a skilled provider during their last pregnancy.^{7 18} Doctors, nurses, midwives and country-specific skilled health providers were considered as skilled ANC providers (online supplemental appendix table 2). The intensity of ANC (ANC4) was defined as four or more visits to ANC. Receipt of components of ANC was considered according to WHO recommendation¹⁹ and the availability of the item among all SA countries. Each respondent with at least one ANC visit was asked during the DHS survey whether she received specific care components during any of the consultations she attended during her pregnancy. Though the number of components collected varied across countries, we used four components (the measurement of blood pressure, urine test, blood test and information or counselling on pregnancy complications) which remained consistent across the countries included in this study. Since the components of ANC were assessed by looking at the proportion of women who received at least one ANC visit and at least one recommended component, we limited the analysis of components of ANC to women who received at least one ANC visit. Finally, a composite and dichotomised variable 'adequacy of ANC' was created by measuring the proportion of women who reported receiving all four components of ANC (checking blood pressure, giving a urine and blood sample and being counselled about pregnancy complications at any point during their pregnancy), received recommended intensity ANC of four or more visits and sought care from skilled ANC providers. The 'adequacy of ANC' was further coded as 1 (adequate ANC), and otherwise 0.

Predictor variable

The combinations of WESES have been considered as the predictor variable, where women's empowerment status (WES) was divided into three categories: low, medium and high; and their SES was divided into poor, middle and rich. Further, based on the intersectional axes of WES and SES categories, nine combinations of predictor variables were formed.

Development of WESES

The level of women's empowerment in the DHS is assessed using two indicators: (1) women's decision-making power in household-level decisions (access to healthcare, household purchasing and freedom to visit relatives), and (2) women's attitude towards violence. In addition to those, women's educational level, earning types and position in the household (household head or not) were included in this study to measure WES, as previous literature of the SA region had frequently studied these domains of measuring women's empowerment.^{20–22} This study considered the above-mentioned five indicators and the scoring process of these indicators was developed using evidence from previous literature to develop a composite index of WES^{21–24}; where the higher values reflect the greater status of empowerment. The conceptualisation of women's empowerment (online supplemental appendix A) and the necessary coding for creating all five indicators have been narrated in the online supplemental appendix table 3. The indicator 'women's decision making power at household level' was constructed using three household-level decisions, that is, person who decides: respondent's healthcare, large household purchases and whether the respondent can visit her relatives. 'Women's attitude toward violence' was assessed using five variables describing whether beating was justified if the respondent: goes out without telling her husband, neglects children, argues with her husband, refuses sex with her husband and burns food. The indicator 'types of earning from employment' identifies whether respondents were employed or not, and if employed, this indicator includes the types of respondents' earning from their employment. The indicator 'educational level' includes the level of education of the respondents. And finally, 'headship of household' discloses whether the respondent herself was the household head or not.

Based on the scores of these five indicators, we performed principal component analysis (PCA) for each country to construct an overall empowerment index. During PCA, scree plots were analysed to define the number of components to be retained and orthogonal varimax rotation was applied to the retained components. We used the very first component only after loadings and getting scores of the components, and then the index scores were divided into quintiles (low, medium and high). Finally, the overall index of women's empowerment had been constructed for each selected country with three ordered categories: low, medium and high; where 'low' meant women have lower empowerment and

'high' meant women have higher empowerment. In the PCA analysis, the value of Kaiser-Meyer-Olkin measure of sampling adequacy ranged from 0.72 to 0.85, indicated that the sample sizes of this study were adequate for PCA. The χ^2 statistic in Bartlett's test of sphericity was significant (ie, $p < 0.001$) for all countries, which confirmed that the selected indicators of women's empowerment were inter-correlated. In addition, the reliability coefficient (Cronbach's alpha) score ranged from 0.60 to 0.79, indicating an acceptable level of correlation among components.²⁵

On the other hand, women's SES was measured based on the household wealth index, which was constructed based on housing characteristics and household assets. The detailed analytical procedures for measuring the wealth index in the DHS surveys are described elsewhere.²⁶ The SES for each country was categorised into five equal quintiles (poorest, poorer, middle, richer and richest), with the first representing the poorest 20%, and the fifth representing the richest 20%. In this study, the SES had further been divided into three classes, that is, poor (combining poorer and poorest), middle and rich (combining richer and richest).

