

Original Article

Magnitude of vaccination delay and associated factors among children aged 12-23 months in Damot Sore Woreda, Wolaita Zone, South Ethiopia

Begidu Bashe^{1*}

¹ Lecture of Epidemiology, Hossana Health Science College, Hossana, Ethiopia, Research Service Coordinator, Pharma College Wolaita Sodo Campus, Wolaita Sodo, Ethiopia

* Corresponding author: beginbashe95@gmail.com

Abstract

Background: Delaying vaccines make children susceptible to vaccine preventable diseases and play important role in persistence of vaccine preventable diseases. WHO reported that, about 17 million infants did not receive an initial dose of DPT vaccine on recommended age and additional 5.6 million infants are partially vaccinated which made the children susceptible to VPDs worldwide. The aim of this study was to determine magnitude of vaccination delay and associated factors among children aged 12-23 months in Damot Sore Woreda, Wolaita, South Ethiopia.

Methods: Community based cross-sectional study was conducted from May 16 to June 30, 2022. A simple random sampling technique was used to select study participants with sample size of 549. Bi-variable and multivariable logistic regression analyses were done to identify factors associated with vaccination delay. Variables in bi-variable logistic regression with P-value <0.25 were candidate variables for multi-variable logistic regression. A P-value of <0.05 was considered to declare significance level.

Results: A total of 529 mothers were participated in the study, making the response rate 96.35%. In this study 224(42.34%) (95% CI 38.18% - 46.61%) children were delayed to receive at least one of vaccines. Children of mothers who have no formal education [AOR = 4.29, (95% CI 1.7 - 10.6)] and who were attended primary school [AOR = 2.97, (95% CI (1.2 - 7.4))]: mothers who delivered at home [AOR = 4.42, (95% CI 2.9- 6.7)] and mothers who have ≥ 2 children aged <5 years in the house [AOR=2.02, 95% CI 1.1 - 3.7)] were significantly associated with vaccination delay.

Conclusion: Our study showed that, significant number of children delayed to receive studied vaccines on time. Lower level of mothers' educational status, home delivery and two or more than two under five children living in the households were determinants of vaccination delay. Health professionals would consider about vaccination delay in addition to the coverage, starting from date of birth.

Keywords: - Vaccination Delay, Children, Wolaita, Ethiopia

Introduction

Delayed vaccination refers to administration of a vaccine dose more than 30 days after the recommended national immunization schedule(1). Vaccination is one of core health programs around the world and widely used indicator of its performance at national and global level is estimating the coverage of two vaccines DPT3/Penta3 (Diphtheria- Pertussis, Tetanus) and Measles containing vaccines(2-4).

Only assessing immunization coverage may overlook the timeliness of specific doses administered. Timely vaccination is crucial to sustain immunity of the community against vaccine preventable diseases (VPDs), ensure populations are fully protected against severe illnesses as early as possible and prevent epidemics of VPDs. Ensuring children have access to timely vaccinations is critically important and cost-effective way to decrease incidence of diseases within population. However, delay in receiving a dose increases vulnerability for VPDs (5).

Children who delay to receive first doses may end up with an altered sequence of vaccinations, which in turn causes non-specific effects of vaccines with negative consequences on childhood morbidity and mortality (6). That why it is so essential to

monitor the immunization timetable because it ensures that infants immune system to defend infants long-term from VPDs. Vaccines should be given on a recommended timetable for the infants to protect them as early from VPDs. If the vaccination is delayed, infants are susceptible to VPDs and at greater risk of developing severe diseases and its complications. Children who are delayed to get vaccines are not only at risk for themselves, but also can spread disease to unimmunized counterparts (7-9).

Evidences showed that vaccination delay among children is common in different parts of the world including developed countries. Most of studies showed that children delay to receive later doses than first doses for vaccines commonly requiring multiple doses. Delay in vaccination of specific vaccines differs from country to country but as shown by many studies it is more common on later age than early age of children and children who received birth dose vaccine timely have less delay in subsequent vaccine doses (9-14). For instance, one-third of children in America delay to receive vaccines on time (15), and in Ethiopia about 73% of children delay to receive all recommended vaccines on time (16). In 2019, WHO included vaccine hesitancy to immunize their children as one of ten threats of global health (17). In 2020,

WHO reported that about 17 million infants did not received an initial dose of DPT vaccine on recommended age and additional 5.6 million infants are partially vaccinated which made the children susceptible to VPDs worldwide(18). In the same year, 13.7 million (80%) children delayed to start first dose of vaccines on time lived in GAVI-eligible countries. From those almost two thirds of zero-dose children were in ten nations including Ethiopia(19). As a result, VPDs are still serious global public health challenges, mainly in SSA and Asia (20).

