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Maternal healthcare utilsation and complete childhood vaccination in sub-Saharan Africa: a cross-sectional study of 29 nationally representative surveys

Eugene Budu,[1] Bright Opoku Ahinkorah ,[2] Richard Gyan Aboagye,[3] Ebenezer Kwesi Armah-Ansah,[1] Abdul-Aziz Seidu ,[1,4] Collins Adu,[5] Edward Kwabena Ameyaw,[2] Sanni Yaya [6,7]

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For numbered affiliations see end of article.

Correspondence to
Dr Sanni Yaya;
sanni.yaya@u0ttawa.ca

ABSTRACT

Objective The objective of the study was to examine the association between maternal healthcare utilisation and complete childhood vaccination in sub-Saharan Africa.

Design Our study was a cross-sectional study that used pooled data from 29 countries in sub-Saharan Africa.

Participants A total of 60 964 mothers of children aged 11–23 months were included in the study.

Outcome variables The main outcome variable was complete childhood vaccination. The explanatory variables were number of antenatal care (ANC) visits, assistance during delivery and postnatal care (PNC).

Results The average prevalence of complete childhood vaccination was 85.6%, ranging from 67.0% in Ethiopia to 98.5% in Namibia. Our adjusted model, children whose mothers had a maximum of three ANC visits were 56% less likely to have complete vaccination, compared with those who had at least four ANC visits (adjusted OR (aOR)=0.44, 95% CI 0.42 to 0.46). Children whose mothers were assisted by traditional birth attendant/other (aOR=0.43, 95% CI 0.41 to 0.56) had lower odds of complete vaccination. The odds of complete vaccination were lower among children whose mothers did not attend PNC clinics (aOR=0.26, 95% CI 0.24 to 0.29) as against those whose mothers attended.

Conclusion The study found significant variations in complete childhood vaccination across countries in sub-Saharan Africa. Maternal healthcare utilisation (ANC visits, skilled birth delivery, PNC attendance) had significant association with complete childhood vaccination. These findings suggest that programmes, interventions and strategies aimed at improving vaccination should incorporate interventions that can enhance maternal healthcare utilisation. Such interventions can include education and sensitisation, reducing cost of maternal healthcare and encouraging male involvement in maternal healthcare service utilisation.

Strengths and limitations of this study

- One of the strengths of the study was the use of data from nationally representative surveys.
- The surveys employed a multistage sampling technique to recruit the study participants, making the results generalisable to all children aged 11–23 months in sub-Saharan Africa.
- One key limitation of the study is that the surveys were cross-sectional in nature and this makes it difficult for the study to establish a causal relationship.
- Use of verbal responses to ascertain information on childhood vaccination could be prone to potential recall bias.

INTRODUCTION

Maternal healthcare and childhood vaccination are major public health issues in sub-Saharan Africa (SSA) and the international community has prioritised them by integrating them into the Sustainable Development Goals (SDGs).[1–3] Maternal healthcare services are regarded as essential because they are not only required to improve and promote women's reproductive health but also needed to reduce maternal and child mortality.[4] Effective utilisation of maternal healthcare services has led to a significant progress in maternal health, as evident in the reduction of maternal mortality ratio from 342 to 211 deaths per 100 000 live births from 2000 to 2017 worldwide.[5] Despite the decline, more than 500 000 women have died from causes related to pregnancy and childbirth, with high vulnerabilities among women in SSA.[6 7]

Target 2 of SDG 3 highlights the need to improve child health and survival rates, and this has enhanced significant changes in public and private investments, with the aim of promoting access to affordable programmes that improve the health of children, particularly in vaccination.[8] Globally, in 2019, about 116 million infants received three doses of diphtheria-tetanus-pertussis (DTP3) vaccine, protecting them against infectious diseases that can cause serious illness and

disability or can be fatal.[9 10] This contributed to the prevention of at least 2.5 million neonatal and under-5 mortality globally.[11–13]

Despite the global improvement in child health due to vaccination, SSA had the highest neonatal mortality rate in 2019 at 27 deaths per 1000 live births, followed by Central and Southern Asia with 24 deaths per 1000 live births.[13] These mortalities can be prevented if women use essential components of basic maternal health services, such as antenatal care (ANC) and skilled healthcare personnel during delivery, and receive available relevant postpartum health services and emergency obstetric care.[14–16]

