International Journal of Advanced Community Medicine

Huda M Jawad Khadim
Department of Community Health, Faculty of Health and Medical Technologies, AL-Furat Al-Awsat Technical University, Al-Najaf, Iraq

AbdulKareem A Mahmood
Department of Community and Medicine, Faculty of Medicine, Alkafaeel University, Al- Najaf, Iraq

Timeliness of BCG vaccination and its associated factors among children aged 12-23 months in Kufa district, Najaf Governorate, Iraq

Huda M Jawad Khadim and AbdulKareem A Mahmood

Abstract
Background: The vaccine schedules recommend that children receive their vaccine at certain ages. The up-to-date method is used to report vaccine coverage data. According to Iraqi immunization schedule BCG vaccine taken by child at birth.
Materials and Methods: A cross-sectional study was conducted in Kufa district from 1 October. 2023 to January 25. 2024, Mothers and their children aged 12 to 23 months was included. Collected data using pre-tested questionnaires.
Results: Most parents are between 20 and 34 years old. Most of the mothers were house wife, while the fathers with free jobs. The families in this study had sufficient income and family status was joint. Most parents need less than 30 minutes to reach Primary health care centers. In regards to child birth and sex, the majority of mothers were with completed tetanus toxoid vaccine and most of children were female and 1st order. Education of fathers and child's place of birth are factors significantly associated with BCG vaccination status.
Conclusion: In the Kufa region, timely BCG vaccination was less compared to the WHO recommendation, and father's education and place of birth were associated with the suitability of BCG vaccination. We need to improve the importance of timely vaccination among parents and provide the best ways to ensure that the child receives the vaccine immediately after birth.

Keywords: Iraq, WHO, mycobacterium tuberculosis, BCG vaccination

Introduction

Vaccination is important to prevent infectious diseases [1], and vaccination in childhood can affect the early development of the immune system [2]. Most neonatal deaths occur during the first week of life [3]. Therefore, delaying vaccination may have serious consequences [4]. Tuberculosis kills 1.6 million people every year and is the leading cause of death. The emergence of drug-resistant Mycobacterium tuberculosis (M.tb) and the coexistence of HIV-TB co-infections have further exacerbated this situation. The Bacille Calmette-Guerin vaccine is the sole authorized vaccination with variable effectiveness. It is ineffective in treating adult pulmonary Tuberculosis [5]. About a century ago, Albert Calmette and Camille Guerin pioneered the development of a live vaccine. The Tuberculosis vaccination has been administered for several decades. The World Health Organization advises administering a solitary dosage of the vaccine to newborns residing in countries with higher disease prevalence and higher risk of infection [6]. The vaccine for children under one year old is given to the right deltoid muscle at birth [7]. After about two weeks, the vaccine produces a lump in the scrotum. A scar is left after that papule increases in size and heals slowly. If there is a profound immune-compromise including HIV, the vaccine is not recommended. The vaccine is not fully protective against the disease. In preventing meningeal and miliary Tuberculosis, it has been suggested that BCG is only 50%-80% effective. The effect of the vaccine is time limited, as it has little effect on the incidence of adulthood Tuberculosis [8]. BCG vaccination coverage is generally higher than other vaccines because BCG can be given at birth as a single vaccine [9]. Coverage assessments can give misleading information about disease control and Unvaccinated or under-vaccinated persons can be missed in immunization coverage assessments, which can lead to epidemics [10]. To ensure adequate protection against disease, timely vaccination is required [1].

Corresponding Author:
Huda M Jawad Khadim
Department of Community Health, Faculty of Health and Medical Technologies, AL-Furat Al-Awsat Technical University, Al-Najaf, Iraq

If BCG vaccination is not possible at birth, it should be administered as soon as possible after birth without delay to protect the child from infection before it occurs [11]. Despite significant declines in vaccine-preventable diseases in Iraq, unvaccinated children under one year of age still pose a risk to the spread and maintenance of infectious diseases in Iraq [12].

