

# BMJ Open Predictors of skilled attendance at delivery among antenatal clinic attendants in Ghana: a cross-sectional study of population data

Mary Amoakoh-Coleman,<sup>1,2</sup> Evelyn K Ansah,<sup>3</sup> Irene Akua Agyepong,<sup>4</sup> Diederick E Grobbee,<sup>1</sup> Gbenga A Kayode,<sup>1</sup> Kerstin Klipstein-Grobusch<sup>1,5</sup>

**To cite:** Amoakoh-Coleman M, Ansah EK, Agyepong IA, *et al.* Predictors of skilled attendance at delivery among antenatal clinic attendants in Ghana: a cross-sectional study of population data. *BMJ Open* 2015;**5**:e007810. doi:10.1136/bmjopen-2015-007810

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2015-007810>).

Received 29 January 2015  
Revised 9 March 2015  
Accepted 18 March 2015



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For numbered affiliations see end of article.

## Correspondence to

Mary Amoakoh-Coleman; menba19@yahoo.com

## ABSTRACT

**Objective:** To identify demographic, maternal and community predictors of skilled attendance at delivery among women who attend antenatal clinic at least once during their pregnancy in Ghana.

**Design:** A cross-sectional study using the 2008 Ghana Demographic and Health Survey (DHS) data. We used frequencies for descriptive analysis,  $\chi^2$  test for associations and logistic regression to identify significant predictors. Predictive models were built with estimation of area under the receiver operating characteristic curves (AUC).

**Setting:** Ghana.

**Participants:** A total of 2041 women who had a live birth in the 5 years preceding the survey, and attended an antenatal clinic having a skilled provider, at least once, during the pregnancy.

**Outcome:** Skilled attendance at delivery.

**Results:** Overall, 60.5% (1235/2041) of women in our study sample reported skilled attendance at delivery. Significant positive associations existed between skilled attendance at delivery and the variables such as maternal educational level, wealth status class, ever use of contraception, previous pregnancy complications and health insurance coverage ( $p < 0.001$ ). Significant predictors of skilled attendance were wealth status class, residency, previous delivery complication, health insurance coverage and religion in a model with AUC (95% CI) of 0.85 (0.83 to 0.88).

**Conclusions:** Women less likely to have skilled attendance at delivery can be identified during antenatal care by using data on wealth status class, health insurance coverage, residence, history of previous birth complications and religion, and targeted with interventions to improve skilled attendance at delivery.

## INTRODUCTION

Risk of maternal death continues to be high in sub-Saharan Africa (SSA) and Southeast Asia compared with the more developed parts of the world. In 2008, maternal deaths in SSA and Southern Asia accounted for

## Strengths and limitations of this study

- The use of nationally representative data that facilitates generalisability of results to pregnant women in Ghana.
- An assessment of a combination of factors that significantly predict skilled attendance at delivery which has not been done for the study setting.
- The Demographic and Health Survey (DHS) data are retrospectively collected data, and therefore has the chance of recall bias potentially affecting results.
- Only surviving mothers were interviewed and this could have affected the prevalence of the outcome.
- Our results are not applicable to the women who do not access antenatal care during pregnancy.

87% of global maternal deaths and progress to reverse this, especially in SSA, has been slow.<sup>1–7</sup> Efforts to encourage utilisation of healthcare facilities should also be vigorously pursued for optimal results.

A skilled attendant is defined as “an accredited health professional—such as a midwife, doctor or nurse—who has been educated and trained to proficiency in the skills needed to manage normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns”.<sup>8,9</sup> Antenatal care and delivery by a skilled attendant both contribute to reduction in maternal deaths.<sup>10–17</sup> The issue of who is a skilled attendant has been debated for some time, with respect to which category of health workers is ‘skilled’.<sup>18</sup> In Ghana, these are obstetricians, general practitioners, midwives, auxiliary midwives and nurses with midwifery training, including community health nurses/officers.<sup>19</sup> There is also evidence that there are variations in these categories, with respect to the extent of training

and roles in different countries across the world.<sup>20–22</sup> Delivery by any other person (health worker or non-health worker) is termed ‘unskilled attendance’ at delivery.