A recent systematic review and meta-analysis found that ANC visits decreased the risk of neonatal mortality by 34% in SSA,[17] and newborns delivered with skilled birth attendance were 16% less likely to die within 2–27 days than those without skilled birth attendance.[18] In terms of postnatal care (PNC), studies have shown that approximately two-thirds of neonatal mortality in SSA could be prevented using existing programmes on maternal and child health, including PNC.[19 20]

Although childhood vaccination has yielded some positive outcomes worldwide, there is low coverage in SSA and consequently poor child health outcomes.[21 22] Childhood vaccination forms an important aspect of maternal healthcare utilisation. Therefore, it is recommended that vaccination should begin immediately after childbirth within a specified period of time.[23] However, whether women in SSA who use maternal healthcare services are more likely to vaccinate their children compared with those who do not use maternal healthcare services is unknown. Therefore, we examined the association between maternal healthcare service utilisation and complete childhood vaccination in SSA.

METHODS

Data source

The study used data from the Demographic and Health Surveys (DHS) of 29 countries in SSA. Specifically, data from birth recode files that contain information on all births of women aged 15–49 were used. The DHS is a nationally representative survey that is carried out in more than 85 low-income and middle-income countries globally. The survey covers a range of significant maternal and child health indicators, such as childhood vaccination and maternal healthcare utilisation.[24]

Study design

The DHS uses a repeated cross-sectional research design. This research design was used because complete coverage of the population was impossible, and it addresses the survey population in a short period of time and produces comparable and equal valid results.

Inclusion and exclusion criteria

In terms of the selection of the surveys, the inclusion criteria were those that were published between January 2010 and December 2019 and had information on maternal healthcare utilisation and childhood vaccination. Hence, surveys that were published before 2010 and did not have information on maternal healthcare utilisation and childhood vaccination were excluded. For the selection of respondents, the inclusion criteria were children less than 23 months whose mothers had complete information on maternal healthcare utilisation and childhood vaccination. Hence, children more than 23 months whose mothers did not have complete information on maternal healthcare utilisation and childhood vaccination were excluded.

Sample size and sampling procedure

A two-stage stratified sampling technique is employed in each survey in order to ensure national representativeness. Details of the sampling process that guide the DHS can be found in the study by Aliaga and Ren.[25] A sample size of 60 964 children under 5 were included in this study. Table 1 provides the details of the surveys and the sample employed in this study. We relied on the Strengthening the Reporting of Observational Studies in Epidemiology statement (online supplemental file 1) in writing the manuscript.[26] The data set is freely available for download at https://dhsprogram.com/data/available-datasets.cfm.

Definition of variables

Dependent variable

The dependent variable in this study is complete vaccination, also called full vaccination. Following the WHO recommendations on routine vaccination[27] and based on previous studies,[28 29] we defined complete childhood vaccination as a child who has received one dose of BCG, three doses of pentavalent pneumococcal conjugate, oral polio vaccines, two doses of rotavirus and one dose of measles vaccine. Children who did not get all these vaccines were considered as those with incomplete vaccination. Complete childhood vaccination was coded as 1 and incomplete as 0.[28 29]

Independent variables

The study used maternal healthcare service utilisation as the main independent variable. These variables included ANC attendance, assistance during delivery and PNC attendance. With ANC, women were asked about the number of antenatal visits they made during their recent pregnancy. Utilisation of ANC visits was coded as <4 visits and ≥4 visits. Assistance during delivery was derived from the question 'Who assisted [NAME] during delivery?' The response to this question was categorised into 'Traditional Birth Attendant (TBA)/Others' and 'Skilled Birth Attendant (SBA)/Health professionals'. PNC attendance was derived from the question 'Did [NAME] go for postnatal checks within 2 months?' By excluding respondents who responded 'don't know' to this question, we coded the variable as 'yes' and 'no'.

