Factors associated with low coverage of the second dose of Measles Containing Vaccine among children aged 19–59 months, Alego-Usonga Sub-County, Kenya, 2020

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ABSTRACT

Introduction: The coverage of the second dose of the measles-containing vaccine (MCV2) in Kenya has remained low since its introduction in 2013. We assessed the MCV2 vaccination coverage and identified the factors associated with low MCV2 coverage in Alego-Usonga Sub-County, Siaya County, Kenya. **Methods:** We conducted a community-based cross-sectional study between July and August 2020 in the Alego-Usonga Sub-County targeting parents/guardians of children aged 19 – 59 months. We used the mother-child (MCH) booklet to identify the eligible children and interviewed their parents/guardians at the household level using structured questionnaires. We calculated mean, median, and standard deviations for continuous variables and frequencies and proportions for categorical variables. We calculated prevalence odds ratios (POR) at the bivariate level and adjusted prevalence odds ratios (APOR) at the multivariable level together with their corresponding 95% confidence intervals to identify factors associated with low MCV2 coverage. We considered those factors which had $p<0.05$ at the multivariable level as independently associated with low MCV2 coverage. **Results:** A total of 417 records of the 420 children who were recruited into the study were included in the analysis. Of these, 51.1%(213/417) children had received MCV2 vaccination. The MCV2 vaccination coverage was higher in Urban 58.0%(/(141/243)) compared to rural 41.4% (72/174) populations. Factors that were independently associated with low MCV2 vaccination for the urban area included; a child's birth order (APOR 2.6; 95% CI=1.33–4.89) and caregiver education (APOR 1.9; 95% CI=1.10–3.31). For the rural; child's birth order (APOR 2.8; 95% CI=1.21–6.32); number of ANC visits (APOR 2.30; 95% C.I =1.17–4.52); caregiver not accompanied by the partner to the clinic (APOR=2.6; 95.5% CI=1.26–5.32); and caregiver not preferring nearby health facility (APOR 2.6; 95% CI=1.32–5.22) remained significantly associated with low MCV2 vaccination. Major reasons for non-vaccination were lack of caregiver awareness of MCV2 and vaccine stock-outs. **Conclusion:** The MCV2 coverage remained sub-optimal below the WHO-recommended ≥ 95%. Caregivers' lack of information on MCV2 and vaccine stock-outs were the main reason for the low coverage. Efforts should focus on raising public awareness of MCV2 vaccination.

Introduction

Since its introduction in 1963, the measles vaccine has led to a reduction in measles-related infections and deaths globally [1,2]. It is estimated that between 2000-2017, about 21.1 million measles-related deaths were prevented through vaccination [3-5]. According to the World Health Organization (WHO), two doses of measles-containing vaccine (MCV) are essential for protecting children against measles disease[6]. Studies on measles vaccine efficacy assessment have shown a vaccine efficacy of 84 percent for a single dose of MCV given at 9-11 months [7,8]. Giving a second dose of MCV increases its efficacy to over 95 percent, thereby raising the need for both doses [7].

The global coverage for the first dose of the measles-containing vaccine (MCV1) has remained relatively constant at 85 percent since 2010 even with population growth [9]. In 2017, the global coverage for the second dose of the measles-containing vaccine (MCV2) stood at 67 percent. The lowest coverage has been recorded in the African Region (AFR) at 74 percent for MCV1 and 25 percent for MCV2 [5,9].

It is estimated that approximately 169 million children missed out on MCV1 vaccination between 2010-2017 and around 19.2 million in 2018 globally [10]. In Kenya, the national coverage was 89 percent for MCV1 and 35 percent for MCV2 in 2017, and 89 percent for MCV1 and 45 percent for MCV2 in 2018 [11,12]. In 2019, Siaya County, where Alego-Usonga Sub-County is located had MCV1 and MCV2 coverage of 73.3 percent and 29.2 percent respectively [13]. These accumulations of high numbers of unvaccinated children and the low coverage of both MCV1 and MCV2 are considered major contributing factors to the significant measles outbreaks experienced between 2017 and 2019 across all the WHO regions [6]. In 2019, an estimated 413,308 measles cases were reported in 187 WHO member countries representing an unprecedented 132 percent rise in cases reported in 2018 [14]. The largest rise was 900% from the African Region and 230% from the Western Pacific Region [15]. Between January and April 2019, Kenya registered a total of 418 cases with five fatalities, a case fatality rate (CFR) of 1.2 percent [16].

While studies have established several factors associated with the general use of vaccination services, there is little information as to why low MCV2 vaccination coverage persists, despite its availability [17,18]. In 2019, the Alego-Usonga Sub-County in Kenya had MCV2 coverage of 38.6 percent pointing to a possibility of the existence of high numbers of unvaccinated children, and the potential for measles outbreaks. We, therefore, sought to assess the MCV2 vaccination coverage and identified the factors associated with its low coverage in Alego-Usonga Sub-County.

