

BMJ Open

Predictors of skilled attendance at delivery amongst antenatal clinic (ANC) attendants in Ghana: a cross-sectional study of population data

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2015-007810
Article Type:	Research
Date Submitted by the Author:	29-Jan-2015
Complete List of Authors:	AMOAKOH-COLEMAN, MARY; UNIVERSITY MEDICAL CENTER, JULIUS GLOBAL HEALTH JULIUS CENTER; SCHOOL OF PUBLIC HEALTH , UNIVERSITY OF GHANA, EPIDEMIOLOGY AND DISEASE CONTROL Ansah, Evelyn; Ghana Health Service, Research and Development Division Agyepong, Irene; University of Ghana, School of Public Health Kayode, Gbenga; UNIVERSITY MEDICAL CENTER, JULIUS GLOBAL HEALTH JULIUS CENTER Grobbee, Diederick; UNIVERSITY MEDICAL CENTER, JULIUS GLOBAL HEALTH JULIUS CENTER Klipstein-Grobusch, Kerstin; University Medical Center, Julius Center for Health Sciences and Primary Care;
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Obstetrics and gynaecology
Keywords:	Antenatal < GENETICS, EPIDEMIOLOGY, Public health < INFECTIOUS DISEASES, Maternal medicine < OBSTETRICS

SCHOLARONE™
Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 **Predictors of skilled attendance at delivery amongst antenatal clinic (ANC)**
2 **attendants in Ghana: a cross-sectional study of population data**

3 **Mary Amoakoh-Coleman**, Evelyn K Ansah , Irene Akua Agyepong, Diederick E Grobbee,
4 Gbenga A Kayode, Kerstin Klipstein-Grobusch

5
6 Julius Global Health, Julius Center for Health Sciences and Primary Care, University Medical
7 Centre Utrecht, Utrecht, The Netherlands, School of Public Health, University of Ghana, Legon,
8 Ghana, Mary Amoakoh-Coleman research associate Research and Development Division, Ghana
9 Health Service, Accra, Ghana E K Ansah deputy director research Department of Health Policy
10 Planning and Management, School of Public Health, University of Ghana, Legon, Ghana I A
11 Agyepong professor Julius Global Health, Julius Center for Health Sciences and Primary Care,
12 University Medical Centre Utrecht, Utrecht, The Netherlands D E Grobbee professor Julius
13 Global Health, Julius Center for Health Sciences and Primary Care, University Medical Centre
14 Utrecht, Utrecht, The Netherlands G A Kayode research associate Julius Global Health,
15 Julius Center for Health Sciences and Primary Care, University Medical Centre Utrecht,
16 Utrecht, The Netherlands, Division of Epidemiology & Biostatistics, School of Public Health,
17 Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa K
18 Klipstein-Grobusch associate professor

19 Correspondence to: M Amoakoh-Coleman menba19@yahoo.com

Abstract

Objective: To identify demographic, maternal and community predictors of skilled attendance at delivery amongst 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-square test for associations and logistic regression to identify significant predictors. Predictive models were built with estimation of area under the receiver operating curves (AUC).

Setting: Ghana

Participants: A total of 2,041 women who had a live birth in the five years preceding the survey, and attended antenatal clinic at least once from a skilled provider during the pregnancy

Outcome: Skilled attendance at delivery

Results: Overall, 60.5% (1,235/2,041) of women in our study sample reported skilled attendance at delivery. Significant positive associations existed between maternal educational level, wealth status classes, 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 (0.83-0.88).

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

1
2
3 40 previous birth complication and religion, and targeted with interventions to improve skilled
4
5
6 41 attendance at delivery.
7
8
9 42

10
11 43 Keywords: Skilled attendance, delivery, antenatal, Ghana, predictor, maternal
12
13

14 44 **Strengths and limitations of this study**

- 15
16
17
18 45 • The use of nationally representative data that facilitates generalizability of results to
19
20 46 pregnant women in Ghana.
- 21
22
23 47 • An assessment of a combination of factors that significantly predict skilled attendance at
24
25 48 delivery which has not been done for the study setting
- 26
27
28
29 49 • However the DHS data is retrospectively collected data and therefore has the chance of
30
31 50 recall bias potentially affecting results.
- 32
33
34
35 51 • Only surviving mothers were interviewed and this could have affected the prevalence of
36
37 52 the outcome.
- 38
39
40 53 • Our results are not applicable to the women who do not access antenatal care during
41
42 54 pregnancy.
43
44
45
46 55
47
48
49 56
50
51
52
53
54
55
56
57

57 Introduction

58 Risk of maternal death continues to be high in sub-Saharan Africa and Southeast Asia compared
59 to the more developed parts of the world. In 2008, maternal deaths in sub-Saharan Africa (SSA)
60 and Southern Asia accounted for 87% of global maternal deaths, and progress to reverse this,
61 especially in SSA has been slow (1-7). Efforts to encourage utilization of health care facilities
62 should also be vigorously pursued for optimal results.

63 A skilled attendant is defined as “an accredited health professional – such as a midwife, doctor
64 or nurse – who has been educated and trained to proficiency in the skills needed to manage
65 normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the
66 identification, management and referral of complications in women and newborns” (8;9).

67 Antenatal care and delivery by a skilled attendant both contribute to reduction in maternal deaths
68 (10-17). The issue of who a skilled attendant is has been debated for some time, with respect to
69 which category of health workers is skilled (18). In Ghana these are obstetricians, general
70 practitioners, midwives, auxiliary midwives and nurses with midwifery training including
71 community health nurses/ officers (19). There is also evidence that there are variations in these
72 categories, with respect to the extent of training and roles in different countries across the world
73 (20-22).

74 Despite the body of evidence of the importance of skilled attendance at delivery, there are
75 records of high antenatal attendance but low skilled attendance at delivery, especially in
76 developing countries (23-26). In Tanzania, over 90% of pregnant women are known to attend
77 antenatal clinic (ANC) at least once, with 62% attending four times. However, less than 50% of
78 these ANC attendants have their deliveries attended to by skilled personnel (3). In a study in

1
2
3 79 Uganda, although ANC attendance was found to be as high as 94%, this was not reflected in care
4
5
6 80 at delivery, with about 25% of women being assisted during labour by a relative or friend (13).
7
8

9 81 In Ghana, according to the 2008 Ghana Demographic and Health Survey (DHS), about 97% of
10
11 82 pregnant women received antenatal care during pregnancy, with as many as 78.2% attending at
12
13 83 least 4 times. However, only 57.1% delivered in health facilities with a total of 59% being
14
15 84 assisted by skilled personnel (19). Several reasons have been attributed to this pattern, including
16
17 85 access to health facilities, health worker attitude towards women during delivery and cultural
18
19 86 issues, amongst others (27).
20
21
22
23

24 87 Some factors have also been quantitatively shown to be associated with skilled attendance at
25
26 88 delivery. Maternal age is believed to influence the decision to take such an action, with younger
27
28 89 women preferring skilled attendance at delivery due to perception of risk. (28). This is closely
29
30 90 linked with parity, where multi-parous women with experience in labour tend to opt for other
31
32 91 unskilled support during delivery due to the perception that they are experienced. Other factors
33
34 92 such as marital status, wealth index, employment status and high educational background,
35
36 93 especially secondary education, of both the woman and the husband has also been positively
37
38 94 associated with the outcome (3;23). Living in rural areas where poverty is more prevalent
39
40 95 compared to urban areas has been shown to be negatively associated with skilled delivery (23-
41
42 96 26;29). Other notable factors that have positive influence on the outcome are short distance to
43
44 97 health facility and availability of a birth preparedness plan designed together with the woman
45
46 98 during ANC (3).
47
48
49
50
51
52

53 99 Many interventions have been implemented to improve maternal health in Ghana, including but
54
55 100 not limited to the Safe Motherhood Initiative (SMI), free delivery policy, High Impact Rapid
56
57

1
2
3 101 Delivery (HIRD) and the Emergency Obstetric and Neonatal Care program (30-32). The free
4
5 102 delivery fee policy, was first introduced in four regions in 2003, and subsequently extended to
6
7
8 103 the entire country in 2005. Some studies have so far been conducted in Ghana to identify factors
9
10 104 that influence skilled attendance at delivery. However, these have largely been unpublished
11
12 105 student thesis papers, and have often focused on women who benefit from skilled care during
13
14 106 delivery. None of these have been national in scope. Secondary data analysis of Ghana DHS
15
16 107 offers the opportunity to evaluate a larger sample across the country in order to identify
17
18 108 demographic, maternal and community predictors of skilled attendance at delivery amongst
19
20 109 women who attend antenatal clinic at least once during their pregnancy in Ghana. The question
21
22 110 we seek to answer is whether there are possible significant predictors that will enable providers
23
24 111 identify women who have a low risk of having skilled attendance at delivery among antenatal
25
26 112 care attendants, so that these women can be supported to have this desirable outcome. The aim of
27
28 113 the study is to identify demographic, maternal, community and contextual predictors of skilled
29
30 114 attendance at delivery amongst women who attend ANC at least once during their pregnancy.
31
32
33
34
35
36

37 115 **Methods**

38 39 40 116 *Study design*

41
42
43 117 Secondary data analysis of the dataset of the 2008 Ghana DHS, a nationally representative
44
45 118 population-based survey of 4,305 women aged 15 – 49 years was conducted.
46
47
48

49 119 *Data collection*

50
51
52 120 Comprehensive information on the sampling techniques and survey procedures applied for data
53
54 121 collection in the Ghana DHS have been published in detail elsewhere (33). In summary, the 10
55
56

1
2
3 122 regions of Ghana are each administratively sub-divided into districts while each district is
4
5 123 divided into localities. Each locality is decomposed into Enumeration Areas (EAs) based on the
6
7
8 124 2000 population census, and these form the primary sampling units (PSU). The PSU, defined for
9
10 125 the purposes of this study as the cluster, was provided by the Ghana Statistical Service. A
11
12 126 stratified two-stage cluster randomized sampling technique was applied. The first stage involved
13
14 127 probability proportional sampling of a total of 412 PSUs (clusters) from all the regions,
15
16 128 comprising of 182 clusters from the urban areas and 230 from rural areas. During the second
17
18 129 stage, an average of 15 households was randomly sampled from each of the PSU using their
19
20 130 household sampling frame. Finally for half of the surveyed households, all eligible women aged
21
22 131 15 – 49 years were interviewed with a women’s questionnaire. This had questions
23
24 132 socioeconomic, demographic and health indicators. Questionnaires were translated into three
25
26 133 major local Ghanaian languages (Akan, Ga and Ewe) and were pre-tested on the field by trained
27
28 134 personnel before finalization for use. All respondents gave informed consent to participate in the
29
30 135 survey. A total of (4,916) women aged between 15 – 49 years were interviewed, with a 96.5%
31
32 136 (4,305) response rate. Out of these, the subset of women who had a live birth in the five years
33
34 137 preceding the survey numbered 2,099; 95.4% (2,041) of them did receive antenatal care from a
35
36 138 skilled provider (doctor, nurse, midwife, auxiliary midwife or community health officer) in the
37
38 139 health system (19). Characteristics of these 2,041 women were assessed in this study.