Table 1 Country, year of survey, population and samples

Country	Year of survey	Population	Sample*	Sample†	Sample‡
Angola	2015–2016	42 002	3043	3028	2567
Benin	2018	45 853	5423	5092	4938
Burkina Faso	2017–2018	56 178	2885	2731	2598
Burundi	2016–2017	45 419	2591	2590	2591
Cameroon	2018	42 312	2441	2441	849
Chad	2014–2015	68 989	4217	4203	4042
Comoros	2012	11 497	1259	1247	1165
Congo	2013	31 948	2067	2056	1744
Democratic Republic of Congo	2013–2014	59 276	3704	3679	3387
Cote D'Ivoire	2011–2012	28 211	1575	1573	1462
Ethiopia	2016	41 392	4016	3992	4046
Gabon	2012	23 109	1682	1466	1217
Gambia	2013	26 601	1677	1561	582
Ghana	2014	23 118	1218	1218	1159
Guinea	2018	28 887	1525	1515	1398
Kenya	2014	83 591	7861	7690	3309
Lesotho	2014	11 710	655	654	211
Liberia	2013	30 804	1499	1475	1258
Malawi	2015–2016	68 074	2207	2126	2098
Mali	2018	33 379	3812	3805	3779
Namibia	2013	18 090	952	947	764
Nigeria	2018	127 545	4965	3694	2550
Rwanda	2014–2015	30 058	1524	1524	732
Senegal	2017–2018	42 510	1908	1877	1488
Sierra Leone	2013	47 392	2150	2129	2090
Togo	2013–2014	26 264	1395	1318	1231
Uganda	2016	57 906	1954	1947	1789
Zambia	2018	38 446	3874	3873	3643
Zimbabwe	2015	20 791	2240	2238	2277
Total		1 211 352	76 319	73 689	60 964

*Children less than 23 months.
†Children who received vaccination.
‡Children with complete cases.

Control variables

Fourteen variables were considered in this study as covariates and were broadly grouped into child and maternal related variables as well as community-level variables. The child and maternal related variables included size of child at birth, birth order, twin status, type of delivery, mother's age, marital status, employment status, religion, and exposure to newspaper, radio and television. The community-level factors included type of place of residence, community literacy level and community socioeconomic status. The selection of these variables was guided by theoretical relevance and practical significance with complete childhood vaccination.[30–34]

Statistical analyses

Using Stata V.14.0, we first computed the prevalence of complete immunisation in SSA as well as the prevalence of each component of maternal healthcare service utilisation. Next, we calculated the proportions of complete immunisation across the independent and control variables using X^2 test of independence. After this, we used variance inflation factor (VIF) to check for multicollinearity and the results showed no evidence of high collinearity (mean VIF=1.30, maximum VIF=2.09 and minimum VIF=1.01). All variables that showed statistical significance during the X^2 test were considered for the final stage of analysis that involved a multilevel logistic

regression analysis. Five models were built for the multilevel logistic regression analysis. Model 0 was the null or empty model and showed the variance in childhood vaccination explained by the primary sampling units. This model had no explanatory variables. Model 1 had only the key independent variables (ANC attendance, assistance during delivery and PNC attendance) and showed their association with complete vaccination. In the next model (model 2), maternal and child factors were added to the first model to find their association with complete vaccination. In model 3, community-level factors were added to model 2 to examine the associations between those variables in the model and complete vaccination. Finally, model 4 was the complete model where all the explanatory variables were included in the model to find their association with complete vaccination. The reference category for the multilevel logistic regression was the category with the least frequency. The multilevel logistic regression analysis comprised fixed effects and random effects.[35] The results of the fixed effects of the model were presented as adjusted OR (aOR), while the random effects were assessed with intracluster correlation.[36] Model comparison was done using the log-likelihood ratio and Akaike's information criterion (AIC) tests. The highest log-likelihood (−20 923.521) and the lowest AIC (41 919.04) were used to determine the best fit model. We applied sample weights (v005/1 000 000) for all the frequency distributions, while the svyset command in Stata was used to adjust for the complex sampling structure of the data in the regression analyses. Missing data were handled using complete cases.

Patient and public involvement

Neither patient groups nor the public were involved in this study.

RESULTS

Prevalence of maternal healthcare utilisation and complete childhood vaccination

The overall prevalence of complete childhood vaccination was 85.6%, ranging from 67.0% in Ethiopia to 98.5% in Namibia. With ANC visits, Chad (32.8%) recorded the lowest coverage, with the highest coverage in Senegal (94.7%). From the 29 countries, the prevalence of at least four ANC visits was 56.0%. Skilled birth attendance was more prevalent in Congo (97.6%), compared with the lowest rate in Gambia (31.8%), with an overall prevalence of 74.7%. PNC attendance was 41.0% in all the countries combined. PNC prevalence ranged from 7.8% in Ethiopia to 83.3% in Zimbabwe (table 2).

