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The level of utilization and associated factors of WHO recommended antenatal care visits in South Asian countries

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ABSTRACT

Background: Antenatal care can play an important role in reducing the death of both mothers and children. This study was designed to find out the determinants of world health organization recommended antenatal care visits in six South Asian countries to achieve the targets for Sustainable Development Goal.

Methods: This study used recent demographic and health survey data from six South Asian countries such as Afghanistan (2015), Bangladesh (2017-18), India (2015-16), Maldives (2016-17), Nepal (2016), and Pakistan (2047-18). Descriptive statistics were calculated for the distribution and prevalence of antenatal care visits. Bivariate and multivariable logistic regressions were used to investigate the influencing factors of antenatal care visits.

Results: 71,862 women aged 15 to 49 years were included in this study, and 46.64% (95% Confidence Interval = 45.59 - 47.69%) had world health organization recommended antenatal care visits. In the pooled data, urban women (AOR ([Adjusted Odds Ratio]=1.48; 95% CI [Confidence Interval]=1.33-1.66), richest family (AOR=1.48; 95% CI=1.25-1.76), women's higher education (AOR=3.76; 95% CI=3.33-4.25), women's partner/husband's higher education (AOR=1.69; 95% CI=1.50-1.92), 35–49 years (AOR=1.25, 95% CI=1.11-1.42), women's age at first birth >25 years (AOR=1.51, 95% CI=1.36-1.68) and fully media exposure (AOR=2.11; 95% CI=1.74-2.56) were significantly positively associated with WHO recommended antenatal care visits. Whereas, working women (AOR=0.82; 95% CI=0.76-0.88), healthcare decision maker by their husband/others (AOR=0.71, 95% CI=0.60-0.84), ≥7 children (AOR=0.59; 95% CI=0.50-0.69), and ≥7 family members (AOR=0.82; 95% CI=0.73-0.93) had significant negative effect on antenatal care visits. In country specific analysis, overall, media exposure, secondary and above education of women, ≥25 of years age at first birth, and <4 living children were the key factors of antenatal care visits.

Conclusions: This study reveals an overall scenario of the WHO-recommended antenatal care visit in South Asian countries, and significant factors related to ANC that we can concentrate onto improve accessibility to healthcare services and promote education and media exposure, especially for rural and less educated women, to increase the prevalence of WHO-recommended antenatal visits in South Asian countries In addition, evidence from this study can be used to assist the policymakers in planning and taking proper steps to increase WHO-recommended antenatal care visits by focusing on the related factors in South Asian countries.

1. Introduction

Worldwide, approximately 830 women die every day due to complications during pregnancy as well as childbirth [1]. The provision of antenatal care (ANC) has been recognized for a long time as an essential part of the comprehensive care that should be offered to women during their pregnancies. It has the capability to function for the women's and newborns' continued existence and healthy development [2,3]. This vital service enables pregnant women with the opportunity to be inspected for preceding diseases and prospective complications throughout their child bearing period, offers a venue for women to get counseling, and makes it possible to begin treatment at the proper time and stage, which may assist them in protecting both their own health and the health of their baby during the antenatal, labor and delivery,

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and postnatal phases of their pregnancy [3,4].Consequently, as the globe goes through an obstetric transformation, the role of ANC as a service is becoming more significant, in which the majority of maternal deaths that could be prevented are now being caused by indirect factors and non-communicable illnesses, which need more customized treatment [3,5,6]. Recently substantial progress was achieved throughout the globe in mother-child health care, with maternal mortality ratios reduced by 43.9% and 48%, respectively [1]. In 2015, the maternal mortality ratio (MMR) in third-world nations was 239 per 100,000 live births, while there were only 12 per 100,000 in industrialized countries [7]. Moreover, as part of the implementation of Sustainable Development Goals (SDGs) 3: Good Health and Well-being, target 3.1 was the global maternal mortality ratio (MMR) reduction of 70 or less per 100,000 live births by 2030 to guarantee universal access to reproductive health care [8]. Almost all maternal deaths (99%) occur due to pregnancy complications [9], which can be prevented through the adequate implementation of antenatal care, and institution-based delivery services, as the utmost purpose of ANC is to increase the number of healthy mothers and newborns after pregnancy [10,11].

Maximum South Asian countries bear a disproportionately high burden of global maternal mortality due to low utilization of maternal healthcare services [12]. However, there is a link between maternal healthcare usage and MMR, and ANC attendance may protect against MMR [13]. Most of the countries in South Asia have successfully attained the Millennium Development Goals (MDGs) for lowering the rate of maternal mortality and are presently concentrating on the latest agreed-upon Sustainable Development Goals (SDGs), which are to be attained by the year 2030 [14]. The World Health Organization (WHO) has revised its ANC recommendations in light of new information gathered from throughout the world and offers a complete ANC plan that covers at least four antenatal visits to ensure safe pregnancy outcomes [3,15]. The recommendations stand out due to the fact that they prioritize providing care that is centered on the needs of individuals rather than communities. This puts considerable emphasis not only on the provision of professional services but also on the quality of healthcare, with the goal of ensuring that women and adolescents have the opportunity to experience a healthy pregnancy adventure [4]. Despite in the sense of industrialized revenue environments, a number of studies have highlighted the poor condition of ANC visits and existing voids linked to the substance of these visits, which is even worse in developing countries [16,17].

Most of the developing countries in South Asia have achieved significant headway in minimizing maternal and newborn fatality over the course of the previous few decades, however, the overall number of deaths and the rates at which they occur are still unacceptably high [4,18,19,20]. The most recent Bangladesh Maternal Mortality and Health Care Survey (BMMS-2016) indicates that momentum in lessening maternal mortality has stagnated [21,22]. In 2012, a study conducted in Bangladesh found that women who had at most one ANC visit were twice as likely to suffer a prenatal death compared to women who had three or more ANC visits [23]. Other studies performed in South Asian countries such as Afghanistan, Bangladesh, India, Nepal and Pakistan, revealed that only 17.8%, 37%, 51.7%, 69.8% and 36.0% of women during their pregnancy underwent a minimum of four ANC visits, and services for mothers and their babies have never lived up to their full potential [18,19,20,24]. Therefore, the new targeted antenatal care strategy prioritizes quality of care over quantity [25].

