

GOOGLE CALENDAR-BASED IMMUNIZATION REMINDERS AND INFANT IMMUNIZATION COMPLIANCE IN GROGOL, KEDIRI REGENCY: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Basic immunization coverage in the working area of Grogol Primary Health Center has not yet reached the national target, highlighting the need for effective strategies to improve maternal compliance with childhood immunization schedules. This study aimed to analyze the effect of a Google Calendar-based immunization reminder on maternal compliance with the basic immunization schedule for infants. A quasi-experimental study with a pretest-posttest control group design was conducted among 60 mothers of infants aged 0–9 months, selected using purposive sampling. Participants were assigned to an intervention group (n=30), which received Google Calendar-based immunization reminders, or a control group (n=30), which received routine immunization services. Compliance was assessed using the Maternal and Child Health (MCH) Handbook observation sheet and a Guttman-scale questionnaire. Data were analyzed using the McNemar and Chi-square tests, with a significance level of $p < 0.05$. Compliance in the intervention group increased from 46.7% at baseline to 83.3% after the intervention ($p = 0.013$), whereas the control group showed a non-significant increase from 36.7% to 46.7% ($p = 0.250$). Post-test comparison demonstrated significantly higher compliance in the intervention group than in the control group ($p = 0.003$). Google Calendar-based reminders effectively improved maternal compliance with the infant basic immunization schedule by providing timely automated notifications. This simple digital intervention has the potential to support immunization services and enhance immunization coverage in primary healthcare settings.

Keywords : Baby, Compliance, Google Calendar, Immunization, Reminder.

INTRODUCTION

Immunization is one of the most effective health interventions for preventing infectious diseases in infants and children, as it works by forming active immunity so that the body can prevent infection or minimize the severity of disease upon exposure to the target disease (Rahma, 2021). In Indonesia, complete basic immunization for infants aged 0–11 months includes the BCG, DPT-HB-Hib, polio, and measles-rubella vaccines, which are provided free of charge through the national immunization program to build herd immunity against vaccine-preventable diseases. Globally, complete basic immunization coverage in 2024 was recorded at 85%, with DTP3 coverage as the main indicator (World Health Organization [WHO], 2025), while Indonesia's national coverage in 2023 was recorded at 95.4% (Kemenkes RI, 2024). Nevertheless, coverage at the district level still shows a gap; complete basic immunization coverage in Kediri Regency in 2024 only reached 83.22%, still below the established target of 100% (Dinas Kesehatan Kabupaten Kediri, 2024).

One working area with coverage below the district target is UPTD Puskesmas Grogol, with complete basic immunization coverage of 78.96% in 2024. Among its nine assisted villages, Sonorejo Village and Grogol Village have the highest numbers of infants, yet their

immunization coverage remains suboptimal. One cause of immunization delays is parents forgetting the schedule for the next immunization, given that the Maternal and Child Health (MCH) Handbook, as the main source of information, is passive and requires parental initiative to open it again.

The use of digital technology in the form of electronic reminders has increasingly been studied as a strategy to improve immunization compliance. Systematic reviews of SMS-based reminder interventions consistently show improvements in the coverage and timeliness of child immunization, although the magnitude of the effect varies according to program context and health service systems (Currie et al., 2024; Eze et al., 2021; Mekonnen et al., 2021). A study in Nigeria found that routinely sending text message reminders to mothers improved the timeliness and completeness of basic immunization compared with a group receiving no reminders (Oladebo et al., 2021), while another systematic review of similar strategies also reported an increase in maternal compliance in providing complete basic immunization to their infants (Samson et al., 2024).

Unlike SMS-based reminders, which have been widely studied, evidence on the effectiveness of digital reminders integrated with common calendar applications such as Google Calendar remains very limited in the national literature. Existing research has only gone as far as developing instant-messaging-based reminder information systems for chronic disease patients and immunization, with evaluation still limited to technical aspects and user acceptance (Ariati et al., 2024). Yet the high use of smartphones among the Indonesian population opens up great opportunities to utilize Google Calendar as a simple, free, and easily accessible reminder medium, with an automatic notification feature that has the potential to help mothers remember their infant's immunization schedule (Vinarti et al., 2024).

Based on the description above, this study aims to analyze the effect of a Google Calendar application-based immunization schedule reminder on compliance with the basic immunization schedule for infants in the working area of UPTD Puskesmas Grogol, Kediri Regency..

