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Determinants of BCG vaccination coverage in Ethiopia: a cross-sectional survey

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ABSTRACT

Objective The objective of this study is to assess the determinants of BCG vaccination in Ethiopia from 2016 Ethiopia Demographic and Health Survey (EDHS).

Setting Since Ethiopia has nine regional states and two administrative cities, sample was taken from all the divisions. The population-based sample was intended to provide estimates of key indicators for the country.

Participant The sampling frame used for the 2016 EDHS is the Ethiopia Population and Housing Census. From 15 683 women recorded in EDHS dataset, women with no child (n=10 379) were excluded from the study. Therefore, the total sample size for this study was 5304 women. The outcome variable was BCG immunisation status of children.

Result Out of the study participants (n=5304), the majority were in between 20 and 34 years of age (73.8%). The median age of the respondents was 28.4 (SD=±6.5) years old. Prevalence of BCG vaccination was 63.6% (n=3373) and BCG vaccination coverage in urban residents was higher (88%) than rural residents (57.3%). Mothers' age between 20 up to 34 (Adjusted odds ratio (AOR)=1.48; 95% CI: 1.13 to 1.93) and between 35 up to 49 (AOR=1.83; 95% CI: 1.35 to 2.46) were more likely to vaccinate their child's than those mothers' age less than 20. Mothers settled in urban areas were two times more likely to vaccinate their child's than those living in rural areas (AOR=1.94; 95% CI: 1.45 to 2.60). Mothers with greater antenatal visits show higher BCG vaccination, Antenatal Care (ANC) 4 and above (AOR=3.48; 95% CI: 2.91 to 4.15). BCG vaccination is higher for mothers delivered at non-governmental organisation health facility than home (AOR=2.9; 95% CI: 1.69 to 4.96). Maternal occupation and wealth index also had a significant association with BCG vaccination.

Conclusion BCG vaccination coverage, in this study, was lower and determinant factors for BCG vaccination were residence, mother's age, place of delivery, mother's antenatal visit, wealth index and mother's occupation.

Strengths and limitations of the study

- There was a large sample size and therefore, our effect estimates for determinants were precise.
- There was no study on determinants of BCG vaccination at country level in Ethiopia.
- The data from the legitimate source, that is Demographic Health Survey.
- All divisions of the country included in the sample affirms its representativeness.
- There may be a risk of bias during sampling the Ethiopia Demographic and Health Survey and something related to data validation.

BACKGROUND

Tuberculosis (TB) is an infectious disease caused by the bacillus *Mycobacterium tuberculosis*. It typically affects the lungs (pulmonary TB) but can affect other sites as well (extra pulmonary TB). Globally, there were an estimated 9.6 million TB incident cases in 2014 worldwide. Of which, 5.4 million were among men, 3.2 million were among women and 1.0 million were among children. There were also high number of deaths, about 1.5 million. TB is the second leading cause of death worldwide.[1] Although the BCG vaccine is introduced about 10 decades ago, Ethiopia is one of the nine high TB-burden countries in the world. Annual estimated TB incidence in Ethiopia is 207 per 100 000 populations and death rate was 33 per 100 000 populations in 2014. Multi-drug-resistant (MDR) TB is also increasing where 1.6% of new TB cases and 11.8% of previously treated TB cases estimated to became MDR TB.[1 2]

BCG vaccination is highly effective in preventing childhood TB. BCG immunisation has also been found to be protective of other mycobacterial infections, such as leprosy, Buruli ulcer and glandular disease.[3] The BCG vaccine has been used since 1921 for TB prevention.[4]

The Expanded Program for Immunization (EPI) in Ethiopia was launched in 1980. One of the core priorities in the past Health Sector Development Programs and the current Health Sector Transformation Plan (HSTP) is EPI. In this programme, the BCG vaccine is given to the newborn if asymptomatic for TB screening to protect TB infection.[2] Currently, the BCG is one of the most widely administered vaccines in infancy and