140 *Ethical approval*

141 Ethical approval to conduct DHS in Ghana was approved by the Ethics Committee of ICF Macro
142 in Calverton, USA and the Ethics Committee, Ghana Health Service, Accra, Ghana. We obtained

1
2
3 143 ethics approval for analysis of this data from the Ethics Committee of ICF Macro in Calverton,
4
5
6 144 USA through an online request
7
8

9 145 *Variables*

10
11 146 ***Outcome***

12
13
14
15 147 Skilled attendance at delivery was the outcome. This in Ghana, and as used in the DHS data
16
17 148 collection and analysis, is defined as delivery by a doctor, nurse, midwife, auxiliary midwife or
18
19 149 community health officer (19), with a response of either Yes (1) or No (0).
20
21

22
23 150 ***Determinants***

24
25 151 The factors included in this study are based on findings from other studies in published literature
26
27 152 and availability in the 2008 DHS data set. These were categorized as demographic, maternal,
28
29 153 community and contextual factors. All the variables were put into building the models to avoid
30
31 154 pre-selection. Table 1 shows the all the variables and their definitions.
32
33
34

35 155 *Statistical analyses*

36
37 156 Total missing data was more than 5%, and this level of missing data is rarely at random. Thus
38
39 157 multiple imputations of missing data were conducted and analysis was based on the dataset with
40
41 158 imputed data. We carried out descriptive univariate analysis to evaluate the prevalence of
42
43 159 delivery by a skilled provider (outcome variable) across the categories of each of the
44
45 160 determinants. We regrouped wealth quintiles into low (poorest and poorer quintiles), middle
46
47 161 (middle quintile) and high (richer and richest quintiles) wealth status classes due to small
48
49 162 numbers in some of the quintile groups.
50
51
52
53
54
55
56
57

1
2
3 163 Bivariate analysis using chi-square test was used to investigate the relationship between the
4
5 164 independent variables and the categorical outcome variable, with detection of significant
6
7
8 165 differences at $p < 0.05$. We explored possible correlations between the variables region and birth
9
10 166 order; region and religious groups; region and wealth status class; residence and wealth status
11
12 167 class and wealth status class and educational level.

13
14
15
16 168 Three predictive models were built using a backward stepwise elimination approach and all
17
18 169 correlated variables were built into the models as interaction terms. Model 1 included the
19
20 170 demographic and maternal characteristics, Model 2 included the community and contextual
21
22 171 factors and Model 3 combined demographics, maternal, community and contextual factors. Age
23
24 172 was explored both as categorical and continuous variable in building the models. Associations
25
26 173 were estimated by odds ratios (ORs) and their corresponding 95% confidence intervals (CI).
27
28 174 Each OR is adjusted for the other covariates in the model. The area under the curve (AUC), of
29
30 175 the receiver operating curves (ROC), for all the models were estimated.

31 32 33 34 35 36 176 **Results**

37 38 39 177 *Background characteristics of the women*

40
41
42 178 Table 2 shows a summary of the characteristics of the 2,041 women who for their latest delivery
43
44 179 within the period of 2003 and 2008 had at least one ANC visit which was attended to by a health
45
46 180 professional. The mean age (standard deviation) of the women was 30 (7.24) years and this was
47
48 181 the same for both groups of women who had skilled and unskilled attendance at delivery. Eighty-
49
50 182 nine percent (1,816/2,041) of women were currently married during the survey and eighty-seven
51
52 183 percent (1,772/2,041) of them were currently working. Forty-one percent (845/2,041) of the
53
54
55
56
57

1
2
3 184 women had secondary or higher education and 35.3% (720/2,041) had no education. Most of
4
5
6 185 them were Christians (68% (1,389/2,041)) and twenty percent (410/2,041) were Muslims.
7
8 186 Wealth distribution amongst this population was 50.2% (1,024/2,041), 17.7% (361/2,041) and
9
10 187 32.1% (656/2,041) for low, middle and high wealth status classes respectively. Only 42.8%
11
12 188 (874/2,041) of the women had health insurance coverage at the time of the survey. Prevalence of
13
14
15 189 ever-use of any contraceptive method amongst the women was 60.0% (1,224/2,041). As many as
16
17 190 80.0% (1,633/2,041) attended ANC at least four times during the pregnancy. Sixty-three percent
18
19 191 (1,293/2,041) of the women lived in rural areas.

20
21
22
23 192 Prevalence of skilled attendance at delivery was 60.5% (1,235/2,041) /2,041), most of them
24
25 193 attended to by midwives and nurses (45.4% (926/2,041)). Doctors conducted only 9%
26
27 194 (184/2,041) of all deliveries.

28 29 30 31 195 *Comparability of the two outcome groups*

32
33
34 196 Table 2 also summarizes the comparison between women who had skilled or unskilled
35
36 197 attendance at delivery. There were significant differences ($p < 0.05$) between those having skilled
37
38 198 and unskilled attendance, amongst all the categories of the characteristics studied, except for
39
40 199 period of delivery as per the free delivery policy ($p = 0.11$). Women with secondary and higher
41
42 200 education had more skilled attendant at delivery compared to those without any education. About
43
44 201 67.0% (929/1389) of Christians had skilled attendance at delivery compared to 57.2% (235/410)
45
46 202 and 45.2% (40/89) of Muslims and non-religious women respectively. Women who had ever
47
48 203 used a contraceptive method were more likely to have skilled attendance at delivery (69.9%
49
50 204 856/1,224)). The proportion of skilled attendance at delivery decreased with increasing birth
51
52 205 order and 95.1% (115/121) of women who had a Caesarean section during their previous

1
2
3 206 pregnancy had skilled attendance at delivery compared to 48.7% (935/1,920) amongst those who
4
5 207 did not have that complication. The outcome was more prevalent (73.9% (646/874)) amongst
6
7
8 208 women with health insurance coverage compared to those without (50.6% (590/1,167)). There
9
10 209 were regional variations in the proportion of women who had skilled attendance at delivery.
11
12 210 Only forty-five percent (584/1,293) of women in rural areas had skilled attendance at delivery
13
14 211 compared to 86.7% (650/748) in urban areas. We checked for correlation amongst variables, and
15
16 212 birth order and timing of first ANC attendance were significantly correlated ($p<0.001$). Wealth
17
18 213 status class was significantly different amongst the categories of region, rural or urban
19
20 214 settlements and educational levels ($p<0.001$). Birth order and religious group categories also
21
22 215 varied across the various regions ($p<0.001$). These correlations were explored as interaction
23
24 216 terms in building the predictive models.
25
26
27
28
29

30 217 *Predictors of skilled delivery*

31
32
33 218 Three models for predicting skilled delivery amongst the women in the survey, using a backward
34
35 219 stepwise approach, were built. These are shown in **Table 3**. **Model 1** consists of maternal
36
37 220 factors and significant predictors were wealth quintile, history of previous delivery complication,
38
39 221 having health insurance, birth order, number of times ANC was attended, the exact maternal age
40
41 222 in years, religious group and ethnicity. Interactions terms explored were not significant
42
43 223 predictors. **Model 2** was built with community or cluster factors and the significant predictors
44
45 224 were residence (rural/ urban), type of residence (capital/ large city, small city and town or
46
47 225 country side) spouse's highest educational level and the geographical region. In **Model 3**,
48
49 226 demographic, maternal and community factors were combined. Significant predictors were
50
51 227 wealth status class, history of previous birth complication, health insurance coverage, residence
52
53
54
55
56

228 and religious group. Again in this model, interaction terms included were not significant. The
229 predictive probabilities of all three models are [c-statistics (95%CI)] 0.85 (0.82 – 0.88); 0.80
230 (0.78 – 0.82) and 0.85 (0.83 – 0.88) respectively for models 1, 2 and 3. Model 3 combines both
231 groups of variables, has the least number of variables and also the best fit, making it the best
232 amongst the three for use in practice.

233 *Model fit statistics*

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

239 **Discussion**

240 *Main findings*

241 The role of skilled attendance at delivery in averting maternal morbidity and mortality cannot be
242 overemphasized being the single most important intervention for safe motherhood (22;34).
243 Highly educated women are significantly more likely to have skilled attendance at delivery
244 compared to women with no education (35-37) and this emphasizes the importance of female
245 education for achievement of MDG5. The relationship between cost and access to health care
246 and specifically maternal health services has been explored in various studies and the summary
247 of findings agrees with what we also found (28;38;39). Wealthier women in Ghana, as well as
248 those with health insurance coverage, are more likely to have skilled delivery compared to poor

1
2
3 249 women. Family planning services uptake is an important indicator for utilization of maternal
4
5
6 250 health services (40;41), which leads to improved outcomes (42). In our study ever use of
7
8 251 contraception increases the chance of having skilled attendance at delivery. Utilization of skilled
9
10
11 252 attendants is also preventive and that is possibly why women who have had previous pregnancy
12
13 253 complications prefer to have skilled attendant for subsequent deliveries, to reduce their
14
15 254 vulnerability.

16
17
18 255 On the community level, we observed previously noted rural-urban disparities (28;38;43). The
19
20 256 opportunities for higher education and improved wealth status amongst other factors are
21
22 257 undeniably few in rural areas and thus most likely contributing to these findings. Apart from
23
24
25 258 rural – urban disparities, we also noted marked regional disparities for skilled delivery. The three
26
27 259 Northern regions, which have the lowest prevalence of the outcome, are mostly rural, with low
28
29 260 wealth class status, lower levels of education, and predominantly Muslim compared to the rest of
30
31 261 the population. These factors are amongst our significant predictors of the outcome.

32
33
34 262 Contextual issues also come into play. The observed influence of spousal education emphasizes
35
36 263 the role of an environment of high literacy on maternal outcomes. Women who have others
37
38 264 participating in the final decision on their health have a reduced chance of having skilled
39
40 265 attendance at delivery from our results. Deliveries after the introduction of free delivery policy
41
42
43 266 were observed to be less attended to by skilled professionals. This is likely to be due to the
44
45
46 267 gradual regional roll out of the policy across the country, the lack of knowledge about the policy
47
48 268 and general implementation challenges as previously observed in studies that evaluated use of
49
50 269 free health services (44;45).

51
52
53 270
54
55 271
56

1
2
3 272 *Application of this prediction*
4

5 273 This prediction ability is only useful when situated within the availability of effective
6
7 274 interventions that encourage skilled attendance at delivery. Birth preparedness is an important
8
9 275 component of the counseling at ANC that women are expected to receive. Key components of
10
11 276 the birth plan include recognition of danger signs, a plan for a skilled birth attendant, a plan for
12
13 277 the place of delivery, and saving money for transport or other costs in case the need arises (46).
14
15 278 Applying the results of our study, providers will be able to sort out ANC attendants into those
16
17 279 who are likely to use skilled attendance at delivery and those who are unlikely to do so. Those
18
19 280 who are unlikely can be supported during the period of pregnancy to access skilled delivery.
20
21 281 These predictors could form the basis of a very a useful clinical decision making tool for
22
23 282 providers. While advocating for validation of these predictors in a prospective study and in a
24
25 283 health facility, all the demographic and maternal data of ANC attendants used in this study are
26
27 284 captured at registration. This makes it possible to screen the women and categorize them into low
28
29 285 and high chance of having skilled attendance at delivery and to institute appropriate counseling
30
31 286 and follow-up and support programs for these groups within a focused ANC (FANC) service.
32
33 287 For example, uninsured pregnant women can be encouraged to register for health insurance at
34
35 288 the onset of the pregnancy or whenever they book for ANC, so that by the time of delivery the
36
37 289 cost of care will be covered by insurance. If need be, discussions can take place with the spouse
38
39 290 or any significant others so that money can be set aside for any eventualities. At the community
40
41 291 level where home visits by community health workers are possible, women who are less likely to
42
43 292 have the outcome can have more purposeful visits by health workers that will ensure that they
44
45 293 improve their chances of having skilled attendance at delivery.
46
47
48
49
50
51
52
53
54
55 294

1
2
3 295 *Strengths and limitations of the study*
4

5 296 Strength of this study is the national representative sample that facilitates generalizability of the
6
7
8 297 study results to pregnant women in Ghana. It also does not only assess possible associations but
9
10
11 298 also a combination of factors that significantly predict the outcome. However the DHS data is
12
13 299 retrospectively collected data and therefore has some limitations. There is the chance of recall
14
15 300 bias potentially affecting results. Only surviving mothers were interviewed and this could have
16
17 301 affected the prevalence of the outcome. Last but not the least our results will not apply to the
18
19
20 302 women who do not access antenatal care during pregnancy.
21