Methods

Study setting

We conducted this study in Alego-Usonga Sub-County which is located in Siaya County in the western region of Kenya. It has six administrative wards, 42 community units, 517 villages, and 2245 households. In the 2019 population census, 12.2% of the population were children under five years of age [19]. The majority of the residents were of the Luo community and roughly 89% lived in rural areas [20]. Of the 68 health facilities in the sub-county, 45 were offering routine immunization services. In 2019, Siaya County, where Alego-Usonga Sub-County is located had MCV2 coverage of 29.2 percent compared to national coverage of 45.0 percent. Alego-Usonga Sub-County had MCV2 coverage of 38.6 percent in the same year [13].

Study design and population

We conducted a community-based cross-sectional study between July 2020 and August 2020. Children born from February 1, 2014, to December 1, 2018 (aged 19-59 months) formed the study population since they were past 18 months, the age due for the second dose of measles (MCV2) vaccination. We interviewed caregivers who had at least one child born during the period under study and must have stayed in the study area for at least one year before the study. Only children whose mother-child booklets (MCH) were available were included in the study.

Sample size determination

We used Cochran´s formula [21] to estimate the sample size required for the study. Assuming an MCV2 coverage of 38.6% for the study area [13], and a 5% level of precision the minimum sample size after adjusting for 10% non-response was 406 participants.

Sampling procedures

We used a multistage sampling technique to select the study participants. Using the 2019 estimated ward MCV2 coverage, two wards (one urban and one rural) with the lowest coverage among the six wards in the Sub-County were selected. We then ranked the community units (CUs) from the highest populated to the lowest populated using the population of children aged under five years and chose the first three CUs in each ward. A total of six CUs were selected. We entered all 84 villages of the six CUs into an MS Excel spreadsheet and using a table of random numbers, selected 42 villages. The sample size for each village was then calculated based on the proportion of the population of children under five years of age for the 42 villages. With the help of the Community Health

Volunteers (CHVs), we determined the central point of each village during data collection. The first household to be visited and the direction of movement was determined by spinning a bottle. The nearest household in the direction of the tip of the bottle was used as the first household for the interview. In case the selected household did not have an eligible child or the household members were absent or declined to participate in the study, the closest neighboring household with an eligible child was visited. The eldest child was selected when a household had more than one eligible child Figure 1.

Definition of operational terms

Caregiver - The person who takes primary responsibility for someone who cannot take care of himself or herself fully, usually a family member (father or mother).

MCV2 vaccine coverage - Proportion of eligible children who had received the second dose of measles-containing vaccine (MCV2) according to the immunization schedule

MCV2 - The second dose of the measles-containing vaccine

Low MCV2 vaccination - Coverage below the WHO-recommended vaccination coverage of 95% to achieve herd immunity

Data collection

We collected data from the caregivers using a pre-tested, structured questionnaire administered at the household. The questionnaire was initially developed in English and later translated into the Luo language. We collected data on; the socio-demographic characteristics of the child and the caregiver, the immunization status of the child, the factors associated with low MCV2 vaccination, and the reasons for non-vaccination. We checked the MCH booklet to verify the child´s immunization status and the information recorded in the questionnaire.

Data management and analysis

The collected data were entered into Epi-info version 7.2.3 (CDC, Atlanta GA, USA) for cleaning and analysis. Data cleaning was done by checking and correcting for duplicates and wrong entries. Three records had wrong entries and were not included in the final analysis. We calculated the mean, median, and range for continuous variables. The categorical variables were summarized into frequencies and proportions. In the bivariate analysis, we calculated prevalence odds ratios (POR), 95% confidence intervals (C.I), and p-values. The outcome of interest for bivariate analysis was low MCV2 vaccination based on the child's MCV2 immunization status. We assessed the relationship between the outcome and sociodemographic characteristics (sex, age, birth order, place of delivery, marital status, caregiver level of education), number of ANC visits, caregiver awareness of MCV2 vaccination, and health facility preference. Variables with a Chi-square test with $p < 0.2$ at the bivariate analysis were taken to the multivariable analysis where a forward stepwise selection logistic regression method was used to identify factors independently associated with low MCV2 coverage. Adjusted Prevalence Odds Ratio (APOR), 95% C.I, and p-values were calculated; those variables with $p < 0.05$ were retained in the final model and considered significantly associated with low MCV2 coverage.

Ethics considerations

This study was approved by the Moi University-Moi Teaching and Referral Hospital Institutional Research and Ethics Committee (MU-MTRH IREC), approval number 0003612. The informed consent form was read to each participant (child´s parent/guardian) and written consent was obtained by them signing the consent form. For the participants who were < 18 years of age, we sought verbal assent from them after obtaining permission from their parents. We maintained confidentially by omitting any personal identifiers of the participants during data analysis..