Despite the body of evidence of the importance of skilled attendance at delivery, there are records of high antenatal attendance, but low skilled attendance at delivery, especially in developing countries.<sup>23–26</sup> In Tanzania, over 90% of pregnant women are known to attend antenatal clinic (ANC) at least once, with 62% attending four times. However, less than 50% of these ANC attendants have their deliveries attended to by skilled personnel.<sup>3</sup> In a study in Uganda, although ANC attendance was found to be as high as 94%, this was not reflected in care at delivery, with about 25% of women being assisted during labour by a relative or friend.<sup>13</sup>

In Ghana, according to the 2008 Ghana Demographic and Health Survey (DHS), about 97% of pregnant women received antenatal care during pregnancy, with as many as 78.2% attending at least four times. However, only 57.1% delivered in health facilities, with a total of 59% being assisted by skilled personnel.<sup>19</sup> Several reasons have been attributed to this pattern, including access to health facilities, health worker attitude towards women during delivery and cultural issues, among others.<sup>27</sup>

Some factors have also been quantitatively shown to be associated with skilled attendance at delivery. Maternal age is believed to influence the decision to take such an action, with younger women preferring skilled attendance at delivery due to perception of risk.<sup>28</sup> This is closely linked with parity, where multiparous women with experience in labour tend to opt for other unskilled support during delivery due to the perception that they are experienced. Other factors such as marital status, wealth index, employment status and high educational background, especially secondary education, of both the woman and the husband has also been positively associated with the outcome.<sup>3 23</sup> Living in rural areas where poverty is more prevalent compared with urban areas has been shown to be negatively associated with skilled delivery.<sup>23–26 29</sup> Other notable factors that have positive influence on the outcome are short distance to health facility and availability of a birth-preparedness plan designed together with the woman during ANC.<sup>3</sup>

Many interventions have been implemented to improve maternal health in Ghana, including but not limited to the Safe Motherhood Initiative (SMI), free delivery policy, High Impact Rapid Delivery (HIRD) and the Emergency Obstetric and Neonatal Care programme.<sup>30–32</sup> The free delivery fee policy was first introduced in four regions in 2003, and subsequently extended to the entire country in 2005. Some studies have so far been conducted in Ghana to identify factors that influence skilled attendance at delivery.<sup>33 34</sup> Secondary data analysis of Ghana DHS offers the opportunity to evaluate a larger sample across the country in order to identify demographic, maternal and community predictors of skilled attendance at delivery among

women who attend ANC at least once during their pregnancy in Ghana. The question we seek to answer is whether there are possible significant predictors that will enable providers to identify women who are less likely to have skilled attendance at delivery from the antenatal care attendants, so that these women can be supported to have this desirable outcome. The aim of the study is to identify demographic, maternal, community and contextual predictors of skilled attendance at delivery among women who attend ANC at least once during their pregnancy.

## METHODS

### Study design

Secondary data analysis of the data set of the 2008 Ghana DHS, a nationally representative population-based survey of 4305 women aged 15–49 years was conducted.

### Data collection

Comprehensive information on the sampling techniques and survey procedures applied for data collection in the Ghana DHS have been published in detail elsewhere.<sup>35</sup> In summary, the 10 regions of Ghana are each administratively subdivided into districts, while each district is divided into localities. Each locality is then further divided into enumeration areas based on the 2000 population census and these form the primary sampling units (PSUs). The PSU, defined for the purposes of this study as the cluster, was provided by the Ghana Statistical Service. A stratified two-stage cluster randomised sampling technique was applied. The first stage involved probability proportional sampling of a total of 412 PSUs (clusters) from all the regions, comprising of 182 clusters from the urban areas and 230 from rural areas. During the second stage, an average of 15 households was randomly sampled from each of the PSU using their household sampling frame. Finally, for half of the surveyed households, all eligible women aged 15–49 years were interviewed with a women’s questionnaire. This had questions with socioeconomic, demographic and health indicators. Questionnaires were translated into three major local Ghanaian languages (Akan, Ga and Ewe) and were pretested on the field by trained personnel before finalisation for use. All respondents gave informed consent to participate in the survey. A total of 4916 women aged between 15 and 49 years were interviewed, with a 96.5% (4305) response rate. Out of these, the subset of women who had a live birth in the 5 years preceding the survey numbered 2099; 95.4% (2041) of them did receive antenatal care from a skilled provider (doctor, nurse, midwife, auxiliary midwife or community health officer) in the health system.<sup>19</sup> Characteristics of these 2041 women were assessed in this study.