22 303 **Conclusion**
23
24

25 304 Women less likely to have skilled attendance at delivery can be identified during antenatal care
26
27 305 using data on wealth status class, health insurance coverage, residence, history of previous birth
28
29 306 complication and religion, and targeted with interventions to improve skilled attendance at
30
31 307 delivery.
32
33
34

35 308 **Acknowledgement**
36
37

38
39 309 The authors gratefully acknowledge technical support from the Julius Center for Health Sciences
40
41 310 and Primary Care.
42
43

44 311 **Contributorship statement**
45
46

47 312 MAC designed and wrote up the study protocol, acquired permission from Measure DHS to use
48
49 313 data, carried out data analysis, wrote the report and drafted this manuscript for publication. GAK,
50
51 314 IAA, DEG, EKA and KKG provided scientific guidance and review of the study design, data
52
53
54
55
56
57

1
2
3 315 analysis and were also actively involved in the preparation and review of the manuscript and
4
5
6 316 approved it.
7

8 9 317 **Competing interests**

10
11
12 318 All authors have completed the ICMJE uniform disclosure form at
13
14 319 www.icmje.org/coi_disclosure.pdf and declare: authors MAC and GAK had financial support
15
16
17 320 from the Netherlands Organization for Scientific Research (NWO) Global Health Policy and 396
18
19 321 Health Systems Research Program, Netherlands, for the submitted work; no financial
20
21 322 relationships with any organizations that might have an interest in the submitted work in the
22
23
24 323 previous three years; no other relationships or activities that could appear to have influenced the
25
26 324 submitted work.
27

28 29 325 **Funding**

30
31
32 326 Funding for the conduct of the study was from the Netherlands Organization for Scientific
33
34 327 Research (NWO) Global Health Policy and 396 Health Systems Research Program, Netherlands,
35
36
37 328 for providing funds (Grant number: 07.45.102.00). They supported authors MAC and GAK as
38
39
40 329 PhD candidates.
41

42 43 330 **Data sharing statement**

44
45
46 331 Secondary data was used for this study. This data is public and freely available to anyone from
47
48 332 MEASURE DHS, on request. The website for MEASURE DHS is
49
50
51 333 <http://dhsprogram.com/data/available-dataset.cfm>.
52

53
54 334
55
56 335
57
58
59
60

Reference List

- 1
2
3 336 (1) WHO, UNICEF. Countdown 2015 Maternal, Newborn and Child survival. Building a future for
4 337 women and children. The 2012 report
5 338 105. <http://www.countdown2015mnch.org/documents/2012Report/2012-complete-no-profiles.pdf> .
6 339 2013.
7
8 340 Ref Type: Online Source
9 341 (2) Bhutta ZA, Chopra M, Axelson H, Berman P, Boerma T, Bryce J, et al. Countdown to 2015 decade
10 342 report (2000-10): taking stock of maternal, newborn, and child survival
11 343 106. Lancet 2010 Jun 5;375(9730):2032-44.
12 344 (3) Magoma M, Requejo J, Campbell OM, Cousens S, Filippi V. High ANC coverage and low skilled
13 345 attendance in a rural Tanzanian district: a case for implementing a birth plan intervention
14 346 92. BMC Pregnancy Childbirth 2010;10:13.
15 347 (4) Hogan MC, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM, et al. Maternal mortality for
16 348 181 countries, 1980-2008: a systematic analysis of progress towards Millennium Development
17 349 Goal 5
18 350 3. Lancet 2010 May 8;375(9726):1609-23.
19 351 (5) Kinney MV, Kerber KJ, Black RE, Cohen B, Nkrumah F, Coovadia H, et al. Sub-Saharan Africa's
20 352 mothers, newborns, and children: where and why do they die?
21 353 15. PLoS Med 2010 Jun;7(6):e1000294.
22 354 (6) United Nations. The Millennium Development Goals Report 2011. New York: United Nations;
23 355 2011. http://www.un.org/millenniumgoals/MDG2011_PRa_EN.pdf . 2011.
24 356 Ref Type: Online Source
25 357 (7) World Health Organization. Trends in maternal mortality 1990 to 2010: Estimates developed by
26 358 WHO, UNICEF, UNFPA and the World Bank.
27 359 http://whqlibdoc.who.int/publications/2010/9789241500265_eng.pdf . 2010. 2-2-2012.
28 360 Ref Type: Online Source
29 361 (8) World Health Organization. Skilled birth attendants, factsheet.
30 362 67. Geneva: World Health Organization; 2008 Apr 2.
31 363 (9) World Health Organization. Reduction of maternal mortality: A Joint WHO/ UNFPA/ UNICEF
32 364 World Bank Statement
33 365 68. 2013.
34 366 Ref Type: Online Source
35 367 (10) Bergsjö P, Villar J. Scientific basis for the content of routine antenatal care. II. Power to eliminate
36 368 or alleviate adverse newborn outcomes; some special conditions and examinations. Acta Obstet
37 369 Gynecol Scand 1997 Jan;76(1):15-25.
38 370 (11) Buor D, Bream K. An analysis of the determinants of maternal mortality in sub-Saharan Africa. J
39 371 Womens Health (Larchmt) 2004 Oct;13(8):926-38.
40 372 (12) Lumbiganon P. Appropriate technology: antenatal care. Int J Gynaecol Obstet 1998 Dec;63 Suppl
41 373 1:S91-S95.
42 374 (13) Tann CJ, Kizza M, Morison L, Mabey D, Muwanga M, Grosskurth H, et al. Use of antenatal
43 375 services and delivery care in Entebbe, Uganda: a community survey. BMC Pregnancy Childbirth
44 376 2007;7:23.
45 377 (14) UNICEF. **Eastern and Southern Africa Regional Office: Maternal Mortality Reduction Strategy.**
46 378 **2003.** <http://www.unicef.org/health/files/MMreductionstrategyShoo2003.pdf> . 10-6-2003.
47 379 Ref Type: Online Source
48 380 (15) van Eijk AM, Bles HM, Odhiambo F, Ayisi JG, Blokland IE, Rosen DH, et al. Use of antenatal
49 381 services and delivery care among women in rural western Kenya: a community based survey.
50 382 Reprod Health 2006;3:2.

- 1
2
3 383 (16) Villar J, Bergsjö P. Scientific basis for the content of routine antenatal care. I. Philosophy, recent
4 384 studies, and power to eliminate or alleviate adverse maternal outcomes. *Acta Obstet Gynecol*
5 385 *Scand* 1997 Jan;76(1):1-14.
- 7 386 (17) Yakoob MY, Ali MA, Ali MU, Imdad A, Lawn JE, Van Den Broek N, et al. The effect of providing
8 387 skilled birth attendance and emergency obstetric care in preventing stillbirths. *BMC Public*
9 388 *Health* 2011;11 Suppl 3:S7.
- 10 389 (18) WHO, ICM, FIGO. Making pregnancy safer: the critical role of skilled delivery.
11 390 <http://whqlibdoc.who.int/publications/2004/9241591692.pdf> . 2014.
- 12 391 Ref Type: Online Source
- 14 392 (19) Ghana Statistical Services, Ghana Health Service, ICF Macro. Ghana Demographic and Health
15 393 Survey Report, 2008. 2009 Sep 9.
- 16 394 (20) Adegoké A, Utz B, Msuya SE, Van Den Broek N. Skilled Birth Attendants: who is who? A
17 395 descriptive study of definitions and roles from nine Sub Saharan African countries. *PLoS One*
18 396 2012;7(7):e40220.
- 20 397 (21) Harvey SA, Blandon YC, McCaw-Binns A, Sandino I, Urbina L, Rodriguez C, et al. Are skilled birth
21 398 attendants really skilled? A measurement method, some disturbing results and a potential way
22 399 forward. *Bull World Health Organ* 2007 Oct;85(10):783-90.
- 23 400 (22) Utz B, Siddiqui G, Adegoké A, Van Den Broek N. Definitions and roles of a skilled birth attendant:
24 401 a mapping exercise from four South-Asian countries. *Acta Obstet Gynecol Scand* 2013
25 402 Sep;92(9):1063-9.
- 26 403 (23) Stanton C, Blanc AK, Croft T, Choi Y. Skilled care at birth in the developing world: progress to
27 404 date and strategies for expanding coverage. *J Biosoc Sci* 2007 Jan;39(1):109-20.
- 28 405 (24) WHO/UNICEF. Antenatal care in developing countries: Promises, achievements and missed
29 406 opportunities. Analysis of trends, levels and differentials 1990-2001. WHO, Geneva; 2003 Feb 2.
- 31 407 (25) Bloom SS, Lippeveld T, Wypij D. Does antenatal care make a difference to safe delivery? A study
32 408 in urban Uttar Pradesh, India. *Health Policy Plan* 1999 Mar;14(1):38-48.
- 33 409 (26) Yanagisawa S, Oum S, Wakai S. Determinants of skilled birth attendance in rural Cambodia. *Trop*
34 410 *Med Int Health* 2006 Feb;11(2):238-51.
- 35 411 (27) Eades CA, Brace C, Osei L, LaGuardia KD. Traditional birth attendants and maternal mortality in
36 412 Ghana. *Soc Sci Med* 1993 Jun;36(11):1503-7.
- 38 413 (28) Doctor HV. Intergenerational differences in antenatal care and supervised deliveries in Nigeria.
39 414 *Health Place* 2011 Mar;17(2):480-9.
- 40 415 (29) Nair M, Ariana P, Webster P. What influences the decision to undergo institutional delivery by
41 416 skilled birth attendants? A cohort study in rural Andhra Pradesh, India *Rural Remote Health*
42 417 2012;12:2311.
- 44 418 (30) Okiwelu T, Hussein J, Adjei S, Arhinful D, Armar-Klemesu M. Safe motherhood in Ghana: still on
45 419 the agenda? *Health Policy* 2007 Dec;84(2-3):359-67.
- 46 420 (31) UNDP. UNDP in Ghana: MDG Overview: Improve maternal health. 2014 Apr 4.
- 47 421 (32) Witter S, Arhinful DK, Kusi A, Zakariah-Akoto S. The experience of Ghana in implementing a user
48 422 fee exemption policy to provide free delivery care. *Reprod Health Matters* 2007 Nov;15(30):61-
49 423 71.
- 51 424 (33) Measure DHS. Ghana Demographic and Health Survey 2008.
52 425 <http://www.measuredhs.com/pubs/pdf/FR221.pdf> . 2011. 11-12-2011.
- 53 426 Ref Type: Online Source
- 54 427 (34) UNICEF. Millenium Development Goals. <http://www.unicef.org/mdg/maternal.html> . 2014.
- 55 428 Ref Type: Online Source

