ORIGINAL RESEARCH ARTICLE

Effectiveness of Mhealth on Immunization Target Tracking Which Affects Drop Out and Left Out Numbers in Rural and Urban Areas at The Public Health Center Level, Indonesia'

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ABSTRACT

Background: The M-KIA (Mobile-Tracking Immunization Target) has features aimed at reducing the number of DO (Drop Out) and LO (Left Out) children. The purpose of this study was to analyze the effectiveness of using the M-KIA application in urban and rural areas.

Method: We conducted a quasi-experiment with control group non-equivalent. The population were all parents with children aged 0-36 months who are DO or LO in the working area of the Bantaeng Public Health Center (PHC), while the number of samples is 226 people. The sampling technique was multistage random sampling. Data were analyzed by the Fisher exact test using STATA.

Results: There is a significant relationship between the use of M-KIA on DO targets in rural areas (p = 0.000<0.05) and in urban areas (p = 0.002<0.05). On the LO target, the use of M-KIA showed a significant relationship in rural areas (p = 0.015 <0.05) while in urban areas the data was not significant (p = 0.612 <0.05).

Conclusion: This study shows that the use of mhealth can reduce the number of DO and LO. Further research is recommended to be conducted to assess the level of usability to assess retention of use with users and admins.

Keywords: Drop out, Left Out, Immunization, mhealth, public health center

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INTRODUCTION

It is estimated that 25 million children under the age of 1 year do not receive basic vaccines, which is the highest number since 2009. In 2021, global coverage will fall by nearly 5% in the last 3 (three) years from 86% in 2019 to 81% and the number of total unvaccinated children increased by 5 million since 2019. An estimated 25 million children under 1 year of age did not receive basic vaccines, which is the highest number since 2009 and over 60% of these children come from countries including; Angola, Brazil, Congo, Ethiopia, India, Myanmar, Nigeria, Pakistan, Philippines and Indonesia.[1] Children who did not receive immunization at all was not evenly distributed by WHO (World Health Organization) region, with a total of 18.2 million LO (Left Out) children in 2021.[2]

In Indonesia, from 2019 to 2020, the DO (Drop Out) rate for the DPT-HB-Hib1st antigen with MR (Measles-Rubella) 1st dose is below the maximum limit of 5%, but tends to increase.[3] The trend in 2019 and 2020 is that the DO number will increase again, until 2021, the DO number for the DPT-HB-Hib 1st antigen with MR 1st is at the minimum threshold (minus value).[3] Likewise, the DO number of DPT-HB-Hib 1st to DPT-HB-Hib 3rd antigen seems to have tended to increase from 2019 to 2021 and the DO number in 2021 exceeded the maximum limit that had been set and was the highest in the last 3 years, namely 6.9%.[3] In the working area of the Bantaeng Public Health Center (PHC), the DO numbers in 2021 were for MR 1 11.4%, DPT-HB-Hib baduta 35%, and MR baduta 59.3%, while the number of LO in 2021 is 14.6%.[4] Based on the Indonesian Immunization Management Manual, DO and LO values above 5% are in the bad category.[5]

This is due to reduced visits to health facilities due to the COVID-19 pandemic, limited vaccines due to limited use of cold chains, and also because parents forget their child's immunization schedule.[5] Other studies have also mentioned the factors that cause immunization failure, including; information about immunization service schedules, busy mothers, inadequate networks and ineffective tracking mechanisms, and ineffective performance of vaccinators in finding immunization targets.[6,7] WHO through the "Immunization Agenda 2030" has recommended increasing immunization coverage in innovative ways, one of which is the use of digital tools.[1]

M-KIA is an application used by vaccinators as admins and cadres as users. This application has several features, namely a schedule reminder system, immunization target data management, maps, and community-based. This study aims to determine the effectiveness of the use of M-KIA in reducing DO and LO rates at Bantaeng Health Centers in urban and rural areas.