Results

Socio-demographic characteristics

A total of 420 children aged 19-59 months were recruited and their caregivers were interviewed. Of these, 417 (99.3%) had sufficient data completed and were included in the analysis; 243 (58.3%) were from urban areas. The median age for children was 34.0 months (IQR=19 Months), the males were 212 (50.8%); 391 (93.8%) of them were born at a health facility and 204 (48.9%) had not received the MCV2 vaccination. For the caregivers, 391 (93.8%) were mothers of the recruited children; their median age was 28 years (Range 17-66 years), and 349 (83.7%) were married. Nearly 80.0% (334) of all the caregivers had either primary or secondary education and 47.2% (197) were not aware of the MCV2 vaccination. The median distance to the nearest health facility was one kilometer (Range 1 - 3 kilometers) Table 1.

MCV2 vaccination coverage

A total of 213 children had received the MCV2 vaccination giving an MCV2 vaccination coverage of 51.1% (213/417). There was a significant difference (p=0.0008) in MCV2 vaccination between urban and rural (58.0% (141/243)) vs (41.4% (72/174)). Among the four community units where the study was conducted, Karapul had coverage of 61.9% (83/134) while Mahola had 10.0% (3/30). The overall drop-out rate for MCV2 for those who had received MCV1 was 46.9% (188/401) with

Mahola Ulawi Community Unit recording the highest drop-out rate of 88.0% (22/25) and Karapul Community Unit recording the lowest at 36.6%(48/131)Table 2.

Factors Associated with low MCV2 Coverage

Overally, the probability of a child not receiving MCV2 vaccination was associated with children who were of higher birth order (Birth order >1)(POR 2.69, 95% CI=1.75 - 4.12) compared to those who were of first birth order (birth order=1); children whose caregiver had primary or no basic education (POR 2.2, 95% CI=1.49 - 3.26) compared to those whose caregivers had at least secondary school education. It was also associated with caregivers having attended less than four (< 4) ANC visits (POR 2.2, 95% CI=1.41 - 3.37) compared to those who had attended at least four or more (≥ 4) ANC visits; caregivers not being accompanied by his or her partner to the clinic (POR 1.6, 95% CI=1.07 - 2.51) compared to those who were accompanied by their partners to the clinic. Similarly, those children whose caregivers did not prefer the nearby health facilities to the households (POR 1.6, 95% CI=1.10 - 2.40) were more likely to miss out on MCV2 vaccination compared to those whose caregivers preferred the health facilities nearer to their households Table 3a and Table 3b .

In the urban setting, children who were not of first birth order (birth order >1) had 3.0 odds of not receiving MCV2 vaccination compared to those who were of first birth order (birth order =1) (POR=3.0; 95% C.I 1.72-5.32). Similarly, the odds of not receiving MCV2 vaccination was 2.3 times higher for the children whose caregivers had primary or no education compared to those whose caregivers had at least secondary school education (POR=2.3; 95% C.I 1.35-3.85). The children whose caregivers attended less the four (< 4) ANC visits (POR 1.9, 95% CI=1.08 - 3.27) were more likely to miss MCV2 vaccination compared to the children whose caregivers attended at least four or more (≥ 4) ANC visits. For the rural setting, children whose caregivers attended less than four (< 4) ANC visits (POR 2.3, 95% CI=1.14 - 4.81) were more likely to miss out on MCV2 vaccination compared to those whose caregivers had made at least four or more (≥ 4) ANC visits. Other factors that were associated with low MCV2 vaccination at the bivariate level included; caregivers not accompanied by the partner to the clinic (POR=2.3; 95% C.I 1.18-4.51) and caregivers not preferring the nearest health facility to their households (POR=2.2; 95% C.I 1.18-4.09; p<0.05) Table 3a and Table 3b.

Adjusting for the factors simultaneously, two factors; child´s birth order (APOR= 2.6; 95% C.I 1.33-4.89) and caregiver education (APOR=1.91; 95% C.I 1.10-3.31) remained significantly associated with the low MCV2 coverage for the urban area. For the rural, four factors; child´s birth order (APOR= 2.8; 95% C.I 1.21 - 6.32); number of ANC visits made by the caregiver (APOR= 2.3; 95% C.I 1.17-4.52); caregiver not accompanied by the partner to the clinic (APOR=2.6; 95.5% C.I 1.26-5.32) and caregiver not preferring nearby health facility (APOR=2.6; 95% C.I 1.32-5.22) remained significantly associated with MCV2 coverage Table 4.