Numerous researches were out in different countries that examined the factors associated with the ANC visits. Prior studies used cross-sectional data for a specific South Asian country to examine the prevalence and determinants of ANC visits. For instance, separate country-wise research work was performed in Afghanistan [18], Bangladesh [24], India [19], Maldives [26], Nepal [27], and Pakistan [20] to inspect the indicators of adequate visitation to ANC. Besides geographical similarities, they belong to the same stage of low- and middle-income countries (LMIC) according to the record of the World Bank data and the definition of developing countries by the International Monetary Fund (IMF), where more specifically, except for Afghanistan, which is a low-income country, the rest of the countries are middle-income countries, and the majority of healthcare expenses in these countries are paid out-of-pocket [28,29]. A few numbers of studies were conducted to identify the risk factors of ANC visits in a specific country. However, studies that combined worked on six South Asian countries at the same time to represent the overall scenario of ANC visits in South Asia are still under explored. Thus, this study was driven to conduct a pooled analysis that took into account these six South Asian nations in order to fill the existing gap. Moreover, the advantages of pooling individual data sets include improved statistical power as well as the potential to compare findings and test models across different locations or contexts and possibilities to generate new measures [30]. This study affords a broader perspective as well as offers a unique opportunity to discern overarching patterns and subtle factors that influence WHO-recommended ANC visits within a geographically connected region. Hence, the fundamental objectives of this study were to investigate the overall prevalence as well as the factors that influence ANC visits in South Asian nations, as recommended by the WHO. In addition, this study performs overall relative ranking of the risk factors associated with WHO recommended ANC visits and also perform similar analysis country wise.

2. Methodology

2.1. Data source and description

This study considered the data from most recent nationally representative demographic and health surveys (DHS) in Afghanistan 2015 [31], Bangladesh 2017-18 [32], India 2015-16 [33], Maldives 2016-17 [34], Nepal 2016 [35], and Pakistan 2017-18 [36] on the basis of availability starting from year 2015. The DHS program is worldwide reputed for conducting nationally representative surveys that collects data on topics related to fertility, family planning, gender, maternal and child health, nutrition etc. DHS follows two-stage stratified sampling technique for collection data. Detail descriptions of questionnaire validation, sampling procedures and data collection and storing methods are available at http://www.dhsprogram.com. A total of 7,84,903 women aged between 15-49 years of age were considered initially, where 5,54,272 cases had ANC information missing. Similarly, variables such as husband/ partner's education had 1,57,901 missing, woman's working status had 1,57,551 missing, and woman's healthcare decision maker variable had 1,57,610 missing values. After removing all the common and uncommon missing values of these variables, 71,862 numbers of complete observations remained which were further utilized for the study purpose. Unexpected values such as data entry errors especially within the categorical variables fell within the missing value removing part so no additional cleaning was required there.

2.2. Conceptual framework

This study employs the modified version of Anderson model of healthcare utilization as the conceptual framework to examine the effects of different exposure variable on WHO recommended ANC visits uptake [24]. The model comprises three categories of factors: geographical environment, predisposing, and enabling factors. Different studies in Bangladesh used this model to investigate healthcare scenario [37–39]. The geographical factors encompass the physical environment, such as the respondent's place of residence. Predisposing factors represents respondents age, age at first birth, education, husband/partners education, number of household members, and the number of living children. Finally, enabling factors correspond to the actual ability of an individual to acquire healthcare services, considering such as, respondent's family wealth index, media exposure, working status, and women's healthcare decision maker. The model's three categories of factors are presented in Fig 1.

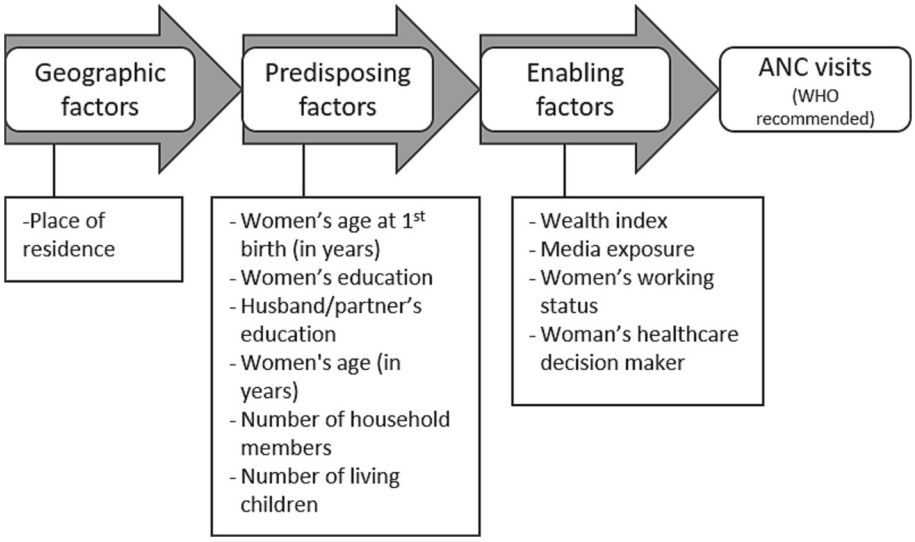

Fig 1. Conceptual Framework of the determinants of WHO recommended ANC visits in Bangladesh.

2.3. Outcome variable

The outcome variable of this study was WHO recommended antenatal care (ANC) visits. According to the WHO guideline, if a woman utilizes 4 or more ANC visits, then she is considered to have properly utilized. The study outcome was reported as a binary variable with "WHO recommended ANC visits properly (≥4 ANC visits)" coded as '1' and 'WHO recommended ANC visits not properly (<4 ANC visits)' coded as '0'.

2.4. Exposure variables

Experiencing from the previous literature and availability of the data in the DHS program, the current study considered several exposure variables. The exposure variables for this study are place of residence (Rural, and Urban), wealth index (Poorest, Poor, Middle class, Rich, Richest), women's education (No education, Primary, Secondary, Higher), husband's education (No education, Primary, Secondary, Higher), age of the respondent in years (15-24, 25-34, ≥35), age at first birth (≤20, 21-25, >25), women's healthcare decision maker (Women alone, Women & husband/others, Husband/others), number of living children (≤3, 4-6, ≥7), family size (≤3, 4-6, ≥7), working status (Not working, Working), and media exposure (No exposure, Partial exposure, Full exposure) [4,12,17,24,40–42]. The media exposure variable was created considering three variables. If a woman did not watch television, read newspaper, or listened to radio at least once a week, then she was considered as not exposed to media, if she did all three of them at least once a week then she was considered to have full media exposure, and else was considered to have partial media exposure [37]. All the variables were also turned into binary category for further analysis purpose of the study. All the detailed description of the recreated factors were presented in Table 1.