These vaccination rates are very low to attain the 90% and 95% coverage target of Africa's Regional Vaccine Action Plan and recommended by the WHO to protect against VPDs, respectively. Meanwhile, the Global Immunization Plan 2030, has the ambitious target to achieve 90% coverage for all important childhood vaccinations which only focused in total coverage and ignored timely vaccination(2,21). Despite best efforts, children could not always get all vaccines in a well-timed manner as per the recommended age of WHO immunization schedule⁽¹⁾. Therefore, it is essential to extend our understanding to the factors for vaccination delay and associated reasons for vaccination delay at community level. This study was aimed to determine the magnitude of vaccination delay, its associated factors for vaccination delay among children aged

12-23 months in Damot Sore Woreda, Wolaita South Ethiopia.

General objective

To determine magnitude of vaccination delay and associated factors among children aged 12-23 months in Damot Sore Woreda, Wolaita zone, South Ethiopia, 2024

Specific objectives

- To determine magnitude of vaccination delay among children aged 12-23 months in Damot Sore Woreda, Wolaita zone, South Ethiopia, 2024
- To identify factors associated with vaccination delay among children aged 12-23 months in Damot Sore Woreda, Wolaita zone, South Ethiopia, 2024

Methods and Materials

Study area and period

The study was conducted in Damot Sore woreda, Wolaita, South Ethiopia from May 16 to June 30, 2022. Damot Sore woreda is one of 16 woredas in the Wolaita zone which is located 17 KM West of Wolaita Sodo town, Capital city of Wolaita zone (**Figure 1**). The woreda has 20 rural kebeles and three semi-urban cities. Based on 2007 national census, the estimated population of the Damot Sore woreda in 2021/2022 is 111,412. Of these 54,592 are males, 56,820 are females and 3554 are children aged between 12-23 months (22).

There are four health centers and twenty health posts in the woreda, which provide primary health care services to the community including vaccination. Each health post operated by at least 2 health extension workers (HEWs) who provide

immunization service for children and carries out home to home children identification and registering, vaccination defaulter finding and awareness creation in the each kebele. Additionally, vaccination service is provided as an outreach service.

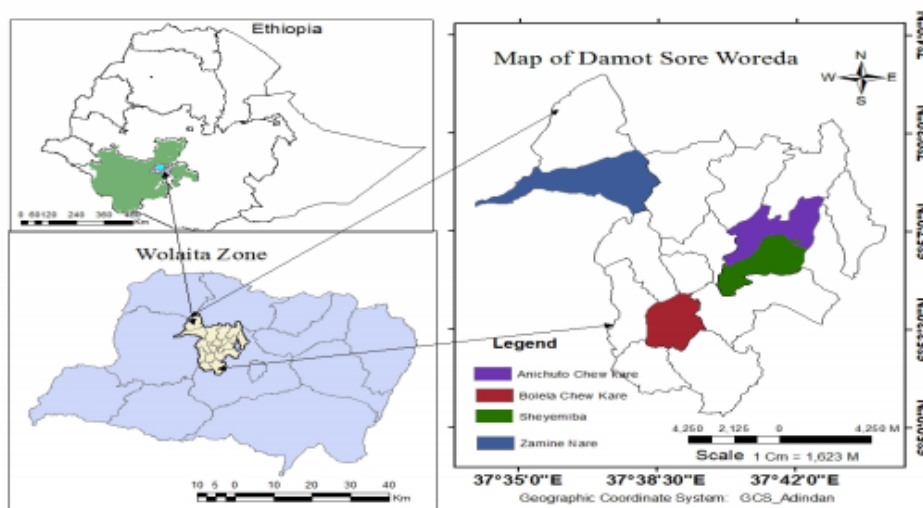


Figure 1. The map of Damot Sore Woreda, Wolaita zone, Southern Ethiopia, 2021

Study design

A community-based cross-sectional study method was conducted.