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most cost-effective particularly in low-income countries where TB is endemic. WHO recommends BCG vaccination to young children, particularly infants.[3]

It was expected that adolescent and adult vaccine with 60% efficacy delivered to 20% of the population at risk could prevent about 30–50 million new cases of TB by 2050.[1] Similar to the global pattern over the same period, BCG coverage in Africa currently stands at 89% compared with 16% in 1980. Each year more than 100 million children are immunised worldwide.[3]

In Ethiopia, four in ten children age 12–23 months (39%) received all basic vaccinations at some time, and 22% received these vaccinations before their first birthday. In Senegal, BCG immunisation coverage at birth was 94.7% as indicated by Senegal Demographic and Health Survey (DHS), 2010–2011. Full immunisation coverage can be affected by mother's education, marital status, mother ability to show a vaccination card, access to information from television and place of delivery.[5] In industrialised countries, higher childhood vaccination rates have been associated with family characteristics, such as higher household income and older maternal age, child characteristics, such as younger age, early birth order and good health, and healthcare organisation factors including easy access to immunisation facilities.[4]

Since there was a little study on the issue, the aim of the study is to show possible determinants of BCG vaccination in Ethiopia from 2016 Ethiopia DHS (EDHS) datasets.

METHODS

Ethiopian demography

The country population is very diverse comprising 80 different ethnic groups. According to the 2017 estimate, the population of Ethiopia was about 107 406 158. Ethiopian population is equivalent to 1.41% of the total world population, which ranks number 12 in the list of countries by population. From the total population, 20% resides in urban areas. Varies religion adhered to Ethiopia. Most Christians live in the highlands, whereas Muslims mainly inhabit in the lowlands.[6 7] According to the 2017 revision of the World Population Prospects, proportion of children below the age of 15 in 2010 was 41.5% and, 55.8% was between 15 and 65 years of age, while 3.3% was 65 years or older, with an average age of 18.8.

Study design and settings

We conducted a cross-sectional secondary data analysis of EDHS datasets collected in 2016. Since the country has nine regional states and two administrative cities, sample was taken from all the divisions. The sample was intended to provide estimates of key indicators for Ethiopia as a whole and separately for urban and rural areas. The 2016 EDHS sample was stratified and selected in two stages where each region stratified into urban and rural areas. Samples of enumeration areas (EAs) were selected independently in each stratum in two stages. Imbedded stratification and relative allocation achieved at each of the lower levels by sorting the sampling frame within each sampling stratum before sample selection, according to the administrative units in different levels.

On the basis of the 2007 Population and Housing Census (PHC), in the first stage, 645 EAs of which 202 from urban areas and 443 from rural areas were selected. A household listing process was done in all of the selected EAs from September 2015 to December 2015. Then household lists helped as a sampling frame for the second-stage selection of households for the study.[8] Up to 300 households were listed in one EA. To reduce the task of household listing, each large EAs selected for the survey was segmented. Then household listing was done only in the selected segments. In the second stage of selection, a fixed number of 28 households in each cluster were selected with an equal probability of systematic selection from the newly created household listing.

Participants

The 2016 EDHS-sampling frame was from the Ethiopia PHC, which was conducted by the Ethiopia Central Statistical Agency in 2007. In Ethiopia, women of reproductive age constitute about a quarter of the entire population. The sex ratio between male and female is almost equal; women in reproductive age group constitute 23.4% of the population.[9] A complete list of 84 915 EAs used as census frame created from the 2007 PHC. One EA covers an average of 181 households. The sampling frame contains information about type of residence (urban or rural), EA location and estimated number of residential households.