A World Health Organization study estimates that there will be 27 TB cases per 100,000 people in Iraq in 2020. As part of the national expanded vaccination programme, BCG is administered to children within the first week of life rather than to children older than one year of age [13]. Due to the importance of BCG vaccine, we conducted this study to determine the adequacy of BCG vaccination age coverage and associated factors in Kufa District, Najaf Governorate in Iraq.

Methodology
Study design and setting
The PHC-based cross-sectional study was conducted from 1October, 2023to 25January, 2024. This study was conducted in Kufa District, Government of Najaf, and Iraq. The purpose of this study was to assess the adequacy of BCG vaccination age coverage and identify associated factors in the Kufa district of Najaf Government, Iraq.

Sample size and sampling method
Sample size was determined using the formula for a single population proportion. The margin of error was 5%, the confidence level was 95%, the age-appropriate vaccination coverage was 50%, the non-response rate was 10%, and the final sample size included 388 children and their mothers. Systematic sampling technique was used to select the required number of children from each primary health care center using specific children in the vaccination session as the sampling frame.

Data collection tools and techniques
Data were collected through personal interviews. The questionnaire included questions on utilization of maternal health services, sociodemographic and economic aspects, and vaccination status of children (including non-vaccination and delayed vaccination). Use vaccination cards to collect data on children's vaccination status.

Data analysis
We entered data using the SPSS program and then analyzed the data using descriptive statistics to determine percentages and frequencies. Chi-square tests describe statistical associations between socioeconomic and demographic factors and appropriateness of BCG vaccination.

Ethical consideration
All participants had their verbal consent taken at the setting. Before starting this work, an official agreement from the Directorate of Health was appointed.

Results
The majority of parent age were between 20-34 y. Most of mothers were married and in term of education most fathers and mothers were had primary education. Majority of father occupations were free jobs 225(57.9%) while most of mother were house wife 334(86.1%). families in this study had sufficient income and regarding to family status were 212(54.6%) single and 176(45.3%) joint. 327(84.3%) were Most parent need <30 min to reach Primary health care centers. Regarding to child birth and sex most were female and 1st order, and mothers were had planned pregnancy 251 (64.6%), with 159(40.9%) regular ANC attendance and majority of mothers were with completed tetanus toxoid vaccine as shown It is listed in [Table 1].

Table 1: Socio-economic and demographic variables

Variable	Category	N	Percentage
age group of father (years)	< 20	12	3.0
	20-34	259	66.7
	35 and more	117	30.1
age group of mother (years)	<20	73	18.8
	20-34	258	66.4
	35 and more	57	14.6
Marital status	married	360	92.7
	divorced	10	2.5
	widowed	1	0.2
	separated	17	4.3
Education of father	illiterate	30	7.7
	Read & write	43	11.0
	Primary school	160	41.2
	Secondary school	73	18.8
	University & above	82	21.1
Education of mother	illiterate	18	4.6
	read and write	43	11.0
	primary school	144	37.1
	secondary school	86	22.1
	University and above	97	25
Occupation of father	government employee	130	33.5
	self-employed	15	3.8
	free job	225	57.9
	private employee	16	4.1
	other	2	0.5
Occupation of mother	House wife	334	86.0

	government employee	45	11.5
	private employee	7	1.8
	other	2	0.5
Family income	sufficient	265	68.2
	insufficient	123	31.7
Family status	single	212	54.6
	joined	176	45.3
Family size	<5	98	25.2
	5-10	213	54.8
	5 and above	77	19.8
Number of children	3 and less	278	71.6
	More than 3	110	28.3
Time to PHCC	<30min	327	84.2
	≥ 30min	61	15.7
Pregnancy status	Planned	251	64.6
	unplanned	137	35.3
ANC attendance	regular	159	40.9
	irregular	84	21.6
	in need	92	23.7
	Seek medication	53	13.6
TT status	Complete	255	65.7
	Uncomplete	88	22.6
	Don't know	44	11.3
	None	1	0.2
Sex of child	Female	201	51.8
	Male	187	48.1
Child order	1st	107	27.5
	2nd	99	25.5
	3rd	81	20.8
	4th	50	12.8
	5&above	51	13.1
Place of birth	home	11	2.8
	government hospital	284	73.1
	private hospital	93	23.9
Weight at birth	<2,500 gram	32	8.2
	≥2,500 gram	356	91.7