The index delivery studied is the latest delivery within the 5 years preceding the survey.

The 2008 DHS data are the latest available population-based data on health indicators that address the objectives of this study. Another survey was due in 2013, but is yet to be conducted.

### Ethical approval

Ethical approval to conduct DHS in Ghana was approved by the Ethics Committee of ICF Macro in Calverton, USA, and the Ethics Committee, Ghana Health Service, Accra, Ghana. We obtained ethics approval for analysis of this data from the Ethics Committee of ICF Macro in Calverton, USA through an online request.

## VARIABLES

### Outcome

Skilled attendance at delivery was the outcome. This in Ghana, and as used in the DHS data collection and analysis, is defined as delivery by a doctor, nurse, midwife,

auxiliary midwife or community health officer,<sup>19</sup> with a response of either yes (1) or no (0).

### Determinants

The factors included in this study are based on findings from other studies in published literature and availability in the 2008 DHS data set. These were categorised as demographic, maternal, community and contextual factors. All the variables were put into building the models to avoid preselection. Table 1 shows all the variables and their definitions.

### Statistical analyses

Total missing data were more than 5% and this level of missing data is rarely random. Thus, multiple imputations of missing data were conducted and analysis was based on the data set with imputed data. We carried out descriptive univariate analysis to evaluate the prevalence of delivery by a skilled provider (outcome variable)

**Table 1** Definition of variables used in the study

Variables	Description
<b>Demographic</b>	
Age	Age (years and categories) at last delivery within 5 years preceding survey (<20; 20–34; ≥35)
Highest educational level	Highest educational attainment (no education; primary; secondary and higher)
Marital status	Marital status as at interview date (never married; currently married; formerly married)
Ethnicity	Local ethnic group (Akan; Ga/Dangme; Ewe; Guan; Mole-Dagbani; Grussi, Gruma, other)
Religion	Christian; Muslim; traditional/spiritualist; no religion and other
Employment	Employment status as at interview date (currently employed (yes or no))
Wealth class status	Wealth quintiles categorised into three classes (low; middle; high)*
Covered by health insurance	Having a viable health insurance registration (yes or no)
<b>Maternal</b>	
Ever use of contraception	Use of any method of contraception at any point in time by woman (yes or no)
Previous birth interval	Number of years between last delivery and the preceding delivery (<2; 2–5; 5+ years)
Complication during previous delivery	Whether woman had any complication during previous deliveries before last delivery (DHS uses caesarian section as proxy) (yes or no)
Birth order	The order in which the index child, whose delivery data are used for our study, was born: 1; 2–3; 4–5; 6+
Gestational age at first ANC	Months pregnant at first ANC visit categorised into three trimesters of pregnancy
Number of times attended ANC	Number of times woman attended ANC during last pregnancy (1; 2–3; 4+; don't know)
<b>Community and contextual</b>	
Region	Where in the 10 regions of Ghana woman lives (Western; Central; Greater Accra; Volta; Eastern ;Ashanti; Brong Ahafo; Northern; Upper East and West)
Residence	Whether woman's residence is rural or urban
Type of city	Woman's residence described as capital or large city, small city; a town or country side
Spouse's highest educational level	Highest educational level of spouse (no education; primary; secondary and higher)
Who has final say on woman's health	Whose decision on woman's health is paramount (respondent alone; respondent and partner; husband/partner/someone else alone)
Period of delivery	Whether last delivery was before or during the period of free cost of delivery, that is, before or after 2005

\*Wealth measured using information on household ownership of consumer items, ranging from a television to a bicycle or car, as well as dwelling characteristics, such as source of drinking water, sanitation facilities and type of flooring material to produce an asset index. ANC, antenatal clinic; DHS, Demographic and Health Survey.

across the categories of each of the determinants. We regrouped wealth quintiles into low (poorest and poorer quintiles), middle (middle quintile) and high (richer and richest quintiles) wealth status classes due to small numbers in some of the quintile groups.

