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Coverage and determinants of infant postnatal care in Nigeria: A population-based cross-sectional study

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ABSTRACT

Importance: In 2019, Nigeria had the largest number of under-5 child deaths globally and many of these deaths occurred within the first week of life. The World Health Organization recommends infant postnatal care (PNC) attendance to support newborn survival; however, utilization of PNC is known to be low in many contexts.

Objective: This study examined coverage and individual-level determinants of infant PNC attendance in Nigeria.

Methods: Nigeria Demographic Health Survey (NDHS) 2018 data were used to evaluate infant PNC coverage and determinants. Infant PNC was defined as receipt of care within 2 days of birth. Children delivered up to 2 years before the 2018 NDHS were included. We examined predictors of infant PNC with modified Poisson regression models to estimate relative risks (RRs).

Results: The national coverage of infant PNC was 37.3% (95% confidence interval [CI]: 35.8%–38.7%). Significant heterogeneity in PNC attendance existed at state and regional levels. Facility delivery was strongly associated with the uptake of PNC (RR: 6.07; 95% CI: 5.60–6.58). Greater maternal education, maternal employment, urban residence, female head of household, and greater wealth were also associated with an increased likelihood of PNC visits.

Interpretation: The uptake of infant PNC is low and interventions are urgently needed to promote equity in access and increase demand for PNC in Nigeria.

KEYWORDS

Infant postnatal care, Epidemiology, Coverage, Determinants, Nigeria

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INTRODUCTION

In 2019, there were an estimated 5.2 million deaths among children under age five, almost half (47%) of which occured during the neonatal period (first 28 days of life).[1,2] Among neonatal deaths, about one-third occur on the first day of life and this increases to close to three-quarters by the early neonatal period within the first week of life.[1] Preterm birth, intrapartum-related complications (e.g., birth asphyxia), infections and congenital anomalies are leading causes of neonatal death.[2] In Nigeria, between 2008 and 2018, child under-5 and infant mortality rates declined considerably; 157–132 per 1000 livebirths and 75/1000–67/1000 livebirths, respectively, however, neonatal deaths hardly declined from 40/1000 to 39/1000 livebirths during the same period.[3] In addition, each year in Nigeria, more than a quarter million neonates die, and this translates to approximately 700 neonates every day.[4]

The World Health Organization (WHO) has recommended infant PNC since 1997[5] and has since reiterated the importance of postnatal care (PNC) in the first weeks of life in reducing infant morbidity and mortality.[6,7] The WHO recommends at least four postpartum and PNC visits for mothers and infants, respectively, within the first 6 weeks after delivery. These four visits are recommended within the first 24 h, on day 3 (48–72 h), between days 7–14, and at 6 weeks. However, given the significance of the first 2 days of life in relation to child survival, the global indicator for monitoring PNC coverage in Demographic Health Surveys (DHS) and other surveys is the receipt of infant PNC within 2 days of delivery.[1–3] Typically, postnatal visits focus on screening and counseling on maternal and neonatal danger signs, as well as encouragement and reinforcement of breastfeeding, skin-to-skin contact, newborn immunization, and emphasizing the importance of prompt care-seeking. Although previous studies have reported the benefits of PNC for both mothers and neonates,[8–10] few analysts have evaluated the determinants that influence mothers to seek infant PNC.[11–13]

In this study, we assessed national and state coverage of infant PNC to identify population-level patterns of uptake of infant PNC. We also evaluated the association of individual-level household, maternal, and infant factors with the uptake of infant PNC. This study is intended to identify populations with low coverage of infant PNC and modifiable individual-level factors to inform the design of interventions to promote infant PNC in Nigeria.

METHODS

Ethical approval

The researchers obtained the written consent of DHS to use the dataset for this study. We did not have direct interactions with the study participants and as such, all informed consents were obtained by the DHS implementers. Before the commencement of each interview, DHS implementers ensured that the informed consent statement was read to the respondent, who may accept or decline to participate. Additionally, the study received a non-human subject's research determination from the Harvard T.H. Chan School of Public Health (Protocol # IRB21-1680).