Table 2 Prevalence of maternal healthcare utilisation and complete childhood vaccination in sub-Saharan Africa

Country	Complete vaccination	Four or more ANC visits	Assisted by skilled birth attendant during delivery	Attended PNC
Angola	74.9	62.7	77.3	22.1
Burkina Faso	94.3	32.0	72.2	82.3
Benin	86.3	53.8	82.9	19.0
Burundi	98.2	51.5	90.6	9.2
Democratic Republic of Congo	80.0	47.3	88.5	16.5
Congo	93.5	76.2	97.6	58.9
Cote D'Ivoire	82.9	42.1	80.8	70.2
Cameroon	71.0	34.5	67.3	15.7
Ethiopia	67.0	34.0	47.4	7.8
Gabon	92.7	78.9	92.8	54.5
Ghana	95.7	87.3	75.2	73.2
Gambia	95.3	75.7	31.8	73.7
Guinea	72.5	35.1	59.0	30.5
Kenya	96.6	55.4	67.3	64.9
Comoros	85.8	61.6	88.1	35.0
Liberia	92.1	80.8	73.1	68.5
Lesotho	97.5	77.8	91.0	81.6
Mali	81.8	46.6	75.9	26.7
Malawi	97.5	49.4	92.9	43.2
Nigeria	78.2	68.5	74.3	29.1
Namibia	98.5	83.2	94.4	53.6
Rwanda	97.4	43.6	85.2	52.4
Sierra Leone	94.6	89.1	71.1	70.2
Senegal	90.2	94.7	72.8	73.1
Chad	62.5	32.8	37.5	15.6
Togo	93.4	54.1	65.0	73.0
Uganda	95.9	60.9	86.9	22.4
Zambia	93.7	63.8	85.3	62.7
Zimbabwe	89.5	74.5	83.5	83.3
Total	85.6	56.0	74.7	41.0

ANC, antenatal care; PNC, postnatal care.

Prevalence of complete vaccination across maternal healthcare utilisation and child and maternal and community-level factors

Table 3 shows the distribution of complete vaccinations across maternal healthcare utilisation and child and maternal and community-level factors in the SSA. The results showed that 92.6% of women who had at least four ANC visits had their children completely vaccinated. The majority (90.8%) of women with SBA had their children vaccinated. Most (95.2%) of the women with PNC attendance vaccinated their children completely. The prevalence of complete childhood vaccination was highest among children whose size at birth was average (86.9%), first birth order (88.8%) and multiple twin birth status (86.7%). Also, the prevalence of complete

Table 3 Distribution of complete vaccination across maternal healthcare utilisation and child and maternal and community-level factors in sub-Saharan Africa

Variables	Weighted n	Weighted %	Complete childhood vaccination	P value*
ANC attendance				<0.001
<4 visits	26817	44.0	76.6	
≥4 visits	34147	56.0	92.6	
Birth assistant				<0.001
Traditional Birth Attendant (TBA)/others	15412	25.3	70.2	
Skilled Birth Attendant (SBA)	45552	74.7	90.8	
PNC attendance				<0.001
No	35945	59.0	78.9	
Yes	25019	41.0	95.2	
Size of child at birth				<0.001
Larger than average	22153	36.3	86.0	
Average	28446	46.7	86.9	
Smaller than average	10365	17.0	81.3	
Birth order				<0.001
First	12875	21.1	88.8	
2–4	29506	48.4	86.8	
5+	18583	30.5	81.4	
Twin status				0.211
Single birth	59956	98.3	85.5	
Multiple birth	1008	1.7	86.7	
Type of delivery				<0.001
Vaginal birth	57806	94.8	85.0	
Caesarean birth	3158	5.2	95.4	
Mother's age				<0.001
15–19	6359	10.4	82.9	
20–24	15214	25.0	86.3	
25–29	16365	26.8	85.8	
30–34	11869	19.5	85.8	
35–39	7624	12.5	85.2	
40–44	2882	4.7	86.2	
45–49	650	1.1	82.2	
Marital status				<0.001
Never married	4265	7.0	91.0	
Married	43967	72.1	84.3	
Cohabiting	9700	15.9	87.8	
Widowed	473	0.8	86.2	
Divorced	2560	4.2	89.5	
Employment status				<0.001
Not working	20089	33.0	82.3	
Working	40875	67.0	87.2	
Frequency of reading newspaper				<0.001
Not at all	52601	86.3	84.1	
Less than once a week	4661	7.6	94.9	
At least once a week	3702	6.1	94.7	
Frequency of listening to radio				<0.001
Not at all	28343	46.5	80.0	
Less than once a week	11053	18.1	89.0	
At least once a week	21567	35.4	91.1	
Frequency of watching television				<0.001
Not at all	38974	63.9	82.1	
Less than once a week	6925	11.4	89.0	
At least once a week	15065	24.7	93.0	
Religion				<0.001
No religion	565	0.9	80.2	
Christianity	16269	26.7	855.0	
Islam	9363	15.4	73.8	
Traditionalist	33904	55.6	89.1	
Others	863	1.4	86.1	
Community literacy level				<0.001
Low	24727	40.5	79.1	
Medium	17294	28.4	88.0	
High	18943	31.1	91.9	
Community socioeconomic status				<0.001
Low	40821	67.0	82.3	
Medium	2217	3.6	87.1	
High	17926	29.4	92.7	
Place of residence				<0.001
Rural	19063	31.3	92.7	
Urban	41901	68.7	82.3	

