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RESEARCH **Open Access**

Assessing Interventions for Declining Childhood Immunization Dropout - A Systematic Review

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Abstract

Childhood routine immunization is a critical stage to ensure the health of infants and protect against serious diseases. Therefore, adequate strategies are urgently needed to increase childhood immunization coverage to prevent global disease and death. This review has identified the effect of interventions to increase immunization coverage among children in developing countries. A review included published studies from 2013 to 2023 on randomized controlled trials (RCT) and pre-post intervention that met eligible criteria. All included studies had been conducted in English-published articles on Pub Med and Google Scholar, without being limited to geographical sites. A total of 1107 published articles were accessed and 12 final eligible articles were reviewed. 66.67% of the included studies were conducted in Africa, 16.67% in South East Asia countries, and others were conducted in East Asia and America. These studies demonstrated that different interventions (SMS and call reminders, sticker reminders, immunization education, home-based records, and community-centered) had significant increases in immunization coverage for childhood compared to the control group with standard care or without any interventions. The present findings suggest that interventions including implementing SMS and call reminders, sticker reminders, education both from health workers and local leaders, and home-based records can potentially reduce immunization dropout. However, strategies to improve coverage for immunization uptake should also be considered preferred community-based to extend the marginal groups.

Keywords: Intervention, Immunization Dropout, Immunization Uptake Coverage.

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1. INTRODUCTION

Routine childhood immunization is critical and has effectively reduced morbidity and mortality. In 2021, about 21.9 million children missed their routine first dose of measles, far from 2019 levels of 19.2 million. Moreover, in the same year, 25 million children were unvaccinated or incompletely vaccinated (Rachlin et al., 2022; WHO, 2023). Indonesia, the most populous country in Southeast Asia, reported only 58% of infants fully immunized, much lower than the 93% national coverage target (Kementerian Kesehatan Republik Indonesia, 2018).

Despite significant progress, the expanded immunization program still faces a higher number of incomplete or immunization dropout rates is still an issue. It was defined that the dropout rate is the rate difference between the first and the last dose or the rate difference between the initial vaccine and the last vaccine (Chanie et al., 2021). Multiple factors may cause increased immunization dropouts. A previous study has proved that living in rural areas, non-compliance with the order of arrival during vaccination in health facilities, and lack of a reminder system on days before the scheduled vaccination were significantly associated with high dropout rates (Kayembe-Ntumba et al., 2022). In addition, social norms, poor quality of health services, and concern about side effects cause vaccine hesitancy, resulting in a greater number of incomplete immunizations (Powelson et al., 2022).

Several strategies were introduced to help the challenges to improve routine immunization coverage. Developed policies, guidelines, human resources, management of vaccines, service delivery, communication, and community partnership were established (Shen et al., 2014). In addition, various approaches have been taken, starting from technology-based, application-based, and community empowerment. Expanding these strategy efforts provides opportunities to address the barrier, while transformative changes are required to improve the effectiveness of the intervention.

In literature searching, many studies were focused on estimating the predictive factors of immunization coverage. It was also found that few studies developed interventions or new strategies to encourage caregivers to bring children for routine immunization. However, some studies offered the developed interventions without assessing the impact on immunization coverage. Addressing these underlying deficiencies, therefore, this review aimed to identify and review the different types of interventions and the effects to reduce the dropout vaccination rate among children in the different regions.

2. RESEARCH METHOD

This study searched Google Scholar and PubMed with no geographical setting restricted as published from 2015 up to 2023. Literature searching was conducted focusing on combinations of the following terms: "reducing immunization dropouts"; "intervention"; and "evaluation of the interventions". Studies were excluded if the article developed tools or other interventions without assessing the impact on the immunization dropout rate. We prioritize selecting existing randomized controlled trials (RCTs), quasi-trials, and before-after intervention studies and reported immunization coverage outcomes. We also searched for additional articles by searching the references of included articles.

The authors screened the title and abstracts. Then, those authors assessed the full text of all potentially eligible studies. The authors discussed whether the articles met the present study's context regarding the topic, the outcome, and the study design.