Data source and sampling

This study utilized data from the 2018 Nigeria DHS (NDHS) to assess the coverage and determinants of infant PNC within 2 days after birth. Official permission to analyze the 2018 NDHS data was sought and obtained from the DHS program.[3] The 2018 NDHS was a nationally representative household survey that collected data on demographic and health indicators from all 36 states and the Federal Capital Territory. The NDHS used a stratified two-stage cluster sampling design with stratification by urban/rural area. A total of 1400 enumeration areas were selected with probability proportional to size sampling and 30 households were randomly selected in each cluster. Women aged 15–49 and men aged 15–59 were the target groups for the survey in the selected households. The complete details of the sampling methods are found in the NDHS 2018 report.[3]

Study population

Of the 41 668 households that were selected for the sample in the survey, 40 666 were occupied, and 40 427 were successfully interviewed, yielding a response rate of 99%. At the individual level, 42 121 women aged 15–49 were identified and only 41 821 were interviewed, yielding a response rate of 99%.[3] The NDHS collected data on all children under 5 years of age residing in selected households; however, collection of data on PNC was limited to births within 2 years of the time of the survey. Formerly, DHS had assessed PNC coverage of all live births within the 5 years preceding the survey; however, the period covered by PNC questions has been reduced to 2 years in an attempt to minimize the risk of recall bias.[1] All live births within 2 years of the survey were included in the study, regardless of facility or non-facility delivery and cesarean or vaginal birth. The analytic sample in the study included 12 945 mother-child pairs.

Outcomes

The global consensus indicator for monitoring infant PNC coverage is a postnatal check within 2 days after childbirth.[1,3] In this analysis, the primary outcome—postnatal check within 2 days, regardless of type of provider—was derived from three different variables; provider of first check, timing of first check, and the amount of elapsed time from delivery to the postnatal check. Information was made available through card and maternal reports. All live births within 2 years prior to the 2018 NDHS were included in the study. The following three questions were used to define the coverage of PNC: (i) How many hours, days, or weeks after the birth of (NAME) did the first check take place; (ii) Who checked on (NAME)'s health at that time; (iii) How long before discharge did the child health check take place.

Explanatory variables

The explanatory variables for the study were selected before the analysis based on the literature and included characteristics related to the mothers, newborns, and the household. Characteristics of mothers included maternal age in years, marital status, mother's educational level, health insurance status, employment, religion, and ethnicity. Place of delivery, sex, multiple births, birth order, and type of birth (cesarean or vaginal) were included as newborn characteristics while region, urban/rural residence, sex of the household head, wealth quintiles, and perception of distance to facilities were included as household characteristics. Mother's age in years was classified into three categories <20, 20–34, and 35–49 years. Marital status was classified as never in a union, married/living with a partner, and widowed/divorced/separated while maternal education has four levels that included no formal education, primary, secondary, and higher education. Health insurance and employment status were determined by maternal report of a yes or no response. As for religion, the categories were as presented in line with the NDHS report: Catholic, other Christian denominations, Islam, Traditionalist, and Others. As a proxy for access to care, we included a variable for maternal reports of whether the distance from the home to the health facility was 'a big problem' or not. Place of delivery was defined by institutional and non-institutional delivery. Birth order was categorized into four categories first, second and third, fourth and fifth, and sixth and above. Household wealth quintiles were directly coded from the 2018 NDHS and were calculated based on ownership of materials and household characteristics using principal component analysis.

Statistical analysis

All analyses accounted for the complex survey design of the DHS including stratification and cluster-based sampling. First, descriptive statistics of mothers, newborns, and households were calculated for the analytic sample for live births that occurred within 2 years of the survey. Second, we calculated the proportion of newborns who received PNC within 2 days nationally and in the 36 States and the Federal Capital Territory; the analysis accounted for stratification and cluster sampling. Third, we examined predictors of PNC in univariable and multivariable modified Poisson regression models to estimate relative risks (RRs).[14,15] The primary multivariable models included all explanatory variables of interest. A sensitivity analysis of the multivariable model excluding ethnicity and region was also conducted due to potential collinearity with the individual-level characteristics of interest. A P value of <0.05 was considered statistically significant. All analyses were conducted in Stata version 12.[16]

RESULTS

The study sample included data from 12 945 live births that occurred during the 2 years prior to the 2018 NDHS. Table 1 shows the characteristics of the study sample. Of note, most mothers were within 20–34 years of age (72.4%), 94.9% were married or living with a partner, 43.7% had no formal education, and only 2.1% of mothers reported having health insurance. About two-thirds of mothers perceived that distance from the home to the health facility to access medical help was 'not a big problem'. As for newborns, 97.2% were singletons, 18.7% were firstborns and 40.7% were delivered at an institutional facility.