Reasons for children missing MCV2 vaccination

Approximately 60.8% (124/204) of the caregivers whose children had not received MCV2 vaccination responded that they were not aware of the existence of MCV2 vaccination and 16.7% (34/204) responded that they took their children for MCV2 vaccination but the service was not available due to vaccine stock-outs Figure 2.

Discussion

This study sought to estimate the MCV2 coverage in Alego Usonga Sub-County, Siaya County, Kenya, and the factors associated with the low coverage of MCV2. We observed a slight variation in MCV2 vaccination coverage and factors associated with low MCV2 for the rural and urban areas in the study area. This study identified childbirth order and caregiver education as the independent factors associated with low MCV2 vaccination for the urban population in the study area. For the rural population, the factors that were found to be significantly associated with low MCV2 coverage included; child birth order, number of Antenatal Care (ANC) visits made by the caregiver, caregiver not being accompanied by their male/female partner to the clinic, and caregiver not preferring the nearby health facility. From the study findings, the MCV2 vaccination coverage was far below ≥ 95%, WHO-recommended coverage for global measles elimination [22,23]. This low proportion of children who had received MCV2 could affect the herd immunity that is required for individual and community protection.

We observed significant variations in the MCV2 vaccination between the rural and urban areas. The coverage for MCV2 vaccination was lower among the rural populace compared to the urban. The possible explanation could be due to long waiting times and lack of information on MCV2 vaccination. Most of the health facilities in the rural areas were mainly health centers and dispensaries with limited numbers of staff. This could have resulted in the long waiting time at the health facilities, which may have discouraged caregivers from taking their children for vaccination. Similarly, the staff shortage could have led to a high workload at the rural health facilities which could have made it difficult for healthcare providers to share relevant information on immunization with the caregivers. This was consistent with findings of other similar studies done in Ethiopia

between 2014 and 2017 where rural residence was associated with low immunization and high dropouts [24-26].

The children who were of higher birth order (Birth order >1) were more likely to miss MCV2 vaccination compared to those of first birth order (firstborns) in both urban and rural areas. This is consistent with findings of other similar studies done in China between 2016 and 2017 where higher birth order was associated with missed opportunities for MCV2 vaccination [27,28]. The possible explanation for this could be due to diverted parental attention and resources to other competing demands by the caregivers. The parents/caregivers tend to take good care and pay keen attention to the firstborns compared to the subsequent children. Additionally, vaccine hesitancy could also be another possible explanation. Caregivers may tend to hesitate to take their subsequent children for more than one dose of measles based on their potential experiences with the side reactions/adverse events following immunization of their firstborn children.

We identified an association between caregiver level of education and low MCV2 vaccination. However, this was only significant for the urban population. Children whose caregivers had no formal education or had only attended primary school were more likely to have missed MCV2 vaccination. Similar studies done in Sub-Saharan Africa and India between 2008 and 2021 have identified a significant association between the caregiver´s level of education and the uptake of immunization services [29-34]. This may be due to the caregivers with a low level of education not being well informed on the importance of vaccination and not being able to read the immunization card and know when the schedule is due.

The number of ANC visits made by the caregivers was associated with low MCV2 vaccination in our study. This finding was consistent with findings from other similar studies done in India, and in 69 low and middle-income countries between 2017 and 2020 [35,36]. In these studies, children whose caregivers had not attended at least four ANC visits as recommended were more likely to have missed MCV2 vaccination compared to those whose caregivers had attended at least four visits. However, for this study, these finding was found to be only significant for the rural population. The possible explanation for this could be due to the caregivers from rural areas missing out on vital information about immunization services and the benefits of routine immunization which is usually provided by the health care providers to the caregivers during the ANC visits. Strategies to strengthen ANC attendance by caregivers in rural areas should be initiated by the health department in the study area.

This study showed that the children whose caregivers were not accompanied by their partners to the clinic for immunization were more likely to miss MCV2 vaccination compared to those whose caregivers were accompanied by their partners. This only applied to rural areas. Partner involvement has been shown to improve health-seeking behavior and seeking health services, especially in the HIV/AIDS program [37]. This is an area that can be leveraged in the provision of immunization services including MCV2 vaccination.

In the rural areas, children whose caregivers did not prefer seeking vaccination services at the nearby health facility to their household were more likely to miss MCV2 vaccination compared to those whose caregivers preferred the nearby health facility. A possible explanation for this could be that these caregivers would have to travel long distances to reach the health facility for immunization services. However, despite other studies indicating a significant association between distance to the nearest facility and low take-up of immunization, no significant association was found in this study. The median distance to the nearest health facility from the households was one kilometer (Range 1-3 Kilometers) for both urban and rural health facilities in the study area hence distance was not a major problem in our study area [38]. There is a need for further investigation to understand the reasons why some caregivers did not prefer a nearer health facility to their household.