Microsoft Excel spreadsheet (2021) software was utilized for data extraction. The authors independently extracted all relevant data using the Population, Intervention, Control, and Outcome format to guide the extraction of information from the articles. Information was extracted on the first author's name, year of publication, study setting, study design, participants, intervention, control, and outcome. The authors discussed the discrepancy between studies to get the final decisions on the articles to be reviewed.

The included studies were analyzed by summarizing the introduced interventions. The outcome of the study, rate of immunization coverage or immunization dropouts, was reported as similar to the studies. To validate the findings, we also compared the findings across studies.

The bias assessment was conducted according to the Cochrane Handbook for Systematic Reviews of Interventions (Chandler et al., 2019). The domains included in the bias measurement were bias arising from the selection of the study's participants, intended interventions, missing outcome data, bias in the measurement of the outcome, and bias in the selection of the reported finding. Overall risk-of-bias judgment was categorized as low bias, some concerns, and a high risk of bias (Higgins et al., 2019).

3. RESULTS AND DISCUSSION

One thousand one hundred articles were retrieved using a search strategy about interventions to reduce immunization dropout through online search engines such as; PubMed and Google Scholar. Titles and abstracts were screened and 311 irrelevant articles were excluded. Full texts of the 41 remaining articles were assessed for eligibility, and 12 articles met the inclusion criteria (Figure 1).

The studies included in this review were conducted in different sites. Studies represented four regions; 66.67% were based in Africa and 16.67% were conducted in South East Asia. The majority of studies were randomized control trials (66.67%) and pre-post-interventions for the rest. All included articles assessed the impact of different interventions on the number of immunization dropouts. The characteristics of the included studies are presented in Table 1.