The national coverage of newborns receiving PNC within 2 days of birth was 37.3% (95% confidence interval [CI]: 35.8%–38.7%). Among those who completed PNC visits, mothers reported that 10.4% were seen by doctors, 19.7% by nurse/midwife, 1.1% were seen by other health workers and 68.8% were either not seen at all or were seen by non-health professionals. There was high variability in the coverage of PNC by region (Figure 1 and Table S1); Kebbi state had the lowest PNC coverage at 5.9% and Osun state had the highest coverage at 80.6%. As shown in the map in Figure 1, the states in the Southwest region had the highest coverage while states in the Northwest region had the lowest coverage.

Table 2 presents the coverage of PNC within 2 days of birth by maternal, newborn, and household characteristics. Of note, the coverage of PNC had high variation by maternal education with 16.0% (95% CI: 15.0%–17.1%) coverage for mothers with no formal education and 76.2% (95% CI: 73.0%–79.1%) for mothers with higher education. The noticeable disparity in PNC coverage level was also observed within ethnicity and religious groups. For example, whereas 17.7% (95% CI: 16.5%–19.1%) and

TABLE 1 Characteristics of mothers, infants, and households in the sample of livebirths within 2 years of the 2018 Nigeria Demographic Health Survey (n = 12 945)

Characteristics	*n* (%)
Maternal age (years)	
< 20	797 (6.2)
20–34	9372 (72.4)
35–49	2776 (21.4)
Current marital status	
Never in union	343 (2.6)
Married/living with partner	12 279 (94.9)
Widowed/Divorced/Separated	323 (2.5)
Maternal educational level	
No education	5652 (43.7)
Primary	1922 (14.8)
Secondary	4334 (33.5)
Higher	1037 (8.0)
Mother covered by health insurance	
No	12670 (97.9)
Yes	275 (2.1)
Mother currently working	
No	4343 (33.6)
Yes	8602 (66.4)
Place of residence	
Urban	4482 (34.6)
Rural	8463 (65.4)
Religion of mother	
Catholic	1192 (9.2)
Other Christian	3998 (30.9)
Islam	7646 (59.1)
Traditionalist	43 (0.3)
Other	66 (0.5)
Getting medical help for self (Mother): Distance to a health facility	
Big problem	4343 (33.5)
Not a big problem	8602 (66.5)
Ethnicity of mother	
Hausa	4056 (31.3)
Fulani	1234 (9.5)
Ekoi	69 (0.5)
Ibibio	194 (1.50)
Igala	120 (0.9)
Igbo	1733 (13.4)
Ijaw/Izon	333 (2.6)
Kanuri/Beriberi	316 (2.4)
Tiv	322 (2.5)
Yoruba	1248 (9.6)
Other	3308 (25.6)
Don't know	12 (0.1)
Sex of child	
Male	6563 (50.7)
Female	6382 (49.3)
Place of delivery	
Non-institutional	7674 (59.3)
Institutional	5271 (40.7)
Type of birth	
Singleton	12579 (97.2)
Multiple births	366 (2.8)
Sex of household head	
Male	11738 (90.7)
Female	1207 (9.3)
Birth order of baby	
First	2415 (18.7)
Second/Third	4377 (33.8)
Fourth/Fifth	3109 (24.0)
Sixth and above	3044 (23.5)
Wealth quintiles	
Poorest	3005 (23.2)
Poorer	2937 (22.7)
Middle	2735 (21.1)
Richer	2399 (18.5)
Richest	1869 (14.5)
Region	
North Central	2308 (17.8)
North East	2760 (21.3)
North West	3752 (29.0)
South East	1446 (11.2)
South South	1311 (10.1)
South West	1368 (10.6)