Data collection took place over a 5.5 month period, from 18 January 2016 to 27 June 2016. Fieldwork was carried out by 33 field teams; each consists of one team supervisor, one field editor, three female interviewers, one male interviewer, two biomarker technicians and one driver. Data collectors were health professionals recruited from different health facilities throughout the country. Either all women in reproductive age (15–49) who resides permanently in the selected households or persons who stayed the night before the survey in the household were entitled to be part of the study subjects. About 16 583 entitled women were identified for individual interviews. Interviews were completed with 15 683 respondents resulting in a response rate of 95%.[8] To determine BCG vaccination status, women with no child (n=10 379) were excluded from the study. Therefore, the total sample size for this study was 5304 women, interviewed about their last child. The data was accessed from the DHS website after sending a request and getting permission. After getting sign up into the DHS website, the dataset will be available publicly.

For further details, please refer to https://dhsprogram.com/pubs/pdf/FR328/FR328.pdf.

Statistical analysis

Bivariate logistic regression with the outcome variable, that is BCG immunisation status of children, was employed. As a first step, univariable analyses were

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performed with each of the demographic indicators and other independent variables (socio-demographic, socio-economic and variables related to BCG vaccine) with the outcome variable. Variables significant at p value ≤0.2 were included in the multivariable logistic regression models. Variables that did not have a significant regression coefficient were removed from the model. Variables that were not significant at the univariate analysis were added back to the model and their significance assessed in the presence of other significant variables. Finally, we added demographic characteristics, such as age and sex, and predictors well known from previous research but not significant in our model. Subsequently, the goodness of fit of our final model was tested using the Hosmer–Lemeshow test. Data management procedures and statistical analysis were done using SPSS software V.20.

Patient and public involvement

There was no patient involvement in this study.

RESULTS

Socio-demographic characteristics

Out of the study participants (n=5304), the majority were in between 20 and 34 years of age (73.8%). The median age of the respondents was 28.4 (SD=±6.5) years old. Most of the participants were Muslims (48.2%) and Orthodox Christianity (3.4%) followers. Women from urban and rural areas were 20.5% and 79.5%, respectively. Large proportion of women (table 1) were married (93.5%) with low educational level, where only 12.6% of women had secondary and higher educations. About half of the women were below middle wealth index, poorer (16.5%) and poorest (35.4%). Only 15.1% were professional worker and many were not working during the study.

Table 1 Characteristics of study participants (women with their child) in Ethiopia (2016 DHS)

Respondent's characteristics	Frequency	Proportion (%)
Age group		
<20	310	5.8
20–34	3913	73.8
35–49	1081	20.4
Residence		
Urban	1086	20.5
Rural	4218	79.5
Education		
No education	3164	59.7
Primary (grade 1–8)	1471	27.7
Secondary (grade 9–12)	436	8.2
Higher (above grade 12)	233	4.4
Religion		
Orthodox	1667	31.4
Catholic	34	0.6
Protestant	954	18
Muslim	2554	48.2
Traditional	52	1
Other	43	0.8
Current marital status		
Married	4957	93.5
Living with partner	54	1
Widowed	56	1.1
Divorced	184	3.5
No longer living together/ separated	53	1
Wealth index		
Poorest	1878	35.4
Poorer	876	16.5
Middle	732	13.8
Richer	657	12.4
Richest	1161	21.9
Mothers' occupation		
Not working	3160	59.6
Professional	802	15.1
Agriculture	1000	18.9
Manual	342	6.4

Wealth index: Scores of consumer goods they own, ranging from a television to a bicycle or car, in addition to housing characteristics, such as source of drinking water, toilet facilities and flooring materials. Professional: Work after or qualified in a profession (eg, lawyer, engineer, nurses, etc).

BCG vaccination coverage

The prevalence of BCG vaccination was 63.6% (n=3373) and BCG vaccination coverage in urban residents was higher (88%) than rural residents (57.3%). A significant amount of difference in BCG vaccination coverage was also shown in the wealth index of women's aged 15–49, richest (87.4%) and richer (71.2%). The sex of the child did not showed a difference in BCG vaccination coverage, male (63.4%) and female (63.8%) with p value 0.413. Women who delivered their child at home (n=3117) had low vaccination coverage (50.5%). Out of the total women (n=356) who practised health check after discharge or home delivery, the majority (81.5%) were vaccinated (table 2).

