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Improving Childhood Immunization Completion in Rural Bayelsa State, Nigeria: A Pragmatic Cluster Randomized Trial of Mobile Phone Reminders and Home Visits

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Abstract

Background: Immunization is a critical public health intervention for preventing vaccine-preventable diseases (VPDs) and achieving herd immunity. However, suboptimal vaccination coverage remains a challenge, particularly in rural and underserved areas. Missed appointments due to forgetfulness and logistical barriers contribute significantly to low immunization rates. This study evaluates the impact of mobile phone (MP) reminders and home visits (HV) on childhood immunization completion rates in Bayelsa State, Nigeria. Aim: The study aimed to assess the effectiveness of MP reminders and HV outreach in improving vaccination coverage among children under two years of age. **Methods**: A pragmatic cluster randomized controlled trial was conducted in rural communities of Bayelsa State, Nigeria. A total of 384 participants were randomly assigned to three study arms: control (no intervention), MP reminders, and HV outreach (128 per arm). A multi-stage sampling technique was employed, and data were collected using a semi-structured WHO SAGE survey tool. Statistical analyses were performed using SPSS v25, with chi-square (χ^2) tests used to compare categorical variables. Statistical significance was set at $p \leq 0.05$, with effect sizes reported. **Results**: The study revealed significant differences in immunization completion rates across study groups: control (46.1%, 59/128), MP reminders (59.4%, 76/128), and HV outreach (63.3%, 81/128). Both interventions were effective in improving vaccination

uptake, with a statistically significant difference ($p = 0.015$) and a moderate effect size (0.257). However, HV outreach demonstrated the highest completion rate, suggesting its greater effectiveness in overcoming access and engagement barriers. **Conclusion**: Integrating MP reminders and HV outreach into routine immunization programs can significantly improve childhood vaccination coverage. HV, in particular, addresses accessibility challenges and enhances community trust, making it a preferred strategy for increasing immunization rates. To optimize immunization coverage, policymakers should implement a hybrid approach, combining MP reminders with HV outreach, particularly in rural and underserved areas. Strengthening community-based health worker engagement and leveraging digital health innovations will further enhance vaccination efforts. Improved immunization coverage through these interventions reduces the risk of VPD outbreaks, enhances herd immunity, and contributes to achieving global vaccination targets. By addressing barriers to vaccine access and adherence, these strategies offer scalable, cost-effective solutions for improving child health outcomes. This trial provides robust evidence on the effectiveness of digital and community-based interventions for improving vaccination coverage. By comparing MP reminders and HV outreach, the study offers practical insights for health policymakers and program implementers. The findings contribute to global immunization research by highlighting scalable, low-cost solutions that can be adapted in resource-limited settings to strengthen immunization programs and reduce childhood morbidity and mortality.

Keywords

Immunization Coverage, Vaccine-Preventable Diseases (VPDs), Mobile Phone Reminders, Home Visits, Childhood Vaccination, Cluster Randomized Controlled Trial, Public Health Intervention, Herd Immunity, Rural Healthcare, Vaccination Adherence

1. Introduction

Vaccines have transformed global health by reducing the burden of infectious diseases. They prevent severe illness, lower mortality rates, and extend life expectancy, making them one of the most effective public health interventions [1]-[9]. The World Health Organization (WHO) estimates that vaccines save 3 to 5 million lives annually, either through direct protection or herd immunity [2]. Despite this success, vaccination gaps persist, threatening progress toward Sustainable Development Goal (SDG) 3, which aims for universal health coverage [10]-[12]. Although the Global Vaccine Action Plan targeted 90% immunization coverage by 2020, the current global rate remains at 84%, below the pre-pandemic level of 86% [13]. Approximately 20 million children worldwide are under-immunized, with 6.5 million receiving no vaccines at all [5] [6] [8] [10]. This gap increases outbreaks of preventable diseases, particularly in low-resource regions. Sub-Saharan