20.6% (95% CI: 18.2%–23.2%) were the PNC coverage levels for both Hausa and Fulani respectively, 65.7% (95% CI: 63.0%–68.2%) and 71.1% (95% CI: 67.3%–74.6%) were respectively observed for the Igbo and Yoruba ethnic groups. Similarly, PNC coverage levels of 59.2% (95 CI: 56.0%–62.3%), 56.5% (95% CI: 54.7%–58.3%), 25.5% (95% CI: 24.4%–26.7%), and 22.4% (95% CI: 11.3%–39.3%) were observed for the Catholic, Other Christian, Islam and the Traditional religious groups, respectively. The wealth quintile had a similarly large variation with 15.0% coverage for the poorest household quintile and

TABLE 2 Coverage proportion and 95% confidence interval of newborns who received postnatal care within 2 days of delivery by maternal, baby, and household characteristics

Characteristics	Percent of infants who received a postnatal check within 2 days of delivery (95% CI)	*P*
Maternal age (years)		<0.001
< 20	26.7 (23.4, 30.3)	
20–34	37.6 (36.4, 38.7)	
35–49	39.2 (37.0, 41.4)	
Current marital status		<0.001
Never in union	50.9 (43.5, 58.2)	
Married/living with partner	36.8 (35.7, 37.8)	
Widowed/Divorced/Separated	44.0 (37.7, 50.5)	
Maternal educational level		<0.001
No education	16.0 (15.0, 17.1)	
Primary	37.2 (34.5, 40.0)	
Secondary	55.4 (53.7, 57.2)	
Higher	76.2 (73.0, 79.1)	
Mother covered by health insurance		<0.001
No	36.6 (35.6, 37.7)	
Yes	66.8 (60.1, 72.8)	
Religion of mother		<0.001
Catholic	59.2 (56.0, 62.3)	
Other Christian	56.5 (54.7, 58.3)	
Islam	25.5 (24.4, 26.7)	
Traditionalist	22.4 (11.3, 39.3)	
Other	8.2 (3.2, 19.4)	
Mother currently working		<0.001
No	27.3 (25.7, 28.9)	
Yes	42.2 (41.0, 43.5)	
Place of residence		<0.001
Urban	55.7 (54.0, 57.5)	
Rural	25.4 (24.4, 26.5)	
Ethnicity of mother		<0.001
Hausa	17.7 (16.5, 19.1)	
Fulani	20.6 (18.2, 23.2)	
Ekoi	43.2 (31.2, 55.9)	
Ibibio	45.8 (38.2, 53.7)	
Igala	60.6 (50.6, 69.8)	
Igbo	65.7 (63.0, 68.2)	
Ijaw/Izon	30.6 (24.8, 37.0)	
Kanuri/Beriberi	28.2 (22.6, 34.6)	
Tiv	48.0 (42.0, 54.1)	
Yoruba	71.1 (67.3, 74.6)	
Other	40.4 (38.4, 42.3)	
Don't know	49.4 (22.3, 76.8)	
Getting medical help for self (Mother): Distance to a health facility		<0.001
Big problem	29.8 (28.1, 31.5)	
Not a big problem	40.2 (39.0, 41.4)	
Place of delivery		<0.001
Non-institutional	9.8 (9.0, 10.5)	
Institutional	77.3 (75.9, 78.6)	
Sex of child		0.020
Male	38.5 (37.1, 39.9)	
Female	36.0 (34.6, 37.4)	
Birth order of baby		<0.001
First	46.7 (44.3, 49.2)	
Second/Third	42.1 (40.3, 43.8)	
Fourth/Fifth	35.6 (33.7, 37.6)	
Sixth and above	24.4 (22.7, 26.2)	
Type of birth		<0.001
Singleton	37.5 (36.5, 38.5)	
Multiple births	27.4 (22.3, 33.1)	
Sex of household head		<0.001
Male	35.8 (34.8, 36.8)	
Female	52.8 (49.5, 56.0)	
Wealth quintiles		<0.001
Poorest	15.0 (13.7, 16.5)	
Poorer	21.1 (19.5, 22.7)	
Middle	36.3 (34.3, 38.4)	
Richer	53.4 (51.0, 55.9)	
Richest	70.4 (67.7, 73.0)	
Region		<0.001
North Central	40.7 (38.4, 43.0)	
North East	30.2 (28.2, 32.3)	
North West	16.0 (14.7, 17.3)	
South East	64.7 (61.9, 67.4)	
South South	44.9 (41.7, 48.1)	
South West	73.0 (69.6, 76.1)	