Bivariate analysis using  $\chi^2$  test was used to investigate the relationship between the independent variables and the categorical outcome variable, with detection of significant differences at  $p < 0.05$ . We explored possible correlations between the variables region and birth order; region and religious groups; region and wealth status class; residence and wealth status class; and wealth status class and educational level.

Three predictive models were built using a backward stepwise elimination approach and all correlated variables were built into the models as interaction terms. Model 1 included the demographic and maternal characteristics; model 2 included the community and contextual factors; and model 3 combined demographics, maternal, community and contextual factors. Age was explored both as a categorical and continuous variable in building the models. Associations were estimated by ORs and their corresponding 95% CIs. Each OR is adjusted for the other covariates in the model. The area under the curve (AUC), that is, under the receiver operating characteristic curves, for all the models were estimated.

## RESULTS

### Background characteristics of the women

Table 2 shows a summary of the characteristics of the 2041 women who for their latest delivery within the period of 2003 and 2008 had at least one ANC visit which was attended to by a health professional. The mean age (SD) of the women was 30 (7.24) years and this was the same for both groups of women who had skilled and unskilled attendance at delivery. As many as 89.0% of women were currently married during the survey and 86.8% of them were currently working. Only 41.4% of the women had secondary or higher education, and 35.3% had no education. Most of them were Christians (68%) and 20.1% were Muslims. Wealth distribution among this population was 50.2%, 17.7% and 32.1% for low, middle and high wealth status classes, respectively. Only 42.8% of the women had health insurance coverage at the time of the survey. Prevalence of ever use of any contraceptive method among the women was 60.0%. As many as 80.0% of women attended ANC at least four times during the pregnancy. Rural dwellers were 63.4%.

Prevalence of skilled attendance at delivery was 60.5%; most of the pregnant women were attended to by midwives and nurses (45.4%). Doctors conducted only 9% of all deliveries.

### Comparability of the two outcome groups

Table 2 also summarises the comparison between women who had skilled or unskilled attendance at delivery.

There were significant differences ( $p < 0.05$ ) between those having skilled and unskilled attendance among all the categories of the characteristics studied, except for period of delivery as per the free delivery policy ( $p = 0.11$ ). Women with secondary and higher education had more skilled attendance at delivery compared with those without any education. About 67.0% of Christians had skilled attendance at delivery compared with 57.2% and 45.2% of Muslims and non-religious women, respectively. Women who had ever used a contraceptive method were more likely to have skilled attendance at delivery (69.9%). The proportion of skilled attendance at delivery decreased with increasing birth order; 95.1% of women who had a caesarean section during their previous pregnancy had skilled attendance at delivery compared with 48.7% of those who did not have that complication. The outcome was more prevalent (73.9%) among women with health insurance coverage compared with those without (50.6%). There were regional variations in the proportion of women who had skilled attendance at delivery. Only 45.0% of women in rural areas had skilled attendance at delivery compared with 86.7% in urban areas. We checked for correlation among variables, and birth order and timing of first ANC attendance were significantly correlated ( $p < 0.001$ ). Wealth status class was significantly different among the categories of region, rural or urban settlements, and educational levels ( $p < 0.001$ ). Birth order and religious group categories also varied across the various regions ( $p < 0.001$ ). These correlations were explored as interaction terms in building the predictive models.

### Predictors of skilled delivery

Three models for predicting skilled delivery among the women in the survey, using a backward stepwise approach, were built. These are shown in table 3. Model 1 consists of maternal factors and significant predictors were wealth quintile, history of previous delivery complication, having health insurance, birth order, number of times ANC was attended, the exact maternal age in years, religious group and ethnicity. Interaction terms explored were not significant predictors. Model 2 was built with community or cluster factors, and the significant predictors were residence (rural/urban), type of residence (capital/large city, small city and town or country side), spouse's highest educational level and the geographical region. In Model 3, demographic, maternal and community factors were combined. Significant predictors were wealth status class, history of previous birth complication, health insurance coverage, residence and religious group. Again in this model, interaction terms included were not significant. The predictive probabilities of all three models are (c-statistics (95% CI)) 0.85 (0.82 to 0.88); 0.80 (0.78 to 0.82) and 0.85 (0.83 to 0.88), respectively, for models 1, 2 and 3. Model 3 combines both groups of variables, has the least number of variables and also the best fit, making it the best among the three for use in practice.