Distance to a health facility to get medical help is not a big problem for about half of the respondents (n=2456); out of them, 72.8% of their child were vaccinated.

All kind of mass media exposure shows its importance on BCG vaccination coverage. From women who listen to radio at least once a week 78% of their children were vaccinated, greater than women who were not listenig radio at all (58.9%). Women watching television at least once a week showed greater BCG coverage (89.9%) than watching less than once a week (73.7%) and not at all (57.6%, p value<0.0001).

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Table 2 Immunisation status by parental and child characteristics in Ethiopia (2016 DHS)

Variables	Number of children	BCG immunised n (%)	P value
Type of place of residence			
Urban	1086	956 (88.0)	<0.0001
Rural	4218	2417 (57.3)	
Wealth index			
Poorest	1878	806 (42.9)	<0.0001
Poorer	876	580 (66.2)	
Middle	732	504 (68.9)	
Richer	657	468 (71.2)	
Richest	1161	1015 (87.4)	
Sex of child			
Male	2674	1696 (63.4)	0.413
Female	2630	1677 (63.8)	
Place of delivery grouped			
Home	3117	1575 (50.5)	<0.0001
Public sector	1924	1567 (81.4)	
Private sector	140	126 (90.0)	
NGO and others	123	105 (85.4)	
Respondent's health checked after discharge/ delivery at home			
No	4948	3083 (62.3)	<0.0001
Yes	356	290 (81.5)	
Getting medical help for self: Distance to health facility			
Big problem	2848	1584 (55.6)	<0.0001
Not a big problem	2456	1789 (72.8)	
Frequency of reading newspaper or magazine			
Not at all	4853	2979 (61.4)	<0.0001
Less than once a week	343	302 (88.0)	
At least once a week	108	92 (85.2)	
Frequency of listening to radio			
Not at all	3948	2327 (58.9)	<0.0001
Less than once a week	683	521 (76.3)	
At least once a week	673	525 (78.0)	
Frequency of watching television			
Not at all	4093	2356 (57.6)	<0.0001
Less than once a week	445	328 (73.7)	
At least once a week	766	689 (89.9)	
Total	5304	3373 (63.6)	

DHS, Demographic and Health Survey; NGO, non-governmental organisation.

Determinants of BCG vaccination

A multivariable logistic regression analysis (table 3) shows that mother's age level had a significant association with BCG vaccination. Mothers' age between 20 up to 34 (AOR=1.48; 95% CI: 1.13 to 1.93) and between 35 up to 49 (AOR=1.83; 95% CI: 1.35 to 2.46) were more likely to vaccinate their child's than those mothers' age less than 20. Type of residence of mothers also had a strong association with BCG vaccination. Women settled in urban areas were two times more likely to vaccinate their child's than those living in rural areas (AOR=1.94; 95% CI: 1.45 to 2.60). According to these finding, mothers who had primary education were 1.4 times more likely to vaccinate their child's than those who have no education (AOR=1.43; 95% CI: 1.22 to 1.68). Mother's work type had a significant effect on vaccination. Although being professional had no difference with non-working mothers, manual and household workers were two times more likely to vaccinate their children (AOR=2.00; 95% CI: 1.49 to2.70) than those who had no work. Households with higher wealth quartile had higher odds of BCG vaccine than poorest income quartile. Antenatal care was the strongest determinant factor for BCG vaccination, where mothers with greater antenatal visits show higher BCG vaccination, ANC 4 and above (AOR=3.48; 95% CI: 2.91 to 4.15).