METHODOLOGY

Population and sample: This research is a quasi-experimental study with a control group. This research was conducted at the Bantaeng District Health Center from January to March 2023. The sample selection technique was multistage random sampling, with the first technique being cluster random sampling to select samples based on rural and urban areas, we selected 2 intervention areas and 2 control areas by demography, distance to Bantaeng PHC and availability of public transport routes, we chosed 2 rural areas (Pallantikang and Tappanjeng) which are the area with the shortest distance from Bantaeng PHC and have public transportation links, and 2 urban areas (Karatuang and Onto) which are the areas with the furthest distance from Bantaeng PHC, do not have public transportation links and are highland areas. The intervention area was selected based on the highest percentage of DO and LO, namely Pallantikang and Karatuang. The second technique was stratified random sampling which divided the number based on the number of DO and LO populations in the intervention and control groups. The population were all children aged 0-36 months who have not received their age-appropriate doses of routine immunization vaccines or children who have not received any vaccine doses at all.

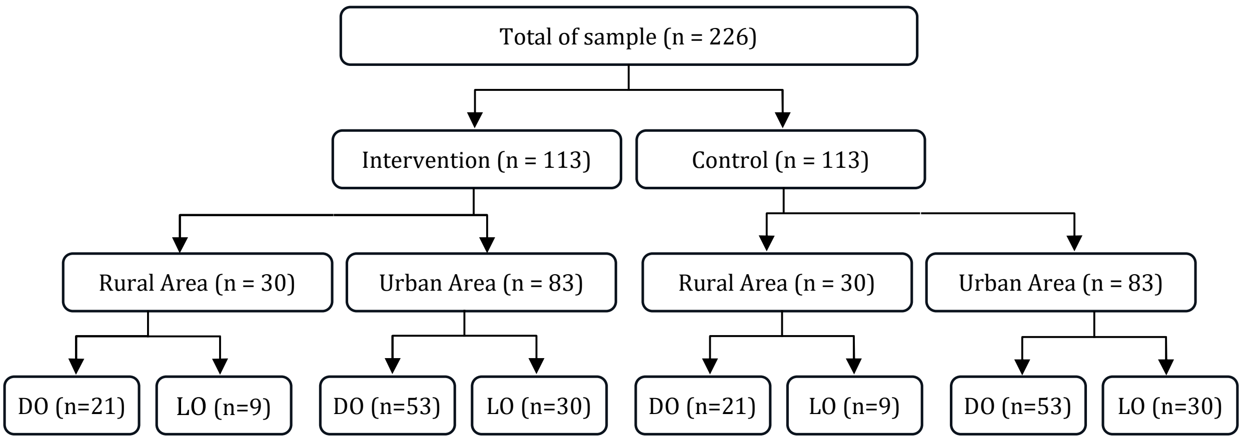

Chart 1: Flow of Sample Selection (DO – Drop out, LO – Left out)

We calculated the sample using the two proportion formula developed by Casagrande, Pike and Smith,[8] to detect a 15% decrease in the number of routine immunization targets with DO and LO status prior to the use of M-KIA, namely 53% to 38%. The number of samples in the DO targeted intervention group in urban areas was 53 children while in rural areas namely 21 children, and the number of samples in the intervention group targeted LO in urban areas was 30 children while in rural areas namely 9 children (comparison of the intervention and control groups in the study this is 1:1). The third technique is simple random sampling to randomly select targets in the intervention and control groups. We made a list of the DO and LO children and then drew lots until the number of children had filled the number of samples. We did the same in both the intervention and control groups.