**Table 2** Baseline characteristics of the study population and univariable associations of predictor variables with outcome

Variable	Frequency (%) (N=2041)	Per cent of unskilled delivery (N=807)	Per cent of skilled delivery (N=1234)	p Value for $\chi^2$ test
<i>Demographic and maternal factors</i>				
Age (years)				0.05
<20	102 (5.0)	44.1	55.9	
20–34	1331 (65.2)	37.6	62.4	
≥35	608 (29.8)	42.9	57.1	
Highest educational level				0.00
No education	720 (35.3)	60.8	39.2	
Primary	476 (23.3)	41.4	58.6	
Secondary and higher	845 (41.4)	21.6	78.4	
Marital status				0.04
Never married	112 (5.5)	28.6	71.4	
Currently married	1816 (89.0)	40.4	59.6	
Formerly married	113 (5.5)	37.2	62.8	
Ethnicity				0.00
Akan	806 (39.5)	29.2	70.8	
Ga/Dangme	96 (4.7)	38.5	61.5	
Ewe	256 (12.6)	32.8	67.2	
Guan	52 (2.6)	46.2	53.8	
Mole-Dagbani	524 (25.7)	52.1	47.9	
Grussi	111 (5.4)	43.2	56.8	
Gruma	108 (5.3)	75.9	24.1	
Other	86 (4.2)	25.6	74.4	
Religion				0.00
Christian	1389 (68.0)	33.1	66.9	
Muslim	410 (20.1)	42.8	57.2	
Traditionalist/spiritualist	149 (7.3)	80.4	19.6	
No religion and other	89 (4.4)	54.8	45.2	
Employment (currently working)				0.00
No	269 (13.2)	33.3	66.7	
Yes	1772 (86.8)	40.5	59.5	
Wealth status class				0.00
Low	1024 (50.2)	60.7	39.3	
Middle	361 (17.7)	30.7	69.3	
High	656 (32.1)	11.3	88.7	
Ever use of contraception				0.00
No	817 (40.0)	51.9	48.1	
Yes	1224 (60.0)	30.1	69.9	
Previous birth interval (years)				0.00
<2	990 (62.4)	42.4	57.6	
2–5	236 (14.9)	48.3	51.7	
5+	360 (22.7)	27.2	72.8	
Complication during previous delivery				0.00
No	1920 (94.1)	51.3	48.7	
Yes	121 (5.9)	4.9	95.1	
Birth order				0.00
1	450 (22.0)	28.0	72.0	
2–3	753 (36.9)	35.7	64.3	
4–5	482 (23.6)	42.9	57.1	
6+	356 (17.4)	57.6	42.4	
Gestational age at first ANC				0.00
1st trimester	1179 (57.8)	34.2	65.8	
2nd trimester	807 (39.5)	45.4	54.6	
3rd trimester	55 (2.7)	64.2	35.8	
Number of times ANC attended				0.00
1	60 (2.9)	75.0	25.0	
2–3	293 (14.3)	65.9	34.1	
4+	1633 (80.0)	33.1	66.9	
Don't know	55 (2.7)	52.7	47.3	