DISCUSSION

This study confirms that BCG vaccination can be influenced by different socio-demographic and socio-economic factors. Mother's residence, number of antenatal visits, place of delivery and health check after delivery were some of the determinants of BCG vaccination in Ethiopia. The study also unveils BCG vaccination coverage was 63.6%, lower than most cited places, 94.7% in Senegal, 82% in East Pokot Baringo, Kenya, 76.7% in North Western Nigeria and 89% in Uganda.[5 10–12] There was a higher home delivery in the country, where 58.7% (n=3117) of the respondents were delivered at home. Vaccination coverage of women who had delivered their child at home was lower than women's delivered at a health institution.

About 73.8% of the respondents were between the age 20 and 34, similar to the findings in North Western Nigeria (73.8%) and Senegal (69.6%).[5 10] A multivariate logistic regression analysis (table 3) showed that older women were vaccinating their child than younger ones; mothers' in the age group 20–34 (AOR=1.48; 95% CI: 1.13 to 1.93) and 35– 49 (AOR=1.83; 95% CI: 1.35 to 2.46) were more likely to vaccinate their child's than those mothers' age less than 20. This may be due to increased awareness on immunisation, as a woman gets older through life experience.

BCG vaccination coverage in urban residents was higher (88%) than rural residents (57.3%), which is consistent with many studies.[3 5 12 13] Place of womens residence had a strong association with BCG vaccination. Women settled

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Table 3 Factors associated with BCG vaccination of children in Ethiopia (2016 DHS)

Variables	COR (95% CI)	AOR (95% CI)	P value
Mothers' age group			
<20	1.00	1.00	
20–34	1.35 (1.07 to 1.71)	1.48 (1.13 to 1.93)	0.004*
35–49	1.27 (0.99 to 1.65)	1.83 (1.35 to 2.46)	<0.001**
Residence			
Rural	1	1	
Urban	5.48 (4.52 to 6.65)	1.94 (1.45 to 2.60)	<0.001**
Mother's educational level			
No education	1	1	
Primary (grade 1–8)	2.49 (2.18 to 2.86)	1.43 (1.22 to 1.68)	<0.001**
Secondary (grade 10–12)	4.24 (2.86 to 5.51)	1.36 (1.00 to 1.84)	0.049
Higher (above grade 12)	6.80 (4.49 to 10.28)	1.27 (0.79 to 2.04)	0.332
Mother's occupation			
Not working	1	1	
Professional	2.00 (1.68 to 2.38)	0.96 (0.78 to 1.18)	0.687
Agriculture	1.35 (1.16 to 1.57)	1.40 (1.19 to 1.65)	<0.001**
Manual/household worker	2.65 (2.02 to 3.46)	2.00 (1.49 to 2.70)	<0.001**
Wealth index			
Poorest	1	1	
Poorer	2.61 (2.20 to 3.08)	1.88 (1.57 to 2.25)	<0.001**
Middle	2.94 (2.45 to 3.52)	1.98 (1.63 to 2.41)	<0.001**
Richer	3.29 (2.72 to 3.99)	1.91 (1.55 to 2.36)	<0.001**
Richest	9.25 (7.60 to 11.25)	2.22 (1.65 to 2.99)	<0.001**
Place of delivery grouped			
Home	1	1	
Public sector	4.30 (3.76 to 4.92)	1.53 (1.30 to 1.81)	<0.001**
Private sector	8.81 (5.05 to 15.37)	1.64 (0.88 to 3.04)	0.118
NGO and others	5.71 (3.45 to 9.46)	2.90 (1.69 to 4.96)	<0.001**
Health checked after discharge/ delivery at home			
No	1	1	
Yes	2.66 (2.02 to 3.49)	1.40 (1.04 to 1.88)	0.028*
Number of antenatal visits			
No antenatal visit	1		
ANC 1	1.78 (1.37 to 2.31)	1.41 (1.07 to 1.86)	0.016*
ANC 2	2.61 (2.10 to 3.23)	1.91 (1.52 to 2.40)	<0.001**
ANC 3	4.26 (3.57 to 5.08)	2.60 (2.14 to 3.15)	<0.001**
ANC 4 and above	7.40 (6.36 to 8.60)	3.48 (2.91 to 4.15)	<0.001**