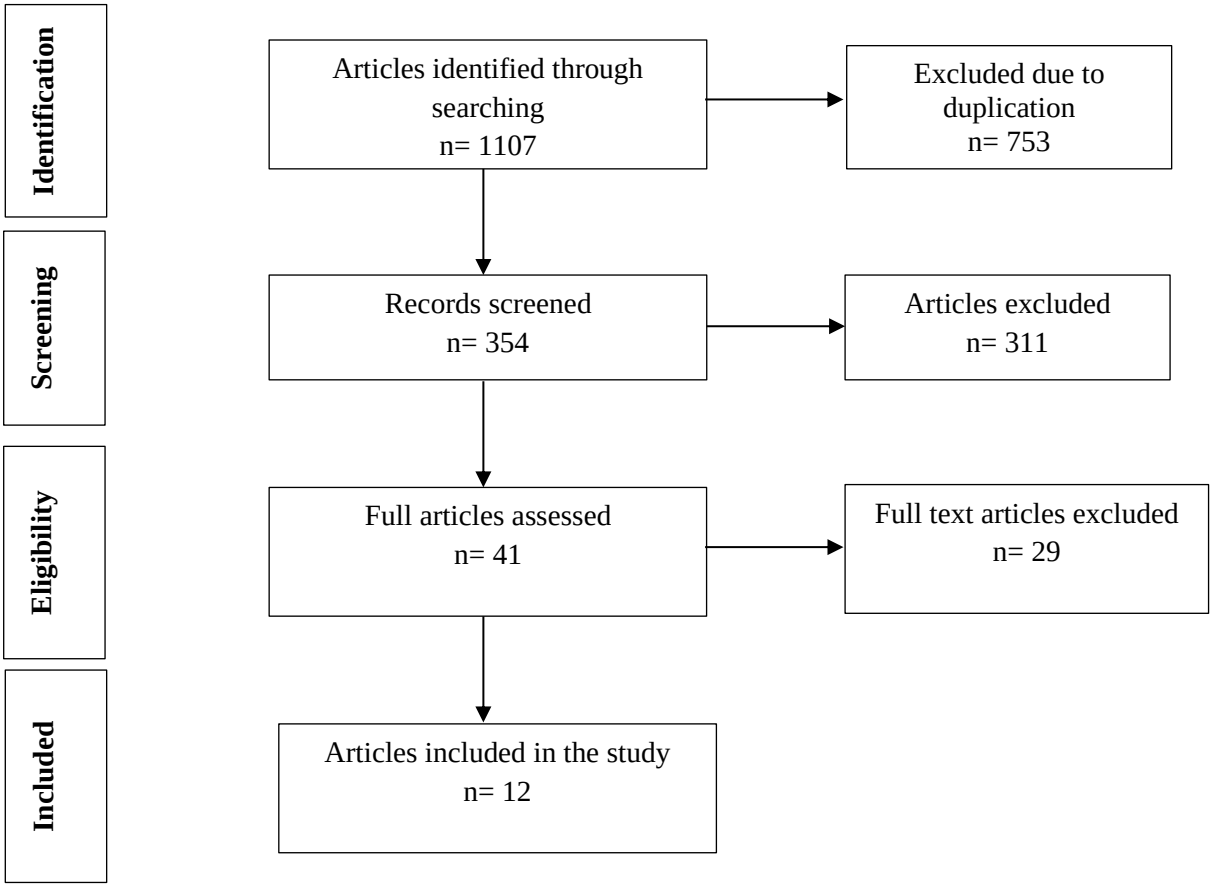

Figure 1. PRISMA Flowchart for Study Selection Process.

Table 1. Characteristics of the Included Studies Regarding the Interventions of Increasing Immunization Coverage or Reducing Immunization Dropout.

Variable	Number of studies	%
Study regions		
Africa	8	66.67
Côte d'Ivoire	1	8.33
Nigeria	5	41.67
Kenya	1	8.33
Zimbabwe	1	8.33
South East Asia:	2	16.67
Indonesia	1	8.33
Vietnam	1	8.33
East Asia	1	8.33
China	1	8.33
America	1	8.33
Arizona	1	8.33
Study design		
Randomized controlled trials (RCT)	8	66.67
Pre and post-intervention	4	33.33
Interventions		
SMS reminder	2	16.67
Phone calls	1	8.33
Routine health education and SMS reminders	1	8.33
Phone calls and SMS reminders	1	8.33
SMS or voice message reminder	1	8.33
SMS or providing stickers for reminders	1	8.33
SMS reminders, phone calls, and SMS health education	1	8.33
Home-based record (HBR) only and a combination of HBR and appointment sticker	1	8.33
Vaccination education session	1	8.33
Training of the traditional and religious leaders	1	8.33
Health Start Program (state-run community health workers' maternal and child health home visiting program)	1	8.33
Primary outcome(s)		
Increase immunization completion and timeliness	2	16.67
Increase certain immunizations coverage	4	33.33
Increase full immunization coverage	4	33.33
Reduce the dropout rate of full immunization	2	16.67
Immunization target		
BCG, OPV, Pentavalent 3, PCV, measles, and yellow fever	2	16.67
DPT3	2	16.67
Pentavalent 1-3 (DPT-HB-Hib) and Measles	1	8.33
Pentavalent	2	16.67
OPV1, Pentavalent	1	8.33
BCG, HepB1, OPV1, DTP1, MR, JEV	1	8.33
BCG, DPT3, hepatitis B, Hib, OPV, measles	1	8.33
BCG, DPT 1-3, Measles	1	8.33
BCG, measles	1	8.33

From 41 full-text articles through screening, it can be seen that most of the excluded studies were due to a lack of the outcome of this study interest (34.48%). 27.59% of the studies were description analysis, hence, this review could not assess the magnitude of the intervention effects. The lowest proportion was insufficient information regarding the outcome (3.45%).

Table 2. Characteristics of the Reasons for Studies Exclusion.

Reason for Exclusion	**No. of Studies**	**%**
Studies developed tools without assessing the findings' impact on the outcome	10	34.48
Studies did not assess any intervention	5	17.24
Descriptive studies	8	27.59
Studies presented protocol	3	10.34
Cross-sectional or cohort studies	2	6.70
Insufficient information regarding the rate of immunization coverage trends pre and post-intervention	1	3.45
Total	29	100

For risk-of-bias assessment, three (25%) out of the 12 studies introduced a high risk of bias and raise some concerns in at least one domain (Dissieka et al., 2019; Ekhaguere et al., 2019; Ibraheem et al., 2021). It was also found that 16.67% of studies raise a concern in one domain (Oyo-Ita et al., 2021; Wallace et al., 2019), two papers (16.67%) determined to be at low risk of bias for all domains (Eze & Adeleye, 2015; Wightman et al., 2022), and others were potentially met the methodological criteria (Bangure et al., 2015; Haji et al., 2016; Hu et al., 2017; Ijeoma, et al., 2015; Nguyen et al., 2017).