In this study, the majority of the participants mentioned lack of awareness and vaccine stock-outs as the major reasons why they had not taken their children for vaccination. We found that nearly half of the caregivers were not aware of MCV2 vaccination. This could be due to inadequate awareness creation to the public during the introduction of the vaccine in the National Immunization Schedule. Besides, the lack of provision of information to the caregivers during clinic visits by the health care providers could have contributed to the same. Studies conducted in Kakamega, Kenya, and Mtwara in Tanzania established an association between lack of awareness and the non-uptake of MCV2 vaccination [18,39]. Knowledge about vaccination services and being reminded about the return date for vaccination may affect the completion of vaccination. According to Etana and Deressa, failure to provide adequate information to the caregivers by the health workers may result in a reduction in the seeking of health services [40]. When the mothers are made aware of the vaccination services being provided including the scheduled dates, they may be able to bring their children for vaccination.

Study limitations

This being a cross-sectional study, the risk factors and outcomes were measured simultaneously, and therefore it may be difficult to determine whether the exposure proceeded or followed the outcome. Also, the lack of inclusion of the design effect during sample size

calculation to control for inter-cluster variation was another limitation of this study.

Conclusion

The MCV2 vaccination coverage among children aged 19–59 in Alego Usonga Sub-County though improving was still far below WHO recommended coverage of ≥ 95%. Lack of information on the second dose of measles vaccination (MCV2) and inability to access vaccination services due to vaccine stock-outs were the main reasons for low MCV2 vaccination coverage. We, therefore, recommend local strategies to be taken at the community/village level to create awareness about MCV2 vaccination. Immunization outreaches could be utilized to capture those eligible children who were yet to receive MCV2 vaccination. The vaccination defaulter tracing systems should also be strengthened to capture those children who had missed out on MCV2 vaccination. The ministry of health through the unit of vaccines and immunization services should also ensure a consistent supply of vaccines to lower-level health facilities.

What is known about this topic

- Place of delivery and the number of ANC visits made by the caregiver is significantly associated with MCV2 vaccination uptake although in this study place of delivery was not significant
- Lack of information on MCV2 vaccination by the caregivers is associated with the non-uptake of MCV2 vaccination.

What this study add

- This study identified that children whose caregivers were not accompanied by their partners (spouses) to the clinic had increased odds of missing on MCV2 vaccination compared to those whose caregivers were accompanied by their spouses. The immunization programs should encourage partner involvement in child immunization
- Lack of caregiver preference for the nearby facility for child immunization was significantly associated with low MCV2 vaccination. We suggest a further investigation to understand why some of the caregivers did not prefer the nearby health facilities
- There are significant variations in MCV2 vaccination coverage and factors associated with low MCV2 vaccination coverage for both rural and urban areas. Some factors apply to both rural and urban settings while others are unique for each.

Competing interests

The authors declare no competing interests.

Authors' Contributions

MN conceived and designed the study, acquired, analyzed, interpreted the data and wrote the first draft of the manuscript. BL contributed substantially to analysis and interpretation of data. BK, LB, ARA and JH critically reviewed the paper for important intellectual content. All authors read and approved the manuscript.

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Tables and Figures

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Table 1: Demographic and socio-economic characteristics of caregivers and children aged 19–59 months, in Alego Usonga Sub-County, Siaya County, Kenya 2020 (n=417)

Variable	**Total**	**Urban**	**Rural**
	Freq. (%)	**Freq. (%)**	**Freq. (%)**
Child Sex			
Male	212(50.8)	115(47.3)	97(55.8)
Female	205(49.2)	128(52.7)	77(44.2)
Child's Birth Order			
1	137(32.9)	92(37.9)	45(25.9)
2_4	241(57.8)	136(56.0)	105(60.3)
> 4	39(9.3	15(6.1)	24(13.8)
Place of Delivery			
Home	26(6.2)	10(4.1)	16(9.2)
Health Facility	391(93.8)	233(95.9)	158(90.8)
Immediate Caregiver			
Mother	391(93.8)	230(94.6)	161(92.5)
Father	11(2.6)	6(2.5)	5(2.9)
Other*	15(3.6)	7(2.9)	8(4.6)
Caregiver age (Years)	237(56.8)	148(60.9)	89(51.2)
< 30	180(43.2)	95(39.1)	85(48.8)
> 30			
Caregiver Marital Status			
Married	349(83.7)	205(84.4)	144(82.8)
Single	43(10.3)	30(12.3)	13(7.5)
cohabiting	11(2.6)	2(0.8)	9(5.1)
Widowed	7(1.7)	5(2.1)	2(1.2)
Other**	7(1.7)	1(0.4)	6(3.4)
Caregiver Education Level			
No formal education	13(3.1)	3(1.2)	10(5.8)
Primary	204(48.9)	102(42.0)	102(58.6)
Secondary	130(31.2)	83(34.2)	47(27.0)
Tertiary	70(16.8)	55(22.6)	15(8.6)
Caregiver Main Occupation			
Unemployed	133(31.9)	85(35.0)	48(27.6)
Employed - Self	222(53.2)	114(46.9)	108(62.1)
Employed - Formal	62(14.9)	44(15.2)	18(10.3)
Number of ANC Visits			
< 4	293(70.3)	159(65.4)	134(77.0)
≥ 4	124(29.7)	84(34.6)	40(23.0)
Caregiver Aware of MCV2 Vaccination			
Yes	220(52.8)	147(60.5)	73(42.0)
No	197(47.2)	96(39.5)	101(58.0)