2.5. Statistical analysis

This study measured the association of each variable with WHO recommended ANC visits by first pooling data from six South Asian countries and then distinctly for each individual country. At the country level and in pooled analyses, this study ensures that the estimates were representative. So, this study included sampling, clustering, and stratification weight according the DHS provided variables and guideline for both country specific and pooled analysis [38]. This study provides the frequency distribution of the overall dataset, along with the prevalence of utilizing proper ANC visits. This study also checks the multicollinearity and found the there are no multicollinearity present in the considered variables. Chi-square test was conducted to access the association between the WHO recommended ANC visits and exposure variables of interest, which was also used as a feature selection process for logistic regression analysis. Two multivariate logistic regression models were performed to find out the effect of the considered factors on WHO recommend ANC visits. Firstly, a general binary regression model was performed fully adjusted models in which all factors having several categories were considered simultaneously. Furthermore, to explore the effect of exposure variables, and compare them in South Asian countries, this study recategorized the exposure variables having two categories, was used to fit another binary logistic regression model. Based on this model, we compared and ranked the factors according to their adjusted odds ratios (AORs). The Hosmer-Lemeshow goodness of fit statistic, and Omnibus test of the model coefficient was utilized to ensure the validity of the model. The full analysis of this study was performed using SPSS (version 25) and R (version 4.1.2). Finally, exposure variables with a p-value <0.05 were considered statistically significant. The full methodological framework is presented in Fig 2.

2.6. Ethics statement

This study considered the secondary data of six South Asian countries from demographic and health survey (DHS) sources. The DHS data are publicly accessible and were made available to us upon request by Measure DHS. The DHS surveys obtained ethical clearance from the Ethics Committee of ORC Macro Inc., and the Ethics Boards of Ministry of Health of the considered six South Asian countries. This survey confirmed international ethical standards and during each of the surveys, either written or verbal consent, was provided by the women. The details of ethics approval of six South Asian countries are described elsewhere [31–36].

3. Results

3.1. Background characteristics of study participants

Table 2 presents the background characteristics of study participants by WHO recommended ANC visits and weighted prevalence of WHO recommended ANC visits with 95% confidence interval. Initially, among the total observations, after excluding missing values that could not be repaired 71,862 women were considered for the final analysis. There

Table 1
Detail descriptions of considered variables in this study.

Variable	Code	Category	Description
Outcome variable			
WHO recommended ANC visits	0	< 4 Visits	Respondent utilized less than 4 ANC visits.
	1	≥ 4 Visits	Respondent utilized 4 or more ANC visits.
Exposure variables			
Urban resident	0	No	Respondent lives in a rural area.
	1	Yes	Respondent lives in an urban area.
Secondary and above women's education	0	No	Respondent received no education (0) or she was primary educated (1).
	1	Yes	Respondent received secondary (2) or higher (3) education.
Secondary and above husband/partner's education	0	No	Respondents husband/partner received no education (0) or primary (1) education.
	1	Yes	Respondents husband/partner received secondary (2) or higher (3) education.
Wealthy household	0	No	Respondent resides in the poorest (1) or Poor (2) or Middle class (3) wealth quintile.
	1	Yes	Respondent resides in the rich (4) or richest (5) wealth quintile.
≥ 35 years of women's age	0	No	Age of the respondent was less than 35 years.
	1	Yes	Age of the respondent was greater than or equal 35 years.
≥ 25 years of women's age at 1st birth	0	No	Respondent's age at first birth was less than 25 years
	1	Yes	Respondent's age at first birth was greater than or equal to 25 years.
Employed women	0	No	Respondent does not work.
	1	Yes	Respondent works.
Women's involvement in healthcare decision	0	No	Respondent alone (1), or Respondent and husband/ partner (2), or respondent and other person (3) makes decision about her healthcare.
	1	Yes	Respondent's husband/ partner alone (4), or someone else (5), or other (6) makes decision about her healthcare.
<7 family size	0	No	Respondent lives in a family with a number of members greater than or equal to 7.
	1	Yes	Respondent lives in a family with a number of members less than 7.
<4 living children	0	No	Respondent has greater than or equal 4 number of living children.
	1	Yes	Respondent has less than 4 numbers of living children.
Media exposure	0	No	Else, the respondent was considered to have no media exposure.
	1	Yes	If the respondent listens to radio, reads newspaper, or watches television at least once a week (2, or 3), then she was considered exposed to media.

was highest 32880 (45.75%) Indian, 50691 (70.54%) lived in rural areas, 31239 (43.47%) had no education, 38068 (52.97%) belong to 25-34 years age group, 58398 (81.26%) had no working experiences, and 38012 (52.90%) women made their healthcare decision with discussing their husband. In the bivariate analysis the distribution of country, place of residence, wealth index, women's education, husband/partner's education, women's age, women's age at first birth, working status, women's healthcare decision maker, number of living children, number of household member, and media exposure between the WHO recommended ANC visits and non-WHO recommended ANC visits groups were statistically significant ($p<0.05$).

3.2. Prevalence of WHO recommended ANC visits

A total of 71,862 women aged 15 to 49 included in the analysis and the overall prevalence of WHO recommended ANC visits was 46.64% (95% CI = 45.59-47.69%). Among South Asian countries, Maldives showed the highest prevalence of utilizing WHO recommended ANC visits (97.4%; 95% CI=96.5-98.08%), followed by Nepal (69.49%; 95% CI=66.52-72.30%), India (55.32%; 95% CI=54.46-56.17%), and Afghanistan (19.65%; 95% CI=18.04-21.37%). It was observed that, respondent residing in urban areas had higher prevalence of WHO recommended ANC visits (63.21%; 95% CI=61.26-65.12%) compared to the rural areas. It was also observed that the prevalence of WHO recommended ANC visits increases with increasing wealth status, women's education, husband/partners education, age, and age at first birth of the participants. However, the prevalence was higher among the working women (51.52%; 95% CI=49.45-53.57%) than the not working women (45.49%; 95% CI=44.46-46.52%). The prevalence of ANC visits was higher among the women whose healthcare decision was made by women only (57.17%; 95% CI=52.94-61.29%), whereas the prevalence was lower among those women whose healthcare decision was made by her husband/others (37.93%; 95% CI=36.44-39.44%). Interestingly the prevalence of WHO recommended ANC visits decreases with increasing number of living children and household members. The prevalence of WHO recommended ANC visits was higher among the women's whose family has full exposure of media (77.03%; 95% CI=73.46-80.24%).

