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Article

Improving Routine Childhood Vaccination Coverage Through Registry-Driven Telephone Outreach: A Large Pre–Post Study from the Federation of Bosnia and Herzegovina

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Abstract

Background: Vaccination coverage declined in many countries during the COVID-19 pandemic, including in Bosnia and Herzegovina. We evaluated a telephone-based outreach intervention implemented in primary healthcare facilities (PHCs) in the Federation of Bosnia and Herzegovina. The intervention targeted missed routine vaccinations among children aged 0–7 years. **Method:** Using a programmatic, non-randomized pre–post design, healthcare teams reviewed registries to identify under-vaccinated children, and parents were contacted by phone to facilitate catch-up visits. **Results:** Among age-eligible children, vaccination coverage increased from 66.5% to 74.2% for measles–mumps–rubella (MMR) dose 1, from 43.4% to 51.7% for MMR dose 2, and from 50.4% to 55.9% for the fourth dose of diphtheria–tetanus–acellular pertussis-inactivated poliovirus–Haemophilus influenzae type b vaccine (DTaP-IPV-Hib). Mixed-effects models adjusting for age, sex, and clustering by facility and canton showed higher odds of vaccination post-intervention for MMR dose 1 (adjusted odds ratio [aOR] 1.65), MMR dose 2 (aOR 1.61), and DTaP-IPV-Hib dose 4 (aOR 1.39; all $p < 0.001$). **Conclusions:** These results show that registry-based, proactive outreach can yield significant improvements in routine childhood vaccination coverage in real-world settings and may be a scalable approach for decentralized health systems recovering from pandemic disruptions.

Keywords: routine immunization; vaccine coverage; catch-up vaccination; outreach intervention; health system strengthening

1. Introduction

Routine childhood immunization is among the most effective and cost-effective public health interventions, saving millions of lives and preventing many diseases worldwide. However, after years of steady progress, that momentum was disrupted during the COVID-19 pandemic. Health systems were stretched, access to vaccination services became more limited, and many families delayed or missed routine immunization altogether. In addition, vaccine hesitancy has increased, partially due to unexpected or uncomfortable experiences associated with the novel COVID-19 vaccines, adding another layer of difficulty [1]. COVID-19 vaccination may have contributed to this hesitancy by shaping beliefs about side effects, reducing confidence in the safety of certain vaccines [1,2]. By 2021, the impact was clear: the WHO and UNICEF estimated that around 25 million infants worldwide were unvaccinated or under-vaccinated, marking the largest sustained drop in routine childhood immunization coverage in nearly 30 years [3,4].

Keeping routine immunization on track is challenging in decentralized health systems, where governance, financing, and service delivery are spread across different levels. Thus, recovery does

not occur evenly. Some areas rebound faster than others, but gaps persist. Without support and intervention, the risk of widening these gaps becomes entrenched and a significant setback, with long-term consequences for population health.

Vaccination coverage in Bosnia and Herzegovina has long struggled to reach high levels for several antigens, with measles-containing vaccines being of particular concern [5]. National WHO/UNICEF Estimates of National Immunization Coverage (WUENIC) show a decline in measles vaccine coverage in Bosnia and Herzegovina during the COVID-19 period, with only partial recovery in 2023-2024 [6]. The consequences of these gaps are visible, as the Federation of Bosnia and Herzegovina has experienced repeated measles outbreaks. In 2024, over 7,000 cases were recorded, with 5,103 cases from 2014 to 2015 and 1,132 cases in 2019. During the 2019 outbreak, over 90% of reported cases in the Sarajevo Canton occurred among unvaccinated children. Local evidence from the Mostar Health Center showed a statistically significant decline in MMR vaccination coverage during and after the COVID-19 pandemic compared with pre-pandemic years [7]. This pattern and repeated outbreaks are a clear sign that immunity gaps remain and that measles continues to circulate [5, 8, 9].

Addressing parental vaccine hesitancy requires a multifaceted strategy that combines transparent communication, as well as clear counseling on expected side effects and differences between vaccines. However, communication alone is often insufficient unless it is translated into structured interventions. In this context, identifying under-vaccinated children and linking them with targeted reminders and proactive outreach interventions is needed to convert parental intention into actual vaccine uptake [10]. The WHO's Tailoring Immunization Programmes (TIP) framework addresses this gap by emphasizing the identification of under-vaccinated groups followed by targeted interventions that support, motivate, and enable vaccine uptake. Strong evidence shows that reminder/recall systems and proactive outreach can improve both uptake and timeliness of childhood vaccination [11,12]. A Cochrane systematic review confirmed that these interventions increase vaccination coverage [13]; for example, telephone reminder systems have been associated with meaningful increases in MMR coverage, with registry-based outreach producing relative gains of around 10% [14]. Similarly, an adolescent-population-based study revealed that those receiving reminders were nearly twice as likely to become up-to-date as those without active follow-ups [15].