Intervention: In the intervention group, data on children born at Bantaeng Health Centers from January 2020 to December 2022 in the form of name, date of birth, gender, address, and the last type of immunization (if any) is input into the M-KIA application. The immunization officer as admin verifies the target data to be immunized in the current month, after which the target data is sent to the cadre page as a user according to their respective work areas. Cadres visit the target house to confirm willingness to be immunized and determine where the immunization is desired by parents/caregivers. If parents/caregivers choose to be immunized at their home, the cadre sends a GPS point through the M-KIA application. Through the use of M-KIA, it is easier for vaccinators to find immunization target homes. The immunization officer/vaccinator will enter the vaccine that has been successfully administered to M-KIA.

In the control group, the immunization officer compiled a list of DO target names obtained from the manual register at the beginning of each month. The activities carried out during the study were the same as those carried out before. For the DO target, the immunization officer then visits the immunization target house based on the address listed in the manual register book. For the LO target, no home visits were made either before or during the study.

Data Collection and Analysis: The data in this study were secondary data obtained from birth data from Bantaeng health center midwives and immunization data from Bantaeng health center vaccinators. The objective criteria in this study are as follows:

Routine immunization target with DO status: Children aged 0-36 months and have received a dose of vaccine but did not receive the next vaccine according to the schedule (e.g., DO of BCG vaccine: 1 month + 29 days).

The target of routine immunization with LO status: Children who have never received any dose of immunization are not even 36 months old.

We present the sociodemographic characteristics of the respondents and the number of immunization visits before and after the intervention using a descriptive analysis. Comparison of the proportion of the number of targets that were successfully immunized between the control group and the intervention group was carried out through the chi square test or fisher's exact test using the STATA application.

Results

The distribution of the characteristics of the respondents can be seen in the table 1. Table 1 shows that there is no difference in the sociodemographic characteristics of DO targets in the intervention group and the control group so that research can be continued in measuring the effectiveness of the M-Kia application.

Table 2 shows that there is no difference in the sociodemographic characteristics of LO targets in the intervention group and the control group so that research can be continued in measuring the effectiveness of the M-Kia application.

Table 3 shows the proportion of M-KIA use to the number of DO and LO immunized in urban and rural areas in the intervention and control groups. In the DO immunization targets in urban areas, in the intervention group, there were 31 respondents who were successfully immunized and 22 respondents who were not immunized, while in the control group there were only 6 respondents who were successfully immunized and 48 respondents who were not immunized (p=0.000). The use of M-KIA in rural areas also showed a significant relationship, there were 18 respondents who were successfully immunized and 3 respondents who were not immunized in the intervention group while in the control group there were 9 respondents who were successfully immunized and 11 respondents who were not immunized (p=0.006).

A significant relationship was also shown for immunization targets that were LO in rural areas, there were 7 respondents who were successfully immunized and 2 who were not immunized in the intervention group while in the control group there was only 1 respondent who was successfully immunized and 8 respondents who were not immunized (p=0.015) , but in urban areas there were only 3 respondents who were successfully immunized and 27 respondents who were not immunized in the intervention group while in the control group there was 1 respondent who was successfully immunized and 8 respondents who were not immunized so it was concluded that there was no significant relationship (p=0.612) .

Table 4 shows a comparison of routine immunization coverage per antigen between the intervention and control groups in rural and urban areas. In urban areas there was a greater increase in immunization coverage in the intervention group. Coverage of 14 types of routine immunization antigens in the intervention group increased with the highest achievement in the BCG and Polio 1 antigen types, namely 56.7%, previously only 17.11%, so the difference in increase the highest was 39.59%, while in the control group in the post test assessment there was an increase in only 4 types of antigens with the highest achievement in the IPV 1st, namely 16.2%, previously only 12.2% so that the highest increase was 3.98%.