Africa faces significant vaccination challenges, with frequent outbreaks of diseases like measles and polio due to low immunization rates [5] [6] [8] [14]. In Nigeria, for example, only 39% of children receive all basic antigens, far below the global target [1] [2] [5]-[8] [15]. This leaves vulnerable populations, especially children under five, at higher risk of preventable deaths. Nigeria's immunization coverage has improved from 21% in 2017 to 39% in 2024, but progress remains slow [1]-[8] [15] [16]. Bayelsa State has one of the lowest rates, with only 36.9% of children aged 12 - 23 months fully immunized. This has prompted emergency interventions like the State Emergency Routine Immunization Coordination Centre (SERICC), yet coverage remains critically low. Reminder strategies, such as mobile alerts and home visits, have proven effective in improving vaccination rates. Studies show that text message reminders increase appointment adherence by 15% - 20% [17], while phone calls improve follow-up rates by 25% [18]. However, their impact in low-resource settings like Bayelsa State remains understudied. While reminder systems work in some contexts, their effectiveness in rural Nigeria, where internet access and literacy vary is unclear. Few studies compare different reminder methods (e.g., mobile calls vs. home visits) in similar settings. Without this data, policymakers lack evidence to allocate resources effectively. While, low vaccination rates disproportionately affect rural, low-income families in Nigeria. Outbreaks of preventable diseases strain healthcare systems, costing an estimated $1.3 billion annually in treatment and outbreak response [19]-[28]. The problem has persisted for decades, with coverage fluctuating due to logistical and cultural barriers. Thus, improving vaccination rates aligns with SDG 3's targets for reducing child mortality and ensuring equitable healthcare [10]-[12]. This study also intersects with research on health communication, technology adoption, and community engagement, offering broader lessons for public health planning. By identifying the most effective reminder method for Bayelsa State, this study can guide policy decisions and resource allocation. The findings will help Nigeria and similar regions close immunization gaps, saving lives and reducing healthcare costs. Thus, this research evaluates mobile phone reminders and home visits in Bayelsa State to determine which method improves vaccination coverage more. By testing these approaches in a real-world setting provide actionable insights for scaling up immunization programs.

2. Methods

2.1. Participants

This study involved two related participant groups. The first comprised children under two years of age who were assessed to establish baseline immunization coverage in rural communities of Bayelsa State, Nigeria. The second group consisted of neonates enrolled at birth and followed from their first vaccine dose through completion of the routine childhood immunization schedule in accordance with the national guidelines. Vaccines introduced into the schedule after 2023 were not included in this study. Exclusion criteria were: infants with congenital conditions;

parents or caregivers planning to relocate during the study period; communities without a functional primary health center; and, for the mobile phone reminder arm (Intervention A), parents or caregivers without access to a mobile phone. Written informed consent was obtained from all participating mothers and caregivers prior to enrollment.

2.2. Interventions

Three local government areas (LGAs) were selected using simple random sampling from the three senatorial districts. These LGAs were then randomly allocated, via balloting, in a 1:1:1 ratio to two intervention arms and one control arm. Two LGAs served as intervention arms: Intervention A (mobile phone reminders) and Intervention B (home visits by community health volunteers). The third LGA served as the control. Within each LGA, five communities were randomly selected, yielding a total of 15 communities for the study. Each LGA had a sample size of 128 participants, proportionally distributed across the selected communities.

2.3. Objectives

The primary objective was to evaluate the impact of two reminder-based interventions on routine childhood immunization coverage in Bayelsa State, Nigeria.

2.4. Outcomes

The primary outcome was the immunization coverage rate, assessed through mobile phone reminders and community health volunteers. The secondary outcome was a comparative analysis of the effectiveness of the two interventions in improving vaccination coverage.

2.5. Sample Size Determination

The required sample size was calculated using the cluster-randomized trial formula:

$$\mathrm{n} = \mathrm{Deff} \times \left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2 \times \frac{\left|P_1\left(1-P_1\right) + P_2\left(1-P_2\right)\right|}{\left(P_1 - P_2\right)^2}. \quad (1)$$

The formula selected represents the standard equation for determining the sample size in a cluster-randomized trial. The breakdown of its components includes:

1) Deff: Design effect, accounting for intracluster correlation.

2) $Z_{1-\alpha/2}$: Critical value of the standard normal distribution at a significance level of 0.05

3) $Z_{1-\beta}$: Critical value of the standard normal distribution for a power of 80%.

4) P_1, P_2: Expected proportions of the outcome (e.g., immunization coverage) in the intervention and control groups.

5) P_1 (1 − P_1) and P_2 (1 − P_2): Variance estimates for the two groups.

6) P_1 − P_2: Expected difference between the intervention and control groups.

Assumptions included:

- Power: 80%
- Significance level (α): 0.05
- Intracluster correlation coefficient: 0.01
- Average cluster size: 25
- Proportion outcome in control group: 24%
- Expected increase in coverage: 18%
- Attrition rate: 20%
- Design effect (Deff) was calculated using Deff = 1 + (m − 1) × ICC, where m is the average cluster size and ICC is the intracluster correlation coefficient.