*Other=(Sister, Relatives);**Other=(Separated, Divorced); Freq.=Frequency

Table 2: Measles Containing Vaccine Vaccination Dropout rate among children aged 19–59 months in Alego Usonga Sub-County, Siaya County, Kenya 2020

			Drop Out	**Dropout Rate***
Community Unit	**MCV1**	**MCV2**	**(MCV1-MCV2)**	**%**
Mahola Ulawi	25	3	22	88.0
Kodiere	28	12	16	57.1
Kabura	28	13	15	53.6
Nyandiwa	86	44	42	48.8
Mulaha	103	58	45	43.7
Karapul	131	83	48	36.6
Overall	401	213	188	46.9

*Drop Out rate=MCV1-MCV/MCV1

Table 3a: Bivariate analysis, of factors associated with low MCV2 coverage among children aged 19–29 months in Alego Usonga Sub-County, Siaya County, Kenya, 2020 stratified by residence (Urban and Rural)

Variable	Overall				Urban				Rural			
	No	Yes	POR (95% C.I)	P-Value	No	Yes	POR (95% C.I)	P-Value	No	Yes	POR (95% C.I)	P-Value
Child Sex												
Female	98	107	0.92(0.62-1.34)	0.654	51	77	0.83(0.49-1.38)	0.477	47	30	1.19(0.65-2.20)	0.563
Male	106	106			51	64			55	42		
Child Birth Order												
> 1	159	121	2.69(1.75-4.12)	0.000	78	73	3.03(1.72-5.32)	0.000	81	48	1.92(0.97-3.82)	0.058
1	45	92			24	68			21	24		
Place of Delivery												
Home	17	9	2.06(0.89-4.73)	0.082	5	5	1.40(0.39-4.97)	0.599	12	4	2.27(0.70-7.33)	1.191
Health Facility	187	204			97	136			90	68		
Immediate Caregiver												
Others*	12	14	0.89(0.40-1.96)	0.770	6	7	1.19(0.38-3.67)	0.753	6	7	0.58(0.18-1.80)	0.342
Mother	192	199			96	134			96	65		
Caregiver age (Years)												
< 30	109	128	0.76(0.51-1.12)	0.169	57	91	0.69(0.41-1.17)	0.172	52	37	0.98(0.53-1.79)	0.957
> 30	95	85			45	50			50	35		
Marital Status												
Single***	23	34	0.66(0.37-1.18)	0.163	14	22	0.86(0.41-1.77)	0.684	9	12	0.48(0.19-1.21)	0.117
Married	181	179			88	119			93	60		
Main Occupation												
Unemployed	63	70	0.91(0.60-1.37)	0.664	37	48	1.10(0.64-1.87)	0.71	26	22	0.77(0.39-1.52)	0.461
Employed	141	143			65	93			76	50		
Caregiver Education												
No formal/Primary	126	90	2.20(1.49-3.26)	0.000	56	49	2.28(1.35-3.85)	0.001	70	41	1.65(0.88-3.09)	0.114
Secondary/Tertiary	78	123			46	92			32	31		
Number of ANC Visits												
< 4	160	133	2.18(1.41-3.37)	0.000	75	84	1.88(1.08-3.27)	0.023	85	49	2.34(1.14-4.81)	0.018
≥ 4	44	80			27	57			17	23		

MCV2=Second Dose of Measles Containing Vaccine; POR=Prevalence ODDs Ratio; C.I =Confidence Interval; **Married= (married, cohabiting), ***Single= (Single, Divorced, Separated, widowed), *Others=(Father, Sister, Relative)

Table 3b: Bivariate analysis, of factors associated with low MCV2 coverage among children aged 19–29 months in Alego Usonga Sub-County, Siaya County, Kenya, 2020 stratified by residence (Urban and Rural)