*P values obtained from X^2 test.
ANC, antenatal care; PNC, postnatal care.

childhood vaccination was mostly found in women who had normal delivery (95.4%), mothers aged 20–24 (86.3%), never married (91.0%), working (87.2%) and affiliated to traditional religion (89.1%). In the area of mass media, women who read the newspapers less than once a week (94.9%), listened to the radio at least once a week (91.1%) and watched television at least once a week (93.0%) had the highest prevalence of complete vaccination. Regarding community-level factors, complete

vaccination was highest among children from communities with a high level of education (91.9%), high socioeconomic status (92.7%) and residing in rural areas (92.7%). Results from the X^2 analysis showed that all the maternal healthcare service utilisation factors were associated with complete childhood vaccination. Also, all the child and maternal and community-level factors were associated with complete vaccination except for twin status. All the associated variables had p<0.001.

Maternal healthcare utilisation and control variables associated with complete childhood vaccination

Table 4 shows the results of the association between maternal healthcare service utilisation and complete childhood vaccination. In the complete model (model 4), children whose mothers had a maximum of three ANC attendance (aOR=0.44, 95% CI 0.42 to 0.46) were 56% less likely to have complete vaccination, compared with those who had at least four ANC visits (aOR=0.44, 95% CI 0.42 to 0.46). We found that children whose mothers had assisted delivery by traditional birth attendant/other (aOR=0.43, 95% CI 0.41 to 0.56) had lower odds of receiving complete vaccination. Also, the odds of complete immunisation were lower among children whose mothers did not attend PNC clinics (aOR=0.26, 95% CI 0.24 to 0.29) as against those whose mothers attended. The lowest odds of complete vaccination were found among children with smaller than average birth size, 5+ birth order children, children delivered through vaginal birth, children born to mothers aged 15–19, children born to non-working mothers, and children born to mothers who never read newspaper nor listened to radio. Similarly, the odds of complete vaccination were lowest among children born to mothers who belonged to 'other religion', those who lived in communities with low educational level and socioeconomic status and those who lived in urban areas.

DISCUSSION

We examined the association between maternal healthcare service utilisation and complete childhood vaccination. The association between other child and maternal and community-level factors and complete childhood vaccination was also examined. We found that mothers who had <4 ANC visits, those who were assisted by traditional birth attendant/other and mothers who did not attend PNC clinics were less likely to provide complete vaccination to their children. The lowest odds of complete vaccination were found among children with smaller than average birth size, 5+ birth order children, children delivered through vaginal birth, children born to mothers aged 15–19, children born to non-working mothers, and children born to mothers who never read newspaper nor listened to radio. Similarly, the odds of complete vaccination were lowest among children born to mothers who belonged to 'other religion', those who lived in communities with low educational level and socioeconomic status and those who lived in urban areas.

Our finding on the association between ANC attendance and complete childhood vaccination is consistent with studies from Ethiopia,[37] Nigeria,[38] South Africa,[39] Senegal[40] and Zimbabwe.[41] In those studies, low ANC attendance was associated with lower odds of complete childhood vaccination. Similarly, Restrepo-Méndez *et al*[42] found in low-income and middle-income countries that full vaccination coverage was lowest among children born to mothers who failed to attend ANC and highest among those whose mothers had four or more ANC visits. Several factors could explain the finding in this current study. First, women with more ANC visits may gain satisfaction with healthcare access and obtain accurate information on the importance of vaccination, which could lead to higher vaccination coverage.[43] For instance, Ndwandwe *et al*[39] stated that frequent ANC visits help women to build good rapport with healthcare providers, and such relationships create opportunities for healthcare providers to encourage and sensitise women to make healthcare-seeking for themselves and their children a priority.