METHODS

This study used a quasi-experimental design with a pretest-posttest control group design. The study was conducted from March to June 2026 in the working area of UPTD Puskesmas Grogol, Kediri Regency, namely Sonorejo Village as the intervention group and Grogol Village as the control group. Village-level assignment was not conducted through randomization. Sonorejo Village and Grogol Village were purposively selected because, among the nine assisted villages, they had the highest numbers of infants, and the two villages are administratively and geographically separate, which was intended to reduce the likelihood of intervention diffusion between groups. However, no formal randomization or matching procedure was applied at the village level, so residual sociodemographic differences between the two villages cannot be ruled out; this is acknowledged as a limitation of the study design.

The study population consisted of all mothers with infants aged 0–9 months in the two villages. The sample comprised 60 respondents, 30 respondents each in the intervention group and the control group, determined using a purposive sampling technique. A probability-based sampling method was not used because eligibility depended on specific, verifiable criteria such as smartphone ownership and an active Google Calendar account that could not be ascertained in advance for the entire population; purposive sampling was therefore considered the more feasible approach for identifying eligible participants within the study period. This non-probability approach is acknowledged as a limitation that may restrict the generalizability of the findings and introduce potential selection bias. Inclusion criteria included mothers with infants aged 0–9 months with a routine immunization schedule during the study period, who owned a smartphone and an active Google Calendar account, and who were willing to be

respondents. Because ownership of a smartphone and an active Google Calendar account was a mandatory inclusion criterion, the study sample was inherently restricted to a digitally literate subgroup of mothers; this pre-selection likely biased the observed intervention effect upward relative to the general population served by the health center, including mothers without adequate access to or familiarity with digital technology. Exclusion criteria included infants with medical conditions delaying immunization and mothers without adequate access to a smartphone or the internet. No respondents dropped out during the study.

The intervention consisted of providing basic immunization schedule reminders using the Google Calendar application. The immunization schedule was prepared based on the Maternal and Child Health (MCH) Handbook, then sent as an event invitation to the respondents' Gmail accounts so that notifications were received one day before (H-1) and on the day of immunization over a period of two months. The control group received routine immunization services according to standard procedure. Immunization schedule compliance was assessed before (pre-test) and after (post-test) the intervention period in both groups.

Immunization schedule compliance was measured using the MCH Handbook observation sheet and a Guttman-scale questionnaire consisting of 18 valid statement items (r calculated = 0.486–0.850; r table = 0.361) with a Cronbach's Alpha reliability value of 0.869. Respondents were categorized as compliant if they obtained a score >9 and non-compliant if they obtained a score ≤ 9 . This cut-off point was derived mathematically from the range of the Guttman-scale instrument (highest possible score 18, lowest possible score 0), following the standard interval formula (interval = range $\div$ number of categories = $18 \div 2 = 9$), rather than from the sample median or an externally validated threshold; scores above this calculated midpoint were categorized as compliant.

Univariate analysis was used to describe respondent characteristics and the distribution of compliance. Bivariate analysis used the McNemar test to analyze changes in compliance before and after the intervention in each group, while the Chi-square test was used to compare the proportion of compliance between the intervention group and the control group. The level of statistical significance was set at $\alpha = 0.05$.

This study obtained ethical approval from the Ethics Committee with number 057/12/VI/EC/KEPK-3/STIKES RSBK/2026.

RESULTS

The study involved 60 respondents divided into an intervention group and a control group, 30 respondents each, selected using a purposive sampling technique. Most respondents in both groups were aged 21–30 years, had a high school/equivalent education, and almost all used Android-based smartphones with active Google accounts, making them technically eligible to receive reminders via the Google Calendar application. No respondents dropped out during the study.

The characteristics of respondents in the intervention group and the control group based on maternal age, education, occupation, infant age, distance of residence to the health facility, type of smartphone, and Google account ownership are presented in Table 1.

Table 1. Characteristics of Respondents in the Intervention Group and the Control Group

Characteristic	Group				p-value
	Intervention Group (n = 30)		Control Group (n = 30)		
	F	%	F	%	
Maternal Age					0,217a
<20 Years	1	3,3	0	0	
21–30 Years	20	66,7	17	56,7	
31–40 Years	7	23,3	11	36,7	
>41 Years	2	6,7	2	6,6	
Education					0,019a
Basic	0	0	1	3,3	
Secondary	22	73,3	22	73,3	
Higher	8	26,7	7	23,4	
Occupation					1,000c
Employed	9	30	8	26,7	
Unemployed/Housewife	21	70	22	73,3	
Infant Age					0,007a
0 Month	1	3,3	0	0	
1 Month	6	20	1	3,3	
2 Months	6	20	5	16,7	
3 Months	7	23,3	15	50	
4 Months	6	20	6	20	
5 Months	2	6,7	2	6,7	
6 Months	2	6,7	1	3,3	
Type of Immunization					0,538b
BCG	7	23,3	5	16,7	
Polio/IPV	3	10	4	13,3	
DPT-HB-HiB	20	66,7	21	70	
Distance of Residence to Health Facility					0,007a
<1 km	21	70	25	83,3	
1-2 km	7	23,4	5	16,7	
3-5 km	1	3,3	0	0	
6-8 km	1	3,3	0	0	
Type of Smartphone					0,121c
Android	25	83,3	28	93,3	
iPhone	5	16,7	2	6,7	