Table 1: Distribution of Socio-demographic Characteristics of Respondents Drop Out Immunization in the Bantaeng PHC Work Area in 2023 (n=74)

Variable	Intervention (%)	Control (%)	Total (%)	P value
Gender				
Male	37 (50)	35 (47.29)	72 (48.64)	0.742*
Female	37 (50)	39 (52.7)	76 (51.35)	
Birth Order				
First	34 (45.94)	29 (39.18)	63 (42.56)	0.406*
Second & next birth	40 (54.05)	45 (60.81)	85 (57.43)	
Father's Education				
No school	4 (5.4)	6 (8.11)	10 (6.76)	0.216*
Elementary Junior School	37 (50)	24 (32.43)	61 (41.22)	
Senior High School	18 (24.32)	22 (29.73)	40 (27.03)	
D3-S1	13 (17.56)	21 (28.38)	34 (22.97)	
S2 & Higher	2 (1.4)	1 (1.35)	3 (2.02)	
Father's occupation				
Doesn't work	1 (1.35)	0 (-)	1 (0.67)	0.588*
Freelancer	41 (57.74)	46 (62.16)	87 (58.78)	
Civil Servant / Permanent	8 (10.81)	9 (12.16)	17 (11.48)	
Self-employed	24 (32.43)	19 (25.67)	43 (29.05)	
Mother's Education				
No school				0.372*
Elementary-Junior	38 (51.35)	29 (39.19)	67 (45.27)	
Senior High School	26 (35.14)	32 (43.24)	58 (39.19)	
D3-S1	9 (12.16)	12 (16.21)	21 (14.19)	
S2 & Onwards	1 (1.35)	0 (-)	1 (0.68)	
Mother's job				
Doesn't work	33 (44.59)	30 (40.54)	63 (42.56)	0.618*
Work	41 (55.4)	44 (59.45)	85 (57.43)	
Marital status				
Marry	71 (95.94)	74 (100)	145 (97.97)	0.245**
Not married yet	3 (4.05)	0 (-)	3 (2.03)	

* Chi square test; ** Fisher Exact Test; Source: Primary Data, 2023

Table 2: Distribution of Socio-demographic Characteristics of LO Immunization Respondent in Bantaeng PHC Work Area in 2023 (n= 39)

Variable	Intervention (%)	Control (%)	Total (%)	P Value
Gender				
Male	16 (41.02)	18 (46.15)	34 (43.58)	0.648*
Female	23 (58.97)	21 (53.84)	44 (56.41)	
Birth Order				
First	18 (46.15)	11 (28.2)	29 (37.17)	0.101*
Second & next birth	21 (53.84)	28 (71.79)	49 (62.82)	
No school	4 (10.25)	5 (12.82)	9 (11.53)	
Elementary-Junior	20 (51.28)	15 (38.46)	35 (44.87)	
Senior High School	11 (28.2)	17 (43.58)	28 (35.89)	
D3-S1	4 (10.25)	2 (5.13)	6 (7.69)	
Father's occupation				*
Doesn't work	1 (2.56)	0 (-)	1 (1.28)	0.217
Freelancer	31 (79.49)	25 (64.1)	56 (71.79)	
Civil Servant / Permanent	1 (2.56)	4 (10.26)	5 (6.41)	
Self-employed	6 (15.38)	10 (25.64)	1 (20.51)	
No school	4 (10.25)	2 (5.12)	6 (7.69)	
Elementary-Junior	15 (38.46)	19 (48.72)	34 (43.59)	
Senior High School	15 (38.46)	18 (46.15)	33 (42.31)	
D3-S1	5 (12.82)	0 (-)	5 (6.41)	
Mother's job				
Doesn't work	16 (43.58)	19 (48.72)	35 (44.87)	0.495*
Work	23 (56.41)	20 (51.28)	43 (55.62)	
Marry	38 (97.44)	39 (100)	77 (98.72)	
Not married yet	1 (2.56)	0 (-)	3 (1.28)	

* Chi square test; ** Fisher Exact Tets; Source: Primary Data, 2023

Table 3: Proportion of M-KIA usage to total DO and LO who have immunized at Bantaeng PHC Work Area in 2023