Controlling variables

Following previous studies,^{1 10 27 28} we included respondent's age (categorised as 15–24, 25–34 and 35–49 age groups), the number of living children (no child, 1–3 children, 4 and more children), media exposure (watching TV, listening to radio and reading newspapers), modern contraceptive usage (yes, no), respondent's age at first birth (15–17, 18–46 years), wanted last pregnancy (yes, no), husband's educational level (no education, primary, and secondary and higher) and place of the region (urban, rural) as controlling variables in this study.

Statistical analysis

Descriptive statistics were used to estimate the proportion outcome with a 95% CI. In the pooled data set, individuals were nested within communities, and communities were further nested with countries. Thus, we used multilevel logistic regression models with a random intercept term at the community and country levels to investigate the relationship between adequacy of ANC and respondent's SES at the household level. A likelihood ratio test was performed to decide the choice of the multilevel model over the fixed-effect model. We presented both unadjusted OR and adjusted OR (AOR) along with 95% CIs, as well as reported the significance level for the differences between the ORs of WESES. Furthermore, we performed sensitivity analysis to observe whether the incremental level of empowerment affects ANC coverage among the poor population. All the analyses considered sampling weight and the complex survey (DHS) design. For all analyses, $p < 0.05$ was set as the significant level. Multicollinearity was tested using variance inflation factor and observed no multicollinearity problem in the included models. Stata MP V.16.1 was used for all the analyses.

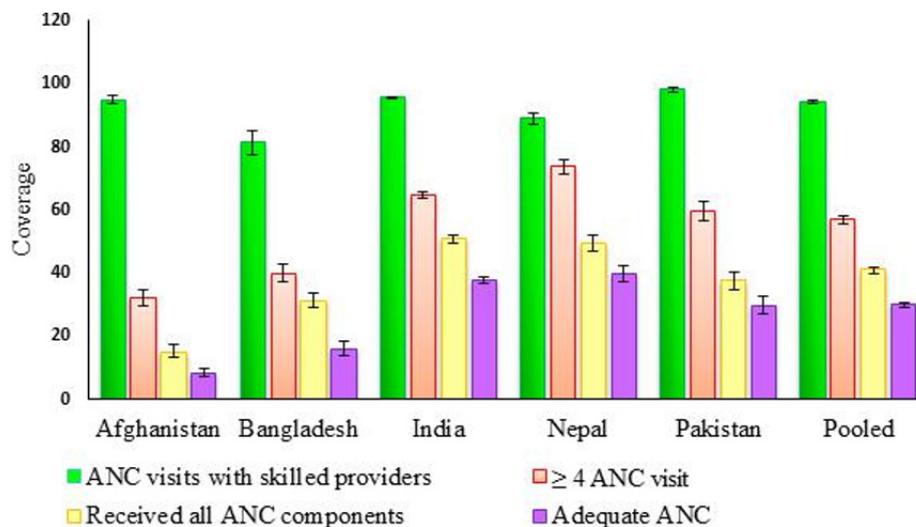


Figure 1 Overall coverage of antenatal care (ANC) in South Asia. Error bar presents 95% CIs. Country-specific coverage has been tabulated in online supplemental appendix table 4.

RESULT

The overall coverage of ANC of SA countries has been shown in [Figure 1](#). Three out of 10 women received adequate ANC in the SA region ranging from 8.4% in Afghanistan to 39.8% in Nepal. Though most of the SA women received at least one ANC visit from country-specific skilled providers, their proportions decreased in terms of receiving four or more recommended ANC visits (about 57%), ranging from 32.0% (in Afghanistan) to 73.7% (in Nepal), and components (about 41%), ranging from 15.1% (in Afghanistan) to 50.8% (in India). Again, the practice of adequate ANC services was poor for the women residing in rural areas and that of poor families as well as low empowerment status in all SA countries ([table 1](#)).

The mean age (\pm SD) of the respondents was 27.51 (\pm 5.79) years. SA women who were both rich and highly empowered received about threefold more adequate ANC service (44.24% vs 17.21%) than those of low empowered and poor ([table 2](#)). In addition, wives of higher educated husbands received comparatively more adequate ANC (37.37% vs 13.88%) than those women whose husbands were illiterate (online supplemental appendix table 5). On the other hand, the independent association of women's empowerment (online supplemental appendix table 6) and SES (online supplemental appendix table 7) with ANC showed that the coverage of ANC was significantly associated with the increment of empowerment and SES, individually.