Our study found that the odds of complete vaccination were lower among children whose mothers had assisted delivery by TBA or others. This finding corroborates previous studies conducted in Ethiopia,[44 45] Senegal[40] and Zimbabwe,[41] which found that children from women who delivered in a health facility were more likely to have complete vaccination. Similar findings were obtained in a study conducted in Nigeria.[46] The observed correlation in the study could be explained that women who delivered at health facilities might have a high level of awareness and be more knowledgeable about their health and that of their children.[47] Also, Mukungwa[41] posited that women who deliver at health facilities are well informed about the benefits of complete vaccination. The result could imply that delivery at health facilities enables women to receive adequate training from health professionals on the importance of childhood vaccinations and this builds their confidence in using preventive health services.[46]

Also, our finding showed that children whose mothers did not attend PNC had lower odds of being vaccinated compared with those whose mothers attended more PNC. This result confirms the association between PNC attendance and full or complete childhood vaccination as found in several studies.[33 38 42 47] It seems possible that the results could be attributed to the fact that early PNC provides an avenue to initiate vaccines such as BCG, Diptheria, Pertussis and Tetanus (DPT) and polio, which could later enhance compliance with the immunisation programme and also an opportunity to initiate vaccination among those not immunised.[47] Another possible explanation could be that during PNC, mothers are educated and counselled on the importance of immunising their children against vaccine-preventable diseases and deaths.[33]

Concerning childhood factors, complete vaccination was lower among children with birth size both larger and

Table 4 Fixed and random effects results on the association between maternal healthcare services utilisation and complete childhood vaccination in sub-Saharan Africa

Variables	Model 0	Model 1	Model 2	Model 3	Model 4
		aOR (95 % CI)	aOR (95 % CI)	aOR (95 % CI)	aOR (95 % CI)
ANC attendance					
≥4 visits		Reference (1.0)			Reference (1.0)
<4 visits		0.39*** (0.35 to 0.39)			0.44*** (0.42 to 0.46)
Birth assistance					
Skilled Birth Attendant (SBA)		Reference (1.0)			Reference (1.0)
TBA/others		0.31*** (0.30 to 0.33)			0.43*** (0.41 to 0.56)
PNC attendance					
Yes		Reference (1.0)			Reference (1.0)
No		0.23*** (0.22 to 0.24)			0.26*** (0.24 to 0.29)
Size of child at birth					
Average			Reference (1.0)		Reference (1.0)
Larger than average			0.96 (0.91 to 1.01)		0.93 (0.90 to 1.01)
Smaller than average			0.72*** (0.68 to 0.77)		0.84*** (0.79 to 0.90)
Birth order					
First			Reference (1.0)		Reference (1.0)
2–4			0.64*** (0.59 to 0.70)		0.78*** (0.72 to 0.85)
5+			0.40*** (0.36 to 0.45)		0.62*** (0.55 to 0.69)
Type of delivery					
Caesarean birth			Reference (1.0)		Reference (1.0)
Vaginal birth			0.39*** (0.32 to 0.46)		0.66*** (0.55 to 0.79)
Mother's age					
20–24			Reference (1.0)		Reference (1.0)
15–19			0.65*** (0.59 to 0.71)		0.71*** (0.64 to 0.78)
25–29			1.16*** (1.08 to 1.24)		1.09* (1.01 to 1.17)
30–34			1.39*** (1.28 to 1.51)		1.19*** (1.09 to 1.30)
35–39			1.55*** (1.41 to 1.71)		1.30*** (1.17 to 1.45)
40–44			1.71*** (1.50 to 1.95)		1.48*** (1.29 to 1.70)
45–49			1.52*** (1.22 to 1.90)		1.31* (1.04 to 1.66)
Marital status					
Never married			Reference (1.0)		Reference (1.0)
Married			0.72*** (0.64 to 0.81)		0.92 (0.82 to 1.04)
Cohabiting			0.78*** (0.69 to 0.89)		0.91 (0.80 to 1.04)
Widowed			0.81 (0.62 to 1.07)		0.98 (0.74 to 1.32)
Divorced			1.12 (0.95 to 1.32)		1.28** (1.08 to 1.53)
Employment status					
Working			Reference (1.0)		Reference (1.0)
Not working			0.68*** (0.65 to 0.72)		0.75*** (0.71 to 0.79)
Frequency of reading newspaper					
Less than once a week			Reference (1.0)		Reference (1.0)
Not at all			0.45*** (0.39 to 0.52)		0.67*** (0.58 to 0.78)
At least once a week			0.69*** (0.56 to 0.84)		0.69*** (0.57 to 0.85)
Frequency of listening to radio					
At least once a week			Reference (1.0)		Reference (1.0)
Not at all			0.58*** (0.55 to 0.62)		0.75*** (0.70 to 0.80)
Less than once a week			0.95 (0.87 to 1.03)		0.97 (0.88 to 1.05)