Variable	Overall				Urban				Rural			
	No	Yes	POR (95% C.I)	P-Value	No	Yes	POR (95% C.I)	P-Value	No	Yes	POR (95% C.I)	P-Value
Did not prefer the nearest health facility to the household												
Yes	106	85	1.62(1.10-2.40)	0.013	51	60	1.35(0.80-2.25)	0.25	55	25	2.20(1.18-4.09)	0.012
No	98	128			51	81			47	47		
Caregiver is not accompanied by the partner to the clinic												
Yes	154	139	1.64(1.07-2.51)	0.022	74	95	1.27(0.73-2.23)	0.387	80	44	2.31(1.18-4.51)	0.012
No	50	74			28	46			22	28		
Waiting time												
≥ One hour	57	58	1.03(0.67-1.59)	0.870	41	47	1.34(0.79-2.28)	0.271	16	11	1.03(0.44-2.37)	0.941
< One hour	147	155			61	94			86	61		
Immunization Postponement												
Yes	63	58	1.19(0.78-1.82)	0.411	24	34	0.96(0.53-1.76)	0.916	39	24	1.23(0.65-2.32)	0.507
No	141	155			78	107			63	48		
Household size												
> 5	88	80	1.26(0.85-1.86)	0.245	41	43	1.53(0.89-2.61)	0.116	47	37	0.80(0.44-1.47)	0.489
≤ 5	116	133			61	98			55	35		

MCV2=Second Dose of Measles Containing Vaccine; POR=Prevalence ODDs Ratio; C.I =Confidence Interval; **Married= (married, cohabiting), ***Single= (Single, Divorced, Separated, widowed), *Others=(Father, Sister, Relative)

Table 4: Independent, factors associated with low MCV2 coverage among children aged 19–29 months in Alego Usonga Sub-County, Siaya County, Kenya, 2020 stratified by residence (Urban and Rural)

Variable	Urban						Rural					
	MCV2						MCV2					
	No	Yes	POR (95% C.I)	P-Value	APOR (95% C.I)	P-Value	No	Yes	POR (95% C.I)	P-Value	APOR (95% C.I)	P-Value
Childbirth Order												
> 1	78	73	3.03(1.72-5.32)	0.000	2.55(1.33-4.89)	0.004	81	48	3.03(1.72-5.32)	0.000	2.76(1.21-6.32)	0.016
1	24	68					21	24				
Caregiver Education												
No formal/Primary	56	49	2.28(1.35-3.85)	0.001	1.91(1.10-3.31)	0.022	70	41	1.65(0.88-3.09)	0.114	1.08(0.53-2.18)	0.831
Secondary/Tertiary	46	92					32	31				
Number of ANC Visits												
< 4	75	84	1.88(1.08-3.27)	0.023	1.19(0.64-2.21)	0.581	85	49	2.34(1.14-4.81)	0.018	2.30(1.17-4.52)	0.015
≥ 4	27	57					17	23				
Did not prefer the nearest health facility to the household												
Yes	51	60	1.35(0.80-2.25)	0.25	---		55	25	2.20(1.18-4.09)	0.012	2.64(1.32-5.22)	0.006
No	51	81					47	47				
Caregiver is not accompanied by the partner to the clinic												
Yes	74	95	1.27(0.73-2.23)	0.387	---		80	44	2.31(1.18-4.51)	0.012	2.60(1.26-5.32)	0.009
No	28	46					22	28				

MCV2=Second Dose of Measles Containing Vaccine; POR=Prevalence ODDs Ratio; C.I =Confidence Interval; **Married= (married, cohabiting), APOR=Adjusted Prevalence ODDs Ratio