Table 2. Summary of the Studies of Intervention to Increase Immunization Rate or Reduce Immunization Dropout

Study and year	Site	Study Design	Participants	Intervention	Control	Outcome: Immunization coverage/dropout (%)			
						Indicators	Pre/ Control	Post/ Intervention	Change
(Dissieka et al., 2019)	North-central region, Côte d'Ivoire	RCT	Infants ≤12 months	Providing mothers with mobile phone message (voice or text) reminders two days before each scheduled visit and two additional reminders for missed doses (n= 798)	No phone reminder messages (n= 798)	Pentavalent 1 visit attendance	76.1	86.6	+10.5 [a]
						Pentavalent 2 visit attendance	67.3	81.0	+13.7 [a]
						Pentavalent 3 visit attendance	58.3	74.2	+15.9 [a]
(Eze & Adeleye, 2015)	South Nigeria	RCT	Infants at their first immunization session (BCG) and second immunization (DPT1)	SMS text reminders	No intervention	DPT3 coverage (Timeliness of immunization completion)			
						Early	60.3	69.0	+8.7 [a]
						Delayed	39.7	31.0	-8.7 [ref.]
(Ibraheem et al., 2021)	Ilorin, Nigeria	Pre-post-intervention	Infants presenting for the first dose of vaccine in the five infant NPI scheduled visits	Call reminders (n= 140), SMS reminders (n= 140), health education messages (n= 140)	Routine care (n= 140)	Timeliness of presentation / receipt of immunization completion:			
						• Six weeks	54.2	99.2; 97.1; 98.5	+45; +42.9; +44.3 [a]
						• Ten weeks	72.1	93.2; 90.1; 86.7	
						• Fourteen weeks	66.9		

						visit (appropriate) • 10 weeks visit (appropriate) • 14 weeks visit (appropriate) • 9 months visit (appropriate)	36.6	87.2; 69.9; 64.9 89.4; 63.7; 56.5	+20.3; +17.2;+ 13.8[a] +20.3; +3; +2 [a] +52.8; +27.1;+ 19.9[a]
(Ekhaguere et al., 2019)	Nigeria	RCT	Children aged 0–12 weeks/ newborn infants	Automated voice call text and email immunization reminders (n= 300)	No reminders (n= 300)	The proportion of infants who received immunization: • Penta-1 at 6 weeks	83 84 78 65	86 85 84 73	+3 [b] +1 [b] +6 [a] +8 [a]

						• Penta-2 at 10 weeks • Penta-3 at 14 weeks • Measles at 12 months • All immunizations	47	57	+10 [a]
(Haji et al., 2016)	Kenya	Pre and post-intervention	Children aged <12 months presenting for the first dose of pentavalent vaccine	Provide SMS (n= 372) or sticker reminders (n= 372)	No reminder (n= 372)	Immunization dropouts • SMS reminder • Sticker reminder	17 17	3.5 16	-13.5 [a] -1 [b]
(Wallace et al., 2019)	West Java, Indonesia	RCT	All children who received DTPcv1	Home-based records and appointment sticker (n= 1103), home-based record only (n= 1434)	Standard care (n= 1079)	Timeliness of DTPcv3 coverage: End of the 200-day study period Within 60 days of DTPcv1	78 23 52 61	77; 74 32; 24 55; 47 61; 53	-1; -4 [b] +9; +1 [a] +3; -5 [a] 0; -8 [b]