The results of multilevel logistic regression models are presented in [table 2](#). The values of the likelihood ratio test were significant ($p < 0.000$ for model I; $p < 0.000$ for model II), meaning that random effects models are more appropriate for this study compared with the fixed-effect model. The unadjusted ORs from model I indicate that highly empowered but poor women had a 50% higher likelihood of receiving adequate ANC (OR: 1.50; 95% CI 1.33 to 1.68) than the poor and lowly empowered women.

This likelihood for poor but highly empowered women decreased by 17% after adjusting all potential covariates, but still showed a significant and positive association with adequate ANC (AOR: 1.33; 95% CI 1.18 to 1.49). Again, the unadjusted association of women's rich and high empowerment status (OR: 5.18; 95% CI 4.68 to 5.72) showed more than fivefold increased odds than the poor and low empowered women while receiving adequate ANC in SA. However, the adjusted association shows that (model II) both highly empowered and rich and lowly empowered but rich women were 3.07 and 2.07 times more likely to receive adequate ANC, respectively, than the lowly empowered and poor women.

Additionally, we investigated the significance level for the differences between the ORs of WESES from [table 2](#). It was found that ANC coverage was less for the poor and low empowered women, compared with the higher empowerment and SES categories; and the difference between the ORs was statistically significant for almost all the WESES categories (online supplemental appendix table 8).

Since [table 2](#) indicated that the probability of receiving adequate ANC was increasing proportionately with the increment of WESES, we further performed sensitivity analysis to investigate whether women's empowerment could accelerate the ANC coverage among low SES (online supplemental appendix table 9). The adjusted model (model II) in online supplemental appendix table 9 revealed that despite being low SES, the likelihood of receiving adequate ANC services was 1.36 times higher (AOR: 1.36; 95% CI 1.20 to 1.54) among the highly empowered women.

DISCUSSION

This study examined the adequacy of ANC in SA countries and how its adequacy was associated with WESES using nationally representatively recent household survey

Table 1 Coverage of adequate antenatal care in South Asian countries according to the place of residence, socioeconomic status and level of empowerment (n=48 107)

	Coverage of adequate antenatal care (95% CI)				
	Afghanistan 2015	Bangladesh 2014	India 2015–2016	Nepal 2016	Pakistan 2018
National level	8.4 (7.1 to 9.9)	16.1 (14.1 to 18.4)	37.8 (36.8 to 38.9)	39.8 (37.4 to 42.2)	29.8 (27.2 to 32.5)
Place of residence					
Rural	5.9 (4.6 to 7.4)	11.3 (9.3 to 13.7)	33.7 (32.6 to 34.8)	30.6 (27.3 to 34.1)	21.1 (17.9 to 24.6)
Urban	14.9 (12.3 to 17.9)	27.3 (23.2 to 31.7)	46.1 (44.2 to 48.1)	47.0 (43.5 to 50.5)	44.7 (40.8 to 48.6)
Socioeconomic status					
Poor	3.8 (2.8 to 5.2)	5.1 (3.7 to 7.0)	25.9 (24.4 to 27.4)	27.1 (24.3 to 30.0)	10.9 (8.9 to 13.3)
Middle	7.4 (5.5 to 10.0)	9.7 (7.1 to 13.1)	39.5 (37.6 to 41.5)	35.3 (31.4 to 39.4)	23.8 (20.0 to 28.1)
Rich	12.2 (9.9 to 14.9)	26.1 (23.1 to 29.4)	47.9 (46.2 to 49.5)	55.7 (52.3 to 59.1)	47.5 (44.2 to 50.8)
Empowerment level					
Low	7.1 (5.4 to 9.3)	11.6 (9.1 to 14.6)	34.7 (33.1 to 36.3)	33.1 (29.6 to 36.8)	14.1 (11.6 to 16.9)
Medium	5.9 (4.3 to 8.1)	13.8 (11.4 to 16.6)	34.9 (33.3 to 36.6)	39.1 (35.4 to 43.0)	30.3 (27.0 to 33.7)
High	12.2 (10.2 to 14.5)	23.1 (19.7 to 26.9)	44.9 (43.2 to 46.5)	47.3 (43.9 to 50.7)	43.1 (39.2 to 47.2)
Socioeconomic status×empowerment level					
Poor					
Low empowered	3.6 (2.5 to 5.3)	4.8 (3.11 to 7.4)	23.9 (21.7 to 26.2)	23.7 (19.8 to 28.0)	7.7 (5.6 to 10.4)
Medium empowered	3.0 (1.6 to 5.6)	4.0 (2.3 to 6.8)	24.9 (22.8 to 27.1)	27.6 (23.3 to 32.2)	11.3 (8.2 to 15.4)
Highly empowered	5.4 (3.6 to 8.2)	7.8 (4.6 to 13.0)	31.7 (28.9 to 34.6)	30.5 (26.2 to 35.1)	17.7 (12.6 to 24.4)
Middle class					
Low empowered	7.5 (5.1 to 10.8)	8.0 (4.3 to 14.5)	39.8 (36.9 to 42.9)	28.8 (23.3 to 35.1)	16.0 (11.1 to 22.7)
Medium empowered	5.4 (3.5 to 8.4)	9.0 (5.6 to 14.3)	36.1 (33.1 to 39.3)	36.7 (29.9 to 44.0)	21.4 (16.8 to 26.9)
Highly empowered	9.5 (5.9 to 15.0)	11.9 (7.5 to 18.5)	42.7 (38.8 to 46.7)	44.4 (37.8 to 51.1)	34.7 (27.0 to 43.3)
Rich					
Low empowered	10.0 (6.6 to 14.9)	22.5 (17.4 to 28.5)	44.9 (41.9 to 47.9)	49.7 (42.7 to 56.8)	29.6 (23.0 to 37.1)
Medium empowered	8.8 (5.8 to 13.2)	22.1 (17.8 to 27.1)	45.4 (42.5 to 48.4)	53.8 (47.7 to 59.7)	44.4 (40.0 to 49.0)
Highly empowered	16.3 (13.2 to 20.0)	31.5 (27.1 to 36.2)	52.1 (49.8 to 54.5)	61.3 (56.7 to 65.6)	55.6 (51.6 to 59.6)