This yielded a required sample size of 128 per cluster, with five communities per LGA and approximately 26 participants per community.

2.6. Sequence Generation

Bayelsa State was stratified into three districts (East, West, and Central). One LGA was randomly selected from each district using simple random sampling. The 1:1:1 allocation ratio was applied via balloting to determine the intervention and control LGAs.

2.7. Allocation Concealment

Cluster-based random allocation was employed. Participants were eligible if they had infants born between February and June 2023. Blinding was maintained among participants and research assistants, ensuring that those in one cluster remained unaware of interventions in other clusters.

2.8. Statistical Methods

The primary analysis was conducted at the LGA level. Descriptive statistics were used to summarize baseline characteristics. Chi-square tests were applied for inferential statistics to compare immunization coverage between intervention and control groups. An intention-to-treat (ITT) approach was adopted to analyze the outcomes, ensuring that all randomized participants were included in their originally assigned groups.

2.9. Participant Flow

Figure 1 illustrates the participant flow for Local Government Area (LGA) selection and intervention allocation in the study. Of the eight LGAs assessed for eligibility, five were excluded after the selection process was completed, leaving three LGAs that were successfully randomized. These three LGAs were then allocated equally to Intervention A (mobile phone-based intervention), Intervention B (home visit–based intervention), and a control group, with 128 participants assigned to each arm. Participants were drawn from five communities per LGA, with approximately 3-26 (or 2-25) participants recruited per community. Follow-up was completed across all study arms with no reported loss to follow-up. Consequently, all 128 par-

ticipants in each group were retained and included in the final analysis, demonstrating complete participant retention and adherence throughout the study period.

2.10. Recruitment

Participants were enrolled over five months (February to June 2023). Follow-up commenced immediately after recruitment, with each child monitored across five visits, completing their routine immunization schedule by 15 months of age. The final cohort of neonates recruited in June 2023 completed their immunization schedule in September 2024, marking the conclusion of the study.

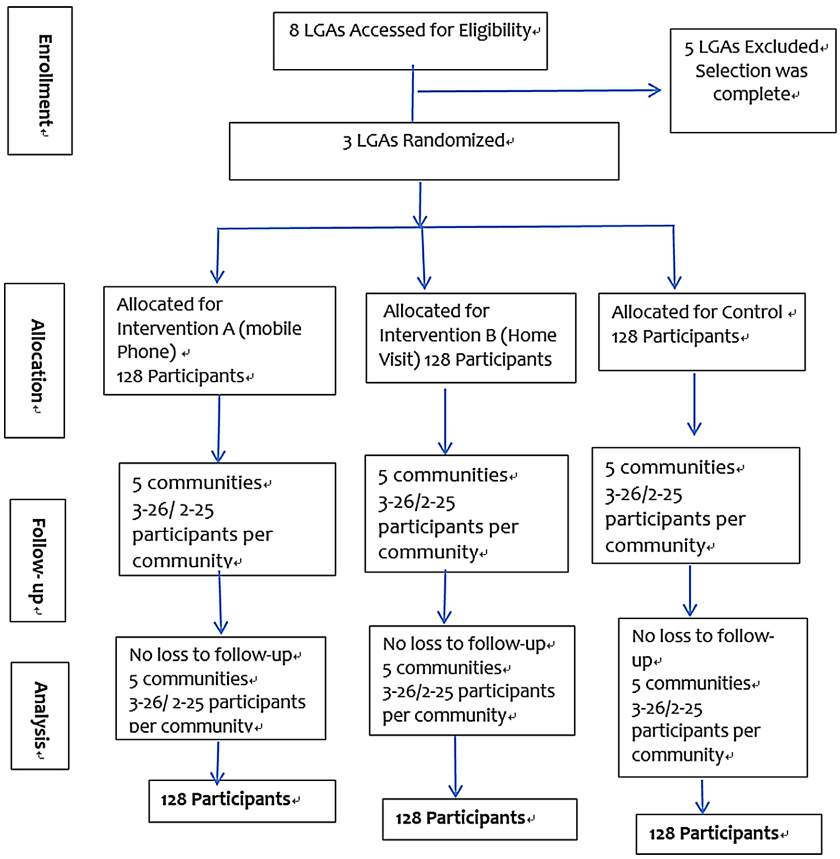

Figure 1. Participant flow diagram for LGA selection and intervention allocation.