Continued

Table 2 Continued

Variable	Frequency (%) (N=2041)	Per cent of unskilled delivery (N=807)	Per cent of skilled delivery (N=1234)	p Value for $\chi^2$ test
Covered by health insurance				0.00
No	1167 (57.2)	49.4	50.6	
Yes	874 (42.8)	26.1	73.9	
<i>Community and contextual factors</i>				
Region				0.00
Western	179 (8.8)	43.0	57.0	
Central	145 (7.1)	37.2	62.8	
Greater Accra	201 (9.8)	11.9	88.1	
Volta	166 (8.1)	39.8	60.2	
Eastern	178 (8.7)	33.7	66.3	
Ashanti	310 (15.2)	23.9	76.1	
Brong Ahafo	199 (9.7)	33.7	66.3	
Northern	287 (14.0)	67.6	32.4	
Upper East	172 (8.5)	52.3	47.7	
Upper West	204 (10.0)	49.5	50.5	
Residence				0.00
Urban	748 (36.6)	13.1	86.9	
Rural	1293 (63.4)	54.8	45.2	
Type of city				0.00
Capital/large	315 (15.4)	10.2	89.8	
Small	263 (12.9)	16.0	84.0	
Town	468 (23.0)	29.5	70.5	
Country side	995 (48.8)	59.8	40.2	
Spouse's highest educational attainment				0.00
No education	569 (27.9)	66.8	33.2	
Primary	179 (8.8)	43.6	56.4	
Secondary and higher	1293 (63.3)	26.0	74.0	
Who has final say on woman's health				0.02
Respondent alone	446 (21.9)	36.2	63.8	
Respondent and partner	915 (44.8)	38.7	61.3	
Husband/partner/someone alone	680 (33.3)	45.1	54.9	
Period of delivery				0.11
Before free delivery policy	535 (26.2)	36.6	63.4	
During free delivery policy	1506 (73.8)	40.6	59.4	

ANC, antenatal clinic.

### Model fit statistics

There was a significant increase in the c-statistic (AUC) estimates for model 3 compared with models 1 and 2. More importantly, there was a progressive increase in  $R^2$  value observed in model 1 when we fitted models 2 and 3. This implies that model 3 explains the predictors better and can, thus, be considered to be the most accurate model for application in clinical practice.

## DISCUSSION

### Main findings

The role of skilled attendance at delivery in averting maternal morbidity and mortality cannot be overemphasised as being the single most important intervention for safe motherhood.<sup>22 36</sup>

Highly educated women are significantly more likely to have skilled attendance at delivery compared with women with no education and previous studies have highlighted

this finding.<sup>33 37–39</sup> This emphasises the importance of female education for achievement of Millennium Development Goal (MDG) 5. The relationship between cost and access to healthcare, specifically, maternal health services, has been explored in various studies and the summary of findings agrees with what we also found.<sup>28 40 41</sup> Wealthier women in Ghana, as well as those with health insurance coverage, are more likely to have skilled delivery compared with poor women. Family planning services uptake is an important indicator for utilisation of maternal health services,<sup>42 43</sup> which leads to improved outcomes.<sup>44</sup> In our study, ever use of contraception increases the chance of having skilled attendance at delivery. Utilisation of skilled attendants is also preventive and that is possibly why women who have had previous pregnancy complications prefer to have a skilled attendant for subsequent deliveries, and thus reduce their vulnerability.

On the community level, we observed previously noted rural–urban disparities.<sup>28 40 45</sup> The opportunities for

**Table 3** Predictors of skilled attendance at delivery among pregnant women who attended ANC at least once during the pregnancy, Ghana Health and Demographic Survey, 2008