Population

The source population consisted of all mothers/care givers with children aged 12-23 months who had initiated routine vaccination and were residing in Damot Sore Woreda and all randomly selected mothers/caregivers with children aged 12-23 months had initiated routine vaccination in selected kebeles were study population.

Inclusion and Exclusion Criteria

Mothers/caregivers who have children aged 12-23 months living in selected kebeles were included in the study whereas

mothers/care givers who were severely ill during data collection or unable to talk were excluded from the study.

Variables

- **Dependent variable:** Vaccination delay was our dependent variable
- **Socio-demographic variables:** Age of mother/care giver, Occupation of mother/care giver, Education level of mother/care giver, Religion, Wealth index, Residence, Marital status, Distance to vaccination site, Number of age <5 children in the household;
- **Maternal factor variables:-** ANC follow up, Place of delivery, Knowledge about vaccination, PNC follow up;

- **Child factor variables:-** Age of child, Birth order, Sex of child, Season of birth, and Illness were independent variables.

Operational definitions

- **Vaccination delay-** refers to the vaccine dose given late or past the window of timeliness set for that vaccine, in the national immunization schedule (after 28 days of the recommended age for Pentavalent vaccine and 12 months age of children for Measles vaccine)(1). Child is said to be delayed, if delayed to receive one of the following vaccines (Penta1, Penta2, Penta3 or Measles).
- **Care giver-** an individual who take full responsibility of the child care including vaccination in first year of life in any setting.

Knowledge about vaccination:- assessed by asking fifteen questions and those who answered eight and above has good knowledge.

Sample size determination

The sample size was calculated using a single population proportion formula to determine sample size for first objective with the following statistical assumptions.

$$n = \frac{z\alpha / 2^2 P(1-P)}{d^2}$$

Taking magnitude of vaccination delay (29.5%) from study conducted in Tigray,

Northern Ethiopia (14), with parameter of 95% of confidence level, 4% margin of error, and 10% non-response rate the final sample size was 549.

Sampling procedure

From total kebele (20) in the woreda, 6 kebeles were selected by lottery method. Samples were proportionally allocated to each selected kebele. Then a simple random sampling technique was used to select households using a sampling frame obtained from the family folder in the health posts. When two or more children living in the same household occur, one child was selected by lottery method. First, a list of all eligible households were prepared in Microsoft excel after obtaining household number from the HEWs then, households were selected. Finally, each eligible study participant was contacted through the house to house visits. Two successive visits were done, in case if a mother was absent in the house during the first visit.

Data collection tool and procedure

Data were collected by using structured questionnaire adapted from 2018 WHO vaccination coverage cluster survey manual(23), WHO survey questions (24) and different literatures (14,25,26). Mothers/care givers knowledge assessing questionnaire was adapted from different literatures which has fifteen close ended questions with two possible responses Yes(1) and No(0)(27,28).

Data about children's vaccination status was collected from home based records (HBRs) referred to as children's vaccination card. If the HBR is not available, or poorly filled (unreadable or incomplete), children's vaccination status was obtained from facility-based records (FBRs)(24). Data were collected by face to face interview by six diploma nurses/midwives and supervised by two other BSc health professionals. Data collectors were addressed each household based on the household's identification number of family folder and parental name which was set by the principal investigator.

Data quality assurance

To assure data quality pre-test was done on 5% of the sample in Waja Kero Kebele, Sodo Zuria Woreda and which adjustments were made on findings. Data collectors and supervisors were trained for 2 successive days to enable them to have a common understanding on the questionnaire. Data were checked for completeness, consistency, accuracy and clarity in daily base. Daily supervision was done by the supervisors and the principal investigator.

Data analysis

Complete data were entered into Epi-data Version 4.6 Software and exported to STATA Version 14 for analyses. After cleaning and coding, descriptive statistics were computed and the outcome variable (vaccination delay) was dichotomized as

delayed and age appropriately vaccinated. Bi-variable and multi-variable logistic regression analyses were used to identify factors associated with vaccination delay. A variable with a P-value of <0.25 in the Bi-variable logistic regression were considered as candidate variable for Multi-variable logistic regression analysis model to identify independent factors for vaccination delay. An adjusted odds ratio (AOR) with 95% confidence level was computed to observe the strength of association between the vaccination delay and its predictors. A P-value of <0.05 was considered to have statistically significant association between independent variables and vaccination delay.