3. Results

3.1. Baseline Characteristics

Table 1. Comparison of vaccination coverage across all baselines.

Vaccination Completion	Baseline Control (n = 128)	Baseline Mobile Phone (n = 128)	Baseline CHV Home Visits (n = 128)	(p-value)
Completed	53 (41.4%)	51 (39.8%)	55 (42.9%)	0.258 (0.879)
Not Completed	75 (58.6%)	77 (60.2%)	73 (57.1%)	

All 128 participants in each cluster were analyzed using the intention-to-treat approach.

Table 1 and Figure 2 present a comparison of vaccination coverage across all three study arms at baseline, showing that the proportion of children who had completed their vaccinations was 41.4% in the control group, 39.8% in the mobile phone intervention group, and 42.9% in the community health volunteer (CHV) home visit intervention group. The Chi-square test yielded a p-value of 0.879, indicating no statistically significant differences in baseline vaccination completion rates across the study arms. This confirms that randomization successfully ensured comparable groups at the start of the trial, eliminating potential selection bias. The relatively low vaccination coverage at baseline, with less than half of the children completing their immunization schedules, underscores the need for targeted interventions to improve uptake. Establishing similarity in baseline vaccination rates is crucial for accurately assessing intervention impact, ensuring that observed improvements in post-intervention coverage are due to the interventions rather than pre-existing differences. In a real-world context, these findings highlight systemic barriers such as vaccine accessibility issues, caregiver awareness gaps, and logistical challenges in distribution, reinforcing the importance of strategies like mobile phone reminders and home visits to enhance immunization coverage.

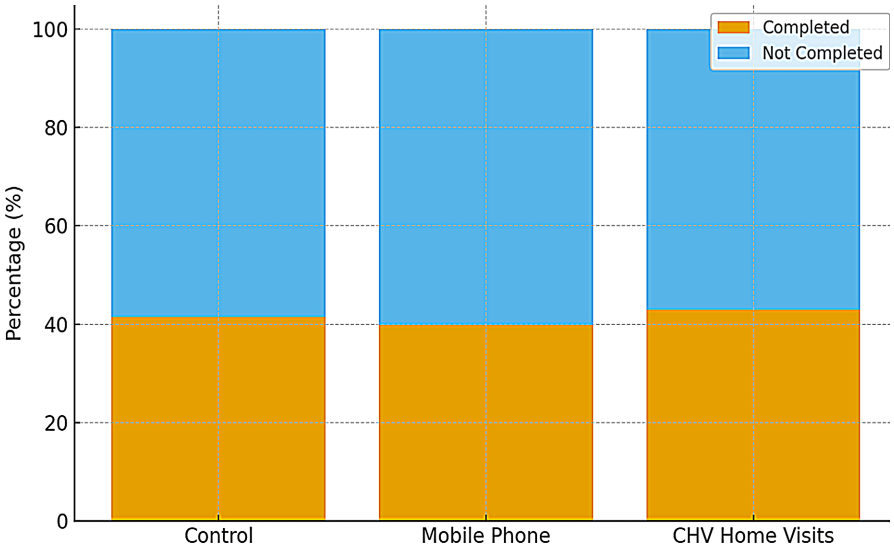

Figure 2. Baseline vaccination completion across study groups.

3.2. Effect of Mobile Phone Reminder on Vaccination Coverage

Table 2. Comparison of vaccination coverage between control and mobile phone intervention.

Vaccination Completion	Control (n = 128)	Mobile Phone (n = 128)	(p-value)
Completed	59 (46.1%)	76 (59.4%)	4.529 (0.033)*
Not Completed	69 (53.9%)	52 (40.6%)	

*Statistically significant ($p < 0.05$).

Table 2 and Figure 3 compare vaccination completion rates between the control group and the mobile phone intervention group, showing that 59.4% of children in the mobile phone intervention group completed their vaccinations, compared to 46.1% in the control group. The Chi-square test yielded a p-value of 0.033, indicating a statistically significant improvement in vaccination completion due to the mobile phone intervention. This result provides strong evidence that mobile phone-based interventions can positively influence vaccination uptake, demonstrating the potential of digital health tools in addressing gaps in immunization coverage. Given the widespread availability of mobile phones, these findings suggest that SMS or voice call reminders can serve as an effective and scalable strategy to enhance immunization adherence. The statistically significant improvement underscores the need for health authorities to integrate mobile phone reminders into national immunization programs, particularly in areas with high mobile phone penetration but limited healthcare infrastructure. By leveraging this intervention, policymakers can enhance timely vaccination uptake, reduce the burden of vaccine-preventable diseases, and improve overall public health outcomes.