*P<0.05; **P<0.001.
COR, crude odds ratio; DHS, Demographic and Health Survey; NGO, non-governmental organisation.

in the urban areas were two times more likely to vaccinate their child's than those living in the rural areas (AOR=1.94; 95% CI: 1.45 to 2.60). This finding was concordance with Burkina Faso[14] Health and Demographic Surveillance, where failure to timely BCG vaccination is higher in rural residences (AOR=3.02; 95% CI: 2.18 to 4.19), which may be due to the accessibility of health facilities in the urban areas. A significant amount of difference in BCG vaccination coverage was also shown in the wealth index of women.

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Immunisation service in Ethiopia is provided free of charge in public health facilities and facilities supported by non-governmental organisations (NGOs). However, service charges are incurred to clients at private health facilities.[15] In this study, wealth index has shown a significant association with BCG vaccination, where richest and richer mothers were two times more likely to vaccinate their child than poorest ones (AOR=2.22; 95% CI: 1.65 to 2.99). The finding was similar with Senegalese survey and systematic review on European parents,[5 16] but studies from Burkina Faso, Nigeria, Afghanistan and China showed that wealth index does not have a significant association with BCG vaccination.[14 17–19]

Table 3 shows that women delivered in public and NGO health facility had a significant association with BCG vaccination.

On the basis of the sex of the child, 63.4% of males and 63.8% of females got BCG vaccination, which shows that mothers had equal concern to vaccinate based on sex of the child. This finding was supported by the study in Burkina Faso and Afghanistan.[14 18] The majority of women (81.5%) who had a health check after discharge or home delivery were vaccinated for BCG, since it will address those children born at home and cannot access the services. Mothers who came for health check after delivery was 1.4 times more likely to vaccinate their child than their counterparts. For mothers who consider distance to a health facility to get medical help is not a big problem, 72.8% of their child are vaccinated, higher than finding from Senegal.[5]

Although all kinds of media exposure show the importance for BCG vaccination in this study, similar studies did not show a significant association of media exposure with BCG vaccination.[5 20] However, media exposure has an impact on awareness and behaviour, which in return influenced the health outcome of the people.

Mothers with primary education were 40% higher to vaccinate their child's than those who have no education (AOR=1.43; 95% CI: 1.22 to 1.68) concordant with the study in Delhi, India (AOR=1.58; 95% CI: 1.15 to 2.16).[21] However, a study in Burkina Faso showed BCG vaccination uptake was similar for mothers who have education and none.[14] Type of mother's work had a significant effect on vaccination. Although being professional had no difference with non-working mothers, manual and household workers were two times more likely to vaccinate their children than those who had no work. Number of antenatal care visits was among the determinant factor for BCG vaccination, where mothers with a greater antenatal visits show higher BCG vaccination like most other studies[10 13 21]; this may be related to health education, health promotion and increased awareness of the importance of BCG vaccination during their visit.

There were limitations of doing a study with survey data, since the variable of interest for the researcher may not found in the dataset. Further studies should be done with primary data to support the evidence of determinants of BCG in Ethiopia in different administrative areas. After all, the finding can be important or applicable to other countries with similar socio-demographic and socio-economic status.

CONCLUSIONS

BCG vaccination coverage in this study was lower, and determinant factors for BCG vaccination were residence, place of delivery, mother's antenatal visit and mother's occupation. On the basis of our findings, we recommend improving outreach and house-to-house BCG vaccination programme to address inaccessible communities in the rural areas. Awareness creation about the importance of BCG vaccination for the community can be another possible intervention. Further studies should also be done with the primary data collected for the interest of studying the determinants of BCG vaccine.