(Figure 1) show that from all 388 children (75.26%) were vaccinated with BCG vaccine on time, (22.68%) were delayed and (2.06%) were found to be unvaccinated.
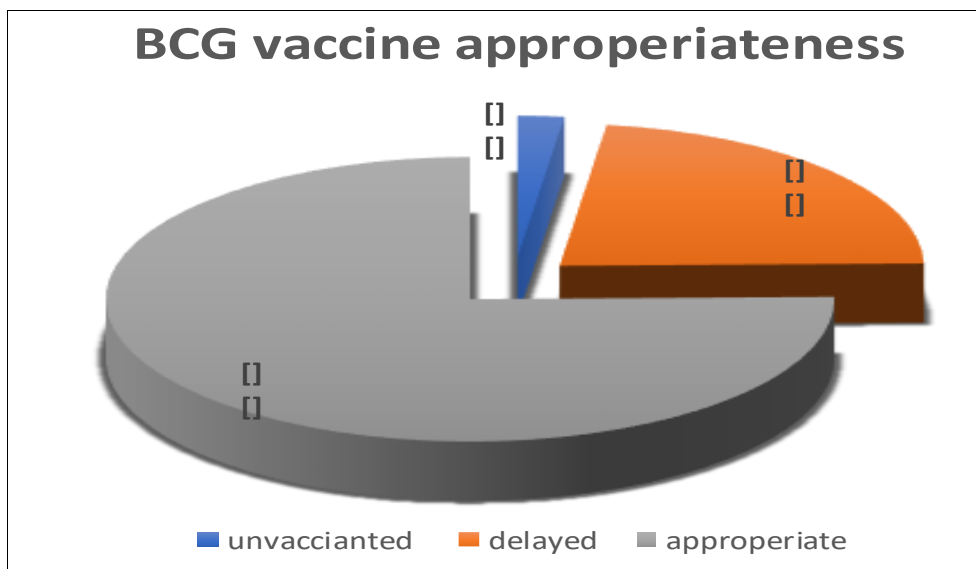

Fig 1: BCG vaccine appropriateness

Factors associated with approperiateness of BCG vaccination

Factors significantly associated with age appropriate BCG vaccination coverage were father education and place of birth. fathers' age were found to be not significantly associated and most of their children had on time BCG vaccination 198(76.4%) while 57(22.0%) were delayed and 4(1.5%) of fathers among this age group had children with unvaccinated BCG vaccine,similar for mothers age wherase 201(77.9%) had on time vaccinated children, 55(21.3%)

were delayed and unvaccinated were 2(0.8%) see (table 2). father education significantly associated with BCG vaccination status p value (0.01) were 160(42.1) primary school education from them 116(72.5%) vaccinated their children on time, 4(2.5%) were unvaccinated and 40(25.0%) had delayed BCG vacciantion, fathers who had unversity and above educational background constiue 82(21.1) were 71(86.6%)timely vaccination, delayed were 10(12.2%)and 1(1.2%)unvaccinated, mothers education level and occupational status of parent not significantly associated with vaccination status for BCG vacine, this study shown that the age apporperiate BCG vaccination coverage among families had sufficient income 265 (68.2) were 199(75.1%) from them vaccinated on time while delayed were 61(23.0%) and 5(1.9%) unvaccinated. 123 (31.7) of insufficient income of families 3(2.4%) had not vaccinated with BCG at all, 27(22.0%) delayed and 93(75.6%) timely vaccination. with regarding to number of children in family we found that most were 3 and less child 5(1.8%) unvaccinated, 58(20.9%) delayed and 215(77.3%) timely vaccinated with BCG vaccination. [Table1] and[Table 2].