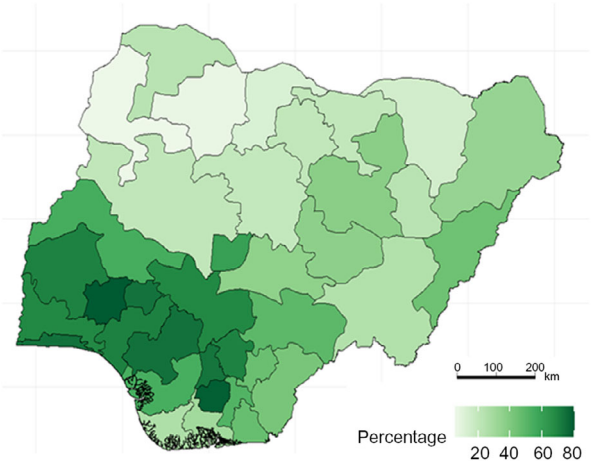

FIGURE 1 Map of infant postnatal care coverage for the 36 States and the Federal Capital Territory of Nigeria.

70.4% for the richest quintile. Coverage of PNC was also significantly higher in urban areas as compared to rural areas (55.7% *vs.* 25.4%). Facility births had significantly higher coverage of PNC at 77.3% as compared to 9.8% for non-facility deliveries.

The univariable and multivariable models for predictors of PNC coverage within 2 days of birth are shown in Table 3 and Table S2. In univariable models all predictors, except for child sex were associated with PNC coverage (*P*-values < 0.05). In the primary multivariable model, greater maternal education, maternal employment, singleton births, urban residence, and greater wealth were associated with an increased likelihood of having a PNC visit (*P*-values < 0.05). Of note, facility deliveries had over six times the likelihood of having a PNC visit as compared to non-facility deliveries (RR: 6.07; 95% CI: 5.60–6.58). Further independent of the maternal, newborn, and household characteristics examined, ethnicity and region were associated with PNC in the primary multivariable model. In the primary multivariable model, maternal age, marital status, maternal health insurance, perceived distance to health facility, child sex, and birth order were not significantly associated with PNC coverage (*P*-values > 0.05).

We also conducted a sensitivity analysis excluding ethnicity and region from the multivariable model due to potential collinearity with the individual-level characteristics of interest (Table 3). There were no qualitative changes in factors associated with PNC; however, the magnitude of the significant predictors tended to be stronger when excluding ethnicity and region.

DISCUSSION

We found that the national average coverage of infant PNC in Nigeria was low at 37.3% among infants and that coverage varied significantly by state. The lowest coverage was found in Kebbi state with approximately one in 20 infants attending infant PNC; the highest coverage was in Osun state where four of five infants attended PNC. We also identified several individual-level maternal, child, and household characteristics that were associated with receipt of PNC. We found that higher maternal education, mothers who were employed, facility deliveries, singleton births, living in an urban setting, and higher household wealth were associated with infant PNC attendance.

Most previous studies have evaluated maternal postpartum care coverage,[17–24] however, the present study examined the coverage of infant PNC. As has been observed in this study, maternal education, residence, place of delivery, and wealth quintiles were all also found to be associated with the uptake of maternal postpartum care. Infant PNC includes important interventions, such as clinical examination, counseling, immunization, and anthropometric assessments. As a result, infants who do not attend PNC are less likely to receive multiple survival interventions. We found significant regional- and state-level variation in uptake of infant PNC and these variations are generally aligned with differences in under-5 mortality in Nigeria.[25,26] In Nigeria, regional diversity in the utilization of maternal PNC has also been reported in other studies.[12,13,20] The differences in the utilization of PNC may be due to regional-specific factors but also differences in the distribution of individual-level risk factors that are related to the uptake of the service between regions. For example, mothers from the southern region generally have higher education and deliver their babies in institutionalized facilities in a greater proportion compared to their counterparts in the northern region of the country. As a result, interventions to promote infant PNC in Nigeria should consider the regional and the local context in terms of barriers and enablers of infant PNC uptake.