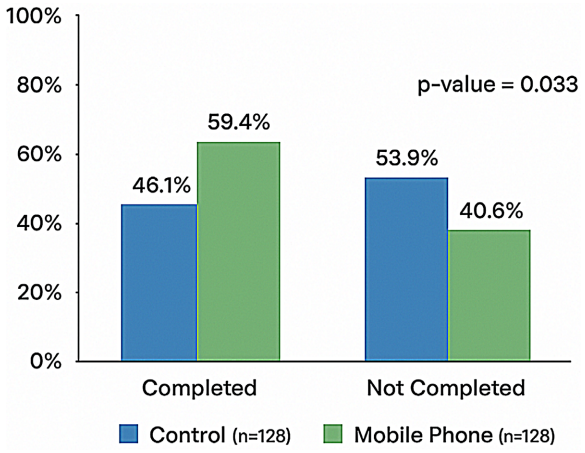

Figure 3. Vaccination completion.

3.3. Effect of CHV Home Visits on Vaccination Coverage

Table 3 and Figure 4 compare vaccination completion rates between the control group and the CHV home visit intervention group, revealing that 63.3% of children in the CHV home visit group completed their vaccinations, compared to 46.1% in the control group. The Chi-square test yielded a p-value of 0.006, indicating a statistically significant improvement in vaccination completion due to the home visit intervention. This result highlights the effectiveness of direct, in-person engagement in increasing immunization adherence, as CHVs educated parents, addressed vaccine hesitancy, and provided personalized follow-ups. The findings reinforce the importance of community-based outreach strategies in public health interventions, particularly in resource-limited settings where access to healthcare facilities may be a challenge. Given this significant impact, governments and health organizations should consider expanding CHV programs as

Table 3. Comparison of vaccination coverage between control and CHV home visit intervention.

Vaccination Completion	Control (n = 128)	CHV Home Visits (n = 128)	(p-value)
Completed	59 (46.1%)	81 (63.3%)	7.630 (0.006)*
Not Completed	69 (53.9%)	47 (36.7%)	

*Statistically significant ($p < 0.05$).

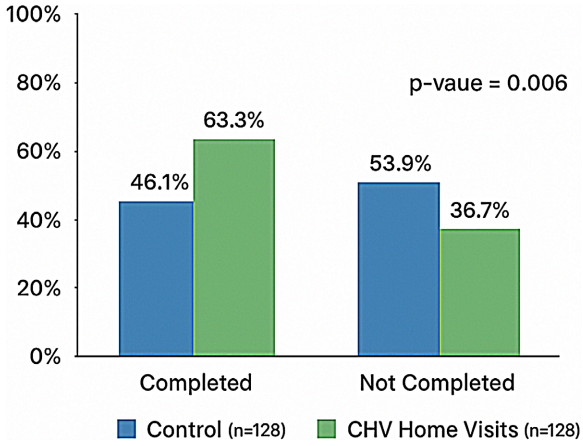

Figure 4. Vaccination completion.

part of broader immunization strategies. By integrating home-based education, reminders, and support into routine healthcare services, CHVs can bridge healthcare access gaps, ensuring that caregivers receive the necessary guidance and motivation to complete their children's immunization schedules.

3.4. Comparison of Vaccination Coverage

Table 4 and **Figure 5** present the overall comparison of vaccination completion rates across all three study arms, with 46.1% completion in the control group, 59.4% in the mobile phone intervention group, and 63.3% in the CHV home visit intervention group. The Chi-square test yielded a p-value of 0.015, confirming a statistically significant difference in vaccination coverage across the groups. Additionally, Cohen's W was calculated as 0.257, indicating a small but meaningful effect of the interventions on vaccination rates. These findings confirm that both interventions significantly improved immunization completion compared to the control, with CHV home visits demonstrating the highest impact, followed by mobile phone reminders. The study highlights the effectiveness of reminder-based interventions in addressing gaps in childhood immunization coverage, particularly in resource-limited settings where caregiver awareness and access to healthcare services may be constrained. In terms of real-world application, these results provide a strong justification for adopting reminder-based strategies to improve vaccination rates. Policymakers could implement mobile-based reminders in urban and semi-urban areas where mobile phone penetration is high, while CHV-led outreach programs could be prioritized in rural areas where direct

Table 4. Comparison of vaccination coverage across control and interventions.