Ethical consideration

After obtaining ethical clearance from Ethical Review Committee of the College of Health Sciences and Medicine, Wolaita Sodo University, an official letter was written to Damot Sore Woreda health office for permission. Similarly, support letters was obtained from Damot Sore Woreda health office. Finally, the objective of the study was briefed to the head of health centers and corresponding HEWs to get permission to conduct the study in the selected kebeles. Before starting the interview with mothers/caregivers of eligible children, oral consent was obtained.

Results

Socio-Demographic Characteristics of Respondents

From 549 samples, 529 mothers/care givers responded to the interviews, making the response rate 96.4%. From all respondents 527(99.3%) were mothers. The mean age of participants was 28.58 ± 4.34 years. About 227(42.9%) of study participant were not

attended formal education and 336(63.52%) mothers were housewife. Most of respondents 516(97.5%) were married and 463(87.5%) of mothers currently have only one child aged under five. More than half 282(53.31%) of children included in the study were females, with mean age of 17.6 ± 2.99 months (**Table 1**).

Table 1: The socio-demographic characteristics of the respondents in Damot Sore Woreda, Wolaita Zone South, Ethiopia, 2024 (n = 529).

Variable	Category	Frequency	Percent
Religion of Respondents	Protestant	251	47.45
	Orthodox	238	44.99
	Catholic	18	3.4
	Other	22	4.16
Age of Respondents in years	15-19	11	2.08
	20-24	92	17.39
	25-29	198	37.43
	30-34	159	30.06
	35+	69	13.04
Educational status of Respondents	No formal education	227	42.91
	Primary	178	33.65
	Secondary	90	17.01
	Diploma/above	34	6.43
Occupation of Respondents	House wife	336	63.52
	Merchant	182	34.40
	Government employed	11	2.08
Marital status of Respondents	Currently married	516	97.54
	Currently not married	13	2.46
Number of children aged < 5 years in the house hold	One child	463	87.52
	Two or more children	66	12.48
Sex of children	Female	282	53.31
	Male	247	46.69
Distance to vaccination site	Less than 30 minutes	519	98.11
	≥ 30 minutes	10	1.89
Age of children in month	12-18	295	55.77
	>18	234	44.23
Wealth index	Poorest	113	21.36
	Poor	104	19.66
	Middle	118	22.31
	Rich	97	18.34
	Richest	97	18.34
Knowledge	Good knowledge	333	37.05
	Poor knowledge	196	62.95

Utilization of health services by mothers/caregivers

Three hundred eighty seven (73.2%) of mothers have history of ANC follow up, from 113(29.2%) and 107(27.7%) mothers

attended twice and three times respectively (Figure 2). Nearly two third (64.1%) of mothers gave birth in the health institution (Figure 3).

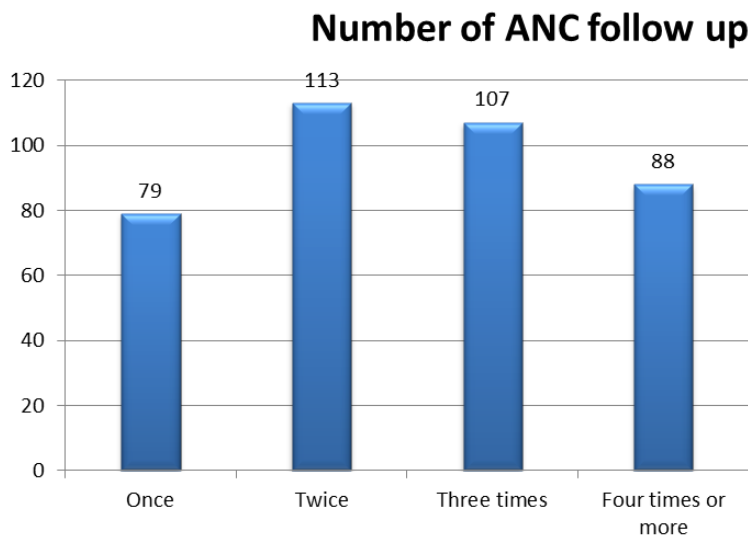


Figure 2. The number of ANC follow up history of study participants in Damot Sore Woreda Wolaiata Zone South Ethiopia, 2024 (n=529)