Table 2: Sociodemographic characteristics of the study sample by state of time appropriateness of BCG vaccine

Sociodemographic characteristics		BCG vaccine appropriateness			Total N=388	P value
		None n=8	Delayed n=88	Appropriate n=292		
age group of father (years)	< 20	1 8.3%	3 25.0%	8 66.7%	12 100.0%	0.534
	20-34	4 1.5%	57 22.0%	198 76.4%	259 100.0%	
	35 and more	3 2.6%	28 23.9%	86 73.5%	117 100.0%	
age group of mother (years)	<20	3 4.1%	20 27.4%	50 68.5%	73 100.0%	0.089
	20-34	2 0.8%	55 21.3%	201 77.9%	258 100.0%	
	35 and more	3 5.3%	13 22.8%	41 71.9%	57 100.0%	
Marital status	married	7 1.9%	84 23.3%	269 74.7%	360 100.0%	0.327
	divorced	0 0.0%	1 10.0%	9 90.0%	10 100.0%	
	widowed	0 0.0%	1 100.0%	0 0.0%	1 100.0%	
	separated	1 5.9%	2 11.8%	14 82.4%	17 100.0%	
Father education	illiterate	3 10.0%	8 26.7%	19 63.3%	30 100.0%	0.010
	Read & write	0 0.0%	9 20.9%	34 79.1%	43 100.0%	
	Primary school	4 2.5%	40 25.0%	116 72.5%	160 100.0%	
	Secondary school	0 0.0%	21 28.8%	52 71.2%	73 100.0%	
	University & above	1 1.2%	10 12.2%	71 86.6%	82 100.0%	
Education of mother	illiterate	0 0.0%	7 38.9%	11 61.1%	18 100.0%	0.375
	read and write	2 4.7%	7 16.3%	34 79.1%	43 100.0%	
	primary school	4 2.8%	36 25.0%	104 72.2%	144 100.0%	
	secondary school	1 1.2%	21 24.4%	64 74.4%	86 100.0%	
	University and above	1 1.0%	17 17.5%	79 81.4%	97 100.0%	
Occupation of father	government employee	1 0.8%	23 17.7%	106 81.5%	130 100.0%	0.366
	self-employed	1 1.7%	5 33.3%	9 60.0%	15 100.0%	
	free job	5 2.2%	55 24.4%	165 73.3%	225 100.0%	
	private employee	1 6.3%	4 25.0%	11 68.8%	16 100.0%	

	other	0 0.0%	1 50.0%	1 50.0%	2 100.0%	
Occupation of mother	House wife	7 2.1%	79 23.7%	248 74.3%	334 100.0%	0.185
	government employee	0 0.0%	7 15.6%	38 84.4%	45 100.0%	
	private employee	1 14.3%	1 14.3%	5 71.4%	7 100.0%	
	other	0 0.01%	1 50.0%	1 50.0%	2 100.0%	
Family income	sufficient	5 1.9%	61 23.0%	199 75.1%	265 100.0%	0.919
	insufficient	3 2.4%	27 22.0%	93 75.6%	123 100.0%	
Family status	single	3 1.4%	52 24.5%	157 74.1%	212 100.0%	0.419
	joined	5 2.8%	36 20.5%	135 76.7%	176 100.0%	
Family size	<5	2 2.0%	24 24.5%	72 73.5%	98 100.0%	0.639
	5-10	3 1.4%	45 21.1%	165 77.5%	213 100.0%	
	>10	3 3.9%	19 24.7%	55 71.4%	77 100.0%	
Number of children	3 and less	5 1.8%	58 20.9%	215 77.3%	278 100.0%	0.313
	More than 3	3 2.7%	30 27.3%	77 70.0%	110 100.0%	
Time to PHCC	<30min	5 1.5%	76 23.2%	246 75.2%	327 100.0%	0.207
	≥30min	3 4.9%	12 19.7%	46 75.4%	61 100.0%	

In table 2 most of mothers had planned pregnancy 251(64.6) with regular antenatal care visits and 255(65.7) had completed TT status however these pregnancy related factors not significantly associated with appropriateness of BCG vaccination. Sex of child were the female and male in this study were nearly equal 201 (51.8%) and 187(48.1%) respectively and found to be not significantly associated with BCG vaccination status. With regarding to child s order results shown that most of child were first order 107 (27.5) and most of them had timely BCG vaccination 84

(78.5%). in term of weight most of children had normal weight at birth. place of birth statistically had significance association with appropriateness of BCG vaccination p value (0.019) most of deliveries occurred in government hospitals 284 (73.1) were 224(78.9%) with timely vaccination with BCG while 93(23.9) at private hospitals were 27(29.0%) had delayed vaccination with 61(65.6%) on time. unvaccinated children found to be higher in private hospital 5(5.4%) than government 3(1.1%) [Table1] [Table 3].