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Contributors AKT conceived and designed the study with additional inputs from GTW and YMA. AKT processed the data and produced the descriptive tables. GTW and YMA analyzed the data. AKT prepared the first draft of the manuscript. All authors contributed to the critical revision of the manuscript for important intellectual content and approved the final version to be published.

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REFERENCES

1. World Health Organization. *Global tuberculosis report*. 20th edn, 2016.
2. Department of Economic and Social Afairs, Population Devision. World population prospects: the 2017 revision. Ethiopian population. 2018.
3. Olusanya BO. Pattern and determinants of BCG immunisation delays in a sub-Saharan African community. *Health Res Policy Syst* 2010;8:1.
4. Li J, Menzies D, Landry JS, *et al*. Determinants of Bacillus Calmette-Guérin (BCG) vaccination among Québec children. *Prev Med* 2014;66:87–94.
5. Mbengue MAS, Sarr M, Faye A, *et al*. Determinants of complete immunization among senegalese children aged 12-23 months: evidence from the demographic and health survey. *BMC Public Health* 2017;17:630.
6. Wikipedia. *Demographics of Ethiopia*, 2018.
7. Ethiopian population. Department of Economic and Social Afairs, Population Devision. World population prospects: the 2017 Revision. 2018.
8. Central Statistical Agency (CSA) [Ethiopia] and ICF. *Ethiopia Demographic and Health Survey 2016*. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF, 2016.
9. Wikipedia. *Women's health in Ethiopia*, 2017:46.

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10. Asuke S, Ibrahim J, Ibrahim M, *et al*. Survey on coverage and factors influencing delays in BCG immunization in Hayin Mallam Zango, Zaria, North Western Nigeria. *Trop Med Surg* 2015;3.
11. Kiptoo E. Factors Influencing low immunization coverage among children between 12 - 23 Months in East Pokot, Baringo Country, Kenya. *International Journal of Vaccines & Vaccination* 2015;1.
12. Bbaale E. Factors influencing childhood immunization in Uganda. *J Health Popul Nutr* 2013;31:118–29.
13. Gidado S, Nguku P, Biya O, *et al*. Determinants of routine immunization coverage in Bungudu, Zamfara State, Northern Nigeria, May 2010. *Pan Afr Med J* 2014;18:8.
14. Schoeps A, Ouédraogo N, Kagoné M, *et al*. Socio-demographic determinants of timely adherence to BCG, Penta3, measles, and complete vaccination schedule in Burkina Faso. *Vaccine* 2013;32:96–102.
15. Federal Ministry of Health. Ethiopian national expanded program on immunization: comprehensive multi-year plan 2016 – 2020. 2015:11.
16. Tabacchi G, Costantino C, Napoli G, *et al*. Determinants of European parents' decision on the vaccination of their children against measles, mumps and rubella: a systematic review and meta-analysis. *Hum Vaccin Immunother* 2016;12:1–15.
17. Federal Ministry of Health. Ethiopian national expanded program on immunization: comprehensive multi-year plan 2016 – 2020. 2015.
18. Farzad F, A Reyer J, Yamamoto E, *et al*. Socio-economic and demographic determinants of full immunization among children of 12-23 months in Afghanistan. *Nagoya J Med Sci* 2017;79:179–88.
19. Hu Y, Chen Y, Liang H, *et al*. An Overview of Coverage of BCG Vaccination and its determinants based on data from the coverage survey in Zhejiang Province. *Int J Environ Res Public Health* 2018;15:1155.
20. Thysen SM, Byberg S, Pedersen M, *et al*. BCG coverage and barriers to BCG vaccination in Guinea-Bissau: an observational study. *BMC Public Health* 2014;14:1037.
21. Devasenapathy N, Ghosh Jerath S, Sharma S, *et al*. Determinants of childhood immunisation coverage in urban poor settlements of Delhi, India: a cross-sectional study. *BMJ Open* 2016;6:e013015.

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