Category	Area	Difference	Intervention (%)	Control (%)	p value
DO	Urban	Immunized	31 (58.49)	6 (11.11)	**0.000***
		Unimmunized	22 (41.51)	48 (88.89)	
	Rural	Immunized	18 (85.71)	9 (45)	**0.006***
		Unimmunized	3 (14.89)	11 (55)	
LO	Urban	Immunized	3 (10)	1 (3.33)	**0.612****
		Unimmunized	27 (90)	29 (93.33)	
	Rural	Immunized	7 (77.78)	1 (11.11)	**0.015***
		Unimmunized	2 (22.22)	8 (88.89)	

* Chi square test ** Fisher's exact test; Source: Primary Data, 2023

Table 4: Comparison of Immunization Coverage Per Antigen at Bantaeng PHC Work Area in 2023

Location	Vaccine	Control (n=14)			Intervention (n=14)		
		Pre (%)	Post (%)	Difference	Pre (%)	Post (%)	Difference
Urban	BCG	15.32	8.1	-7.22	17.11	56.7	39.59
	Polio 1st	15.32	8.1	-7.22	17.11	56.7	39.59
	DPT 1st	21.65	13.2	-8.45	19.81	32.4	12.59
	Polio 2nd	21.65	13.2	-8.45	19.81	32.4	12.59
	PCV 1st	18.32	12	-6.32	25.21	35.1	9.89
	DPT 2nd	12.22	7.1	-5.12	18.16	37.8	19.64
	Polio 3rd	12.22	7.1	-5.12	18.16	37.8	19.64
	PCV 2nd	5.22	7.1	1.88	15.46	38.1	22.64
	DPT 3rd	10.32	11.2	0.88	17.71	21.6	3.89
	Polio 4th	10.32	12.2	1.88	17.71	21.6	3.89
	IPV 1st	12.22	16.2	3.98	17.71	32.4	14.69
	MR 1st	20.06	12.2	-7.86	15.6	37.8	22.2
	DPT 4th	15.23	2.4	-12.83	11.41	12.7	1.29
	MR 2nd	12.11	3.3	-8.81	9.06	7.5	-1.56
Rural	BCG	9.4	7.8	-1.6	9.2	14.1	4.9
	Polio 1st	9.4	7.8	-1.6	9.2	14.1	4.9
	DPT 1st	12.1	7.8	-4.3	9.67	21.1	11.43
	Polio 2nd	12.1	7.8	-4.3	9.67	21.1	11.43
	PCV 1st	3.7	4.1	0.4	8	14	6
	DPT 2nd	8.1	7.8	-0.3	7.7	12.3	4.6
	Polio 3rd	8.1	7.8	-0.3	7.7	12.3	4.6
	PCV 2nd	3.7	4.1	0.4	2.8	12.3	9.5
	DPT 3rd	8.1	10.5	2.4	9.7	14	4.3
	Polio 4th	8.1	10.5	2.4	9.7	17	7.3
	IPV 1st	8.1	11.5	3.4	8.7	18.5	9.8
	MR 1st	8.1	11.9	3.8	12.9	18.5	5.6
	DPT 4th	6.5	1.3	-5.2	9.4	4.2	-5.2
	MR 2nd	3.4	2.9	-0.5	6.8	4.1	-2.7

Source: Primary Data, 2023

In rural areas, there was an increase in the coverage of 12 types of routine immunization coverage in the intervention group, with the highest achievement in the DPT 1 and Polio 2 antigen types, namely 21.1%, which was only 9.67% previously, so that the difference in the highest increase was 11.43%, while in the In the control post-test assessment there was an increase in 6 types of antigen with the highest achievement in the type of MR (Measles Rubella) antigen, namely 11.9%, previously only 8.1% so that the highest increase was 3.8%.