Table 3: Pregnancy related characteristics by BCG vaccination time appropriateness

Pregnancy related characteristics by BCG vaccination time appropriateness		BCG vaccine appropriateness			total	P value
		None n=8	Delayed n=88	Appropriate n=292	N = 388	
Pregnancy status	Planned	3 1.2%	59 23.5%	189 75.3%	251 100.0%	0.246
	unplanned	5 3.6%	29 21.2%	103 75.2%	137 100.0%	
ANC attendance	regular	3 1.9%	35 22.0%	121 76.1%	159 100.0%	0.344
	irregular	2 2.4%	13 15.5%	69 82.1%	84 100.0%	
	in need	1 1.1%	28 30.4%	63 68.5%	92 100.0%	
	Seek medication	2 3.8%	12 22.6%	39 73.6%	53 100.0%	
TT status	Complete	3 1.2%	56 22.0%	196 76.9%	255 100.0%	0.498
	Uncomplete	4 4.5%	19 21.6%	65 73.9%	88 100.0%	
	Don't know	1 2.3%	13 29.5%	30 68.2%	44 100.0%	

	None	0 0.0%	0 0.0%	1 100.0%	1 100.0%	
Sex of child	Female	5 2.5%	48 23.9%	148 73.6%	201 100.0%	0.678
	Male	3 1.6%	40 21.4%	144 77.0%	187 100.0%	
Child order	1st	3 2.8%	20 18.7%	84 78.5%	107 100.0%	0.570
	2nd	0 0.0%	20 20.2%	79 79.8%	99 100.0%	
	3rd	2 2.5%	20 24.7%	59 72.8%	81 100.0%	
	4th	2 4.0%	13 26.0%	35 70.0%	50 100.0%	
	5&above	1 2.0%	15 29.4%	35 68.6%	51 100.0%	
Place of birth	home	0 0.0%	4 36.4%	7 63.6%	11 100.0%	0.019
	government hospital	3 1.1%	57 20.1%	224 78.9%	284 100.0%	
	private hospital	5 5.4%	27 29.0%	61 65.6%	93 100.0%	
Weight at birth	<2,500 gram	1 3.1%	10 31.3%	21 65.6%	32 100.0%	0.417
	≥2,500 gram	7 2.0%	78 21.9%	271 76.1%	356 100.0%	

Discussion
The aim of our study was to determine the age appropriate of vaccination coverage for BCG vaccination in children aged 12 to 23 months and the main factors associated with it, we found that from 388 child within 2 years of age (75.26%) were had on time vaccination, this percentage lower than that found by study conducted in Mongolia they found age appropriately vaccinated for BCG were (97.7%) [14]. The proportion of children vaccinated with BCG on time was higher than in a study conducted in Bangladesh (24%) [15]. It may be due to the difference in geographical area and the resulting difference in cultures and beliefs .

Parent education considered one of important factors that affect the vaccination status as indicated by other studies [16-18], in our research we found that father education significantly associated while the educational background for the mothers had no effect. This is in sharp contrast to the results of some studies, which confirmed that maternal education in particular is one of the most important factors affecting children's vaccination [19, 20] This outcome may be attributed to the fact that the Iraqi father bears the responsibility for all matters concerning the kid, including taking them to the primary health care center (PHCC) for vaccinations, thereby influencing their child's health through education.