3.3. Determinants of WHO recommended ANC visits

3.3.1. Pooled analysis

Factors associated with WHO recommended ANC visits among participants are reported in Table 3. Results from the unadjusted models indicate that place of residence, wealth index, women's education, husband/partner's education, women's age, women's age at 1st birth, working status, women's healthcare decision maker, number of living children, number of household member, and media exposure were significantly associated with WHO recommended ANC visits. These associations to be continued dependable in the adjusted examinations. In multivariate analysis, the chance of WHO recommended ANC visits was significantly associated with place of residence, including residence in the urban area's women (AOR=1.48; 95% CI=1.33-1.66) had higher odds of ANC visits, compared to the rural area's women. The odds of WHO recommended ANC visits was increased with increasing the wealth status, respondents' education, and the respondents' partners/ husbands' education. The odds of WHO recommended ANC visits among women age group 25–34 years and 35–49 years increase by 8% (AOR=1.08; 95% CI=1.02-1.15) and 25% (AOR=1.25; 95% CI=1.11-1.42) as compared to women age group 15–24 years, respectively. Women whose age at first birth 21-25 years and >25 years were 1.20 (AOR=1.20; 95% CI=1.13-1.28) and 1.51 (AOR=1.51; 95% CI=1.36-1.68) times more likely to visit WHO recommended ANC than ≤20 years women. Working status had statistically significant associations with WHO recommended ANC visits. Not working women was 0.82 times (AOR=0.82; 95% CI=0.76-0.88) less likely to visit WHO recommended ANC than working women. The odds of WHO recommended ANC visits among women who can decide healthcare decision maker by their husband/others decrease by 29% (AOR=0.71; 95% CI=0.60-0.84) as compared to women whose healthcare decision decided by women alone. Women having 4-6 children, and ≥7 children were 0.63 times (AOR=0.63; 95% CI=0.58-0.68), and 0.59 times (AOR=0.59; 95% CI=0.50-0.69) times less likely to visit WHO recommended ANC than Women having ≤3 number of children. Similarly, Women having ≥7 family members was 0.82 times (AOR=0.82; 95% CI=0.73-0.93) times lower odds of WHO recommended ANC visits than women living in a family of ≤3 number of members. The chance of WHO recommended

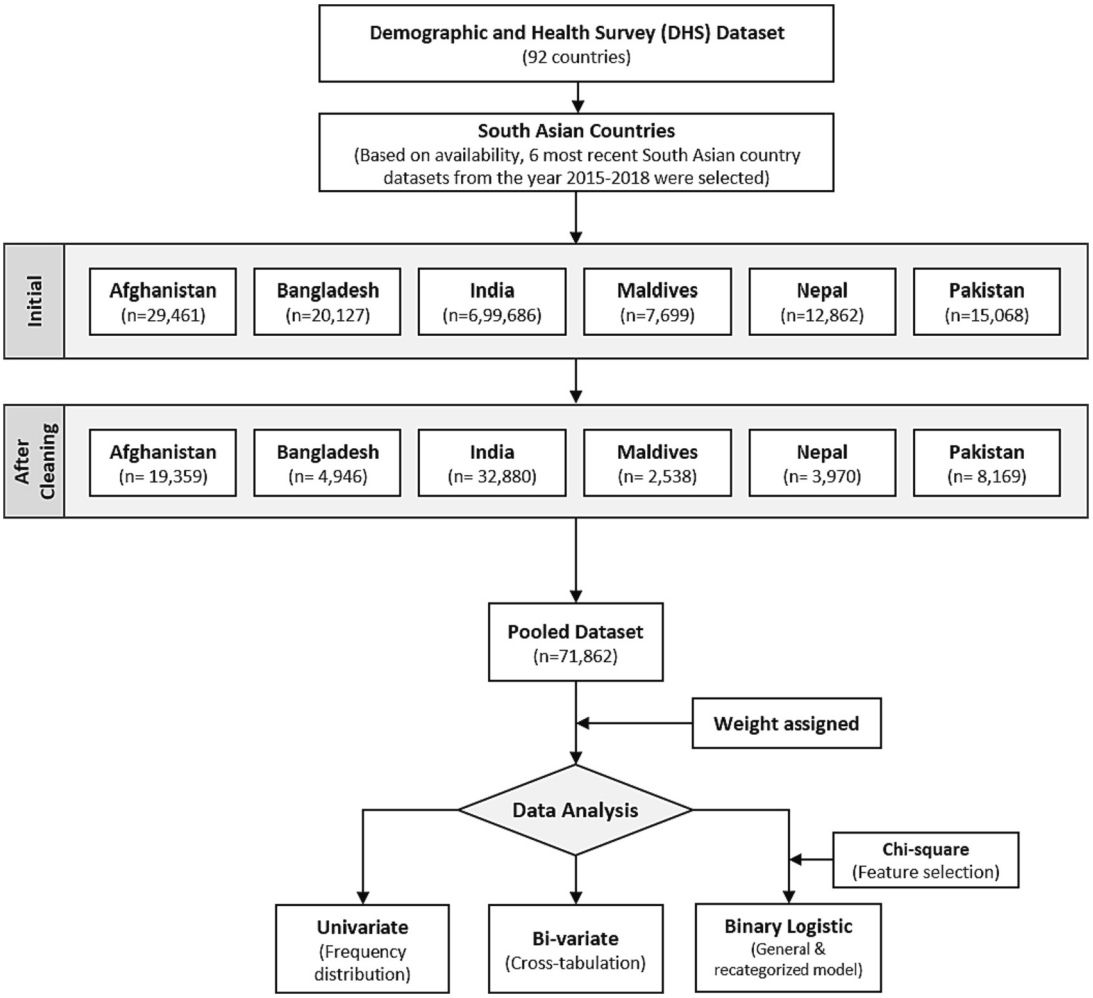

Fig 2. Methodological Framework.

ANC visits were 1.68 and 2.11 times higher among partially exposure (AOR=1.68; 95% CI=1.58-1.79) and fully exposure (AOR=2.11; 95% CI=1.74-2.56) family, respectively compared to the no exposure family.

Relative ranking of considered 11 factors associated with WHO recommended ANC visits from fully adjusted model were presented in Fig 3. Conditional on all other factors, secondary and above women's education had the strongest association with child WHO recommended ANC visits, followed by employed women, media exposure, urban residency, secondary and above husband/partner's education, >25 years of women's age at first birth, <4 number of living children, women's involvement in healthcare decision, <7 family size, wealthy household and ≥35 years of women's age.

3.3.2. *Country specific analysis*

The country specific analysis results were presented in Fig 4 and Fig 5. The odds of WHO recommended ANC visits in different countries in accordance with its influencing variables were heterogeneous. Media exposure had the strongest association with WHO recommended ANC visits for all countries excepts Pakistan, with odd ratios being ranked first in India and Maldives, third in Afghanistan, and fourth in Bangladesh and Nepal. Secondary and above women's education had also significant effect on WHO recommended ANC visits and ranked first in Afghanistan, second in Nepal and Pakistan, and third in Bangladesh and India. However, the effect of <4 number of living children ranked first in Bangladesh, second in India and third in Maldives and Nepal. Similarly, ≥25 years of women's age at first birth ranked first in Nepal and second in Bangladesh and Maldives. Wealthy household placed first in Pakistan and urban residency placed second in Afghanistan. Finally, overall urban residency, wealthy household, secondary and above women's education, ≥25 years of women's age at first birth, <4 number of living children and media exposure mostly effect on WHO recommended ANC visits among the all countries. On the other hand, family size, working status, current age, and respondent's healthcare decision maker variables were found least influencing in multiple countries. Rests of the variables such as husband/partner's education, place of residence, etc. variables were found moderately influencing in multiple South Asian countries.