At the individual level, we found that greater maternal education was observed to be associated with an increased uptake of infant PNC. This finding agrees with previous studies that found significant associations between the uptake of maternal PNC and mothers' level of education.[8,9,12,13,21,22] Mothers with higher education may have greater knowledge of the importance of infant PNC. In addition, a higher level of education can be associated with employment and financial autonomy which may support PNC attendance.[12] Living in urban settings may also contribute to increased access to health services. We found that the uptake of PNC was associated with greater household wealth. This finding agrees with results from other studies in Africa.[12,13,18–21] Greater wealth may offer resources and support for travel to health centers, and likely correlates positively with education, employment, and other factors that promote attendance at PNC. It

TABLE 3 Multivariable modified Poisson regression models to estimate the relative risk of postnatal care within 2 days of delivery by maternal, newborn, and household characteristics

Characteristics	Multivariable relative risk (95% CI)	*P*	Sensitivity analysis- multivariable relative risk excluding region & ethnicity (95% CI)	*P*
Maternal age (years)				
< 20	Reference		Reference	
20–34	0.93 (0.85, 1.02)	0.110	0.95 (0.87, 1.04)	0.241
35–49	0.97 (0.88, 1.07)	0.581	1.01 (0.91, 1.11)	0.870
Current marital status				
Never in union	Reference		Reference	
Married/living with partner	0.97 (0.89, 1.07)	0.025	0.97 (0.88, 1.07)	0.582
Widowed/Divorced/Separated	1.01 (0.89, 1.16)	0.291	1.01 (0.88, 1.15)	0.972
Maternal educational level				
No education	Reference		Reference	
Primary	1.19 (1.11, 1.28)	<0.001	1.21 (1.12, 1.30)	<0.001
Secondary	1.24 (1.15, 1.32)	<0.001	1.24 (1.16, 1.33)	<0.001
Higher	1.22 (1.12, 1.31)	<0.001	1.23 (1.14, 1.32)	<0.001
Mother covered by health insurance				
No	Reference		Reference	
Yes	1.07 (0.99, 1.15)	0.132	1.03 (0.96, 1.10)	0.441
Mother currently working				
No	Reference		Reference	
Yes	1.10 (1.05, 1.15)	<0.001	1.13 (1.08, 1.17)	<0.001
Getting medical help for self (Mother): Distance to a health facility				
Big problem	Reference		Reference	
Not a big problem	0.97 (0.93, 1.02)	0.251	0.96 (0.92, 1.00)	0.061
Religion of mother				
Catholic	Reference		Reference	
Other Christian	0.96 (0.84, 1.02)	0.081	1.04 (0.99, 1.08)	0.122
Islam	0.94 (0.82, 1.00)	0.063	1.02 (0.97, 1.08)	0.381
Traditionalist	0.84 (0.46, 1.39)	0.513	0.85 (0.52, 1.40)	0.532
Other	0.20 (0.08, 0.39)	<0.001	0.24 (0.11, 0.51)	<0.001
Ethnicity				
Hausa	Reference			
Fulani	1.03 (0.92, 1.15)	0.622		
Ekoi	0.73 (0.58, 0.93)	0.011		
Ibibio	1.24 (1.03, 1.50)	0.020		
Igala	1.10 (0.97, 1.24)	0.143		
Igbo	0.93 (0.84, 1.04)	0.201		
Ijaw/Izon	1.02 (0.86, 1.21)	0.852		
Kanuri/Beriberi	1.06 (0.88, 1.26)	0.541		
Tiv	0.87 (0.76, 1.00)	0.064		
Yoruba	1.01 (0.96, 1.12)	0.722		

(Continues)

TABLE 3 (Continued)