						Within 70 days of DTPcv1 Within 90 days of DTPcv1			
(Bangure et al., 2015)	Kadoma, Zimbabwe	RCT	Children aged <12 months right after they were born or during the 3rd and 7th-day visits after the infants born	Routine health education and SMS reminders (n= 152)	Routine health education (n= 152)	Timeliness of immunization coverage: • 6th week • 10th week • 14th week	82 80 75	97 96 95	+15 +16 +20
(Hu et al., 2017)	Zhejiang Province, Eastern China	RCT	Infants <12 months	Vaccination education session (n= 418)	No intervention (n= 433)	The coverage of full immunization scheduled: • BCG • HepB1 • OPV1 • DTP1 • MR • JEV	84.1 88.0 66.1 60.0 75.1 52.9 33.0	82.1 89.0 73.9 72.0 92.1 65.1 51.9	-2 [b] +1 [b] +7.8 [a] +12 [a] +17 [a] +12.2 [a] +18.9 [a]

						• Full immunization (overall)			
(Nguyen et al., 2017)	Vietnam	Pre and post-intervention	All children born in Ben Tre	SMS reminders (2014: n= 4078; 2015: n= 3374)	No intervention (n= 3997)	Full immunization coverage (2013 as preintervention/baseline): • 2014 • 2015	75.4 75.4	81.7 99.2	+6.3 [a] +23.8 [a]
(Ijeoma, 2015)	South Eastern Nigeria	RCT	Infants that that commenced their childhood immunizations in the month of April	Telephone calls reminders (n= 119)	Standard care (n= 119)	Immunization dropout: • April - BCG/measles - DPT • May - BCG/measles - DPT	45 21 37 14	37 14 47 22	-8 [b] -7[a] +10 [b] +8[b]
(Wightman et al., 2022)	Arizona, USA	Pre-post-intervention	Firstborn	Arizona's Health Start Program (n= 3004)	Standard care (n= 18,266)	7 vaccination series intended for young children: HepB, DTaP/DTP, Hib, PCV13,	27.7 62.8	29.3 67.9	+1.6 [b] +5.1 [a]

						MMR, Varicella. On scheduled completion, all series Completion by age 5, all series			
(Oyo-Ita et al., 2021)	Cross River State, Nigeria	RCT	children aged 0–23 months	Training of the traditional and religious leaders (TRLs): • Baseline: n= 1297 • Mid-term: n= 1302 • Final evaluation: n= 1276	No intervention • Baseline: n= 1301 • Mid-term: n= 1268 • Final evaluation: n= 1274	up-to-date vaccination for BCG, OPV, Pentavalent 3, PCV, measles, and yellow fever appropriate for the age • Baseline • Mid-term • Final evaluation	48 56 55	46 54 52	-2 -2 -3

[a] *Significant change;* [b] *no significant change;* [ref.] *reference category*

This review study reported ten studies investigating the intervention's effects on reducing infants' immunization dropout. These studies developed interventions, including healthcare providers-centered, technology approach, and community-based interventions. Most studies utilized health workers to manually remind participants, such as text or phone call reminders, sticker reminders, or giving education sessions.

The adoption of short message services (SMS) has been documented to enhance immunization coverage. SMS reminders were associated with no immunization delay and increased the proportion of children receiving routine immunization. Participants were willing to receive and they assumed that it was beneficial so that immunization was on time (Bangure et al., 2015). In addition, the budget effectiveness proved the use of SMS was reasonable as it was cheaper than home visiting (Nguyen et al., 2017). However, another study showed that most participants preferred receiving voice reminders over text messages. This may be due to a lack of technology exposure and low educational background since the study was conducted in rural areas (Dissieka et al., 2019).

Following up on the fact that parents tend to prefer voice messages over text messages, another study intervened with phone calls (Brown et al., 2016; Ijeoma, 2015; Ibraheem et al., 2021). This intervention has shown positive results in improving the rate of appointments kept (Huldah Ijeoma, 2015). Undeniably, through phone call reminders, the participants tend to give responses and non-responses directly and even clarifications during calls. Phone call reminders proved improvements with the inception of the recall intervention. Yet, this method would be more expensive than text messages (Mekonnen et al., 2019; Obi-Jeff et al., 2022).

Both text reminders and phone calls require effort from health workers, henceforth, time and human resource dependence become a consideration (Brown et al., 2020). Automated reminders using technology applications may be more beneficial. A positive lesson was learned from a previous study conducted in Nigeria, where integrated a software application to send automated voice call text and email reminders (Ekhaguere et al., 2019). The reminders were sent automatically 2 days before the scheduled date of the Penta-1, 2, 3, and measles immunization based on the prior data regarding the date of birth of the newborn. While this finding significantly improved immunization completion and timeliness, growing evidence of its effectiveness resulted from poor phone and internet networks. This is acknowledged as the consequence of web-based text and call systems.