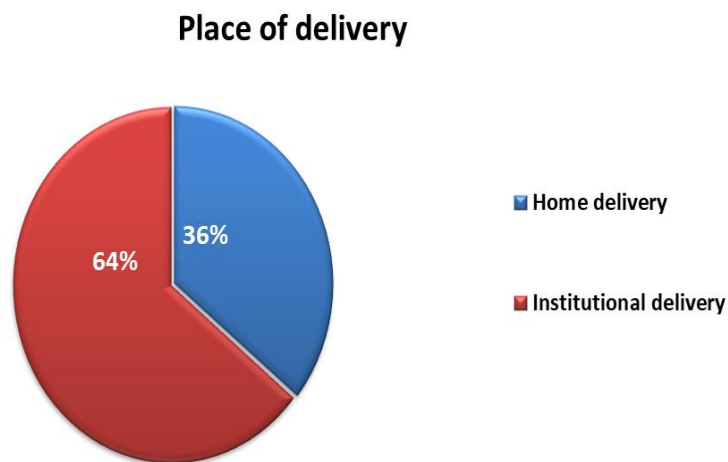


Figure 3. The places of delivery of study participants in Damot Sore Woreda, Wolaita Zone South Ethiopia 2024 (n=529)

Magnitude of vaccination delay

A total of 224(42.3%, 95% CI 38.2% - 46.6%) children were experienced delayed vaccination for at least one vaccine dose.

Among these, the magnitude of delay for each vaccine dose category pentavalent one (PENTA-1), two (PENTA-2), three (PENTA-3) and measles vaccines was found

to be 33.9%, 54%, 60.3%, and 53.1% respectively (Figure 4).

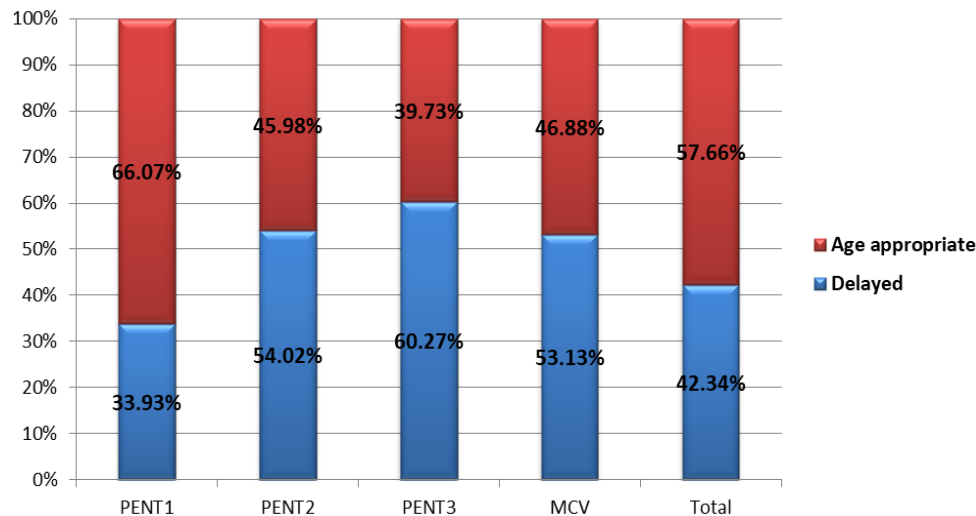


Figure 4. The magnitude of vaccination delay in Damot Sore Woreda, Wolaita Zone South Ethiopia 2024 (n=529)

Factors associated with vaccination delay

Bi-variable logistic regression analysis for associated factors

In the Bi-variable logistic regression analysis educational status of mothers/care givers, birth order of children, season of birth, history of severe illness of children, number of under-five children in the house, place of delivery, age of mothers/care givers and age of children were variables that showed significant association with children vaccination delay at p-value of <0.25.

Multivariable logistic regression analysis for associated factors

After adjusting for the confounding effects of others, mothers/care givers educational status, number of under-five children in the household and place of delivery were

variables significantly associated with vaccination delay (Table 2).

Children's from mothers/care givers who have no formal education were 4.3 (AOR= 4.3, 95%CI 1.7 - 10.6) and mothers/care givers who were attended primary school were 3.0 (AOR= 3.0, 95%CI (1.2 - 7.4) times higher odds of delay to vaccinate their children in the recommended age compared to mothers /care givers who attended College or above.