Many studies found that Place of birth found to be significantly associated. The mothers who get deliveries at public hospitals were more likely to have on time vaccination while private and on home deliveries had more delayed vaccination [21-23]. A study in Nigeria finds that delays in receiving the BCG vaccine are widespread among children born outside hospitals [24]. In this study, our findings indicate that individuals who gave birth at public hospitals had a significantly higher rate of timely BCG vaccination compared to those who gave birth at private hospitals. This discrepancy may be attributed to the fact that the majority of deliveries occur in government hospitals, where infants receive the BCG vaccination promptly after birth. Conversely, private hospitals do not provide any

immunizations, and parents are directed to visit the nearest health center to acquire the required vaccine. As a result, numerous parents choose to postpone the vaccination of their children.

There was no evidence of a connection between family income and BCG vaccination. This may be because the immunization is provided for free in Iraq, without any cost. Another Study found that the families with high income had more percent of being on time vaccination [25].

The attendance of mothers at antenatal care (ANC) did not have any impact on the timely decision to administer the BCG vaccination. This lack of effect may be attributed to the fact that most mothers received their antenatal care from a specific doctor, rather than relying on primary health care centers. Therefore, the vaccination of their children was not influenced by whether or not the mothers attended ANC regularly at the pregnancy unit in health centers [25].

Other factors were not had effect on BCG vaccination were sex of child, birth order and number of children and it's opposite to results by other studies [26-28].

Conclusion
In this study, it was discovered that over 75% of the children included had received the BCG vaccination in the correct time frame. However, this percentage is not acceptable, and therefore strategies need to be developed to ensure that all children receive the vaccine at birth. Additionally, it was found that the education level of the father and the place of birth were significantly associated with the timeliness of BCG vaccination.

Conflict of Interest
Not available

Financial Support
Not available

References
1. Bechini A, Boccalini S, Ninci A, Zanobini P, Sartor G,

Bonaccorsi G, et al. Childhood vaccination coverage in Europe: impact of different public health policies. Expert Rev Vaccines. 2019;18(7):693-701. DOI:10.1080/14760584.2019.1639502.

2. Ilyas M, Afzal S, Ahmad J, Alghamdi S, Khurram M. The resurgence of measles infection and its associated complications in early childhood at a tertiary care hospital in Peshawar, Pakistan. Pol J Microbiol. 2020;69:1-8.

3. Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: when? Where? Why?. Lancet. 2005;365(9462):891-900.

4. Thysen SM, Byberg S, Pedersen M, Rodrigues A, Ravn H, Martins C, et al. BCG coverage and barriers to BCG vaccination in Guinea-Bissau: an observational study. BMC Public Health. 2014;14:1-12.

5. Fatima S, Kumari A, Das G, Dwivedi VP. Tuberculosis vaccine: A journey from BCG to present. Life Sci. 2020;252:117594.

6. Aspatwar A, Gong W, Wang S, Wu X, Parkkila S. Tuberculosis vaccine BCG: the magical effect of the old vaccine in the fight against the COVID-19 pandemic. Int Rev Immunol. 2022;41(2):283-296.

7. Szczua L. Adverse events following immunization with BCG vaccine in Poland 1994-2000. Przegl Epidemiol. 2002;56(2):205-216.

8. Kliegman. Nelson textbook of pediatrics. 20th ed. Philadelphia: Elsevier; c2015. Chapter 172.

9. Ndirangu J, Bärnighausen T, Tanser F, Tint K, Newell ML. Levels of childhood vaccination coverage and the impact of maternal HIV status on child vaccination status in rural KwaZulu-Natal, South Africa. Trop Med Int Health. 2009;14(11):1383-1393.

10. Grassly NC, Fraser C, Wenger J, Deshpande JM, Sutter RW, Heymann DL, et al. New strategies for the elimination of polio from India. Science. 2006;314:1150-1153.

11. World Health Organization. BCG vaccine: WHO position paper, February 2018 – recommendations. Vaccine. 2018;36(24):3408-3410.

12. Hassan ZA. Factors associated with immunisation coverage of children aged 12-24 months in Erbil / Iraq 2017-2018; c2020 Sep. DOI:10.37200/IJPR/V24I8/PR281205.