Google Account Ownership					0,019 ^c
Yes	30	100	29	96,7	
No	0	0	1	3,3	

Note: *a* Fisher-Freeman-Halton Exact Test (Monte Carlo Exact Test), *b* Pearson Chi-Square Test, *c* Fisher's Exact Test

Source: Primary Data Processed by the Researcher, 2026.

Based on Table 1, most respondents in both groups were aged 21–30 years and had a secondary education, with an equal proportion of secondary education in both groups (73.3%). The homogeneity test results showed that the characteristics of maternal age ($p=0.217$), occupation ($p=1.000$), type of smartphone ($p=0.121$), and type of scheduled immunization ($p=0.538$) were homogeneous between the intervention group and the control group, while the characteristics of education, infant age, distance of residence to the health facility, and Google account ownership showed significant differences ($p<0.05$). Because group allocation was not randomized, these baseline imbalances in education, infant age, distance to the health facility, and Google account ownership are potential confounders that may partly explain the observed difference in compliance between the intervention and control groups. Stratified or multivariable adjustment for these variables was not performed in the present analysis and is recommended for future studies. Almost all respondents in both groups used Android-based smartphones with active Google accounts, so that all respondents were technically eligible to receive reminders via the Google Calendar application.

A. Implementation of Google Calendar-Based Reminders

Monitoring of reminder implementation was carried out using an implementation observation sheet and confirmed directly at Posyandu (Integrated Health Post) activities by asking respondents to show the notifications they had received. The observation results showed that all respondents in the intervention group received reminders according to the established procedure, without any significant technical obstacles, given that all respondents already had a Gmail account and an Android smartphone.

B. Immunization Schedule Compliance Before and After the Intervention

Differences in basic immunization schedule compliance before and after the treatment in each group were analyzed using the McNemar test, as presented in Table 2 (intervention group) and Table 3 (control group).

Table 2. Differences in Basic Immunization Schedule Compliance Before and After the Intervention in the Intervention Group ($n=30$)

Immunization Schedule Compliance	Pre-Test		Post-Test		p-value
	F	%	F	%	
Non-compliant	16	53,3	5	16,7	0,013 ^b
Compliant	14	46,7	25	83,3	

Note: *b* McNemar Test

Source: Primary Data Processed by the Researcher, 2026.

Table 3. Differences in Basic Immunization Schedule Compliance Before and After in the Control Group (n=30)

Immunization Schedule Compliance	Pre-Test		Post-Test		p-value
	F	%	F	%	
Non-compliant	19	63,3	16	53,3	0,250b
Compliant	11	36,7	14	46,7	

Note: *b McNemar Test*

Source: *Primary Data Processed by the Researcher, 2026.*

Based on Table 2, the McNemar test results in the intervention group showed a value of $p = 0.013$ ($p < 0.05$), which means there was a significant change in compliance before and after the Google Calendar application-based reminder, from 46.7% before the intervention to 83.3% after the intervention. In contrast, based on Table 3, in the control group a value of $p = 0.250$ was obtained ($p > 0.05$), which means there was no significant change in compliance in the group that did not receive reminders. This finding indicates that providing a Google Calendar application-based immunization schedule reminder has a significant effect on improving compliance with the basic immunization schedule in infants.

The difference in compliance between the intervention group and the control group, both at pre-test and post-test, was further analyzed using the Chi-square test, as presented in Table 4. The post-test difference was the main focus because it reflects the change in compliance after the intervention period.