Vaccination Completion	Control (n = 128)	Mobile Phone (n = 128)	CHV Home Visits (n = 128)	(p-value)
Completed	59 (46.1%)	76 (59.4%)	81 (63.3%)	8.444 (0.015) *
Not Completed	69 (53.9%)	52 (40.6%)	47 (36.7%)	

*Statistically significant ($p < 0.05$).

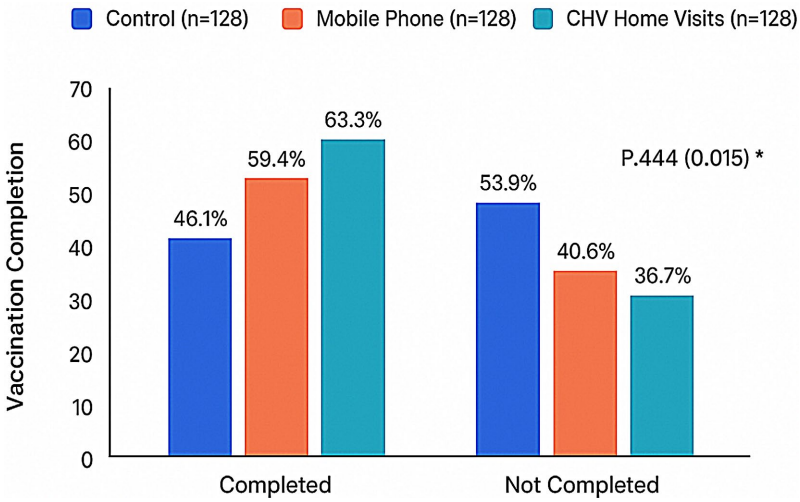

Figure 5. Vaccination completion rates by intervention group.

engagement is necessary to address vaccine hesitancy and accessibility challenges. Additionally, a hybrid approach that combines digital tools with in-person outreach may offer a comprehensive strategy to maximize immunization coverage.

3.5. Effect Size Analysis: Cohen's W

Cohen's W, a measure of effect size for categorical data, was calculated as:

$$W = \sqrt{\frac{8.444}{128}} = 0.257 . \quad (2)$$

A Cohen's W of 0.257 suggests a small but meaningful impact of the interventions on vaccination coverage.

Thus, this study contributes valuable evidence on the role of low-cost, scalable interventions in improving childhood immunization coverage. The findings support the integration of digital health tools and community-based outreach into routine immunization programs. These interventions could be particularly beneficial in settings where immunization coverage remains suboptimal due to systemic barriers.

4. Discussion

This study demonstrated that both mobile phone reminders and community health volunteer (CHV) home visits significantly improved childhood immunization completion compared with the control group. The baseline equivalence ob-

served across study arms (p = 0.879) confirms that randomization was successful and supports the validity of post-intervention comparisons. Similar emphasis on baseline comparability has been reported in previous immunization studies, where researchers highlighted that parity in pre-intervention characteristics strengthens causal inference and minimizes confounding [29]-[31]. Studies conducted in Bayelsa and other Nigerian settings also underscored the importance of baseline uniformity when assessing vaccination interventions [3] [4]. The improvement in vaccination completion observed in the mobile phone intervention arm aligns with existing evidence showing that digital reminders enhance immunization uptake. SMS and call-based interventions have consistently demonstrated positive effects on appointment adherence and timely vaccination in various settings [1] [2] [17] [32] [33]. These findings are further supported by research indicating high caregiver receptivity to mobile health (mHealth) reminders in Nigeria and other low-resource contexts [33]. The present study reinforces this body of evidence by demonstrating a statistically significant improvement (59.4% vs. 46.1%) attributable to digital reminders. However, consistent with prior work, this study also acknowledges that the effectiveness of mobile-based interventions is shaped by broader contextual factors such as network reliability, digital literacy, and persistent vaccine hesitancy [4] [6] [8] [21] [25] [30]. These challenges suggest that digital reminders alone may not fully overcome structural and behavioral barriers to vaccination. The CHV home visit intervention produced the highest completion rate (63.3%), highlighting the added value of direct community engagement strategies. This result is consistent with evidence from multiple studies showing that personalized, in-person visits enhance caregiver understanding, address hesitancy, and provide opportunities to overcome logistical constraints [14] [20] [21] [25] [34] [35]. The role of CHVs has been widely documented as critical in improving vaccine uptake in underserved populations, with several studies demonstrating that community workers effectively bridge gaps in access, information, and trust [3] [36]-[49]. The present findings reinforce these observations, underscoring that interpersonal communication remains a powerful mechanism for increasing adherence, particularly in settings where structural barriers limit routine health facility attendance. The results also align with broader literature that highlights the complementary strengths of mobile reminders and community-based strategies. Previous studies in African and Asian contexts have shown that integrating mHealth solutions with community outreach enhances vaccination timeliness and completion [50]-[58]. While digital reminders are scalable and cost-effective, they may be limited by socioeconomic disparities and infrastructural challenges, as noted in studies from Togo and other low-income settings [22] [44]-[66]. Conversely, CHV-led approaches provide deeper engagement but require consistent training, supervision, and incentive structures to remain sustainable. Thus, evidence from this trial supports a multifaceted strategy that combines digital and community-based interventions to maximize immunization outcomes. Overall, the study's findings demonstrate that both mobile phone remind-