n, number of total respondents.

data from five SA countries. Our study has found that about 94% of women in SA received at least a single ANC visit and five out of 10 received at least four ANC visits. A recent UNICEF data (2019) on ANC showed that these statistics were far more downcast compared with the Middle East and North Africa (ANC4: 70%), East Asia and the Pacific (ANC1: 96%; ANC4: 75%) and Latin America and the Caribbean (ANC1: 97%; ANC4: 91%).⁹ In SA, the trend of seeking adequate ANC was not significant compared with other Asian regions. Within the last two decades, Indonesia, the Philippines, Vietnam and Cambodia showed more than a 10% increase in adequate ANC reception than Bangladesh, India and Nepal.²⁹

In our study, inadequate ANC was mostly prevalent among poor and low empowered women who were as well residing in rural areas. Urban-rural differences were found to be greatest in other studies when overall use of ANC was low.^{29 30} North Africa and West Africa, including Guinea, Mali, Niger and Senegal, had the most striking urban-rural gap (ie, three times as high) of receiving

ANC services, while countries of South/Southeast Asia possessed a considerable gap (about twice), especially in Bangladesh and Nepal. Physical remoteness from health facilities and inaccessibility of proper ANC services staying in rural areas were marked as the prime reasons for such disparities.³⁰ Nevertheless, part of the explanation may lie in the impact of WESES on the use of ANC.

In low and middle-income countries, women's SES has been appeared to be a major determinant in terms of ensuring adequate ANC. And the poorest fifth of the population is less likely to have proper ANC than the richest fifth, mostly in Asia.^{10 11 27 30} Whereas about half (48%) of the SA population are multidimensionally poor, socioeconomic factors could impact the ANC of women in many ways.^{10 31} But, without empowering women multidimensionally along with the improvement of their SES, any further improvement of effective utilisation of maternal healthcare would not contribute to adequate ANC services for marginal groups.^{10 27} Because household wealth status was found to be weakly associated with the

**Table 2** Association of women's empowerment and socioeconomic status with coverage of antenatal care in the pooled data (n=48 107)