- 1
2
3 429 (35) Prata N, Greig F, Walsh J, West A. Ability to pay for maternal health services: what will it take to
4 430 meet who standards? *Health Policy* 2004 Nov;70(2):163-74.
5 431 (36) Stekelenburg J, Kyanamina S, Mukelabai M, Wolffers I, van RJ. Waiting too long: low use of
6 432 maternal health services in Kalabo, Zambia. *Trop Med Int Health* 2004 Mar;9(3):390-8.
7 433 (37) Wall LL. Dead mothers and injured wives: the social context of maternal morbidity and mortality
8 434 among the Hausa of northern Nigeria. *Stud Fam Plann* 1998 Dec;29(4):341-59.
9 435 (38) Mills S, Bertrand JT. Use of health professionals for obstetric care in northern Ghana. *Stud Fam*
10 436 *Plann* 2005 Mar;36(1):45-56.
11 437 (39) Zere E, Oluwole D, Kirigia JM, Mwikisa CN, Mbeeli T. Inequities in skilled attendance at birth in
12 438 Namibia: a decomposition analysis. *BMC Pregnancy Childbirth* 2011;11:34.
13 439 (40) Kesuma ZM, Chongsuvivatwong V. Utilization of the Local Government Health Insurance Scheme
14 440 (JKA) for Maternal Health Services Among Women Living in Underdeveloped Areas of Aceh
15 441 Province, Indonesia. *Asia Pac J Public Health* 2014 Feb 24.
16 442 (41) Mumtaz Z, Salway S. ΓÇÿI never go anywhereΓÇÖ: extricating the links between women's
17 443 mobility and uptake of reproductive health services in Pakistan. *Social Science & Medicine* 2005
18 444 Apr;60(8):1751-65.
19 445 (42) Yao J, Murray AT, Agadjanian V. A geographical perspective on access to sexual and reproductive
20 446 health care for women in rural Africa. *Social Science & Medicine* 2013 Nov;96(0):60-8.
21 447 (43) Mengesha ZB, Bikis GA, Ayele TA, Tessema GA, Koye DN. Determinants of skilled attendance for
22 448 delivery in Northwest Ethiopia: a community based nested case control study. *BMC Public*
23 449 *Health* 2013;13:130.
24 450 (44) Mills S, Williams JE, Adjuik M, Hodgson A. Use of health professionals for delivery following the
25 451 availability of free obstetric care in northern Ghana. *Matern Child Health J* 2008 Jul;12(4):509-
26 452 18.
27 453 (45) Quaye RK. Paying for Health Services in East Africa: A Research Note. *Social Theory & Health*
28 454 2004 Feb;2(1):94-105.
29 455 (46) Kakaire O, Kaye DK, Osinde MO. Male involvement in birth preparedness and complication
30 456 readiness for emergency obstetric referrals in rural Uganda. *Reprod Health* 2011;8:12.
31 457
32 458
33
34
35
36
37
38
39 459
40
41 460
42
43
44

45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
461 **Table 1: Definition of variables used in the study**

Variables	Description
Demographic	
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 & 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 & Other
Employment	Employment status as at interview date (Currently employed (Yes or No))
Wealth class status	Wealth quintiles categorized into three classes (Low; Middle; High)*
Covered by health insurance	Having a viable health insurance registration (Yes or No)
Maternal	
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 (< 2years; 2-5 years; 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 is used for our study, was born: 1; 2-3; 4-5; 6+
Gestational age at first ANC	Months pregnant at 1 st ANC visit categorized into 3 trimesters of pregnancy
No. of times attended ANC	Number of times woman attended ANC during last pregnancy (1 ; 2-3; 4+; Don't know)
Community & contextual	
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 & Higher)
Who has final say on woman's health	Whose decision on woman's health is paramount (Respondent alone; Respondent & partner; Husband/partner/Someone else alone)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Period of delivery	Whether last delivery was before or during the period of free cost of delivery ie before or after 2005.
--------------------	---

462 *Wealth measured using information on household ownership of consumer items, ranging from a
 463 television to a bicycle or car, as well as dwelling characteristics, such as source of drinking water,
 464 sanitation facilities, and type of flooring material to produce an asset index.

For peer review only

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

Variable	Frequency (%) (N=2,041)	% Unskilled delivery (N=807)	% Skilled delivery (N=1,234)	p-value for chi- square test
Demographic and Maternal factors				
Age (years)				0.05
<20	102 (5.0)	44.1	55.9	
20-34	1,331 (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 & Higher	845 (41.4)	21.6	78.4	
Marital Status				0.04
Never married	112 (5.5)	28.6	71.4	
Currently married	1,816 (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	1,389 (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 & Other	89 (4.4)	54.8	45.2	
Employment (Currently Working)				0.00
No	269 (13.2)	33.3	66.7	
Yes	1,772 (86.8)	40.5	59.5	
Wealth Status Class				0.00
Low	1,024 (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	1,224 (60.0)	30.1	69.9	
Previous birth interval				0.00
< 2 years	990 (62.4)	42.4	57.6	
2-5 years	236 (14.9)	48.3	51.7	
5+ years	360 (22.7)	27.2	72.8	

1					
2					
3	Complication during previous delivery				0.00
4	No	1,920 (94.1)	51.3	48.7	
5	Yes	121 (5.9)	4.9	95.1	
6					
7	Birth order				0.00
8	1	450 (22.0)	28.0	72.0	
9	2-3	753 (36.9)	35.7	64.3	
10	4-5	482 (23.6)	42.9	57.1	
11	6+	356 (17.4)	57.6	42.4	
12					
13	Gestational age at first ANC				0.00
14	1 st Trimester	1,179 (57.8)	34.2	65.8	
15	2 nd Trimester	807 (39.5)	45.4	54.6	
16	3 rd Trimester	55 (2.7)	64.2	35.8	
17					
18	Number of times ANC attended				0.00
19	1	60 (2.9)	75.0	25.0	
20	2-3	293 (14.3)	65.9	34.1	
21	4+	1,633 (80.0)	33.1	66.9	
22	Don't know	55 (2.7)	52.7	47.3	
23					
24	Covered by Health Insurance				0.00
25	No	1167 (57.2)	49.4	50.6	
26	Yes	874 (42.8)	26.1	73.9	
27					
28	Community & Contextual factors				
29	Region				0.00
30	Western	179 (8.8)	43.0	57.0	
31	Central	145 (7.1)	37.2	62.8	
32	Greater Accra	201 (9.8)	11.9	88.1	
33	Volta	166 (8.1)	39.8	60.2	
34	Eastern	178 (8.7)	33.7	66.3	
35	Ashanti	310 (15.2)	23.9	76.1	
36	Brong Ahafo	199 (9.7)	33.7	66.3	
37	Northern	287 (14.0)	67.6	32.4	
38	Upper East	172 (8.5)	52.3	47.7	
39	Upper West	204 (10.0)	49.5	50.5	
40					
41	Residence				0.00
42	Urban	748 (36.6)	13.1	86.9	
43	Rural	1,293 (63.4)	54.8	45.2	
44					
45	Type of City				0.00
46	Capital/ large	315 (15.4)	10.2	89.8	
47	Small	263 (12.9)	16.0	84.0	
48					
49	Town	468 (23.0)	29.5	70.5	
50	Country side	995 (48.8)	59.8	40.2	
51					
52	Spouse's highest educational attainment				0.00
53	No Education	569 (27.9)	66.8	33.2	
54	Primary	179 (8.8)	43.6	56.4	
55	Secondary & Higher	1,293 (63.3)	26.0	74.0	
56					

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Who has final say on woman's health				0.02
Respondent alone	446 (21.9)	36.2	63.8	
Respondent & 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	1,506 (73.8)	40.6	59.4	

For peer review only

1 Table 3: Predictors of Skilled Attendance at Delivery amongst pregnant women who attended ANC at
 2 least once during the pregnancy, Ghana Health and Demographic Survey, 2008

Predictor	Beta	p-value	OR *(CI 95%)
Demographic and Maternal factors (Model 1)			
AUC (95% CI): 0.85 (0.82 – 0.88)			
Wealth Status Class			
Low	†	†	†
Middle	1.34	0.00	3.82 (2.25 – 6.49)
High	2.10	0.00	2.14 (1.09 – 4.20)
Complication during previous delivery (Yes)	2.16	0.00	13.53 (2.63 – 69.47)
Covered by health insurance (Yes)	1.10	0.00	3.00 (1.98 – 4.54)
Birth order			
1	†	†	†
2 – 3	-0.30	0.24	0.74 (0.45 – 1.22)
4 – 5	-0.88	0.02	0.42 (0.21 – 0.84)
Maternal age in years	0.05	0.04	1.05 (1.00 – 1.09)
Religious group			
Christian	†	†	†
Muslim	-0.12	0.40	0.77 (0.43 – 1.40)
Traditionalist	-1.34	0.01	0.26 (0.10 – 0.67)
No religion/ Other	-0.52	0.28	0.60 (0.23 – 1.54)
Ethnicity			
Akan	1.00	0.02	2.72 (1.14 – 6.46)
Ga/ Dangme	†	†	†
Ewe	1.53	0.03	4.62 (1.71 – 12.53)
Guan	0.43	0.60	1.55 (0.30 – 7.90)
Mole-Dagbani	0.62	0.21	1.87 (0.71 – 4.94)
Grussi	0.84	0.15	2.32 (0.74 – 7.30)
Gruma	0.77	0.20	2.15 (0.68 – 6.86)
Other	1.56	0.02	4.78 (1.30 – 17.56)
Community & Contextual factors (Model 2)			
AUC (95% CI):0.80 (0.78 – 0.82)			
Residence (rural)	-1.31	0.00	0.27 (0.18 – 0.41)
Type of city			
Capital/ large	0.49	0.14	1.63 (0.85 – 3.10)
Small	†	†	†
Town	0.03	0.92	1.03 (0.62 – 1.70)

Country side	-0.66	0.01	0.52 (0.31 – 0.88)
Spouse's highest educational level			
No Education	-0.87	0.00	0.42 (0.28 – 0.63)
Primary	‡	‡	‡
Secondary & Higher	0.30	0.12	1.36 (0.92 – 1.99)
Region			
Western	-1.53	0.60	0.86 (0.49 – 1.52)
Central	‡	‡	‡
Greater Accra	0.24	0.53	1.27 (0.60 – 2.70)
Volta	0.22	0.43	1.25 (0.72 – 2.19)
Eastern	0.32	0.26	1.38 (0.79 – 2.42)
Ashanti	0.50	0.06	1.65 (0.97 – 2.78)
Brong Ahafo	0.47	0.09	1.61 (0.93 – 2.79)
Northern	-0.47	0.09	0.63 (0.37 – 1.08)
Upper East	0.31	0.28	1.37 (0.78 – 2.41)
Upper West	0.60	0.03	1.83 (1.05 – 3.17)
Demographic, Maternal, Community & Contextual factors (Model 3)			
AUC (95% CI): 0.85 (0.83 – 0.88)			
<i>(Interactions not significant in model)</i>			
Wealth status class			
Low	‡	‡	‡
Middle	0.63	0.04	1.88 (1.02 – 3.47)
High	1.18	0.00	3.27 (1.60 – 6.68)
Residence (rural)	-1.31	0.00	0.27 (0.14 – 0.52)
Complication during previous delivery (Yes)	3.09	0.04	21.93 (2.61 – 184.04)
Covered by health insurance (Yes)	1.03	0.00	2.74 (1.83 – 4.30)
Religious group			
Christian	0.34	0.51	1.40 (0.52 – 3.76)
Muslim	-0.08	0.99	0.99 (0.34 – 2.87)
Traditionalist/ Spiritualist	-0.78	0.24	0.46 (0.12 – 1.70)
No religion/ Other	‡	‡	‡

‡ Reference category

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

5

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	Title page
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6 & 7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7, Table 1
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7, Table 1
Bias	9	Describe any efforts to address potential sources of bias	None
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8 & 9
		(b) Describe any methods used to examine subgroups and interactions	9
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	None
		(e) Describe any sensitivity analyses	None
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	None
		(c) Consider use of a flow diagram	None
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	9 & 10
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(b) Report category boundaries when continuous variables were categorized	None
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12,13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Predictors of skilled attendance at delivery amongst antenatal clinic (ANC) attendants in Ghana: a cross-sectional study of population data