The added health workers-centered method was the home-based record (HBR) and placing an appointment sticker on HBR (Wallace et al., 2019). The findings highlight the success of this method in getting a significantly higher number of individuals to bring their children for more timely vaccinations compared to the control group. Health workers provided an HBR to ensure that the caregiver is aware of the immunization services the child has and has not received. In addition, placing a parental appointment sticker on the HBR could be used to ensure that parents return promptly for the next childhood immunization. This intervention provides an inexpensive and effective tool for promoting childhood immunization, however, policies requiring the presentation of the record should be considered with care, as some children may drop out of the system if the child is turned away from immunization services just because the caregiver forgot the child's record (WHO, 2015).

Among all the innovative interventions, health education plays an essential as the basic need to improve immunization coverage. Education could be done through technology or by individuals. The previous study evaluated the SMS immunization facts which contain health education regarding immunization and also received automatic messages indicating the next appointment date (Bangure et al., 2015; Ibraheem et al., 2021). As a result, significant improvement in the vaccination knowledge among participants in the intervention group was

one of the most clearly identified outcomes, followed by positive trends in the increased immunization coverage (Hu et al., 2017).

Nonetheless, the majority of the existing interventions mentioned above are still health worker-centered. There has not been a reciprocal communication relationship or an active role from the caregivers themselves, meaning that strengthening routine immunization programs needs considered to focus on building awareness among residents through social engagement (Mahachi et al., 2022; Syed et al., 2023). Arizona's Health Start Program (HSP) was a well-established model by promotes the optimal use of community-based family healthcare services and education services through the use of community health workers (CHWs) for maternal and child health home visits (Wightman et al., 2022). Families in the CHW home visiting intervention were significantly more likely to report better immunization outcomes by utilizing CHWs who live in and reflect the ethnic, cultural, and socioeconomic characteristics of the local society. In addition, increasing parental knowledge through local leaders may be more sufficient to reach marginalized communities (Haldane et al., 2019) due to geographical or socioeconomic factors to encourage children's immunization completion. Mobilizing communities for immunization may strengthen weak links in the causal chain, as traditional and religious leaders (TRLs) met the local characteristics, thus the information dissemination through local language may impact a greater outreach (Sabarwal et al., 2015). Despite the fact that a multi-component intervention involving TRLs had an insignificant effect on the proportion of children up-to-date with vaccination, the effectiveness in increasing the proportion of children receiving at least one vaccination should be considered (Oyo-Ita et al., 2021).

Of all the interventions, the most underlying consideration was rural settings. Though the effects of the implementations against immunization dropout were found significant, the application of the offered method faces similar barriers. The use of electronic or technology-based services may be struggling due to insufficient electricity and an internet connection, thus electronic-based reminders, such as SMS reminders and phone calls, may also be considered for future studies.

This systematic review on outcomes of community participation in high and upper-middle-income countries is the first of its kind to be conducted. A strength of this review was the use of a wide range of databases and the inclusion of papers in multiple languages to ensure broad representation.

The present study is a comprehensive and updated review of childhood immunization interventions including randomized trial evidence and pre-post studies. However, different settings and scales of the targeted population may influence these findings, therefore, this systematic review study may be subject to several limitations. First, included studies may be overestimated to African countries as 70% of the findings were conducted in African regions. Different characteristics at different sites could impact the results of the interventions. Second, literature searching only uses Google Scholar and PubMed databases, hence, this may result in limited articles found. However, the small number of identified studies has reflected the big-picture objectives of this study based on strategic search keywords.

4. CONCLUSION

Overall, the most common interventions are phone calls and text messages to remind caregivers to bring infants for routine immunization on appointed dates. The impact of the interventions varied by study setting and sample characteristics, however, all the included studies proved to be significantly associated with an increasing trend of immunization rates. Nevertheless, these findings still face obstacles in the implementation, hence, improving social engagement is way better to reach the marginal groups that have limited internet connection and electricity.

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