Characteristics	Total n (%)	Adequate ANC (%) (95% CI)	Model I OR (95% CI)	Model II AOR (95% CI)
Women's empowerment and socioeconomic status (WESES)				
Poor				
Low empowered	7270 (15.2)	17.2 (15.8 to 18.7)	1 (Ref)	1 (Ref)
Medium empowered	3795 (13.1)	18.6 (17.1 to 20.2)	1.07 (0.96 to 1.19)	1.07 (0.96 to 1.19)
Highly empowered	5634 (8.2)	23.3 (21.5 to 25.2)	1.50 (1.33 to 1.68)***	1.33 (1.18 to 1.49)***
Middle class				
Low empowered	6293 (7.9)	29.4 (27.2 to 31.6)	2.02 (1.79 to 2.28)***	1.57 (1.38 to 1.77)***
Medium empowered	3233 (6.7)	26.9 (24.7 to 29.2)	1.98 (1.75 to 2.24)***	1.50 (1.32 to 1.70)***
Highly empowered	6611 (6.2)	33.6 (30.8 to 36.5)	2.65 (2.35 to 3.00)***	1.91 (1.69 to 2.17)***
Rich				
Low empowered	3961 (11.7)	35.1 (32.8 to 37.5)	3.22 (2.88 to 3.60)***	2.07 (1.84 to 2.32)***
Medium empowered	2990 (13.7)	36.7 (34.0 to 39.4)	3.57 (3.21 to 3.96)***	2.22 (1.99 to 2.49)***
Highly empowered	8319 (17.3)	44.2 (42.2 to 46.3)	5.18 (4.68 to 5.72)***	3.07 (2.75 to 3.43)***
Random variance parameter: variance (SE)				
Community level			1.62 (0.06)	1.48 (0.06)
Country level			1.03 (0.65)	0.75 (0.47)

Model II was additionally adjusted by respondent's age, number of children, media exposure, modern contraceptive usage, age at birth, wanted last pregnancy, husband's educational level and place of region.

Significance level: *p<0.05; **p<0.01; ***p<0.001.

Results of full models are presented in online supplemental appendix table 5.

ANC, antenatal care; AOR, adjusted OR; n, number of total respondents; Ref, reference category.

involvement in decision-making¹⁴; and lower decision-making power resulting from lower empowerment status consequently jeopardises proper maternal care during pregnancy.²⁷ Therefore, lowly empowered women, even though residing in a wealthy and urban environment, might get inadequate ANC services due to active discrimination by the providers or due to women's low empowerment to demand higher quality services from the providers.³² In contrast, along with the outcome of the study from Guinea,³³ this study revealed a positive and significant effect of women's empowerment on the utilisation of adequate ANC services, even among the poor people. In a nutshell, this study indicated women's higher empowerment status as a mitigating factor to the known risk of low SES on ANC coverage.

More specifically, our study revealed that women with higher education and empowerment status were more likely to use ANC services in any regional setting, which is matched with the outcomes of several studies.^{11 27 29 32} Perhaps because educated women are more likely to realise the benefits of using maternal healthcare services.³⁴ Again, education usually improves the empowerment level of women by increasing women's earning opportunities, changing their attitude towards violence and building decision-making power within the household, which consequently influences the uptake of maternal healthcare services.^{34 35} Moreover, studies from Nepal,¹¹

Bangladesh³⁴ and India³² showed that as an educated household head with economic solvency and possessing decision-making power on healthcare, women had significantly higher chances of receiving proper ANC services than those who did not.

The present study has several strengths. Previous efforts to evaluate prenatal care through indicators of ANC have only considered the opportunity and/or frequency of care.^{10 11 13 34} Again, those studies were based on estimating the coverage of each indicator separately or considering different thresholds for each of the components (eg, recommended ANC visits), which represented a barrier for international comparisons. The approach depicted in this study is more comprehensive and combines all the available indicators (in DHS). This measure is internationally comparable and allows the nationwide identification of women who receive frequent, sufficient and appropriate care. By identifying women who received each type of ANC, this study can be used to show the existing gaps in coverage among different socioeconomic groups. Moreover, this nationally representative study was conducted rigorously using standard protocols and trained data collectors with pretesting, which made our findings more reliable and valid. Nonetheless, our study has several limitations. First, because of using DHS data set across countries, adequacy of ANC was possible to measure including only three indicators and thus be

seen as a starting point for the assessment of adequacy rather than a definitive measure. Second, WHO (2016)¹⁹ has recently updated the ANC guidance by increasing the number of ANC visits to a minimum of eight contacts with a trimester-wise timeline during pregnancy. But, most of the global, regional and comparable country-reported data, such as DHS, are only available for the previous recommendation (minimum of four visits), and data regarding timing are not available in all countries.^{9 18 36} Third, the findings may introduce recall biases that may not correctly present the health-seeking behaviours of mothers. Finally, due to data limitation, this study mainly focused on the relationship of adequate ANC with WESES but could not address the confounding effects of other potential factors (cost of care, availability, and accessibility of health facilities, equity in health service delivery, the timing of ANC visits and knowledge and attitudes towards modern healthcare services) which may act as a barrier for achieving recommended level of adequate ANC.