4. Discussion

This study performed a pooled analysis to determine the factors influencing the WHO-recommended ANC visits in six South Asian countries (Afghanistan, Bangladesh, India, Maldives, Nepal and Pakistan). This study found that place of residence, wealth index, women's education, husband/partner's education, women's age, women's age at 1st birth, and media exposure were positively associated with WHO recommended ANC visits. On the other hand, women's working status, women's healthcare decision maker, number of living children, and number of household members were negatively associated with the WHO-recommended ANC visits.

The combined prevalence of WHO recommended ANC visits was 46.64% (95% CI=45.59-49.46%) and ranging from 19.85% in Afghanistan to 97.40% in Maldives. This study found that the prevalence of ANC in Afghanistan, Bangladesh, India, Maldives, Nepal, and Pakistan

Table 2
Distribution of WHO recommended ANC visits by selected factors in 6 South Asian countries.

Variable Name	Frequency, n (%)	Utilization of ANC: No, n (%)	Utilization of ANC: Yes, n (%)	Prevalence, % (95% Cls)	p-value
Overall	**71862 (100)**	**39697 (55.24)**	**32165 (44.76)**	**46.64 (45.59-47.69)**	
Country					<0.001
Bangladesh	4946 (6.88)	2558 (51.72)	2388 (48.28)	47.13 (44.81-49.46)	
Afghanistan	19359 (26.94)	15830 (81.77)	3529 (18.23)	19.65 (18.04-21.37)	
India	32880 (45.75)	15918 (48.41)	16962 (51.59)	55.32 (54.46-56.17)	
Maldives	2538 (3.53)	72 (2.84)	2466 (97.16)	97.40 (96.50-98.08)	
Nepal	3970 (5.52)	1194 (30.08)	2776 (69.92)	69.49 (66.52-72.30)	
Pakistan	8169 (11.37)	4125 (50.50)	4044 (49.50)	52.04 (48.75-55.31)	
Place of residence					<0.001
Urban	21171 (29.46)	8835 (41.73)	12336 (58.27)	63.21 (61.26-65.12)	
Rural	50691 (70.54)	30862 (60.88)	19829 (39.12)	39.42 (38.25-40.60)	
Wealth index					<0.001
Poorest	15744 (21.91)	11352 (72.1)	4392 (27.90)	27.00 (25.76-28.28)	
Poorer	16167 (22.50)	10203 (63.11)	5964 (36.89)	38.16 (36.73-39.61)	
Middle	15039 (20.93)	7947 (52.84)	7092 (47.16)	48.08 (46.03-50.13)	
Richer	13552 (18.86)	6404 (47.26)	7148 (52.74)	55.59 (53.39-57.77)	
Richest	11360 (15.81)	3791 (33.37)	7569 (66.63)	67.35 (64.49-70.08)	
Women's education					<0.001
No education	31239 (43.47)	23917 (76.56)	7322 (23.44)	23.93 (22.85-25.04)	
Primary	9512 (13.24)	5130 (53.93)	4382 (46.07)	47.29 (45.58-49.00)	
Secondary	23876 (33.22)	9008 (37.73)	14868 (62.27)	64.40 (63.20-65.58)	
Higher	7235 (10.07)	1642 (22.7)	5593 (77.30)	79.43 (77.90-80.88)	
Husband/partner's education					<0.001
No education	20174 (28.07)	15578 (77.22)	4596 (22.78)	24.19 (22.81-25.62)	
Primary	11549 (16.07)	6751 (58.46)	4798 (41.54)	41.80 (40.17-43.44)	
Secondary	30124 (41.92)	14002 (46.48)	16122 (53.52)	56.23 (55.16-57.29)	
Higher	10015 (13.94)	3366 (33.61)	6649 (66.39)	70.40 (68.97-71.79)	
Women's age (in years)					<0.001
15-24	22302 (31.03)	12296 (55.13)	10006 (44.87)	48.15 (46.83-49.47)	
25-34	38068 (52.97)	20127 (52.87)	17941 (47.13)	48.61 (47.47-49.76)	
35-49	11492 (15.99)	7274 (63.30)	4218 (36.70)	36.28 (34.63-37.97)	
Women's age at 1st birth (in years)					<0.001
≤20	39464 (54.92)	24763 (62.75)	14701 (37.25)	39.42 (38.11-40.74)	
21-25	24989 (34.77)	12253 (49.03)	12736 (50.97)	53.32 (52.23-54.40)	
> 25	7409 (10.31)	2681 (36.19)	4728 (63.81)	64.35 (62.28-66.36)	
Women's working status					<0.001
Not working	58398 (81.26)	33063 (56.62)	25335 (43.38)	45.49 (44.46-46.52)	
Working	13464 (18.74)	6634 (49.27)	6830 (50.73)	51.52 (49.45-53.57)	
Woman's healthcare decision maker					<0.001
Women alone	6070 (8.45)	2653 (43.71)	3417 (56.29)	57.17 (52.94-61.29)	
Women & husband/ others	38012 (52.90)	19062 (50.15)	18950 (49.85)	51.19 (50.07-52.31)	
Husband/ others	27780 (38.66)	17982 (64.73)	9798 (35.27)	37.93 (36.44-39.44)	
Number of living children					<0.001
≤3	52908 (73.62)	25516 (48.23)	27392 (51.77)	53.67 (52.76-54.59)	
4-6	14638 (20.37)	10683 (72.98)	3955 (27.02)	26.93 (25.51-28.40)	
≥7	4316 (6.01)	3498 (81.05)	818 (18.95)	20.21 (18.00-22.63)	
Number of household members					<0.001
≤3	5315 (7.40)	2353 (44.27)	2962 (55.73)	57.80 (55.38-60.26)	
4-6	29731 (41.37)	14485 (48.72)	15246 (51.28)	53.00 (52.09-53.99)	
≥7	36816 (51.23)	22859 (62.09)	13957 (37.91)	39.30 (37.85-40.86)	
Media exposure					<0.001
No exposure	29881 (41.58)	21742 (72.76)	8139 (27.24)	28.04 (27.00-29.11)	
Partial exposure	40061 (55.75)	17556 (43.82)	22505 (56.18)	57.27 (55.80-58.73)	
Full exposure	1920 (2.67)	399 (20.78)	1521 (79.22)	77.03 (73.46-80.24)	

Table 3
Multivariable logistic regression model analysis result of recommended antenatal care visit in 6 South Asian countries.