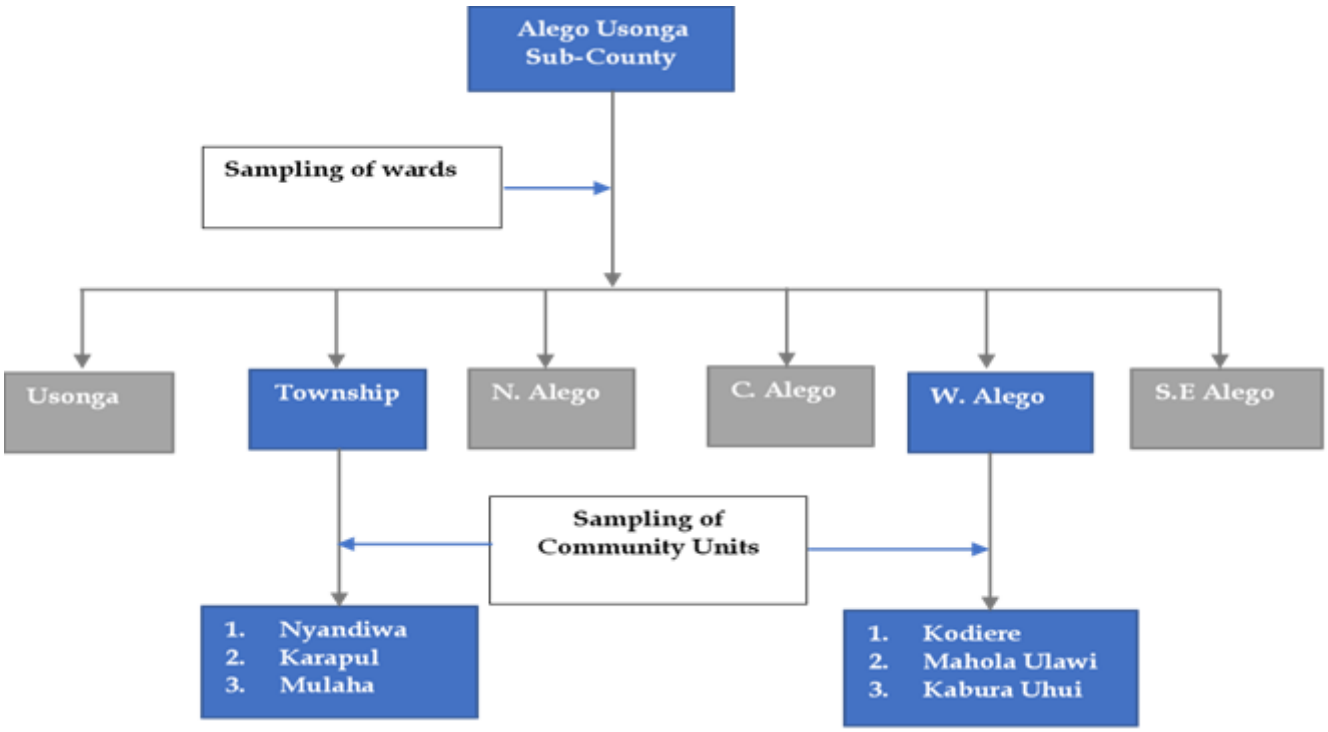
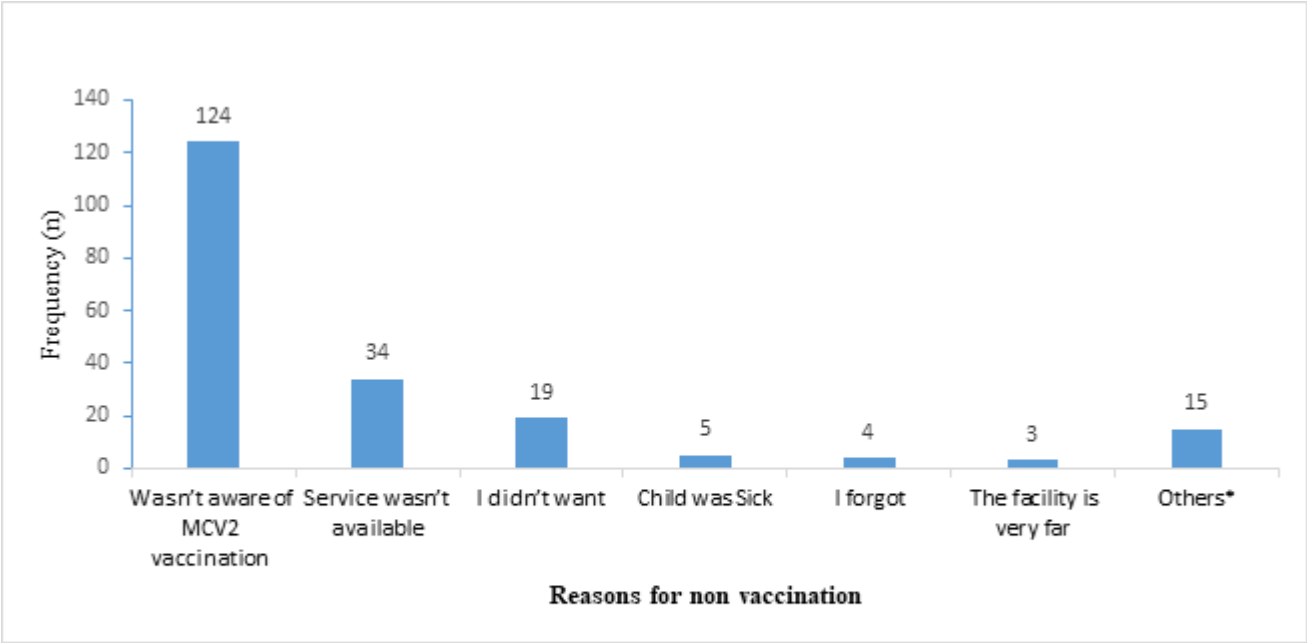


Figure 1: Schematic presentation of the sampling strategy



*Facility was closed=2, nurses were on strike=2, I did not feel like=2, the child was old enough=2, there was no need=2, mother was away=2, no response=3

Figure 2: Reasons for the children missing MCV2 vaccination (n=204)