ers and CHV home visits are effective strategies for improving childhood immunization completion in rural Nigeria, with home visits offering the greatest impact. This aligns with a growing body of evidence emphasizing that improving vaccination outcomes in resource-limited settings requires integrated approaches that address behavioral, structural, and access-related barriers simultaneously. By contributing new empirical evidence from Bayelsa State, this study adds to the global discourse on scalable, low-cost interventions that can strengthen immunization programs and accelerate progress toward national and global vaccination targets.

5. Conclusion

This study demonstrates that reminder-based interventions, specifically mobile phone reminders and community health volunteer (CHV) home visits, significantly improve childhood vaccination coverage in Bayelsa State, Nigeria. The findings revealed that while the control group had the lowest vaccination completion rate (46.1%), the mobile phone intervention group exhibited a significantly higher rate (59.4%), and the CHV home visit intervention yielded the highest completion rate (63.3%). These statistically significant differences indicate that both interventions effectively enhance immunization adherence, with CHV home visits showing the greatest impact. The results confirm that targeted interventions addressing vaccine uptake barriers can substantially improve immunization rates in communities with historically low coverage. Mobile phone reminders leverage digital accessibility to enhance compliance, while CHV home visits provide direct engagement, education, and personalized follow-ups to caregivers. The calculation of Cohen's W effect size further validates the meaningful impact of these interventions, reinforcing their potential for broader implementation in public health strategies. By highlighting the effectiveness of these approaches, this study provides critical insights for policymakers, healthcare providers, and global health organizations seeking to improve immunization rates. The findings underscore the need for sustainable, community-driven programs that integrate both digital and human resource-based strategies to strengthen immunization systems and protect children from vaccine-preventable diseases.

6. Policy Implication and Public Health Significance

The findings of this study underscore the critical need for policymakers to integrate reminder-based interventions into routine immunization programs at national and subnational levels. The demonstrated effectiveness of mobile phone reminders and community health volunteer (CHV) home visits highlights their value as low-cost, scalable strategies for improving childhood vaccination completion. Incorporating mobile health (mHealth) tools such as automated SMS and voice call reminders into immunization schedules can reduce missed appointments, particularly in urban and peri-urban areas with high mobile phone penetration. Sustaining these interventions will require strong public–private partnerships, where telecommunications companies, donor organizations, and govern-

ment agencies collaborate to support and subsidize digital reminder systems. Strengthening community-based health workforce capacity is equally important. CHV-led home visits address vaccine hesitancy, close knowledge gaps, and improve accessibility in rural and hard-to-reach communities. Policy frameworks should prioritize the recruitment, training, supervision, and motivation of CHVs as part of broader primary healthcare system strengthening. Institutionalizing community-driven outreach within immunization programs can significantly enhance vaccine uptake and help reduce preventable child morbidity and mortality. The public health significance of these findings extends beyond Bayelsa State. The combined use of mHealth interventions and CHV engagement offers a replicable model for improving immunization coverage in other low-resource settings. By addressing both behavioral and structural barriers to vaccination, these strategies contribute meaningfully to global goals for herd immunity, reduced disease outbreaks, and progress toward WHO and UNICEF immunization targets. Investing in digital tools alongside community-based platforms represents a practical, people-centered approach to ensuring that no child is left unvaccinated due to logistical constraints or lack of awareness. Thus, graphically it is represented (Figure 6 below) as:

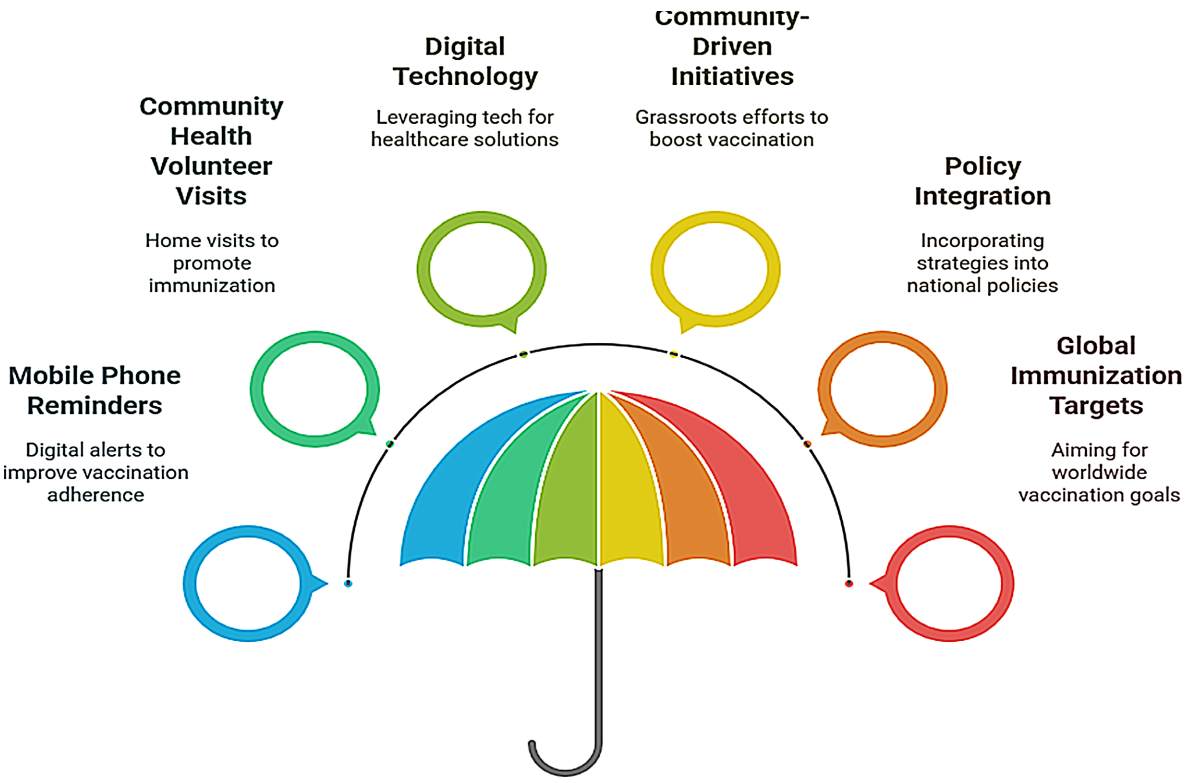

Figure 6. Enhancing immunization coverage.

7. Recommendations

1) Scale-Up of Mobile Phone Reminders: Given the positive impact of mobile phone reminders on vaccination completion, health authorities should integrate SMS and voice call reminders into national immunization schedules. Future in-

terventions could explore personalized messaging that includes culturally appropriate content to further improve caregiver compliance.

2) Expansion of CHV Home Visit Programs: Governments and health organizations should prioritize the recruitment and training of CHVs to provide door-to-door vaccination education, follow-ups, and support. This approach is particularly beneficial in rural and underserved communities where healthcare access is limited. Incentivizing CHVs through stipends or non-monetary rewards can enhance program sustainability.

3) Hybrid Intervention Strategies: Combining mobile reminders with CHV-led follow-ups may yield even greater improvements in vaccination rates. Future studies should evaluate the effectiveness of integrated approaches to determine the most efficient and cost-effective immunization reminder model.

4) Strengthening Community Engagement: Health campaigns should involve community leaders, religious groups, and parent associations in promoting immunization. Social mobilization strategies that incorporate storytelling, peer education, and advocacy can address vaccine hesitancy and misinformation.

5) Policy Integration and Sustainability Planning: Governments should institutionalize reminder-based interventions within immunization policies, ensuring long-term funding through domestic health budgets or external grants. Research into cost-effectiveness and scalability will further support policy adoption and implementation.

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Authors Contribution

All authors contributed equally to conceptualization, validation, writing review and editing.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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