Continued

Table 4 Continued

Variables	Model 0	Model 1 aOR (95 % CI)	Model 2 aOR (95 % CI)	Model 3 aOR (95 % CI)	Model 4 aOR (95 % CI)
Frequency of watching television					
At least once a week			Reference (1.0)		Reference (1.0)
Not at all			0.54*** (0.51 to 0.59)		0.95 (0.81 to 1.04)
Less than once a week			0.71*** (0.64 to 0.79)		0.95 (0.85 to 1.07)
Religion					
Traditionalist			Reference (1.0)		Reference (1.0)
No religion			0.53*** (0.43 to 0.66)		0.57*** (0.46 to 0.71)
Christianity			0.68*** (0.65 to 0.72)		0.73*** (0.69 to 0.78)
Islam			0.41*** (0.38 to 0.43)		0.56*** (0.52 to 0.60)
Others			0.60*** (0.50 to 0.72)		0.53*** (0.43 to 0.64)
Community educational level					
High				Reference (1.0)	Reference (1.0)
Low				0.43*** (0.40 to 0.46)	0.68*** (0.64 to 0.74)
Medium				0.82*** (0.76 to 0.88)	0.84*** (0.78 to 0.91)
Community socioeconomic status					
High				Reference (1.0)	Reference (1.0)
Low				0.64*** (0.60 to 0.69)	0.74*** (0.68 to 0.80)
Medium				1.02 (0.86 to 1.20)	1.40*** (1.18 to 1.66)
Place of residence					
Rural				Reference (1.0)	Reference (1.0)
Urban				0.64*** (0.60 to 0.69)	0.83*** (0.77 to 0.89)
Random effect result					
PSU variance (95% CI)	0.14 (0.12 to 0.18)	0.09 (0.07 to 0.11)	0.10 (0.08 to 0.12)	0.11 (0.09 to 0.14)	0.08 (0.06 to 0.10)
ICC	0.042	0.025	0.029	0.034	0.023
LR test	χ^2=349.68, p<0.001	χ^2=145.11, p<0.001	χ^2=207.65, p<0.001	χ^2=251.53, p<0.001	χ^2=114.51, p<0.001
Wald X^2	Reference	6515.58***	3722.45***	2018.85***	8677.69***
Model fitness					
Log-likelihood	−25 868.35	−21 733.98	−23 682.79	−24 724.00	−20 923.52
AIC	51 740.70	43 477.96	47 421.58	49 462.00	41 919.04
n	60 964	60 964	60 964	60 964	60 964
Number of clusters	1577	1577	1577	1577	1577

Exponentiated coefficients, 95% CI in brackets.
1.0=reference category.
*P<0.05, **P<0.01, ***P<0.001.
AIC, Akaike's information criterion; ANC, antenatal care; aOR, adjusted OR; ICC, intraclass correlation; LR Test, likelihood ratio test; PNC, postnatal care; PSU, primary sampling unit.

small than average compared with those with average size at birth. Compared with those with first birth order, children from second birth order and above had lower odds of complete vaccination. Per the present results on birth order, previous studies have demonstrated that the odds of complete immunisation decrease with increasing birth order.[41 44] The result could be explained by the mother's reduced desire in immunisation uptake for children of higher birth order.[44] In explaining the association between birth order and complete vaccination, Kawakatsu and Honda[48] stated that the larger the family size, the greater the resource utilisation, and this could become problematic especially for families in resource-poor setting, and this subsequently influences their livelihood in which health-seeking behaviour could be a component. With size at birth, children born with low birth weight had lower odds of complete childhood vaccination. This could be attributed to the fragile belief in respect to small children as most parents often consider them too fragile for immunisation.[44] Also, the lower odds of vaccination with larger birth size could be due to large size often being perceived as a sign of good health and this can influence their immunisation-seeking behaviour.