Variable Name	COR (95% CI)	p-value	AOR (95% CI)	p-value
Place of residence				
Rural (Ref)	1.00		1.00	
Urban	2.64 (2.40-2.91)	<0.001	1.48 (1.33-1.66)	<0.001
Wealth index				
Poorest (Ref)	1.00		1.00	
Poorer	1.67 (1.54-1.81)	<0.001	1.18 (1.09-1.29)	<0.001
Middle	2.50 (2.26-2.78)	<0.001	1.41 (1.29-1.55)	<0.001
Richer	3.39 (3.05-3.76)	<0.001	1.44 (1.27-1.62)	<0.001
Richest	5.58 (4.86-6.40)	<0.001	1.48 (1.25-1.76)	<0.001
Women's education				
No education (Ref)	1.00		1.00	
Primary	2.85 (2.62-3.12)	<0.001	1.95 (1.79-2.12)	<0.001
Secondary	5.75 (5.32-6.22)	<0.001	2.78 (2.57-3.02)	<0.001
Higher	12.28 (11.02-13.69)	<0.001	3.76 (3.33-4.25)	<0.001
Husband/partner's education				
No education (Ref)	1.00		1.00	
Primary	2.25 (2.05-2.47)	<0.001	1.30 (1.19-1.42)	<0.001
Secondary	4.03 (3.70-4.38)	<0.001	1.52 (1.40-1.65)	<0.001
Higher	7.46 (6.74-8.24)	<0.001	1.69 (1.50-1.92)	<0.001
Women's age (in years)				
15-24 (Ref)	1.00		1.00	
25-34	1.02 (0.97-1.07)	0.450	1.08 (1.02-1.15)	0.007
35 or more	0.61 (0.57-0.66)	<0.001	1.25 (1.11-1.42)	<0.001
Women's age at 1st birth (in years)				
≤20 (Ref)	1.00		1.00	
21-25	1.76 (1.66-1.86)	<0.001	1.20 (1.13-1.28)	<0.001
> 25	2.77 (2.52-3.06)	<0.001	1.51 (1.36-1.68)	<0.001
Women's working status				
Working (Ref)	1.00		1.00	
Not working	0.79 (0.73-0.85)	<0.001	0.82 (0.76-0.88)	<0.001
Woman's healthcare decision maker				
Women alone (Ref)	1.00		1.00	
Women & husband/others	0.79 (0.67-0.92)	0.003	0.89(0.77-1.02)	0.087
Husband/others	0.46 (0.38-0.55)	<0.001	0.71 (0.60-0.84)	<0.001
Number of living children				
≤3 (Ref)	1.00		1.00	
4-6	0.32 (0.30-0.34)	<0.001	0.63 (0.58-0.68)	<0.001
≥7	0.22 (0.19-0.25)	<0.001	0.59 (0.50-0.69)	<0.001
Number of household members				
≤3 (Ref)	1.00		1.00	
4-6	0.82 (0.74-0.91)	<0.001	1.01 (0.90-1.14)	0.809
≥7	0.47 (0.42-0.53)	<0.001	0.82 (0.73-0.93)	0.002
Media exposure				
No exposure (Ref)	1.00		1.00	
Partial exposure	3.44 (3.20-3.69)	<0.001	1.68 (1.58-1.79)	<0.001
Full exposure	8.60 (7.06-10.48)	<0.001	2.11 (1.74-2.56)	<0.001
Hosmer-Lemeshow goodness of fit				0.141
Omnibus Chi-square				<0.001

Ref, reference; CI, Confidence Interval.

were 19.85%, 47.13%, 55.32%, 97.4%, 69.49% and 52.04%, respectively, yielding higher results than previous studies [18,19,20,24,26,27]. In pooled analysis, women's education was found to be a strong predictor of ANC visits in the present study. The result revealed that increased education of women was more likely to WHO recommend ANC visit compared to the women who had no education. This result is consistent with the findings done in Ethiopia, India and Nigeria [41,42,45]. This could be explained by the fact that educated women have a clear knowledge of information and are more aware of the necessity of the service [41]. Furthermore, literate women have a higher chance of gaining independence, self-assurance and the capacity to make health-related decisions for themselves. Educated women are more likely to seek out facilities of elevated quality and have a stronger ability to utilize healthcare resources that provide better care [44,45].

This study exposed places of residence had a significant effect on ANC visits. The result stated that urban women had a higher likelihood of ANC visits compared to rural women, which is compatible with the findings conducted in Ethiopia, Nepal and Nigeria [12,40,46]. The discrepancy could be because women in urban areas have better health facilities accessibility and resources, and hence can easily take services provided by neighboring health institutions, whereas rural areas have limited or sometimes no efficient transit infrastructure, making health care harder to obtain for rural women [46]. Wealth index was significantly associated with ANC visits in the current study. The result showed that women with an increased wealth status had higher odds of ANC visits compared to the lower wealth status women which is supported by the findings performed in some South Asian countries and Nigeria [40,41]. The possible reason behind this could be that ANC requires both explicit and indirect expenses, and it is difficult to totally ignore economical restraints while seeking quality healthcare throughout pregnancy. Moreover, sometimes pregnant women bear the transportation changes to reach far-flung health care facilities. This could make it more difficult for women to start their antenatal treatment early and return for subsequent sessions. When women travel a considerable distance to the health facility, they spend a significant amount of money on transportation for their accompanying families, which might prove to be a major hurdle [45]. Alongside respondent's education, husband/partner's education level also had a significant positive relation with ANC visits. The result of this study depicted that women's, having higher educated husband/partners, had higher odds of ANC visits compared to their counterparts. This result is consistent with findings done in different South Asian countries [40,47]. This might be due to the fact that husband/partners who are more educated may be more concerned and knowledgeable and maintain better interaction with their wives about receiving ANC [43].

The current study showed that the respondent's age had significant association with ANC visits. The result found that older women were more likely to get ANC visits compared to younger women, which is supported by the findings conducted in a low- and middle-income countries [48]. The reason possibly could be that due to lack of age maturity and information regarding ANC visits, younger women have limitations in their ability to handle and supervise the maternity period, and older women, on the other hand, due to their maturity remain more cautious about pregnancy difficulties [49]. Besides the respondent's age, the age of respondent at first birth was also positively significantly related to ANC visits. The result revealed that higher age of first