Table 4. Differences in Basic Immunization Schedule Compliance between the Intervention Group and the Control Group at Pre-Test and Post-Test

Time	Immunization Schedule Compliance	Intervention Group (n=30)		Control Group (n=30)		P- value
		F	%	F	%	
Pre-Test	Non-compliant	16	53,3	19	63,3	0,432a
	Compliant	14	46,7	11	36,7	
Post-Test	Non-compliant	5	16,7	16	53,3	0,003a
	Compliant	25	83,3	14	46,7	

Note: *a Chi-Square Test*

Source: *Primary Data Processed by the Researcher, 2026.*

Based on Table 4, the Chi-square test results showed that before the intervention there was no significant difference in compliance between the intervention group and the control group ($p=0.432$), meaning both groups started from a relatively similar baseline compliance condition. After the intervention, there was a significant difference in compliance between the two groups ($p=0.003$), with the proportion of compliance in the intervention group (83.3%) being much higher than in the control group (46.7%). This finding indicates that the difference in compliance that emerged after the study period was more likely caused by the provision of the Google Calendar application-based reminder than by differences in the initial characteristics of the two groups.

DISCUSSION

The finding that all respondents in the intervention group received reminders without any significant technical obstacles reinforces the picture that Google Calendar, as a form of electronic reminder that utilizes an automatic notification feature, can function as a reminder medium that is easily integrated into primary health care services (Ardian, 2021). A similar

working principle was also found in the WhatsApp Gateway-based reminder system developed by Ariati et al. (2024), namely the automatic delivery of scheduled information without relying on the manual intervention of health workers at all times.

The increase in compliance in the intervention group, from 46.7% before the intervention to 83.3% after the intervention (Table 2), was greater than the effect generally reported for SMS-based reminders, which in various systematic reviews tend to produce improvements in immunization coverage and timeliness with an effect size that varies depending on program context and health service systems (Currie et al., 2024; Eze et al., 2021). This difference indicates that automatic notifications based on a digital calendar, which do not require message delivery costs and are already integrated into most Android smartphones, may be broadly comparable to the impact commonly reported for SMS-based reminders. As this study did not directly compare Google Calendar with SMS-based reminders within the same trial, this observation should be regarded as an indirect, cross-study comparison rather than evidence that one modality is superior to the other.

A. Effect of Google Calendar Reminders on Basic Immunization Compliance

Before the reminders were given, maternal compliance with the basic immunization schedule in both groups was still not optimal. This condition indicates that the unavailability of a reminder medium capable of providing active notifications is one of the contributing factors. A person's compliance behavior is influenced not only by knowledge and motivation but also by the support received, including support in the form of media that helps individuals remember or carry out a health action (Isdairi et al., 2021). The MCH Handbook, as a source of information on the immunization schedule, is passive because mothers need to reopen the book, so the schedule may potentially be missed if the mother forgets or does not have time to check it.

After the reminders were given, compliance in the intervention group increased sharply, while the control group showed no significant change. The automatic notifications that appeared at the scheduled time gave mothers the opportunity to prepare for a visit to the health care facility, so that the reminder functioned as a form of support that made it easier for mothers to carry out immunization according to schedule. This finding is in line with the results of systematic reviews showing that SMS-based reminders consistently improve the coverage and timeliness of child immunization (Eze et al., 2021; Mekonnen et al., 2021), as well as a study reporting an improvement in the timeliness of immunization visits in the group receiving message reminders compared with the control group (Samson et al., 2024).

The fact that significant changes in compliance occurred only in the group that received reminders strengthens the notion that Google Calendar does not merely function as a passive reminder medium, but also helps mothers manage the timing of visits amid various daily activities. This result is consistent with a study in Nigeria showing that text message reminders sent routinely to mothers improved the timeliness and completeness of basic immunization compared with a group without reminders (Oladebo et al., 2021). Thus, reminders based on a free and easily accessible digital calendar application have the potential to become an alternative, simple strategy for promoting immunization compliance that can be widely adopted by primary health care facilities, particularly in assisted villages where complete basic immunization coverage remains below target.

Google Calendar is a form of electronic reminder that provides an automatic notification feature, allowing users to receive information exactly at the scheduled time. This kind of reminder-recall strategy has long been recommended as one of the evidence-based approaches for improving immunization coverage, whether delivered through text messages, email, phone calls, or digital calendars (Kempe et al., 2021).

These findings reinforce evidence from a systematic review and meta-analysis of 25 randomized controlled trials, which found that mobile phone text-message-based reminders consistently improved vaccination uptake compared with routine services (Louw et al., 2024), as well as a randomized controlled trial showing that a combination of text messages and calendar reminders was able to improve the timeliness of infant immunization (Menzies et al., 2020). Although the media used differ, the working principle of these reminders is similar to the use of Google Calendar in this study, namely providing automatic notifications to parents before the immunization schedule arrives.

A systematic review by Dathini et al. (2022) also showed that various parental reminder strategies, including text messages and phone calls, are effective in improving child immunization uptake while also being cost-efficient, making them potentially suitable for wide application in primary health care services. This supports the use of Google Calendar in this study as a free reminder medium that does not require the development of a special application and is easily accessible to mothers who already have a Google account.