We found that maternal characteristics such as divorce, not working, less exposure to mass media, not having a normal delivery and being affiliated to other religious bodies aside from the traditional religion were associated with lower odds of complete childhood vaccination. On the other hand, complete vaccination increased with higher maternal age. The results confirm those of other studies which found consistent associations between maternal characteristics and childhood vaccination.[41 46 49 50] As found in other studies,[33 41 46] exposure to mass media should be emphasised due to its significant positive association with complete vaccination. As a result, well-crafted and tailored information and sensitisation programmes and messages should be disseminated through radio stations, newspapers and television stations based on the positive outcomes from other studies.[46 51] Also, higher likelihood of complete childhood vaccination with increasing age could be explained using the assertion that the level of experience and knowledge on the importance of immunisation increases over time, and cues from health complications resulting from not immunising a child could account for the observed association and hence the need for further education and sensitisation on vaccination.[51] With respect to the results on the religious affiliation in this current study, Costa *et al*[52] argued that the coverage of vaccination increases with the involvement of religious leaders and this is in line with the leave-no-one-behind agenda of the SDGs. Thus, religious leaders should be involved in the sensitisation, education and delivery of immunisation information. A study in Nigeria concluded that inherit cultural beliefs underpinning vaccination mistrust could be the reason for the negative association found in the study.[50]

At the community level, our finding showed that the odds of complete vaccination were low for children residing in urban areas, living in communities with low socioeconomic status, and low and medium educational levels. However, children from communities with medium socioeconomic status were more likely to be completely vaccinated. The association between socioeconomic status and complete vaccination supports works from other studies which assert that high socioeconomic status (education and wealth) increases the likelihood of childhood vaccination.[43 44 46 50] As stated in Adedokun *et al*[46] the socioeconomic status of the community influences the health-seeking behaviour of individuals, which could explain the observed association in the study where children from communities with socioeconomic status above medium and high educational level increased the odds of complete vaccination. In explaining the interaction between education and wealth, Kawakatsu and Honda[48] posited that the interaction is disordinal such that the effect of literacy depends on the wealth index; thus, literacy is significantly related to full vaccination in the context of the rich or richest. The authors further revealed that literacy among wealthy households enables them to better access health-related information provided by the mass media and health professionals.

Strengths and limitations

The strength of the study lies in the use of regionally representative data from SSA countries that used a multistage sampling technique to recruit the study respondents. The results could be generalised to all children aged 11–23 months in the SSA. The study comes with limitations. First of all, the cross-sectional nature of the study makes it difficult to establish a causal relationship between complete childhood vaccination and explanatory variables. Second, the use of verbal responses to ascertain vaccination coverage could be prone to potential recall bias. Also, due to the secondary data used, the study could not use health system factors such as poor scheduling of vaccination days, shortage of vaccines and logistics, and long waiting periods, which could impact the observed association in our study. Moreover, the findings should be interpreted carefully due to variations in country-specific factors such as socioeconomic factors, healthcare system distribution and accessibility, cultural belief, geographical inequalities, and delivery of vaccination activities. Finally, in terms of X^2 test, some of the variables had more than two groups, which made the use of X^2 test less efficient to provide enough information to understand the nature of the relationship between those variables and the outcome variable.

CONCLUSION

This study has shown that children whose mothers had <4 ANC visits, delivered with assistance from TBA/others and no PNC were less likely to vaccinate their children completely. The empirical findings in this study provide evidence on the association between maternal healthcare utilisation and childhood vaccination. Findings from the study therefore call for the development and implementation of interventions aimed at improving maternal healthcare utilisation. Comprehensive strategies used in delivering immunisation should encompass counselling and education on the benefits of vaccination. This will aid in achieving SDG 3 target 3.2.

Author affiliations
[1]Department of Population and Health, University of Cape Coast, Cape Coast, Ghana
[2]Faculty of Health, The Australian Centre for Public and Population Health Research, University of Technology Sydney, Sydney, New South Wales, Australia
[3]School of Public Health, University of Health and Allied Sciences, Ho, Ghana
[4]College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Queensland, Australia
[5]Department of Health Promotion, and Disability Studies, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[6]School of International Development and Global Studies, University of Ottawa, Ottawa, Ontario, Canada
[7]The George Institute for Global Health, Imperial College London, London, UK

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ORCID iDs
Bright Opoku Ahinkorah http://orcid.org/0000-0001-7415-895X
Abdul-Aziz Seidu http://orcid.org/0000-0001-9734-9054
Sanni Yaya http://orcid.org/0000-0002-4876-6043

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