Table 5 shows that statistical test results during the pre-post-test in rural areas in the control group obtained a p-value of 0.48 <α 0.05, which means that there is no significant difference in immunization coverage before and after the intervention, with a mean pre-test of 7 .53% to the post-test value of 7%, while in the intervention group a p-value of 0.000 <α 0.05 was obtained, which means that there was a significant difference in immunization coverage before and after the intervention with an increase in the mean value from the pre-test of 17% to the value post-test 33.07%.

Statistical test results during the pre-post-test in urban areas in the control group obtained a p-value of 0.004 <α 0.05, which means that there was a significant difference in immunization coverage before and after the intervention. However, this difference was caused by a decrease in the mean value from the pre-test of 13.87% to the post-test value of 9.47%, whereas in the intervention group the p-value was 0.002 < α 0.05, which means that there is a significant difference in the immunization coverage rate. before and after the intervention with an increase in the mean value from the pre-test of 8.27% to the post-test value of 13.93%.

Table 5: Differences in Pre-Post Test Immunization Coverage Rates Between Intervention and Control Groups in the Working Areas of Bantaeng PHC in 2023

Area	Control (n=113) Mean ± SD	Intervention (n=113) Mean ± SD	p-value
Urban			
Pre	13.87 ± 4.61	17 ± 3,76	**0,974***
Post	9.47 ± 3.89	33.07 ± 13,7	**0,000***
p value	**0.004****	**0.000****	
Rural			
Pre	7.53 ± 2.79	8.27 ± 2,25	**0,435***
Post	7 ± 3.13	13.93 ± 5,01	**0,000***
p value	**0.48****	**0.002****	

* Independent paired t-test; ** dependent paired t-test,
Source: Primary Data, 2023

Discussion

Sociodemographic characteristics of respondents with DO and LO status in the sex category with the highest number in this study, but with almost the same proportion. This is in accordance with the results of research conducted in Ethiopia[9], that the highest number of DO respondents was female (54.7%) and research in the Congo[10], with the highest number of DO respondents being women (50.23%) with p = 0.914.

The birth order category shows that children with second birth order and so on are higher than first born children. Similar results were also found in a study conducted in Ethiopia, children with birth order 2-4 had the highest number, namely 51.1% (*p* = <0.001). Order of child birth is another determining factor of incomplete immunization status. The second and subsequent children born in the family show a strong association with incomplete vaccinations. As the number of children in a family increase, family resources, including time and attention, are divided among the children. This can result in children born late in the family not getting the full series of vaccines.[11]

The category of education of the father and mother of the target respondents who dropped out showed the highest order, namely the last educated senior high school, while the father and mother of the target respondents who were LO showed the highest order, namely the last educated elementary-junior high school. Parents' education level is the most important factor related to parents' knowledge and immunization practices. Most of the information regarding the risks and benefits of immunization is related to the educational level of parents. If parents are well informed about immunization, their worries and fears about immunization will decrease.[12]

Indonesian society in general still adheres to a patriarchal culture in which a father has full authority in making decisions so that giving immunizations is also often a decision taken by the father.

Educated mothers are more likely to complete their child's immunizations than those who are not educated, this is in accordance with the results of research in Iraq[12], stated that mothers who had adequate knowledge and action about immunization were higher for mothers with education duration >18 years compared to mothers whose education duration was <18 years (p = 0.001). Mother's education level can also influence a person's knowledge of child immunization, just like her husband and mother-in-law, which in turn can influence their decision to administer immunizations to their children. Mother's education influences child health service-seeking behavior where education increases knowledge and enables a better understanding of immunization in mothers with higher levels of education.[13]

The highest category of father's occupation in the DO and LO groups was casual workers. Research conducted by Singh et al., (2018), which differentiates fathers' work into 2 categories, namely unskilled and semiskilled, states that the number of fathers who are unskilled is higher in children with DO and LO (53.3%) compared to children with complete immunization (p = 0.22). In line with these results, many studies have measured the effect of father's occupation on the completeness of children's immunizations, but similar to the educational aspects of fathers, it is also concluded that father's occupation is not related to the completeness of immunizations of their children.[15]