CONCLUSION

Adequacy of ANC services was found to be worst in Afghanistan, followed by Bangladesh, compared with the other SA countries. Elevating WES, as well as establishment of necessary healthcare centres in remote areas, is essential to ensure sustainable adequacy of ANC services in SA. A comprehensive understanding through the identified risk factors and incorporating them into short and long-term strategies would help improving this present scenario of the adequacy of ANC services. Special surveillance systems, incentives and proper accommodation arrangements for skilled healthcare providers of rural areas would make them obliged to provide appropriate ANC services to the underprivileged and poor pregnant women. Again, despite being poor, women received adequate ANC due to their high empowerment status. So, national health policies should incorporate and address inequalities in WES, as investments in the empowerment may yield high returns that accrue to individuals, families and societies at large. Additionally, in an economically deprived region like SA, women's higher empowerment level could play an important role to gain full access to adequate ANC services. Therefore, promoting women's empowerment level as well as nationwide awareness programme regarding the necessity of ANC during pregnancy would create demand for higher quality ANC services among SA women.

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Appendix

Appendix A: Conceptualization of women empowerment status

Conceptualization of women empowerment

The measurement approaches of women's empowerment vary widely because of its multidimensional characteristics and country specific contextualization [1]. For this reason, different studies have used different indicators and developed models to measure women's empowerment, and yet none of these can be considered as a universal model [2]. According to Kishor (2000) [3], capturing the empowerment process with cross-sectional data requires indicators that evaluate the end product of the process (i.e., indicators that measure evidence of empowerment), as well as indicators of women's access to different sources of empowerment and of women's location within an appropriate setting for empowerment. Following this statement, evidence of empowerment could be sought out in terms of indicators that measure women's extrinsic and intrinsic control, i.e. women's participation in household decision making, as well as rejection of the gender-based subordination of women. Potential sources of empowerment are those that provide the building blocks for empowerment and access to resources, such as knowledge and employment for cash. And, indicators of the setting for empowerment refer to the circumstances of the respondent's current and past living arrangements and household structure, i.e. headship of the household. Together the indicators of evidence, sources, and setting provide a clear view of both the success and existence of the empowerment status of women within the household [3,4].

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Appendix Table 1: Determination of total sample size

Country, survey year	No. of Household interviewed	Total women (15-49 years)	Women with at least one birth in the last 3 or 5 years	Women with ANC history	Women with at least one ANC visit	Women receiving at least one ANC component	Missing information	Final sample size
South Asia (N = 48107)								
Afghanistan 2015	24395	29461	19642	19609	11755	10823	1855	8968
Bangladesh 2014	17300	17863	7004	4626	3630	3630	92	3538
India 2015-16	601509	699686	184641	184641	152638	152638	126312	26326
Nepal 2016	11040	12862	3998	3998	3762	3751	39	3712
Pakistan 2018	11869	12364	6711	6711	5866	5865	302	5563
Total	666113	772236	221996	219585	177651	176707	128600	48107

N, number of total women eligible for this study

Appendix Table 2: Country-specific skilled health care providers

Country	Specified skilled ANC providers
Afghanistan	Doctors, Nurses/midwives, and Auxiliary nurse/midwives
Bangladesh	Qualified doctor, Nurse/midwife/paramedic, Family Welfare Visitor (FWV), Community Skilled Birth Attendant (CSBA), and Medical Assistant or sub-assistant community medical officer (SACMO)
India	Doctor, Auxiliary nurse midwife, Nurse, Midwife, and Lady health visitor
Nepal	Doctor, nurse, and midwife
Pakistan	Doctor, Nurse/midwife/lady health visitor

Appendix Table 3: Indicators and their related variables, questions as well as aggregate codes of variables used in describing women empowerment status (WES)