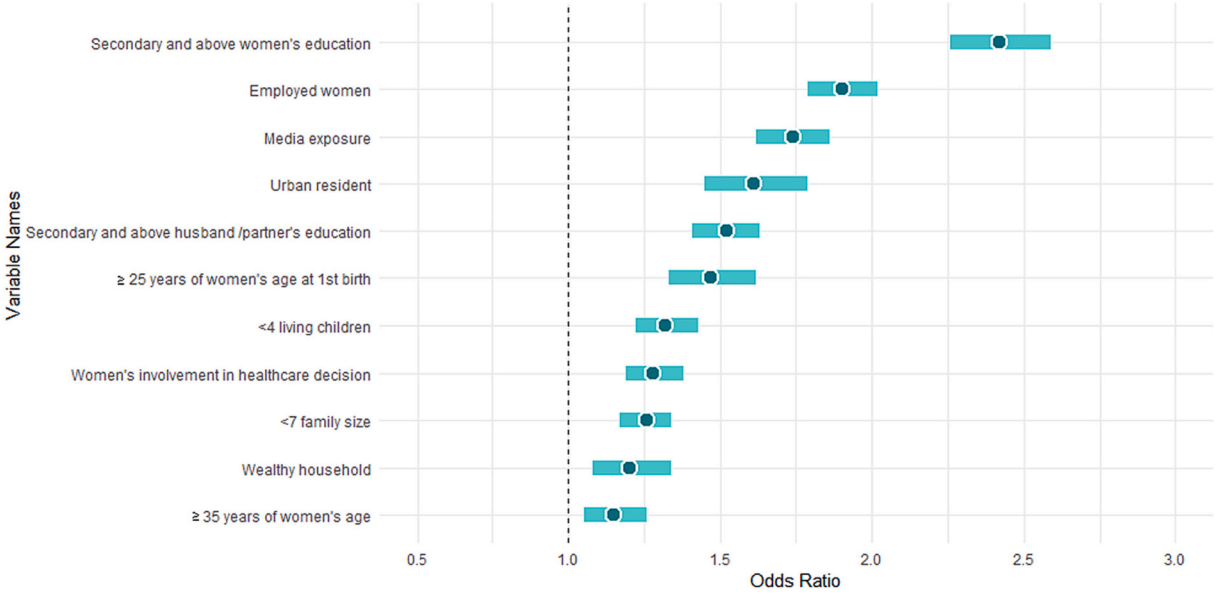

Fig 3. Relative ranking of 11 factors associated with WHO recommended ANC visits from fully adjusted models.

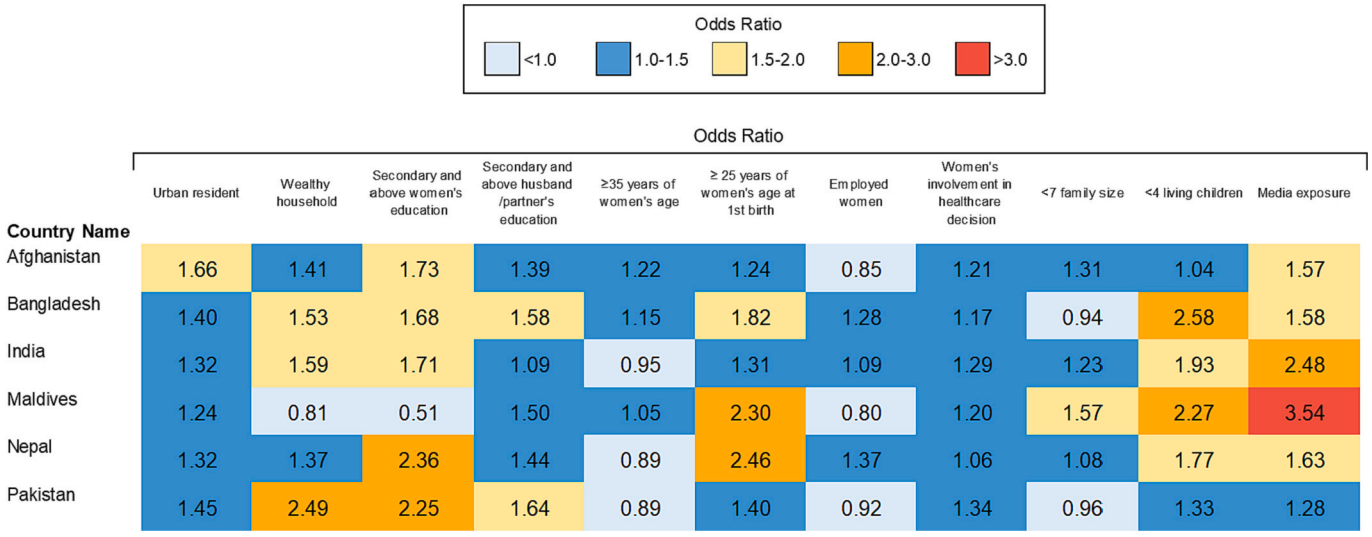

Fig 4. Country-specific odds ratios for 11 factors associated with WHO recommended ANC visits from fully adjusted models on WHO recommended ANC visits.

marriage of women had a greater likelihood of receiving ANC visits compared to younger women. This result is consistent with the findings performed in Nepal and Nigeria [50,51]. The possible reason might be that younger women as new mothers frequently suffer conflicting sensations and emotional vulnerability [49,50]. Besides, unplanned pregnancies are more usual in younger than older women which leads to unsatisfactory antenatal care, whereas older women are less likely to confront these repercussions and more aware of antenatal problems [52].

This present study found that family size had a negative association with ANC visits. The result showed that larger families were less likely to visit ANC compared to smaller families which is consistent with the findings done in Bangladesh and Cameroon [53,54]. This might be explained by increasing financial difficulties as the size of the family grows, on the contrary, women from smaller families can meet sufficient food intake and demands, leading to quality utilization of antenatal care [53]. Similarly, a negative significant link was found between the number of living children and ANC visits. The result revealed that women who had an increased number of children had lower odds of ANC visits. This result is similar to findings carried out in developing countries [55]. This could be due to a woman's prior experience, as she might be hesitant to get ANC checkups in consecutive pregnancies if she had an unpleasant past experience or thought the necessity of ANC is minimal in later pregnancies [55].

Another major influencing factor positively related to ANC was women's working status. The result showed that working women were more likely to utilize ANC compare to non-working women. This outcome is consistent with the studies conducted in Sub-Saharan African countries [12,46]. The possible reason will be that working outside the house brings both positive economic and social impacts, whereas due to deficiency of employment, the financial ability to pay for healthcare treatment may be limited [56]. Women's healthcare decision-maker was significantly associated with ANC in the study. The result stated that women's involvement in decision-making increased the odds of ANC visits compared to the women who were not involved in decision-making. This result is related to findings performed in Nepal and Ethiopia [40,46]. This might be due to antenatal care being affected by the women's status in the family and her husband's understanding, and