Characteristics	Multivariable relative risk (95% CI)	*P*	Sensitivity analysis- multivariable relative risk excluding region & ethnicity (95% CI)	*P*
Other	0.94 (0.86, 1.03)	0.191		
Don't know	1.01 (0.64, 1.59)	0.970		
Place of delivery				
Non-institutional	Reference		Reference	
Institutional	6.07 (5.60, 6.58)	<0.001	6.21 (5.73, 6.72)	<0.001
Sex of child				
Male	Reference		Reference	
Female	0.98 (0.95, 1.01)	0.181	0.97 (0.94, 1.01)	0.111
Birth order of baby				
First	Reference		Reference	
Second/Third	1.01 (0.96, 1.05)	0.783	1.00 (0.96, 1.04)	0.942
Fourth/Fifth	1.04 (0.99, 1.09)	0.162	1.02 (0.96, 1.07)	0.551
Sixth and above	1.03 (0.96, 1.10)	0.421	0.99 (0.92, 1.06)	0.711
Type of birth				
Singleton	Reference		Reference	
Multiple births	0.53 (0.45, 0.63)	<0.001	0.54 (0.46, 0.63)	<0.001
Place of residence				
Urban	Reference		Reference	
Rural	0.94 (0.91, 0.98)	0.001	0.93 (0.89, 0.96)	<0.001
Sex of household head				
Male	Reference		Reference	
Female	1.04 (0.99, 1.09)	0.101	1.05 (0.96, 1.10)	0.061
Wealth quintiles				
Poorest	Reference		Reference	
Poorer	1.05 (0.96, 1.14)	0.282	1.03 (0.94, 1.13)	0.452
Middle	1.14 (1.05, 1.24)	0.002	1.13 (1.04, 1.23)	0.003
Richer	1.20 (1.10, 1.31)	<0.001	1.20 (1.11, 1.31)	<0.001
Richest	1.23 (1.13, 1.35)	<0.001	1.24 (1.14, 1.35)	<0.001
Region				
North Central	Reference			
North East	1.10 (1.03, 1.18)	0.004		
North West	0.83 (0.76, 0.91)	<0.001		
South East	0.98 (0.90, 1.06)	0.643		
South South	1.03 (0.96, 1.10)	0.422		
South West	1.12 (1.06, 1.19)	<0.001		

appears important that interventions to promote infant PNC consider knowledge and access barriers for women with low education and fewer resources in Nigeria.

In addition, we found that institutional delivery was a strong predictor of receipt of PNC in the first 2 days of life. In Nigeria, home delivery is common; in our sample over half (59.3%) of women did not deliver in a facility. Previous studies have also reported a strong association between institutional delivery and receipt of maternal PNC in Nigeria.[12,13] Our findings are also consistent with a previous study in Uganda that also found facility delivery was associated with the utilization of infant PNC within 2 days of delivery.[11] Women who delivered at health facilities

have demonstrated access to and trust in the health system, and thus it is not unexpected these women are likely to return for their PNC. However, we note that almost a quarter of women who did deliver in a facility did not receive an infant PNC. In general, interventions that promote institutional deliveries may be likely to support the uptake of infant PNC. Further, interventions that also improve the quality of prenatal and delivery care in facilities may also further increase demand for PNC services.

Living in rural areas was found to be associated with a lower likelihood of utilization of infant PNC as compared to residing in urban areas. This finding is in line with evidence on the rural-urban disparities in health service utilization in Nigeria and other settings.[12,13,21] Rural areas represent the most deprived settlement in terms of social amenities including availability of health services. As has been observed in previous studies in Nigeria and other parts of Africa,[12,13,19–26] rural populations generally have lower education and higher levels of poverty as compared to urban areas which are important determinants of health care utilization. Living in rural areas was also associated with a lesser odd of uptake of infant PNC in a study done in Indonesia.[27] Furthermore, we found that neonates from multiple births were observed in our study to have a lower likelihood of using PNC compared to neonates from singleton birth, despite a higher risk of morbidity including disability that has been associated with multiple births compared to singletons.[28] Mothers with multiple births may experience additional pregnancy complications that make travel difficult.

This study has several limitations. First, PNC coverage was collected using health cards and maternal reports and therefore there may be some degree of misclassification. Nevertheless, we expect the misclassification may be non-differential to our exposures of interest which would result in us underestimating the true association. Further, due to social desirability, some mothers may over-report infant PNC attendance. Second, this was an observational cross-sectional study and therefore we cannot directly infer causality. Last, the WHO recommends four PNC visits for infants; however, the DHS data is limited to receipt of PNC in the first 2 days of life. As a result, future surveys and studies should also assess the coverage and determinants of all four recommended PNC visits to support interventions for the continuum of care of mothers and infants.

In conclusion, National coverage of infant PNC is currently low in Nigeria with very marked heterogeneity at the state and regional levels. We identified several individual-level factors that were associated with not attending infant PNC including not having a facility delivery, low maternal education, low household health, and rural residence which can be targeted in the design of interventions to support uptake of infant PNC. Our results support the urgent need for research and implementation of interventions to promote equitable access and uptake of infant PNC in Nigeria to support the achievement of global child mortality goals.

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CONFLICT OF INTEREST

None.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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