Indicators	Variables	Questions	Recode used for DHS response categories
Household decision making	Women's health	Person who usually decides on respondent's healthcare	Code = 1, if 'Respondent alone' = 0, if 'Respondent and husband/partner; or, Husband/partner alone; or, Someone else; or, Other'
	Large household purchases	Person who usually decides on large household purchases	
	Visiting relatives/family	Person who usually decides on visits to family or relatives	
Attitudes towards violence	Goes out without telling husband	Beating justified if wife goes out without telling husband	Code = 1, if 'No' = 0, if 'Yes; or, Don't know'
	Neglects children	Beating justified if wife neglects the children	
	Argues with husband	Beating justified if wife argues with husband	
	Refuses sex	Beating justified if wife refuses to have sex with husband	
	Burns food	Beating justified if wife burns the food	
Earning types	Earning types	Type of earnings from respondent's work	Code = 0, if 'Not paid; or, Not working' = 1, if 'In-kind only' = 2, if 'Cash and in-kind' = 3, if 'Cash only'
Educational level	Educational level of respondent	Highest educational level	Code = 0, if 'No education' = 1, if 'Primary' = 2, if 'Secondary' = 3, if 'Higher'
Headship of household	Household head	Relationship to household head	Code = 2, if 'head' = 0, if ' wife; or, daughter; or, daughter-in-law; or, granddaughter; or, mother; or, mother-in-law; or, sister; or any other relatives'

Appendix Table 4: Coverage of antenatal care (ANC) in South Asia

Country	Sample sizes	ANC visits with skilled providers	4 and more ANC visit	Received all ANC components	Adequate ANC
Afghanistan	8968	95.0 (93.7-96.1)	32.0 (29.5-34.6)	15.1 (13.2-17.3)	8.4 (7.1-9.9)
Bangladesh	3538	81.5 (77.3-85.1)	40.0 (37.3-42.8)	31.3 (29.0-33.7)	16.1 (14.1-18.4)
India	26326	95.7 (95.3-96.0)	64.7 (63.8-65.6)	50.8 (49.7-51.8)	37.8 (36.8-38.9)
Nepal	3712	89.1 (87.2-90.8)	73.7 (71.2-76.0)	49.3 (46.7-51.0)	39.8 (37.4-42.2)
Pakistan	5563	98.1 (97.4-98.6)	59.5 (56.5-62.5)	37.6 (34.8-40.5)	29.8 (27.2-32.5)
Pooled data	48107	94.3 (93.8-94.8)	56.9 (55.8-57.9)	41.1 (39.9-42.1)	30.0 (29.1-30.9)

Note: Coverage of antenatal care with 95% confidence interval in parentheses

Appendix Table 5: Association of women empowerment and socio-economic status with coverage of antenatal care in the pooled data [N = 48107]

Characteristics	Total N (%)	Adequate ANC (%) [95% CI]	Model 1 OR [95% CI]	Model 2 AOR [95% CI]
Women's empowerment and socio-economic status (WESES)				
Poor				
Low empowered	7270 (15.2)	17.2 (15.8-18.7)	1 (Ref.)	1 (Ref.)
Medium empowered	3795 (13.1)	18.6 (17.1-20.2)	1.07 (0.96-1.19)	1.07 (0.96-1.19)
Highly empowered	5634 (8.2)	23.3 (21.5-25.2)	1.50 (1.33-1.68)	1.33 (1.18-1.49)
Middle class				
Low empowered	6293 (7.9)	29.4 (27.2-31.6)	2.02 (1.79-2.28)	1.57 (1.38-1.77)
Medium empowered	3233 (6.7)	26.9 (24.7-29.2)	1.98 (1.75-2.24)	1.50 (1.32-1.70)
Highly empowered	6611 (6.2)	33.6 (30.8-36.5)	2.65 (2.35-3.00)	1.91 (1.69-2.17)
Rich				
Low empowered	3961 (11.7)	35.1 (32.8-37.5)	3.22 (2.88-3.60)	2.07 (1.84-2.32)
Medium empowered	2990 (13.7)	36.7 (34.0-39.4)	3.57 (3.21-3.96)	2.22 (1.99-2.49)
Highly empowered	8319 (17.3)	44.2 (42.2-46.3)	5.18 (4.68-5.72)	3.07 (2.75-3.43)
Respondent's age (in years)				
15-24	16852 (35.0)	30.2 (28.9-31.4)	-	1 (Ref.)
25-34	25307 (52.6)	37.7 (30.7-32.8)	-	1.06 (1.00-1.12)
35-49	5948 (12.4)	22.0 (20.1-24.2)	-	1.18 (1.07-1.30)
Number of living children				
1-3	37276 (77.5)	34.7 (33.8-35.7)	-	1.65 (1.52-1.79)
4 and more	10831 (22.5)	13.6 (12.5-14.8)	-	1 (Ref.)
Media exposure				
No	10779 (22.4)	14.7 (13.6-15.8)	-	1 (Ref.)
Yes	37328 (77.6)	34.4 (33.3-35.6)	-	1.69 (1.56-1.82)
Modern contraceptive used				
No	30250 (62.9)	27.8 (26.8-28.8)	-	1 (Ref.)
Yes	17857 (37.1)	33.7 (32.4-35.0)	-	1.23 (1.16-1.30)
Age at first birth				
≥18 years	39269 (81.6)	32.3 (31.3-33.3)	-	1.20 (1.11-1.30)
10-17 years	8838 (18.4)	19.6 (18.2-21.1)	-	1 (Ref.)