Mothers/care givers who gave birth at home were 4.4 (AOR = 4.4, 95%CI 2.9- 6.7) times higher odds of delay to vaccinate their children in the recommended age compared to mothers/care givers who were delivered in the health institutions.

Mothers/care givers who have two or more children aged less than five years in the house were 2 (AOR = 2.0, 95%CI 1.1- 3.7)

times higher odds of delay to vaccinate their children in the recommended age compared to mothers /caregivers who have one child aged less than five years in the house. Final

model fitness was checked by Hosmer-Lemeshow goodness-of fit test and the model was a good fit with P-value = 0.695.

Table 2. The Multivariable logistic regression for factors associated with vaccination delay among children aged 12-23 months in the Damot Sore Woreda, Wolaita zone, South Ethiopia, 2024 (n=529).

Variables	Delayed n (%)	Age appropriate n (%)	COR	AOR [95% CI]	P-value
Educational status					
No formal education	116(51.11%)	111(48.89%)	2.90	4.29[1.74 - 10.59]	(0.002)**
Primary school	79(44.38%)	99(55.62%)	2.22	2.97[1.19 – 7.42]	(0.019)**
Secondary school	20(22.22%)	70(77.78%)	0.79	0.84[0.31 - 2.27]	0.729
College/above	9(26.47%)	25(73.53%)	1	1	1
Number of <5 children in the house					
2 or > 2 children	42(63.64%)	24(36.36%)	2.70	2.03[1.11 - 3.71]	(0.022)**
1 child	182(39.51%)	281(60.69%)	1	1	1
Place of delivery					
Home	120(63.16%)	70(36.84%)	3.87	4.42[2.90 - 6.73]	<0.001**
Health institutions	104(30.68%)	235(69.32%)	1		1

COR= Crude Odds Ratio, **AOR**= Adjusted Odds Ratio, ******= Significance level at $p < 0.05$, **1**= Reference

Discussion

Vaccination brought greater impact on public health interventions by decreasing the burden of childhood disease and preventing millions of deaths worldwide. On the other hand, insufficient and partial immunization is a major public health problem in poor nations like Ethiopia. In this study, the magnitude of childhood vaccination delay in receiving at least one vaccine among children aged 12-23 months was found to be 42.3% (95% CI 38.2% - 46.6%).

Finding from this study is comparable with study conducted in Addis Ababa which reported that the magnitude of childhood

vaccination delay is 44% (29). Finding of this study is higher when compared to study conducted in Edagahamus Tigray, Northern Ethiopia 29.5%⁽¹⁴⁾ and lower than a study of Toke Kutaye district, Central Ethiopia 65.4%(30). This figure is lower when compared with findings from Gambia 63.3 %(31) and Toke Kutaye district, Central Ethiopia 65.4%(30). This difference might be related with difference in study design, and study settings.

Magnitude of delay for pentavalent3 vaccines (60.3%) is higher compared to studies conducted in Mongolia (43.2%) (11), Bangladesh (51%) (32), Toke Kutaye

Central Ethiopia (21%) (30) and Tigray, Northern Ethiopia (6.6%) (14) and lower compared with studies conducted in India (78.02%) (33). This difference might be due to study setting and difference in sample size. The magnitude of pentavalent3 vaccines is consistent with studies conducted in North East Ethiopia (64.5%) (26). This consistency might be due to similarity of study population characteristics and study design.

The magnitude of pentavalent2 vaccines is higher compared to studies conducted in Toke kutaye Central Ethiopia (18.3%) (30) and Tigray Northern Ethiopia (3.3%) (14). This might be due to health service utilization of study participants and sample size. The magnitude of pentavalent2 vaccine is consistent with finding from study conducted in North Eastern Ethiopia (57.3%) (26). This consistency might be due to similarity of study population and study setting.

The magnitude of pentavalent1 vaccine delay is higher compared with studies conducted in Mongolia (23.8%) (11), Toke Kutaye Central Ethiopia (12.7%) (30) and Tigray Northern Ethiopia 1.7% (14), and it is lower compared to studies conducted in Ethiopia (63.8%) (34) and North Eastern Ethiopia (54.1%) (26). This might be due to sample size, study setting, and design.