Predictor	$\beta$	p Value	OR* (95% CI)
<i>Demographic and maternal factors (model 1)</i>			
<i>AUC (95% CI) 0.85 (0.82 to 0.88)</i>			
Wealth status class			
Low	†	†	†
Middle	1.34	0.00	3.82 (2.25 to 6.49)
High	2.10	0.00	2.14 (1.09 to 4.20)
Complication during previous delivery (yes)	2.16	0.00	13.53 (2.63 to 69.47)
Covered by health insurance (yes)	1.10	0.00	3.00 (1.98 to 4.54)
Birth order			
1	†	†	†
2–3	−0.30	0.24	0.74 (0.45 to 1.22)
4–5	−0.88	0.02	0.42 (0.21 to 0.84)
Maternal age in years	0.05	0.04	1.05 (1.00 to 1.09)
Religious group			
Christian	†	†	†
Muslim	−0.12	0.40	0.77 (0.43 to 1.40)
Traditionalist	−1.34	0.01	0.26 (0.10 to 0.67)
No religion/other	−0.52	0.28	0.60 (0.23 to 1.54)
Ethnicity			
Akan	1.00	0.02	2.72 (1.14 to 6.46)
Ga/Dangme	†	†	†
Ewe	1.53	0.03	4.62 (1.71 to 12.53)
Guan	0.43	0.60	1.55 (0.30 to 7.90)
Mole-Dagbani	0.62	0.21	1.87 (0.71 to 4.94)
Grussi	0.84	0.15	2.32 (0.74 to 7.30)
Gruma	0.77	0.20	2.15 (0.68 to 6.86)
Other	1.56	0.02	4.78 (1.30 to 17.56)
<i>Community and contextual factors (model 2)</i>			
<i>AUC (95% CI) 0.80 (0.78 to 0.82)</i>			
Residence (rural)	−1.31	0.00	0.27 (0.18 to 0.41)
Type of city			
Capital/large	0.49	0.14	1.63 (0.85 to 3.10)
Small	†	†	†
Town	0.03	0.92	1.03 (0.62 to 1.70)
Country side	−0.66	0.01	0.52 (0.31 to 0.88)
Spouse's highest educational level			
No education	−0.87	0.00	0.42 (0.28 to 0.63)
Primary	†	†	†
Secondary and higher	0.30	0.12	1.36 (0.92 to 1.99)
Region			
Western	−1.53	0.60	0.86 (0.49 to 1.52)
Central	†	†	†
Greater Accra	0.24	0.53	1.27 (0.60 to 2.70)
Volta	0.22	0.43	1.25 (0.72 to 2.19)
Eastern	0.32	0.26	1.38 (0.79 to 2.42)
Ashanti	0.50	0.06	1.65 (0.97 to 2.78)
Brong Ahafo	0.47	0.09	1.61 (0.93 to 2.79)
Northern	−0.47	0.09	0.63 (0.37 to 1.08)
Upper East	0.31	0.28	1.37 (0.78 to 2.41)
Upper West	0.60	0.03	1.83 (1.05 to 3.17)
<i>Demographic, maternal, community and contextual factors (model 3)</i>			
<i>AUC (95% CI) 0.85 (0.83 to 0.88)</i>			
<i>(Interactions not significant in model)</i>			
Wealth status class			
Low	†	†	†
Middle	0.63	0.04	1.88 (1.02 to 3.47)
High	1.18	0.00	3.27 (1.60 to 6.68)

Continued

Table 3 Continued

Predictor	$\beta$	p Value	OR* (95% CI)
Residence (rural)	-1.31	0.00	0.27 (0.14 to 0.52)
Complication during previous delivery (yes)	3.09	0.04	21.93 (2.61 to 184.04)
Covered by health insurance (yes)	1.03	0.00	2.74 (1.83 to 4.30)
Religious group			
Christian	0.34	0.51	1.40 (0.52 to 3.76)
Muslim	-0.08	0.99	0.99 (0.34 to 2.87)
Traditionalist/spiritualist	-0.78	0.24	0.46 (0.12 to 1.70)
No religion/other	†	†	†

\*Each OR is adjusted for the other covariates in the model.

†Reference category.

ANC, antenatal clinic; AUC, area under the curve.

higher education and improved wealth status, among other factors, are undeniably few in rural areas<sup>46 47</sup> and when these were adjusted for in the prediction model, women from rural areas still had less prevalence in the outcome. Perhaps other factors such as geographical access to healthcare are at play here, but the data we used did not allow us to explore this in any meaningful way. Apart from rural-urban disparities, we also noted marked regional disparities for skilled delivery. The three Northern regions, which have the lowest prevalence of the outcome, are mostly rural, with low wealth class status, lower levels of education and are predominantly Muslim compared with the rest of the population. These factors are among our significant predictors of the outcome.

Contextual issues also come into play. The observed influence of spousal education emphasises the role of an environment of high literacy on maternal outcomes. Women who have other people, including their partners, participating in the final decision on their health have a reduced chance of having skilled attendance at delivery from our results. ANC attendance and counselling for couples could be explored as a strategy to improve knowledge of the significant others and eventually improve outcomes as has been shown for HIV/AIDS prevention interventions.<sup>48</sup> Deliveries after the introduction of free delivery policy were observed to be less attended to by skilled professionals. This is likely to be due to the gradual regional roll out of the policy across the country, the lack of knowledge about the policy and general implementation challenges, as previously observed in studies that evaluated use of free health services.<sup>49 50</sup>

Among ANC attendants, providers of care can adequately identify women who are likely to have skilled delivery (and therefore, those who are unlikely to) using the information on their wealth status class, history of previous birth complication, health insurance coverage, rural or urban residence, and religious group. This provides an opportunity to use routinely collected data to enhance service delivery and improve health outcomes.