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2015-007810.R1
Article Type:	Research
Date Submitted by the Author:	09-Mar-2015
Complete List of Authors:	AMOAKOH-COLEMAN, MARY; UNIVERSITY MEDICAL CENTER, JULIUS GLOBAL HEALTH JULIUS CENTER; SCHOOL OF PUBLIC HEALTH , UNIVERSITY OF GHANA, EPIDEMIOLOGY AND DISEASE CONTROL Ansah, Evelyn; Ghana Health Service, Research and Development Division Agyepong, Irene; University of Ghana, School of Public Health Grobbee, Diederick; UNIVERSITY MEDICAL CENTER, JULIUS GLOBAL HEALTH JULIUS CENTER Kayode, Gbenga; UNIVERSITY MEDICAL CENTER, JULIUS GLOBAL HEALTH JULIUS CENTER Klipstein-Grobusch, Kerstin; University Medical Center, Julius Center for Health Sciences and Primary Care;
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Obstetrics and gynaecology
Keywords:	Antenatal < GENETICS, EPIDEMIOLOGY, Public health < INFECTIOUS DISEASES, Maternal medicine < OBSTETRICS

SCHOLARONE™
Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 **Predictors of skilled attendance at delivery amongst antenatal clinic (ANC)**
2 **attendants in Ghana: a cross-sectional study of population data**

3 **Mary Amoakoh-Coleman**, Evelyn K Ansah , Irene Akua Agyepong, Diederick E Grobbee,
4 Gbenga A Kayode, Kerstin Klipstein-Grobusch

5
6 Julius Global Health, Julius Center for Health Sciences and Primary Care, University Medical
7 Centre Utrecht, Utrecht, The Netherlands, School of Public Health, University of Ghana, Legon,
8 Ghana, Mary Amoakoh-Coleman research associate Research and Development Division, Ghana
9 Health Service, Accra, Ghana E K Ansah deputy director research Department of Health Policy
10 Planning and Management, School of Public Health, University of Ghana, Legon, Ghana I A
11 Agyepong professor Julius Global Health, Julius Center for Health Sciences and Primary Care,
12 University Medical Centre Utrecht, Utrecht, The Netherlands D E Grobbee professor Julius
13 Global Health, Julius Center for Health Sciences and Primary Care, University Medical Centre
14 Utrecht, Utrecht, The Netherlands G A Kayode research associate Julius Global Health,
15 Julius Center for Health Sciences and Primary Care, University Medical Centre Utrecht,
16 Utrecht, The Netherlands, Division of Epidemiology & Biostatistics, School of Public Health,
17 Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa K
18 Klipstein-Grobusch associate professor

19 Correspondence to: M Amoakoh-Coleman menba19@yahoo.com

Abstract

Objective: To identify demographic, maternal and community predictors of skilled attendance at delivery amongst 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-square test for associations and logistic regression to identify significant predictors. Predictive models were built with estimation of area under the receiver operating curves (AUC).

Setting: Ghana

Participants: A total of 2,041 women who had a live birth in the five years preceding the survey, and attended antenatal clinic at least once from a skilled provider during the pregnancy

Outcome: Skilled attendance at delivery

Results: Overall, 60.5% (1,235/2,041) of women in our study sample reported skilled attendance at delivery. Significant positive associations existed between skilled attendance at delivery and the variables maternal educational level, wealth status classes, 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 (0.83-0.88).

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

1
2
3 41 previous birth complication and religion, and targeted with interventions to improve skilled
4
5
6 42 attendance at delivery.
7
8
9 43

10
11 44 Keywords: Skilled attendance, delivery, antenatal, Ghana, predictor, maternal
12
13

14 45 **Strengths and limitations of this study**

- 16
17
18 46 • The use of nationally representative data that facilitates generalizability of results to
19
20 47 pregnant women in Ghana.
21
22
23 48 • An assessment of a combination of factors that significantly predict skilled attendance at
24
25 49 delivery which has not been done for the study setting
26
27
28
29 50 • However the DHS data is retrospectively collected data and therefore has the chance of
30
31 51 recall bias potentially affecting results.
32
33
34
35 52 • Only surviving mothers were interviewed and this could have affected the prevalence of
36
37 53 the outcome.
38
39
40 54 • Our results are not applicable to the women who do not access antenatal care during
41
42 55 pregnancy.
43
44
45
46 56
47
48
49 57

58 Introduction

59 Risk of maternal death continues to be high in sub-Saharan Africa and Southeast Asia compared
60 to the more developed parts of the world. In 2008, maternal deaths in sub-Saharan Africa (SSA)
61 and Southern Asia accounted for 87% of global maternal deaths, and progress to reverse this,
62 especially in SSA has been slow (1-7). Efforts to encourage utilization of health care facilities
63 should also be vigorously pursued for optimal results.

64 A skilled attendant is defined as “an accredited health professional – such as a midwife, doctor
65 or nurse – who has been educated and trained to proficiency in the skills needed to manage
66 normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the
67 identification, management and referral of complications in women and newborns” (8;9).

68 Antenatal care and delivery by a skilled attendant both contribute to reduction in maternal deaths
69 (10-17). The issue of who a skilled attendant is has been debated for some time, with respect to
70 which category of health workers is skilled (18). In Ghana these are obstetricians, general
71 practitioners, midwives, auxiliary midwives and nurses with midwifery training including
72 community health nurses/ officers (19). There is also evidence that there are variations in these
73 categories, with respect to the extent of training and roles in different countries across the world
74 (20-22). Delivery by any other person (health worker or non-health worker) is termed unskilled
75 attendance at delivery.

76 Despite the body of evidence of the importance of skilled attendance at delivery, there are
77 records of high antenatal attendance but low skilled attendance at delivery, especially in
78 developing countries (23-26). In Tanzania, over 90% of pregnant women are known to attend
79 antenatal clinic (ANC) at least once, with 62% attending four times. However, less than 50% of

1
2
3 80 these ANC attendants have their deliveries attended to by skilled personnel (3). In a study in
4
5 81 Uganda, although ANC attendance was found to be as high as 94%, this was not reflected in care
6
7
8 82 at delivery, with about 25% of women being assisted during labour by a relative or friend (13).
9

10
11 83 In Ghana, according to the 2008 Ghana Demographic and Health Survey (DHS), about 97% of
12
13 84 pregnant women received antenatal care during pregnancy, with as many as 78.2% attending at
14
15 85 least 4 times. However, only 57.1% delivered in health facilities with a total of 59% being
16
17 86 assisted by skilled personnel (19). Several reasons have been attributed to this pattern, including
18
19 87 access to health facilities, health worker attitude towards women during delivery and cultural
20
21 88 issues, amongst others (27).
22
23
24

25
26 89 Some factors have also been quantitatively shown to be associated with skilled attendance at
27
28 90 delivery. Maternal age is believed to influence the decision to take such an action, with younger
29
30 91 women preferring skilled attendance at delivery due to perception of risk. (28). This is closely
31
32 92 linked with parity, where multi-parous women with experience in labour tend to opt for other
33
34 93 unskilled support during delivery due to the perception that they are experienced. Other factors
35
36 94 such as marital status, wealth index, employment status and high educational background,
37
38 95 especially secondary education, of both the woman and the husband has also been positively
39
40 96 associated with the outcome (3;23). Living in rural areas where poverty is more prevalent
41
42 97 compared to urban areas has been shown to be negatively associated with skilled delivery (23-
43
44 98 26;29). Other notable factors that have positive influence on the outcome are short distance to
45
46 99 health facility and availability of a birth preparedness plan designed together with the woman
47
48
49
50
51 100 during ANC (3).
52
53
54
55
56
57

1
2
3 101 Many interventions have been implemented to improve maternal health in Ghana, including but
4
5
6 102 not limited to the Safe Motherhood Initiative (SMI), free delivery policy, High Impact Rapid
7
8 103 Delivery (HIRD) and the Emergency Obstetric and Neonatal Care program (30-32). The free
9
10 104 delivery fee policy, was first introduced in four regions in 2003, and subsequently extended to
11
12 105 the entire country in 2005. Some studies have so far been conducted in Ghana to identify factors
13
14 106 that influence skilled attendance at delivery (33;34). Secondary data analysis of Ghana DHS
15
16 107 offers the opportunity to evaluate a larger sample across the country in order to identify
17
18 108 demographic, maternal and community predictors of skilled attendance at delivery amongst
19
20 109 women who attend antenatal clinic at least once during their pregnancy in Ghana. The question
21
22 110 we seek to answer is whether there are possible significant predictors that will enable providers
23
24 111 identify women who less likely to have skilled attendance at delivery among antenatal care
25
26 112 attendants, so that these women can be supported to have this desirable outcome. The aim of the
27
28 113 study is to identify demographic, maternal, community and contextual predictors of skilled
29
30 114 attendance at delivery amongst women who attend ANC at least once during their pregnancy.
31
32
33
34
35
36

37 **Methods**

38 *Study design*

39
40
41 116 Secondary data analysis of the dataset of the 2008 Ghana DHS, a nationally representative
42
43 117 population-based survey of 4,305 women aged 15 – 49 years was conducted.
44
45
46
47
48

49 *Data collection*

50
51
52 120 Comprehensive information on the sampling techniques and survey procedures applied for data
53
54 121 collection in the Ghana DHS have been published in detail elsewhere (35). In summary, the 10
55
56

1
2
3 122 regions of Ghana are each administratively sub-divided into districts while each district is
4
5 123 divided into localities. Each locality is decomposed into Enumeration Areas (EAs) based on the
6
7
8 124 2000 population census, and these form the primary sampling units (PSU). The PSU, defined for
9
10 125 the purposes of this study as the cluster, was provided by the Ghana Statistical Service. A
11
12 126 stratified two-stage cluster randomized sampling technique was applied. The first stage involved
13
14 127 probability proportional sampling of a total of 412 PSUs (clusters) from all the regions,
15
16 128 comprising of 182 clusters from the urban areas and 230 from rural areas. During the second
17
18 129 stage, an average of 15 households was randomly sampled from each of the PSU using their
19
20 130 household sampling frame. Finally for half of the surveyed households, all eligible women aged
21
22 131 15 to 49 years were interviewed with a women's questionnaire. This had questions
23
24 132 socioeconomic, demographic and health indicators. Questionnaires were translated into three
25
26 133 major local Ghanaian languages (Akan, Ga and Ewe) and were pre-tested on the field by trained
27
28 134 personnel before finalization for use. All respondents gave informed consent to participate in the
29
30 135 survey. A total of (4,916) women aged between 15 – 49 years were interviewed, with a 96.5%
31
32 136 (4,305) response rate. Out of these, the subset of women who had a live birth in the five years
33
34 137 preceding the survey numbered 2,099; 95.4% (2,041) of them did receive antenatal care from a
35
36 138 skilled provider (doctor, nurse, midwife, auxiliary midwife or community health officer) in the
37
38 139 health system (19). Characteristics of these 2,041 women were assessed in this study.
39
40
41 140 The index delivery studied is the latest delivery within the five years preceding the survey
42
43
44 141 The 2008 DHS data is the latest available population based data on health indicators that address
45
46 142 the objectives of this study. Another survey was due in 2013 but is yet to be conducted.
47
48
49
50
51
52
53
54
55
56
57

1
2
3 143 *Ethical approval*
4
5

6
7 144 Ethical approval to conduct DHS in Ghana was approved by the Ethics Committee of ICF Macro
8
9 145 in Calverton, USA and the Ethics Committee, Ghana Health Service, Accra, Ghana. We obtained
10
11 146 ethics approval for analysis of this data from the Ethics Committee of ICF Macro in Calverton,
12
13
14 147 USA through an online request
15

16
17 148 *Variables*
18

19
20 149 ***Outcome***
21

22
23 150 Skilled attendance at delivery was the outcome. This in Ghana, and as used in the DHS data
24
25 151 collection and analysis, is defined as delivery by a doctor, nurse, midwife, auxiliary midwife or
26
27 152 community health officer (19), with a response of either Yes (1) or No (0).
28
29

30
31 153 ***Determinants***
32

33 154 The factors included in this study are based on findings from other studies in published literature
34
35 155 and availability in the 2008 DHS data set. These were categorized as demographic, maternal,
36
37 156 community and contextual factors. All the variables were put into building the models to avoid
38
39 157 pre-selection. Table 1 shows the all the variables and their definitions.
40
41
42

43
44 158 *Statistical analyses*
45

46 159 Total missing data was more than 5%, and this level of missing data is rarely at random. Thus
47
48 160 multiple imputations of missing data were conducted and analysis was based on the dataset with
49
50 161 imputed data. We carried out descriptive univariate analysis to evaluate the prevalence of
51
52 162 delivery by a skilled provider (outcome variable) across the categories of each of the
53
54 163 determinants. We regrouped wealth quintiles into low (poorest and poorer quintiles), middle
55
56
57

164 (middle quintile) and high (richer and richest quintiles) wealth status classes due to small
165 numbers in some of the quintile groups.