The magnitude of Measles vaccine delay is higher compared to studies conducted in Mongolia (44.7%) (11), Bangladesh (36%) (32), North Eastern Ethiopia (22.3%) (26), Toke Kutaye Central Ethiopia (26%) (30) and Tigray Northern Ethiopia (7.3%) (14), and lower compared to studies conducted in India (65.08%) (33) and Ethiopia (68.5%) (34). This might be due to sample_size and study setting. This shows that, more children delay to get vaccinated on later doses than first dose and this may contribute to in increasing vaccine dropout rate and missing out children. Finally, those children were not protected and susceptible for vaccine preventable disease. Therefore, decreasing number of children those delays to get vaccines may improve immunization program.

Regarding to factors associated with vaccination delay, our study found that mothers/care givers educational status, place of delivery and number of children in the household were significantly associated factors with childhood vaccination delay. According to this study, low level of educational status of mothers/care givers is significantly associated with vaccination delays, which means mothers/care givers who were completed primary school and have no formal education have higher odds of delay to vaccinate their children. This is

due to mothers/care givers with lower educational level were less likely to utilize health care service and more likely to forget the appointments and schedules of immunization. Another reason was mothers/caregivers did not understanding the risk of vaccination delay. This indicated as mothers not understanding the risk of delaying to vaccinate their children was related with low level of maternal educational status and lack of sufficient information regarding to vaccination. Lack of adequate information about benefits of vaccines was another reason for vaccination delay. Most of mothers reported that, they don't know the benefits of each vaccines, rather they vaccinate when HEWs come on the date of vaccination.

This finding is in line with studies conducted in Bangladesh (32), India (33), China (35), LMICs (5), Senegal (36) and Tigray Northern Ethiopia (14). This finding is in contradiction with study conducted in Lebanon (37). This indicates that, mothers who were illiterate and have lower level of educational status need consideration from date of delivery by counseling where and when to vaccinate their children. In addition to this, great emphasis would be set to make mothers to remember date of appointment and immunization schedule. Another reason that contributes for vaccination delay was

lack of motivation of mothers to give birth in the health institutions. This is because; they prefer home delivery due to not to expose themselves for health professionals which they don't know and not understanding the risk of giving birth at home. This finding is supported by previous studies. It is consistent with studies conducted in China (35), India (33), Bangladesh (32), Gambia (31) and Tseke Central Ethiopia (30).

Strengths of the study

One of the strength of this study is being a community-based study and using sufficient sample size.

Limitations of the study

The study has several limitations like using family folder to get study participants is limitation of this study which may have poor quality. Since this study included only fully vaccinated children those for appropriately recorded on vaccination registration and family folder only, therefore the proportion of vaccination delay might be over or under estimated. The findings for associated factors were not indicating causality since the study design was cross-sectional. Further, the present study did not include health professionals and facility side factors that contribute for vaccination delays are other limitations of the study.

Conclusion

Our study showed that, many children delay to receive studied vaccines later than recommended period on study area. Lower level of mothers/care givers educational status, home delivery and two or more than two under five children living in the house holds were important determinants of vaccination delay. Monitoring not only vaccination coverage but also vaccination delay is also a useful tool to improve immunization program. Health leaders and policy makers should incorporate vaccination timeliness indicators into routine EPI program monitoring system. In the future, researchers should incorporate factors related with health professionals and health facility side factors that contribute for vaccination delay.

Conflict of interest

Authors have no conflict of interest.

Acknowledgment

I would like to acknowledge Wolaita Sodo University College of Health Science and Medicine, School of Public Health., Damot Sore Woreda Health Office and HEWs of each health post for their cooperation. Also my gratitude goes to data collectors, supervisors and respondents for their commitment and collaboration.

Abbreviations and acronyms

ANC- Anti-Natal Care, DPT- Diphtheria-Pertussis-Tetanus, DHS- Demographic Health Survey, EDHS-Ethiopia Demographic Health Survey, EPI- Expanded Program of Immunization, FBR- Facility Based Record, FGD- Focus Group Discussion, GAVI- Global Alliance for Vaccine and Immunization, HBR- Home Based Record, HEWs- Health Extension Workers, LMICs- Low and Middle Income Countries, MCV- Measles Containing Vaccines, SSA- Sub-Saharan Africa, VPD- Vaccine Preventable Diseases.

Author contributions

Conceptualization, data curation, formal analysis, investigation, methodology, software, writing – original draft, and writing – review and editing: **Begidu Bashe**

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