Last pregnancy was wanted				
Unwanted	5557 (11.6)	20.3 (18.5-22.1)	-	1 (Ref.)
Wanted	42550 (88.5)	31.2 (30.3-32.2)	-	1.45 (1.33-1.58)
Husband's educational level				
No education	10484 (21.8)	13.9 (12.7-15.1)	-	1 (Ref.)
Primary	7780 (16.2)	23.3 (21.6-25.1)	-	1.17 (1.06-1.29)
Secondary and higher	29842 (62.0)	37.4 (36.4-38.4)	-	1.44 (1.32-1.56)
Place of residence				
Rural	31636 (65.8)	24.7 (23.7-25.8)	-	1 (Ref.)
Urban	16471 (34.2)	40.1 (38.5-41.7)	-	1.28 (1.18-1.39)
Random variance parameter: variance (SE)				
Community level			1.62 (0.06)	1.48 (0.06)
Country level			1.03 (0.65)	0.75 (0.47)

N, number of total respondents; CI, confidence intervals; OR, odds ratio; AOR, adjusted odds ratio, Ref., reference category; SE, standard error;

Model II was additionally adjusted by respondent's age, number of children, media exposure, modern contraceptive usage, age at birth, wanted last pregnancy, husband's educational level, and place of region;

Significance level: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$;

Appendix Table 6: Independent association of women empowerment with the coverage of antenatal care

Characteristics	Odds ratio (95% CI)
Women empowerment	
Low	1.00
Medium	1.13 (1.06-1.21)***
High	1.79 (1.68-1.91)***
Random variance parameter: variance (SE)	
Community level	1.91 (0.07)
Country level	0.96 (0.61)

Significance level: *p<0.05; **p<0.01; ***p<0.001

Appendix Table 7: Independent association of socio-economic status (SES) with the coverage of antenatal care

Characteristics	Odds ratio (95% CI)
Socio-economic status	
Low	1.00
Medium	1.95 (1.81-2.10)***
High	3.60 (3.37-3.86)***
Random variance parameter: variance (SE)	
Community level	1.65 (0.07)
Country level	1.03 (0.66)

Significance level: *p<0.05; **p<0.01; ***p<0.001

Appendix Table 8: Level of significance of the differences between the odds ratios from different categories of women empowerment and socio-economic status (WESES)

Poor-low empowered (Ref.)	Poor-Medium empowered	Poor-Highly empowered	Middle class-Low empowered	Middle class-Medium empowered	Middle class-Highly empowered	Rich-Low empowered	Rich-Medium empowered	Rich-Highly empowered
Poor-Medium empowered	xx							
Poor-Highly empowered	0.000	xx						
Middle class-Low empowered	0.000	0.000	xx					
Middle class-Medium empowered	0.531	0.000	0.000	xx				
Middle class-Highly empowered	0.000	0.152	0.000	0.000	xx			
Rich-Low empowered	0.016	0.000	0.000	0.075	0.000	xx		
Rich-Medium empowered	0.003	0.222	0.000	0.000	0.011	0.000	xx	
Rich-Highly empowered	0.000	0.000	0.000	0.000	0.000	0.000	0.000	xx

Ref., reference category; xx, not applicable

Red color indicates statistically non-significant difference

Appendix Table 9: Association of women empowerment with coverage of ANC among the poor women (i.e. Sensitivity analysis)

Characteristics	Model I OR [95% CI]	Mode II AOR [95% CI]
Women empowerment level		
Low	1.00	1.00
Medium	1.04 (0.93-1.16)	1.04 (0.93-1.16)
High	1.53 (1.35-1.73)***	1.36 (1.20-1.54)***
Random variance parameter: variance (SE)		
Community level	1.93 (0.14)	1.59 (0.12)
Country level	1.08 (0.70)	0.79 (0.51)

Model II was additionally adjusted by respondent's age, number of children, media exposure, modern contraceptive usage, age at birth, wanted last pregnancy, husband's educational level, and place of region;

Significance level: *p<0.05; **p<0.01; ***p<0.001