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

171 Three predictive models were built using a backward stepwise elimination approach and all
172 correlated variables were built into the models as interaction terms. Model 1 included the
173 demographic and maternal characteristics, Model 2 included the community and contextual
174 factors and Model 3 combined demographics, maternal, community and contextual factors. Age
175 was explored both as categorical and continuous variable in building the models. Associations
176 were estimated by odds ratios (ORs) and their corresponding 95% confidence intervals (CI).
177 Each OR is adjusted for the other covariates in the model. The area under the curve (AUC), of
178 the receiver operating curves (ROC), for all the models were estimated.

179 **Results**

180 *Background characteristics of the women*

181 Table 2 shows a summary of the characteristics of the 2,041 women who for their latest delivery
182 within the period of 2003 and 2008 had at least one ANC visit which was attended to by a health
183 professional. The mean age (standard deviation) of the women was 30 (7.24) years and this was
184 the same for both groups of women who had skilled and unskilled attendance at delivery. As

1
2
3 185 many as 89.0% of women were currently married during the survey and 86.8% of them were
4
5
6 186 currently working. Only 41.4% of the women had secondary or higher education and 35.3% had
7
8 187 no education. Most of them were Christians (68%) and 20.1% were Muslims. Wealth
9
10 188 distribution amongst this population was 50.2% 17.7% and 32.1% for low, middle and high
11
12
13 189 wealth status classes respectively. Only 42.8% of the women had health insurance coverage at
14
15 190 the time of the survey. Prevalence of ever-use of any contraceptive method amongst the women
16
17 191 was 60.0%. As many as 80.0% of women attended ANC at least four times during the
18
19 192 pregnancy. Rural dwellers were 63.4%.

20
21
22
23 193 Prevalence of skilled attendance at delivery was 60.5% most of them attended to by midwives
24
25 194 and nurses (45.4%) Doctors conducted only 9% of all deliveries.

26 27 28 195 *Comparability of the two outcome groups*

29
30
31
32 196 Table 2 also summarizes the comparison between women who had skilled or unskilled
33
34 197 attendance at delivery. There were significant differences ($p < 0.05$) between those having skilled
35
36 198 and unskilled attendance, amongst all the categories of the characteristics studied, except for
37
38 199 period of delivery as per the free delivery policy ($p = 0.11$). Women with secondary and higher
40
41 200 education had more skilled attendance at delivery compared to those without any education.
42
43 201 About 67.0% of Christians had skilled attendance at delivery compared to 57.2% and 45.2% of
44
45 202 Muslims and non-religious women respectively. Women who had ever used a contraceptive
46
47 203 method were more likely to have skilled attendance at delivery (69.9%). The proportion of
48
49 204 skilled attendance at delivery decreased with increasing birth order and 95.1% of women who
50
51 205 had a Caesarean section during their previous pregnancy had skilled attendance at delivery
52
53 206 compared to 48.7% amongst those who did not have that complication. The outcome was more

1
2
3 207 prevalent (73.9%) amongst women with health insurance coverage compared to those without
4
5 208 (50.6%) . There were regional variations in the proportion of women who had skilled attendance
6
7
8 209 at delivery. Only 45.0% of women in rural areas had skilled attendance at delivery compared to
9
10 210 86.7% in urban areas. We checked for correlation amongst variables, and birth order and timing
11
12 211 of first ANC attendance were significantly correlated ($p<0.001$). Wealth status class was
13
14 212 significantly different amongst the categories of region, rural or urban settlements and
15
16 213 educational levels ($p<0.001$). Birth order and religious group categories also varied across the
17
18 214 various regions ($p<0.001$). These correlations were explored as interaction terms in building the
19
20 215 predictive models.
21
22
23
24

25 216 *Predictors of skilled delivery*

27
28 217 Three models for predicting skilled delivery amongst the women in the survey, using a backward
29
30 218 stepwise approach, were built. These are shown in **Table 3**. **Model 1** consists of maternal
31
32 219 factors and significant predictors were wealth quintile, history of previous delivery complication,
33
34 220 having health insurance, birth order, number of times ANC was attended, the exact maternal age
35
36 221 in years, religious group and ethnicity. Interactions terms explored were not significant
37
38 222 predictors. **Model 2** was built with community or cluster factors and the significant predictors
39
40 223 were residence (rural/ urban), type of residence (capital/ large city, small city and town or
41
42 224 country side) spouse's highest educational level and the geographical region. In **Model 3**,
43
44 225 demographic, maternal and community factors were combined. Significant predictors were
45
46 226 wealth status class, history of previous birth complication, health insurance coverage, residence
47
48 227 and religious group. Again in this model, interaction terms included were not significant. The
49
50 228 predictive probabilities of all three models are [c-statistics (95%CI)] 0.85 (0.82 – 0.88); 0.80
51
52
53
54
55
56

229 (0.78 – 0.82) and 0.85 (0.83 – 0.88) respectively for models 1, 2 and 3. Model 3 combines both
230 groups of variables, has the least number of variables and also the best fit, making it the best
231 amongst the three for use in practice.

232 *Model fit statistics*

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

238 **Discussion**

239 *Main findings*

240 The role of skilled attendance at delivery in averting maternal morbidity and mortality cannot be
241 overemphasized being the single most important intervention for safe motherhood (22;36).

242 Highly educated women are significantly more likely to have skilled attendance at delivery
243 compared to women with no education and previous studies have highlighted this finding (33;37-
244 39). This emphasizes the importance of female education for achievement of MDG5. The
245 relationship between cost and access to health care and specifically maternal health services has
246 been explored in various studies and the summary of findings agrees with what we also found
247 (28;40;41). Wealthier women in Ghana, as well as those with health insurance coverage, are
248 more likely to have skilled delivery compared to poor women. Family planning services uptake
249 is an important indicator for utilization of maternal health services (42;43), which leads to

1
2
3 250 improved outcomes(44). In our study ever use of contraception increases the chance of having
4
5 251 skilled attendance at delivery. Utilization of skilled attendants is also preventive and that is
6
7
8 252 possibly why women who have had previous pregnancy complications prefer to have skilled
9
10 253 attendant for subsequent deliveries, to reduce their vulnerability.

11
12 254 On the community level, we observed previously noted rural-urban disparities (28;40;45). The
13
14 255 opportunities for higher education and improved wealth status amongst other factors are
15
16 256 undeniably few in rural areas (46;47) and when these were adjusted for in the prediction model
17
18 257 women from rural areas still had less prevalence of the outcome. Perhaps other factors such as
19
20 258 geographical access to health care are at play here but the data we used did not allow us to
21
22 259 explore this in any meaningful way. Apart from rural – urban disparities, we also noted marked
23
24 260 regional disparities for skilled delivery. The three Northern regions, which have the lowest
25
26 261 prevalence of the outcome, are mostly rural, with low wealth class status, lower levels of
27
28 262 education, and predominantly Muslim compared to the rest of the population. These factors are
29
30 263 amongst our significant predictors of the outcome.

31
32 264 Contextual issues also come into play. The observed influence of spousal education emphasizes
33
34 265 the role of an environment of high literacy on maternal outcomes. Women who have other
35
36 266 people, including their partners, participating in the final decision on their health have a reduced
37
38 267 chance of having skilled attendance at delivery from our results. ANC attendance and
39
40 268 counselling for couples could be explored as a strategy to improve knowledge of the significant
41
42 269 others and eventually improve outcomes as has been shown for HIV/AIDS prevention
43
44 270 interventions (48). Deliveries after the introduction of free delivery policy were observed to be
45
46 271 less attended to by skilled professionals. This is likely to be due to the gradual regional roll out
47
48 272 of the policy across the country, the lack of knowledge about the policy and general

1
2
3 273 implementation challenges as previously observed in studies that evaluated use of free health
4
5 274 services (49;50).

6
7
8 275 Amongst ANC attendants, providers of care can adequately identify women who are likely to
9
10 276 have skilled delivery (and therefore those who are unlikely to) using the information on their
11
12 277 wealth status class, history of previous birth complication, health insurance coverage, rural or
13
14 278 urban residence and religious group. This provides an opportunity to use routinely collected data
15
16 279 to enhance service delivery and improve health outcomes.

17
18
19
20 280 *Application of this prediction*

21
22 281 This prediction ability is only useful when situated within the availability of effective
23
24 282 interventions that encourage skilled attendance at delivery. Birth preparedness is an important
25
26 283 component of the counseling at ANC that women are expected to receive. Key components of
27
28 284 the birth plan include recognition of danger signs, a plan for a skilled birth attendant, a plan for
29
30 285 the place of delivery, and saving money for transport or other costs in case the need arises (51).

31
32 286 Applying the results of our study, providers will be able to sort out ANC attendants into those
33
34 287 who are likely to use skilled attendance at delivery and those who are unlikely to do so. Those
35
36 288 who are unlikely can be supported during the period of pregnancy to access skilled delivery.

37
38
39 289 . For example, uninsured pregnant women can be encouraged to register for health insurance at
40
41 290 the onset of the pregnancy or whenever they book for ANC, so that by the time of delivery the
42
43 291 cost of care will be covered by insurance. If need be, discussions can take place with the spouse
44
45 292 or any significant others so that money can be set aside for any eventualities. At the community
46
47 293 level where home visits by community health workers are possible, women who are less likely to
48
49 294 have the outcome can have more purposeful visits by health workers that will ensure that they
50
51 295 improve their chances of having skilled attendance at delivery.

1
2
3 296 These predictors could form the basis of a very a useful clinical decision making tool for
4
5
6 297 providers. We advocate for future validation of these predictors in a prospective study and in a
7
8 298 health facility since all the demographic and maternal data of ANC attendants used in this study
9
10 299 are captured at ANC registration. Upon validation the model can be incorporated into health
11
12 300 facility antenatal protocols and other job aids that ensures that health workers identify and
13
14 301 practically support pregnant women to opt for skilled attendance at delivery.
15
16
17
18 302

19
20 303 *Strengths and limitations of the study*

21
22 304 Strength of this study is the national representative sample that facilitates generalizability of the
23
24 305 study results to pregnant women in Ghana. It also does not only assess possible associations but
25
26 306 also a combination of factors that significantly predict the outcome. However the DHS data is
27
28 307 retrospectively collected data and therefore has some limitations. There is the chance of recall
29
30 308 bias potentially affecting results. Only surviving mothers were interviewed and this could have
31
32 309 affected the prevalence of the outcome. Also we were unable to study other variables that
33
34 310 possibly influence the outcome but for which data is not available in the 2008 DHS database.
35
36 311 Last but not the least our results will not apply to the women who do not access antenatal care
37
38 312 during pregnancy.
39
40
41
42

43 313 **Conclusion**

44
45
46 314 Women less likely to have skilled attendance at delivery can be identified during antenatal care
47
48 315 using data on wealth status class, health insurance coverage, residence, history of previous birth
49
50 316 complication and religion, and targeted with interventions to improve skilled attendance at
51
52 317 delivery.
53
54
55
56
57

1
2
3 318 **Acknowledgement**
4

5
6 319 The authors gratefully acknowledge technical support from the Julius Center for Health Sciences
7
8
9 320 and Primary Care.