### Application of this prediction

This prediction ability is only useful when situated within the availability of effective interventions that

encourage skilled attendance at delivery. Birth preparedness is an important component of the counselling at ANC that women are expected to receive. Key components of the birth plan include recognition of danger signs, a plan for a skilled birth attendant, a plan for the place of delivery, and saving money for transport or other costs in case the need arises.<sup>51</sup> Applying the results of our study, providers will be able to sort out ANC attendants into those who are likely to use skilled attendance at delivery and those who are unlikely to do so. Those who are unlikely can be supported during the period of pregnancy to access skilled delivery.

For example, uninsured pregnant women can be encouraged to register for health insurance at the onset of the pregnancy or whenever they sign up for ANC, so that by the time of delivery the cost of care will be covered by insurance. If need be, discussions can take place with the spouse or any significant other so that money can be set aside for any eventualities. At the community level, where home visits by community health workers are possible, women who are less likely to have the outcome can have more purposeful visits by health workers that will ensure that they improve their chances of having skilled attendance at delivery.

These predictors could form the basis of a very useful clinical decision-making tool for providers. We advocate for future validation of these predictors in a prospective study and in a health facility since all the demographic and maternal data of pregnant women attending ANC in this study are captured at ANC registration. On validation, the model can be incorporated into health facility antenatal protocols and other job aids that ensure that health workers identify and practically support pregnant women to opt for skilled attendance at delivery.

### Strengths and limitations of the study

Strength of this study is the national representative sample that facilitates generalisability of the study results to pregnant women in Ghana. It also not only assesses possible associations but also considers a combination of factors that significantly predict the outcome. However, the DHS data are retrospectively collected data, and therefore has some limitations. There is the chance of



recall bias potentially affecting results. Only surviving mothers were interviewed and this could have affected the prevalence of the outcome. Also, we were unable to study other variables that possibly influence the outcome, for which data are not available in the 2008 DHS database. Last but not the least, our results will not apply to the women who do not access antenatal care during pregnancy.

## CONCLUSION

Women less likely to have skilled attendance at delivery can be identified during antenatal care using data on wealth status class, health insurance coverage, residence, history of previous birth complication and religion, and can be targeted with interventions to improve skilled attendance at delivery.

## Author affiliations

<sup>1</sup>Julius Global Health, Julius Center for Health Sciences and Primary Care, University Medical Centre Utrecht, Utrecht, The Netherlands

<sup>2</sup>School of Public Health, University of Ghana, Legon, Ghana

<sup>3</sup>Research and Development Division, Ghana Health Service, Accra, Ghana

<sup>4</sup>Department of Health Policy Planning and Management, School of Public Health, University of Ghana, Legon, Ghana

<sup>5</sup>Faculty of Health Sciences, Division of Epidemiology & Biostatistics, School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

**Acknowledgements** The authors gratefully acknowledge technical support from the Julius Center for Health Sciences and Primary Care.

**Contributors** MA-C designed and wrote up the study protocol, acquired permission from Measure DHS to use data, carried out data analysis, wrote the report and drafted this manuscript for publication. GAK, IAA, DEG, EKA and KK-G provided scientific guidance and did review of the study design, data analysis, and were also actively involved in the preparation and review of the manuscript and approved it.

**Funding** Funding for the conduct of the study was from the Netherlands Organization for Scientific Research (NWO) Global Health Policy and 396 Health Systems Research Program, the Netherlands (Grant number: 07.45.102.00). They supported authors MA-C and GAK as PhD candidates.

**Competing interests** Authors MA-C and GAK had financial support from the Netherlands Organization for Scientific Research (NWO) Global Health Policy and 396 Health Systems Research Program, the Netherlands, for the submitted work.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data sharing statement** Secondary data were used for this study. These data are public and freely available to anyone from MEASURE DHS, on request. The website for MEASURE DHS is <http://dhsprogram.com/data/available-dataset.cfm>.

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