The condition of not-yet-optimal compliance before the intervention is in line with findings that delays and untimeliness in immunization remain a global challenge, as demonstrated by a scoping review mapping the measurement of immunization timeliness in various low- and middle-income countries (Wariri et al., 2022). Disruptions to health services, including those that occurred during the COVID-19 pandemic, have also been reported to have reduced global routine child immunization coverage (Causey et al., 2021), confirming that factors beyond parental characteristics also affect immunization timeliness, so that support from the service system, including reminder media, is needed to help overcome these barriers.

Maternal compliance behavior with the immunization schedule is influenced not only by knowledge and motivation but also by enabling factors in the form of media that make it easier for individuals to carry out a health action (Notoatmodjo, 2018). The Google Calendar-based reminder in this study served as such an enabling factor, providing automatic notifications at the scheduled time so that mothers had the opportunity to prepare for a visit to the health care facility before the immunization schedule took place.

Unlike previous studies that generally used SMS-based reminders, this study utilized the Google Calendar application, which is already widely integrated into Android-based smartphones, does not require message delivery costs, and is able to provide automatic notifications according to a predetermined schedule. Thus, the Google Calendar application-based reminder has the potential to become a simple, easily implemented, and sustainable alternative reminder medium to support the implementation of basic immunization in infants, particularly in assisted villages where complete basic immunization coverage remains below target.

B. Strengths of the Study

This study used a quasi-experimental pre-test post-test control group design, allowing comparison of changes in compliance between the intervention group and the control group. The Google Calendar application-based reminder used is free, easily accessible, and already integrated with most Android smartphones, making it potentially applicable on a wide scale without requiring message delivery costs or the development of a special application. Compliance measurement was also verified using the Maternal and Child Health (MCH) Handbook, increasing data accuracy, and all respondents successfully completed the study without dropping out, so that all data could be analyzed.

C. Limitations of the Study

This study used a quasi-experimental design without randomization, so there remains the possibility of confounding factors that could not be fully controlled. The study was

conducted only in two villages within the working area of UPTD Puskesmas Grogol, Kediri Regency, so the results cannot yet be generalized to a broader population. In addition, because the intervention and control villages are geographically close and share community activities such as Posyandu sessions, there is a risk of contamination between groups through shared attendance or word-of-mouth information exchange, which may have diluted or inflated the estimated intervention effect. The baseline imbalances in education, infant age, distance to the health facility, and Google account ownership noted in Table 1 may also have partly contributed to the observed difference in compliance between groups. This study also did not control for other factors that may influence compliance, such as family support, maternal motivation, access to health services, and infant health condition, and the implementation of the intervention depended on smartphone ownership, an active Gmail account, and internet connection, so that the effectiveness of the reminder may be influenced by respondents' ability to access digital technology.

D. Implications of the Study

These findings have implications for primary health care services, namely that Google Calendar can be utilized as a reminder medium to improve compliance with the basic immunization schedule in infants, while also serving as an innovative alternative for health workers in the education and monitoring of immunization schedules based on digital technology. For the community, the use of Google Calendar can help parents remember the immunization schedule, thereby reducing the risk of delay, while for future research, these findings can be developed further using a larger sample size, a broader area coverage, and by considering other factors that influence immunization schedule compliance..

CONCLUSION

The use of a Google Calendar application-based immunization schedule reminder was associated with improved compliance with the basic immunization schedule for infants in the working area of UPTD Puskesmas Grogol, Kediri Regency. The group that received reminders showed a significant increase in compliance after the intervention, whereas the control group showed no significant change. However, because this study used a non-randomized design involving two villages and baseline differences were observed between the intervention and control groups, these findings should be interpreted with caution. The use of Google Calendar has the potential to become a simple, easily accessible reminder medium that can be integrated into primary health care services to support improvements in compliance with the basic immunization schedule in infants. Further studies using randomized designs, multiple intervention and control clusters, larger sample sizes, and adjusted analyses are warranted to establish the effectiveness and generalizability of this intervention.

Future research is recommended to use a randomized controlled trial (RCT) design with a larger sample size and broader area coverage, as well as to consider other factors that may influence compliance, such as family support, maternal motivation, and access to health services. Future studies employing similar quasi-experimental designs are also encouraged to follow a structured reporting guideline, such as TREND or the CONSORT extension for non-randomized designs, and to include a participant flow diagram, in order to improve transparency and comparability across studies.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in the implementation of this study or the preparation of this article.

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