10
11
12 321 **Contributorship statement**
13

14
15 322 MAC designed and wrote up the study protocol, acquired permission from Measure DHS to use
16
17 323 data, carried out data analysis, wrote the report and drafted this manuscript for publication. GAK,
18
19 324 IAA, DEG, EKA and KKG provided scientific guidance and review of the study design, data
20
21 325 analysis and were also actively involved in the preparation and review of the manuscript and
22
23 326 approved it.
24
25
26
27

28 327 **Competing interests**
29

30
31 328 All authors have completed the ICMJE uniform disclosure form at
32
33 329 www.icmje.org/coi_disclosure.pdf and declare: authors MAC and GAK had financial support
34
35 330 from the Netherlands Organization for Scientific Research (NWO) Global Health Policy and 396
36
37 331 Health Systems Research Program, Netherlands, for the submitted work; no financial
38
39 332 relationships with any organizations that might have an interest in the submitted work in the
40
41 333 previous three years; no other relationships or activities that could appear to have influenced the
42
43 334 submitted work.
44
45
46
47

48 335 **Funding**
49

50
51 336 Funding for the conduct of the study was from the Netherlands Organization for Scientific
52
53 337 Research (NWO) Global Health Policy and 396 Health Systems Research Program, Netherlands,
54
55
56

338 for providing funds (Grant number: 07.45.102.00). They supported authors MAC and GAK as
 339 PhD candidates.

340 **Data sharing statement**

341 Secondary data was used for this study. This data is public and freely available to anyone from
 342 MEASURE DHS, on request. The website for MEASURE DHS is
 343 <http://dhsprogram.com/data/available-dataset.cfm>.

344 **Reference List**

- 345
- 346 (1) WHO, UNICEF. Countdown 2015 Maternal, Newborn and Child survival. Building a future for
 347 women and children. The 2012 report
 348 105. <http://www.countdown2015mnch.org/documents/2012Report/2012-complete-no-profiles.pdf> .
 349 2013.
- 350 Ref Type: Online Source
- 351 (2) Bhutta ZA, Chopra M, Axelson H, Berman P, Boerma T, Bryce J, et al. Countdown to 2015 decade
 352 report (2000-10): taking stock of maternal, newborn, and child survival
 353 106. Lancet 2010 Jun 5;375(9730):2032-44.
- 354 (3) Magoma M, Requejo J, Campbell OM, Cousens S, Filippi V. High ANC coverage and low skilled
 355 attendance in a rural Tanzanian district: a case for implementing a birth plan intervention
 356 92. BMC Pregnancy Childbirth 2010;10:13.
- 357 (4) Hogan MC, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM, et al. Maternal mortality for
 358 181 countries, 1980-2008: a systematic analysis of progress towards Millennium Development
 359 Goal 5
 360 3. Lancet 2010 May 8;375(9726):1609-23.
- 361 (5) Kinney MV, Kerber KJ, Black RE, Cohen B, Nkrumah F, Coovadia H, et al. Sub-Saharan Africa's
 362 mothers, newborns, and children: where and why do they die?
 363 15. PLoS Med 2010 Jun;7(6):e1000294.
- 364 (6) United Nations. The Millennium Development Goals Report 2011. New York: United Nations;
 365 2011. http://www.un.org/millenniumgoals/MDG2011_PRa_EN.pdf . 2011.
- 366 Ref Type: Online Source
- 367 (7) World Health Organization. Trends in maternal mortality 1990 to 2010: Estimates developed by
 368 WHO, UNICEF, UNFPA and the World Bank.
 369 http://whqlibdoc.who.int/publications/2010/9789241500265_eng.pdf . 2010. 2-2-2012.
- 370 Ref Type: Online Source
- 371 (8) World Health Organization. Skilled birth attendants, factsheet.
 372 67. Geneva: World Health Organization; 2008 Apr 2.
- 373 (9) World Health Organization. Reduction of maternal mortality: A Joint WHO/ UNFPA/ UNICEF
 374 World Bank Statement
 375 68. 2013.

- 1
2
3 376 Ref Type: Online Source
4 377 (10) Bergsjö P, Villar J. Scientific basis for the content of routine antenatal care. II. Power to eliminate
5 378 or alleviate adverse newborn outcomes; some special conditions and examinations. *Acta Obstet*
6 379 *Gynecol Scand* 1997 Jan;76(1):15-25.
7
8 380 (11) Buor D, Bream K. An analysis of the determinants of maternal mortality in sub-Saharan Africa. *J*
9 381 *Womens Health (Larchmt)* 2004 Oct;13(8):926-38.
10 382 (12) Lumbiganon P. Appropriate technology: antenatal care. *Int J Gynaecol Obstet* 1998 Dec;63 Suppl
11 383 1:S91-S95.
12 384 (13) Tann CJ, Kizza M, Morison L, Mabey D, Muwanga M, Grosskurth H, et al. Use of antenatal
13 385 services and delivery care in Entebbe, Uganda: a community survey. *BMC Pregnancy Childbirth*
14 386 2007;7:23.
15
16 387 (14) UNICEF. Eastern and Southern Africa Regional Office: Maternal Mortality Reduction
17 Strategy. 2003. <http://www.unicef.org/health/files/MMreductionstrategyShoo2003.pdf> . 10-6-
18 388 2003.
19 389
20 390 Ref Type: Online Source
21 391 (15) van Eijk AM, Bles HM, Odhiambo F, Ayisi JG, Blokland IE, Rosen DH, et al. Use of antenatal
22 392 services and delivery care among women in rural western Kenya: a community based survey.
23 393 *Reprod Health* 2006;3:2.
24 394 (16) Villar J, Bergsjö P. Scientific basis for the content of routine antenatal care. I. Philosophy, recent
25 395 studies, and power to eliminate or alleviate adverse maternal outcomes. *Acta Obstet Gynecol*
26 396 *Scand* 1997 Jan;76(1):1-14.
27 397 (17) Yakoob MY, Ali MA, Ali MU, Imdad A, Lawn JE, Van Den Broek N, et al. The effect of providing
28 398 skilled birth attendance and emergency obstetric care in preventing stillbirths. *BMC Public*
29 399 *Health* 2011;11 Suppl 3:S7.
30 400 (18) WHO, ICM, FIGO. Making pregnancy safer: the critical role of skilled delivery.
31 401 <http://whqlibdoc.who.int/publications/2004/9241591692.pdf> . 2014.
32 402
33 402 Ref Type: Online Source
34 403 (19) Ghana Statistical Services, Ghana Health Service, ICF Macro. Ghana Demographic and Health
35 404 Survey Report, 2008. 2009 Sep 9.
36 405 (20) Adegoké A, Utz B, Msuya SE, Van Den Broek N. Skilled Birth Attendants: who is who? A
37 406 descriptive study of definitions and roles from nine Sub Saharan African countries. *PLoS One*
38 407 2012;7(7):e40220.
39 408 (21) Harvey SA, Blandon YC, McCaw-Binns A, Sandino I, Urbina L, Rodriguez C, et al. Are skilled birth
40 409 attendants really skilled? A measurement method, some disturbing results and a potential way
41 410 forward. *Bull World Health Organ* 2007 Oct;85(10):783-90.
42 411 (22) Utz B, Siddiqui G, Adegoké A, Van Den Broek N. Definitions and roles of a skilled birth attendant:
43 412 a mapping exercise from four South-Asian countries. *Acta Obstet Gynecol Scand* 2013
44 413 Sep;92(9):1063-9.
45 414 (23) Stanton C, Blanc AK, Croft T, Choi Y. Skilled care at birth in the developing world: progress to
46 415 date and strategies for expanding coverage
47 416 89. *J Biosoc Sci* 2007 Jan;39(1):109-20.
48 417 (24) WHO/UNICEF. Antenatal care in developing countries: Promises, achievements and missed
49 418 opportunities. Analysis of trends, levels and differentials 1990-2001
50 419 70. WHO, Geneva; 2003 Feb 2.
51 420 (25) Bloom SS, Lippeveld T, Wypij D. Does antenatal care make a difference to safe delivery? A study
52 421 in urban Uttar Pradesh, India

- 1
2
3 422 88
4 423 94. Health Policy Plan 1999 Mar;14(1):38-48.
5 424 (26) Yanagisawa S, Oum S, Wakai S. Determinants of skilled birth attendance in rural Cambodia
6 425 90
7
8 426 96. Trop Med Int Health 2006 Feb;11(2):238-51.
9 427 (27) Eades CA, Brace C, Osei L, LaGuardia KD. Traditional birth attendants and maternal mortality in
10 428 Ghana. Soc Sci Med 1993 Jun;36(11):1503-7.
11 429 (28) Doctor HV. Intergenerational differences in antenatal care and supervised deliveries in Nigeria.
12 430 Health Place 2011 Mar;17(2):480-9.
13 431 (29) Nair M, Ariana P, Webster P. What influences the decision to undergo institutional delivery by
14 432 skilled birth attendants? A cohort study in rural Andhra Pradesh, India
15 433 93. Rural Remote Health 2012;12:2311.
16 434 (30) Okiwelu T, Hussein J, Adjei S, Arhinful D, Armar-Klemesu M. Safe motherhood in Ghana: still on
17 435 the agenda? Health Policy 2007 Dec;84(2-3):359-67.
18 436 (31) UNDP. UNDP in Ghana: MDG Overview: Improve maternal health. 2014 Apr 4.
19 437 (32) Witter S, Arhinful DK, Kusi A, Zakariah-Akoto S. The experience of Ghana in implementing a user
20 438 fee exemption policy to provide free delivery care. Reprod Health Matters 2007 Nov;15(30):61-
21 439 71.
22 440 (33) Asamoah BO, Agardh AF, Cromley EK. Spatial analysis of skilled birth attendant utilization in
23 441 Ghana.(1916-9736 (Print)).
24 442 (34) Asamoah BO, Agardh AF, Pettersson KO FAU - Ostergren P-O, Ostergren PO. Magnitude and
25 443 trends of inequalities in antenatal care and delivery under skilled care among different socio-
26 444 demographic groups in Ghana from 1988 - 2008.(1471-2393 (Electronic)).
27 445 (35) Measure DHS. Ghana Demographic and Health Survey 2008.
28 446 <http://www.measuredhs.com/pubs/pdf/FR221.pdf> . 2011. 11-12-2011.
29 447 Ref Type: Online Source
30 448 (36) UNICEF. Millenium Development Goals. <http://www.unicef.org/mdg/maternal.html> . 2014.
31 449 Ref Type: Online Source
32 450 (37) Prata N, Greig F, Walsh J, West A. Ability to pay for maternal health services: what will it take to
33 451 meet who standards? Health Policy 2004 Nov;70(2):163-74.
34 452 (38) Stekelenburg J, Kyanamina S, Mukelabai M, Wolffers I, van RJ. Waiting too long: low use of
35 453 maternal health services in Kalabo, Zambia. Trop Med Int Health 2004 Mar;9(3):390-8.
36 454 (39) Wall LL. Dead mothers and injured wives: the social context of maternal morbidity and mortality
37 455 among the Hausa of northern Nigeria. Stud Fam Plann 1998 Dec;29(4):341-59.
38 456 (40) Mills S, Bertrand JT. Use of health professionals for obstetric care in northern Ghana. Stud Fam
39 457 Plann 2005 Mar;36(1):45-56.
40 458 (41) Zere E, Oluwole D, Kirigia JM, Mwikisa CN, Mbeeli T. Inequities in skilled attendance at birth in
41 459 Namibia: a decomposition analysis. BMC Pregnancy Childbirth 2011;11:34.
42 460 (42) Kesuma ZM, Chongsuvivatwong V. Utilization of the Local Government Health Insurance Scheme
43 461 (JKA) for Maternal Health Services Among Women Living in Underdeveloped Areas of Aceh
44 462 Province, Indonesia. Asia Pac J Public Health 2014 Feb 24.
45 463 (43) Mumtaz Z, Salway S. ΓÇÿl never go anywhereΓÇÖ: extricating the links between women's
46 464 mobility and uptake of reproductive health services in Pakistan. Social Science & Medicine 2005
47 465 Apr;60(8):1751-65.
48 466 (44) Yao J, Murray AT, Agadjanian V. A geographical perspective on access to sexual and reproductive
49 467 health care for women in rural Africa. Social Science & Medicine 2013 Nov;96(0):60-8.