The occupational category of mothers in the DO and LO groups in this study had the highest number, namely working mothers. Research results in Greece[16] also shows a similar thing where the number of mothers who work for children who DO and LO is 88.9% of the total sample of 1015 people. The immunization target of working mothers is more likely to get complete immunization compared to children of non-working mothers (housewives). This can happen because women who are not working (housewives) are freer to spend more time with children, she can meet their health care needs by utilizing child health services more efficiently and effectively compared to working women. The same is more relevant in rural areas where the majority of working women belong to a lower socioeconomic class and are less educated.[15]

Several other studies have mentioned causal factors apart from sociodemographic factors, the occurrence of high DO rates. Research in Petaling, Malaysia, said that in multivariate results, DO rates increased with increasing travel time to immunization health facilities because if a health facility is located in close proximity, it is likely to motivate the mother to adhere to the immunization schedule.[13]

Based on research conducted by Vangola et al.,17 states that children from rural areas, no immunization cards, long waiting time for immunization queues, and no reminder system in the days before the vaccination schedule are more likely to fail immunization .

This study shows that the use of M-KIA to strengthen routine immunization programs in the public health system in the Bantaeng Health Center area is acceptable and successful in increasing vaccination coverage among children with DO status both living in rural and urban areas and also increasing coverage among children with LO status although only in children who live in rural areas while among children in urban areas there is no significant relationship to the use of M-KIA. Immunization targets with LO status in urban areas of Bantaeng Health Centers are mostly migrants or refugees in slums and densely populated areas. Dadari, 2023, states that rapid urbanization has accompanying complications, especially in LMICs where the number of informal settlements is large and the urban poor population continues to grow, resulting in large inequalities in access to basic primary health services, including immunizations.[18]

Most immigrants do not have a residence permit so they cannot easily access health services including immunization services. As a result, they tend to rely on traditional healers, street vendors and private pharmacies for their health needs.[19]

Significant differences in immunization coverage rates before and after the use of M-KIA in the intervention group both in urban areas and in rural areas. Likewise in the average value of the difference in immunization coverage there is a difference before and after the use of M-KIA. The same results were shown by Nguyen et al.,[20] that the ImmReg application has helped increase complete immunization coverage and timely vaccination rates for children under one year old, even after the study ended. Different results were shown by Chen et al.,[21] when comparing the difference from the baseline survey to the end-line between the intervention and control groups, the intervention group had a 17% increase in full vaccination coverage and the control group had a 10% increase, but the difference between the interventions and the control group was not statistically significant (p = 0.164).

Apart from having an impact on reducing DO and LO children, the increase in the number of daily visits is due to the increase in timely immunization visits. This will have implications for greater immunization benefits. As has been described in other studies[22], that the timing of vaccine administration is important for vaccine effectiveness and safety. Timely administration of vaccines has implications for the success of childhood immunization programmes, and timely initiation of immunization is important in the first year of life because transplacental immunity declines rapidly.

The limitations of this research are the constraints on study design and implementation of M-KIA in the field. Limited time and funds, resulting in complete vaccination coverage on the same sample starting from BCG-MR1 and continuing until MR2 is resolved. As it is known that immunization adherence decreases with increasing age of the child for various reasons. Studies of longer duration and larger samples allow for more accurate analyses. In addition, measurements of usability, feasibility and acceptability also need to be carried out to determine the ability and readiness of the health system to integrate with the M-KIA application.

Conclusion

Based on this study, we conclude that the use of the M-KIA application can reduce the number of routine immunization targets aged 0-36 months who drop out in rural and urban areas and routine immunization targets aged 0-36 months who are LO in rural areas but not in rural areas. urban. It is hoped that further research can measure the attitudes, knowledge and skills of cadres in a system that is integrated with the use of this application. Usability, feasibility and acceptability tests also need to be measured to determine the sustainability of the use of M-KIA.

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