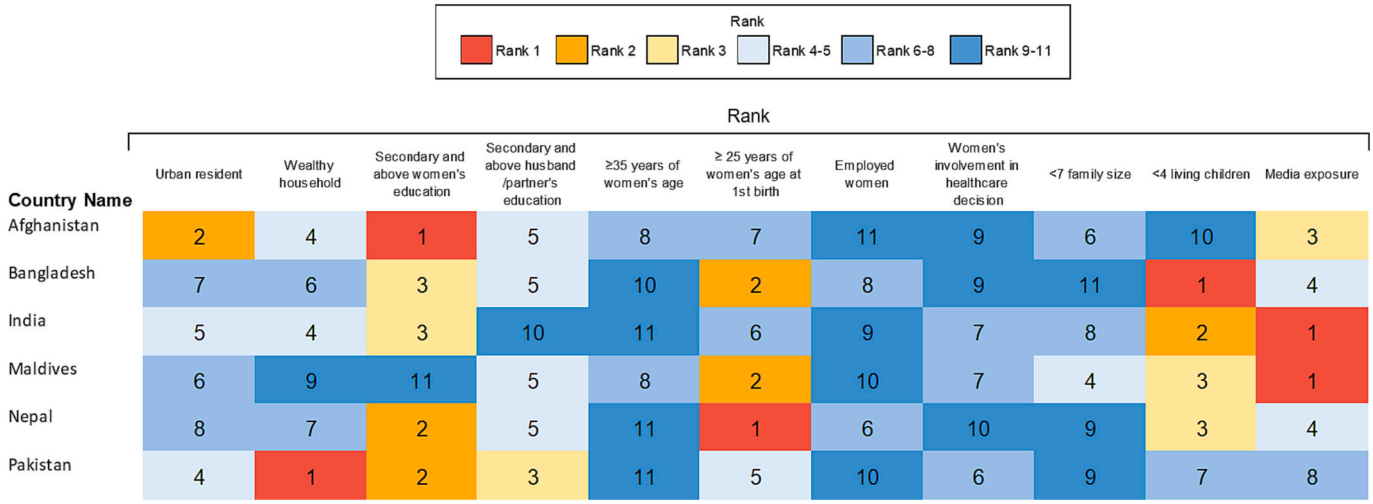

Fig 5. Country-Specific Ranking of considered Factors Associated with WHO recommended ANC visits.

when women have the ability to take a decision regarding their health condition and the husband/partner supporting their decision to seek medical assistance leads to better utilization of maternity care [57,58].

The present study also noticed that media exposure plays a significant role in ANC visits. The result asserted that women who were exposed to media were more likely to utilize ANC compared to the women who had no media exposure which is supported by the studies done in low-and middle-income countries [46,59,60]. The possible explanation might be that these findings identified media to be a significant medium for spreading health information. Thus, having access to information regarding the positive effect of antenatal care and pregnancy-related danger issues could aid women to take an efficient decision about healthcare utilization services [45,59].

The outcomes of this study underscore several critical public health implications for enhancing ANC utilization in South Asian countries. ANC visits mainly focus on both medical and non-medical risk factors. However, this study emphasis on non-medical risk factors. Addressing disparities in ANC attendance based on socio-economic factors such as education, wealth status, and place of residence should be a priority. Implementing targeted interventions to improve education levels among women and their partners could significantly enhance ANC visits. A study conducted in a South Asian country found lack of proper indicators for ANC service preparedness such as staff and guidelines and equipment on union-level facilities, community clinics, private facilities and administrative divisions [61]. Thus, efforts to increase accessibility to healthcare facilities, particularly in rural areas, and initiatives to alleviate financial barriers for lower-income households are crucial. Additionally, empowering women as decision-makers regarding healthcare, promoting media campaigns to disseminate accurate and pertinent information about the benefits of ANC, and creating supportive environments for working women are pivotal strategies. Encouragingly, the positive association between media exposure and ANC utilization suggests the potential impact of health education campaigns through various media channels. By recognizing these factors and crafting tailored interventions, policymakers and health authorities can strategically focus on augmenting ANC coverage, ultimately contributing to improve maternal and child health outcomes across the South Asian countries. Even a greater awareness among pregnant women's and healthcare professionals are needed to improve the number of ANC visits. While efforts were made to enhance internal validity through rigorous variable selection, measurement accuracy, and appropriate model specification, the study acknowledges the need for caution in generalizing findings to other South Asian countries.

5. Strengths and limitations

The key feature of this study is that it is a population-based pooled survey that includes six South Asian countries and uses the most up-to-date DHS data to access the prevalence and determinants of WHO recommended ANC visits. As a result, the findings of this study may be generalized to Afghanistan, Bangladesh, India, Maldives, Nepal and Pakistan's target population. The use of complex samples data analysis to account for sample weight is another notable strength of this study. However, while interpreting the findings, some limitations have to be addressed. First, due to the survey's cross-sectional structure, a causal association could not be established. Second, the dataset was collected retrospectively and self-reported, making it sensitive to social preferences and the possibility of recall biases. Third, certain recognized factors found to be significant in earlier studies, for example, internet use and religion were also excluded from the analysis. Finally, a large number of values in our selected dataset were missing which appears to be random but can result in incomplete information.

6. Conclusion

Still more than half of the South Asian women didn't receive the minimum four antenatal visits recommended by WHO. This study highlighted several significant factors associated with WHO recommended ANC visits. In pooled analysis, place of residence, wealth index, women's and their husband/partner's education, women's age and age at first birth, healthcare decision-maker, number of living children and family size, working status, and exposed to media had a significant relationship with WHO recommended ANC visits. Secondary and above education of women, employed women, medic exposure, urban residency, secondary and above education of husband/partners were the five most top ranked factors of WHO recommended ANC visits. However, in country specific analysis, overall, media exposure, secondary and above education of women, $\geq$25 years age at first birth, $<$4 number of living children were the key factors of WHO recommended ANC visits. Despite significant strides, the persistently low adherence to WHO-recommended ANC visits among South Asian women demands targeted and actionable interventions. Policymakers should prioritize initiatives ensuring equitable access to healthcare services, particularly in rural areas, through the development and enhancement of healthcare infrastructure. Furthermore, strategic educational programs should be implemented to empower women, especially those with lower education levels, and their partners, emphasizing the importance of ANC. Tailored campaigns utilizing various media channels should be deployed to reach diverse demographics. Additionally, incentivizing ANC attendance, such

as through conditional cash transfers during pregnancy, can serve as a practical approach to overcome financial barriers. Collaborative efforts involving healthcare providers, community leaders, and media outlets are crucial to effecting positive change. By implementing these specific, evidence-based measures, South Asian countries can significantly enhance ANC utilization, ultimately improving maternal and child health outcomes.

CRediT authorship contribution statement

Md. Akib Al-Zubayer: Conceptualization, Data curation, Formal analysis, Methodology, Resources, Software, Validation, Writing – original draft. **Hasibul Hasan Shanto:** Conceptualization, Data curation, Formal analysis, Methodology, Resources, Validation, Writing – original draft. **Subarna Kundu:** Visualization, Writing – review & editing. **Md. Alamgir Sarder:** Visualization, Writing – original draft, Writing – review & editing. **Benojir Ahammed:** Conceptualization, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors reported no potential conflict of interest.

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