- 1
2
3 468 (45) Mengesha ZB, Biks GA, Ayele TA, Tessema GA, Koye DN. Determinants of skilled attendance for
4 469 delivery in Northwest Ethiopia: a community based nested case control study. BMC Public
5 470 Health 2013;13:130.
6
7 471 (46) Sahn DE, Stifel DC. Urban-Rural Inequality in Living Standards in Africa. Journal of African
8 472 Economies 2003 Dec 1;12(4):564-97.
9 473 (47) Knight J, Shi L. EDUCATIONAL ATTAINMENT AND THE RURAL-URBAN DIVIDE IN CHINA. Oxford
10 474 Bulletin of Economics and Statistics 1996 Feb 1;58(1):83-117.
11 475 (48) Farquhar C, Kiarie JN, Richardson BA, Kabura MN, John FN, Nduati RW, et al. Antenatal Couple
12 476 Counseling Increases Uptake of Interventions to Prevent HIV-1 Transmission. J Acquir Immune
13 477 Defic Syndr 2004 Dec 15;37(5):1620-6.
14 478 (49) Mills S, Williams JE, Adjuik M, Hodgson A. Use of health professionals for delivery following the
15 479 availability of free obstetric care in northern Ghana. Matern Child Health J 2008 Jul;12(4):509-
16 480 18.
17 481 (50) Quaye RK. Paying for Health Services in East Africa: A Research Note. Social Theory & Health
18 482 2004 Feb;2(1):94-105.
19 483 (51) Kakaire O, Kaye DK, Osinde MO. Male involvement in birth preparedness and complication
20 484 readiness for emergency obstetric referrals in rural Uganda. Reprod Health 2011;8:12.
21
22 485
23 486
24
25
26 487
27
28 488
29
30
31 489

Table 1: Definition of variables used in the study

Variables	Description
Demographic	
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 & 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 & Other
Employment	Employment status as at interview date (Currently employed (Yes or No))
Wealth class status	Wealth quintiles categorized into three classes (Low; Middle; High)*
Covered by health	Having a viable health insurance registration (Yes or No)

insurance	
Maternal	
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 (< 2years; 2-5 years; 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 is used for our study, was born: 1; 2-3; 4-5; 6+
Gestational age at first ANC	Months pregnant at 1 st ANC visit categorized into 3 trimesters of pregnancy
No. of times attended ANC	Number of times woman attended ANC during last pregnancy (1 ; 2-3; 4+; Don't know)
Community & contextual	
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 & Higher)
Who has final say on woman's health	Whose decision on woman's health is paramount (Respondent alone; Respondent & partner; Husband/partner/Someone else alone)
Period of delivery	Whether last delivery was before or during the period of free cost of delivery ie before or after 2005.

490 *Wealth measured using information on household ownership of consumer items, ranging from a
 491 television to a bicycle or car, as well as dwelling characteristics, such as source of drinking water,
 492 sanitation facilities, and type of flooring material to produce an asset index.

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

Variable	Frequency (%) (N=2,041)	% Unskilled delivery (N=807)	% Skilled delivery (N=1,234)	p-value for chi- square test
Demographic and Maternal factors				
Age (years)				0.05
<20	102 (5.0)	44.1	55.9	
20-34	1,331 (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 & Higher	845 (41.4)	21.6	78.4	
Marital Status				0.04
Never married	112 (5.5)	28.6	71.4	
Currently married	1,816 (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	1,389 (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 & Other	89 (4.4)	54.8	45.2	
Employment (Currently Working)				0.00
No	269 (13.2)	33.3	66.7	
Yes	1,772 (86.8)	40.5	59.5	
Wealth Status Class				0.00
Low	1,024 (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	1,224 (60.0)	30.1	69.9	
Previous birth interval				0.00
< 2 years	990 (62.4)	42.4	57.6	
2-5 years	236 (14.9)	48.3	51.7	
5+ years	360 (22.7)	27.2	72.8	

1					
2					
3	Complication during previous delivery				0.00
4	No	1,920 (94.1)	51.3	48.7	
5	Yes	121 (5.9)	4.9	95.1	
6					
7	Birth order				0.00
8	1	450 (22.0)	28.0	72.0	
9	2-3	753 (36.9)	35.7	64.3	
10	4-5	482 (23.6)	42.9	57.1	
11	6+	356 (17.4)	57.6	42.4	
12					
13	Gestational age at first ANC				0.00
14	1 st Trimester	1,179 (57.8)	34.2	65.8	
15	2 nd Trimester	807 (39.5)	45.4	54.6	
16	3 rd Trimester	55 (2.7)	64.2	35.8	
17					
18	Number of times ANC attended				0.00
19	1	60 (2.9)	75.0	25.0	
20	2-3	293 (14.3)	65.9	34.1	
21	4+	1,633 (80.0)	33.1	66.9	
22	Don't know	55 (2.7)	52.7	47.3	
23					
24	Covered by Health Insurance				0.00
25	No	1167 (57.2)	49.4	50.6	
26	Yes	874 (42.8)	26.1	73.9	
27					
28	Community & Contextual factors				
29	Region				0.00
30	Western	179 (8.8)	43.0	57.0	
31	Central	145 (7.1)	37.2	62.8	
32	Greater Accra	201 (9.8)	11.9	88.1	
33	Volta	166 (8.1)	39.8	60.2	
34	Eastern	178 (8.7)	33.7	66.3	
35	Ashanti	310 (15.2)	23.9	76.1	
36	Brong Ahafo	199 (9.7)	33.7	66.3	
37	Northern	287 (14.0)	67.6	32.4	
38	Upper East	172 (8.5)	52.3	47.7	
39	Upper West	204 (10.0)	49.5	50.5	
40					
41	Residence				0.00
42	Urban	748 (36.6)	13.1	86.9	
43	Rural	1,293 (63.4)	54.8	45.2	
44					
45	Type of City				0.00
46	Capital/ large	315 (15.4)	10.2	89.8	
47	Small	263 (12.9)	16.0	84.0	
48	Town	468 (23.0)	29.5	70.5	
49	Country side	995 (48.8)	59.8	40.2	
50					
51	Spouse's highest educational attainment				0.00
52	No Education	569 (27.9)	66.8	33.2	
53	Primary	179 (8.8)	43.6	56.4	
54	Secondary & Higher	1,293 (63.3)	26.0	74.0	
55					
56					
57					
58					
59					
60					

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Who has final say on woman's health				0.02
Respondent alone	446 (21.9)	36.2	63.8	
Respondent & 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	1,506 (73.8)	40.6	59.4	

For peer review only

1 **Table 3: Predictors of Skilled Attendance at Delivery amongst pregnant women who attended ANC at**
 2 **least once during the pregnancy, Ghana Health and Demographic Survey, 2008**

Predictor	Beta	p-value	OR *(CI 95%)
<i>Demographic and Maternal factors (Model 1)</i>			
<i>AUC (95% CI): 0.85 (0.82 – 0.88)</i>			
Wealth Status Class			
Low	†	†	†
Middle	1.34	0.00	3.82 (2.25 – 6.49)
High	2.10	0.00	2.14 (1.09 – 4.20)
Complication during previous delivery (Yes)	2.16	0.00	13.53 (2.63 – 69.47)
Covered by health insurance (Yes)	1.10	0.00	3.00 (1.98 – 4.54)
Birth order			
1	†	†	†
2 – 3	-0.30	0.24	0.74 (0.45 – 1.22)
4 – 5	-0.88	0.02	0.42 (0.21 – 0.84)
Maternal age in years	0.05	0.04	1.05 (1.00 – 1.09)
Religious group			
Christian	†	†	†
Muslim	-0.12	0.40	0.77 (0.43 – 1.40)
Traditionalist	-1.34	0.01	0.26 (0.10 – 0.67)
No religion/ Other	-0.52	0.28	0.60 (0.23 – 1.54)
Ethnicity			
Akan	1.00	0.02	2.72 (1.14 – 6.46)
Ga/ Dangme	†	†	†
Ewe	1.53	0.03	4.62 (1.71 – 12.53)
Guan	0.43	0.60	1.55 (0.30 – 7.90)
Mole-Dagbani	0.62	0.21	1.87 (0.71 – 4.94)
Grussi	0.84	0.15	2.32 (0.74 – 7.30)
Gruma	0.77	0.20	2.15 (0.68 – 6.86)
Other	1.56	0.02	4.78 (1.30 – 17.56)
<i>Community & Contextual factors (Model 2)</i>			
<i>AUC (95% CI):0.80 (0.78 – 0.82)</i>			
Residence (rural)	-1.31	0.00	0.27 (0.18 – 0.41)
Type of city			
Capital/ large	0.49	0.14	1.63 (0.85 – 3.10)
Small	†	†	†
Town	0.03	0.92	1.03 (0.62 – 1.70)

Country side	-0.66	0.01	0.52 (0.31 – 0.88)
Spouse's highest educational level			
No Education	-0.87	0.00	0.42 (0.28 – 0.63)
Primary	‡	‡	‡
Secondary & Higher	0.30	0.12	1.36 (0.92 – 1.99)
Region			
Western	-1.53	0.60	0.86 (0.49 – 1.52)
Central	‡	‡	‡
Greater Accra	0.24	0.53	1.27 (0.60 – 2.70)
Volta	0.22	0.43	1.25 (0.72 – 2.19)
Eastern	0.32	0.26	1.38 (0.79 – 2.42)
Ashanti	0.50	0.06	1.65 (0.97 – 2.78)
Brong Ahafo	0.47	0.09	1.61 (0.93 – 2.79)
Northern	-0.47	0.09	0.63 (0.37 – 1.08)
Upper East	0.31	0.28	1.37 (0.78 – 2.41)
Upper West	0.60	0.03	1.83 (1.05 – 3.17)
Demographic, Maternal, Community & Contextual factors (Model 3)			
AUC (95% CI): 0.85 (0.83 – 0.88)			
<i>(Interactions not significant in model)</i>			
Wealth status class			
Low	‡	‡	‡
Middle	0.63	0.04	1.88 (1.02 – 3.47)
High	1.18	0.00	3.27 (1.60 – 6.68)
Residence (rural)	-1.31	0.00	0.27 (0.14 – 0.52)
Complication during previous delivery (Yes)	3.09	0.04	21.93 (2.61 – 184.04)
Covered by health insurance (Yes)	1.03	0.00	2.74 (1.83 – 4.30)
Religious group			
Christian	0.34	0.51	1.40 (0.52 – 3.76)
Muslim	-0.08	0.99	0.99 (0.34 – 2.87)
Traditionalist/ Spiritualist	-0.78	0.24	0.46 (0.12 – 1.70)
No religion/ Other	‡	‡	‡

‡ Reference category

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

5

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	Title page
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6 & 7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7, Table 1
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7, Table 1
Bias	9	Describe any efforts to address potential sources of bias	None
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8 & 9
		(b) Describe any methods used to examine subgroups and interactions	9
		(c) Explain how missing data were addressed	8
		(d) If applicable, describe analytical methods taking account of sampling strategy	None
		(e) Describe any sensitivity analyses	None
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	None
		(c) Consider use of a flow diagram	None
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	9 & 10
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(b) Report category boundaries when continuous variables were categorized	None
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12,13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.