13. Ali ZA, Al-Obaidi MJ, Sameer FO, Mankhi AA, Misha'al KI, Jassim IA, et al. Epidemiological profile of tuberculosis in Iraq during 2011-2018. Indian J Tuberc. 2022;69(1):27-34.

14. Rauniyar SK, Munkhbat E, Ueda P, Yoneoka D, Shibuya K, Nomura S. Timeliness of routine vaccination among children and determinants associated with age-appropriate vaccination in Mongolia. Heliyon; c2020, 6(9).

15. Sheikh N, Sultana M, Ali N, et al. Coverage, timelines, and determinants of incomplete immunization in Bangladesh. Trop Med Infect Dis; c2018.

16. Al-Shemari KD. Causes of delay in age-appropriate vaccination. Iraqi Postgrad Med J. 2006;5:32-98.

17. Sheikh N, Sultana M, Ali N, Akram R, Mahumud RA, Asaduzzaman M, et al. Coverage, timelines, and determinants of incomplete immunization in Bangladesh. Trop Med Infect Dis. 2018;3(3):72.

18. Alrowaili GZ, Dar UF, Bandy AH. May we improve vaccine timeliness among children? A cross sectional survey in northern Saudi Arabia. J Fam Community Med. 2019;26(2):113-117.

19. Pugliese-Garcia M, Heyerdahl LW, Mwamba C, Nkwemu S, Chilengi R, Demolis R, et al. Factors influencing vaccine acceptance and hesitancy in three informal settlements in Lusaka, Zambia. Vaccine. 2018;36(37):5617-5624.

20. Piot P, Larson HJ, O'Brien KL, N'kengasong J, Ng E, Sow S, et al. Immunization: vital progress, unfinished agenda. Nature. 2019;575(7781):119-129. DOI:10.1038/s41586-019-1656-7.

21. Nadella P, Smith ER, Muhihi A, Noor RA, Masanja H, Fawzi WW, et al. Determinants of delayed or incomplete diphtheria-tetanus-pertussis vaccination in parallel urban and rural birth cohorts of 30,956 infants in Tanzania. BMC Infect Dis. 2019;19:188. DOI:10.1186/s12879-019-3828-3.

22. Meleko A, Geremew M, Birhanu F. Assessment of child immunization coverage and associated factors with full vaccination among children aged 12-23 months at Mizan Aman town, Bench Maji zone, Southwest Ethiopia. Int J Pediatr. 2017;7976587. DOI:10.1155/2017/7976587.

23. Akwataghibe NN, Ogunsola EA, Broerse J, Popoola OA, Agbo AI, Dieleman MA. Exploring factors influencing immunization utilization in Nigeria-A mixed methods study. Front Public Health. 2019;7:392. DOI:10.3389/fpubh.2019.00392.

24. Olusanya BO. Pattern and determinants of BCG immunisation delays in a sub-Saharan African community. Health Res Policy Syst. 2010;8:1-10.

25. Mekonnen ZA, Gelaye KA, Were MC, Tilahun B. Timely completion of vaccination and its determinants among children in northwest, Ethiopia: a multilevel analysis. BMC Public Health. 2020;20:1-13.

26. Marefiaw TA, Yenesew MA, Mihirete KM. Age-appropriate vaccination coverage and its associated factors for pentavalent 1-3 and measles vaccine doses, in northeast Ethiopia: A community-based cross-sectional study. PLoS One; c2019, 14(8).

27. Ariyibi SO, Ojuawo AI, Ibraheem RM, Afolayan FM, Ariyibi RO, Akanbi PO. Factors influencing routine vaccination uptake and completion among children aged 12–23 months in Ilorin, North-Central Nigeria: A cross-sectional survey. Int J Med Health Dev. 2023;28(4):314-320.

28. Mbengue MAS, Mboup A, Ly ID, Faye A, Camara FBN, Thiam M, et al. Vaccination coverage and immunization timeliness among children aged 12-23 months in Senegal: a Kaplan-Meier and Cox regression analysis approach. Pan Afr Med J; c2017, 27(Suppl 3).