However, these mixed findings indicate that the effectiveness of such interventions depends not only on the communication modality used but also on how well these systems are integrated into routine service delivery. In the Federation of Bosnia and Herzegovina, recall and reminder practices are not implemented, and there are no systematic mechanisms to identify under-vaccinated children—a gap that has been confirmed by previous qualitative research among healthcare workers [16].

Despite this evidence base, the extent to which such interventions are effective remains insufficiently documented in Southeast Europe. This evidence gap is important because local health system organization, trust dynamics, and service delivery capacity may influence an intervention's effectiveness and scalability. Thus, this study evaluated an intensive immunization outreach intervention implemented by primary healthcare facilities in the Federation of Bosnia and Herzegovina. Using individual pre–post vaccination records, we assessed changes in coverage and estimated adjusted intervention effects for key antigens while accounting for clustering at the facility and canton levels.

2. Materials and Methods

2.1. Study Design and Setting

We carried out a non-randomized pre–post intervention study between April and November 2023 in the Federation of Bosnia and Herzegovina (FBiH). In Bosnia and Herzegovina, routine childhood immunization schedules are defined at three entity levels: the Federation of Bosnia and

Herzegovina, Republika Srpska, and the Brcko District. However, this evaluation applies only to the schedule implemented in the Federation of Bosnia and Herzegovina.

The intervention was delivered through primary healthcare centers (PHCs) responsible for routine childhood immunization services. For the evaluation, we relied on routinely collected immunization registry data, comparing each child's vaccination status immediately before the intervention ("pre") with their status after outreach and sufficient time was allowed for catch-up vaccination ("post").

2.2. Selection of Participating PHCs

Participating PHCs were those involved in implementing intensive immunization outreach activities during the study period and that agreed to participate in these activities. Data were collected from 60 PHCs out of 79 total facilities in the FBiH. The evaluation included all PHCs where the intervention was operationalized and for which complete pre- and post-intervention registry data were available. The study did not involve random selection of facilities. Of the 19 PHCs that did not participate in the intervention, 10 declined to participate, while 9 were not included because they had already achieved satisfactory vaccination coverage. The 10 PHCs that declined were predominantly small facilities with a low child population.

2.3. Study Population

This study included 28,264 children identified through facility immunization registries as having delayed or incomplete vaccination, representing approximately 26% of the estimated total population aged 0–7 years in the Federation of Bosnia and Herzegovina (108,710 children). Coverage analyses were restricted to age-eligible children within this intervention cohort for each vaccine dose assessed. Children were eligible for inclusion if they had a registry record during the intervention period and were identified as either unvaccinated or partially vaccinated for one or more antigens under the immunization schedule used in the Federation of Bosnia and Herzegovina. Children who had not yet reached the recommended age for a particular dose were excluded from analysis.

2.4. Data Sources and Data Collection Procedures

The outreach intervention consisted of several coordinated components meant to improve vaccine uptake among under-vaccinated children. To maximize intervention success, a standardized operation protocol was developed and implemented. Healthcare workers responsible for registry review and caregiver outreach received one-day preparatory training on the study procedures, the use of the protocol, and a standardized communication approach. Structured communication referred to a predefined framework for delivering immunization messages while also allowing PHCs to respond to caregivers' questions and concerns. In addition, the training covered active listening, empathetic communication, respectful engagement, and management of vaccine-related concerns. To ensure message consistency, during training, PHC workers received promotional materials and key communication messages developed by the World Health Organization (WHO). Trained healthcare workers systematically reviewed facility immunization registries to identify children with delayed or incomplete immunization. Caregivers were contacted by telephone and provided with tailored reminders and invitations to attend catch-up vaccination appointments. The core message reminded caregivers of their children's vaccination status and provided information about the benefits of vaccination and the risks of vaccine-preventable diseases, with emphasis on measles due to recent outbreaks. These messages also reassured caregivers regarding vaccine safety. In addition to delivering the core message, calls included practical support, such as scheduling vaccination appointments and helping parents to overcome potential access barriers. Calls were conducted by healthcare workers employed in PHCs, including both nurses and doctors. If there was no response to the initial call, the caregiver was contacted a second or, when needed, third time. During outreach

calls, caregivers were asked about reasons for missed vaccinations, and these caregiver-reported barriers were recorded using standardized response categories.

Data were collected using a standardized electronic form and included child age and sex; facility and canton identifiers; pre- and post-vaccination status for each antigen/dose assessed; and caregiver-reported barriers to vaccination. Data were entered into a centralized database in real time, with logical checks to reduce entry errors.

Children who could not be reached after three attempts were flagged for future follow-up through regular immunization services. Post-intervention vaccination status was assessed 30 days after the last outreach attempt.

2.5. Outcomes and Variable Definitions

For each antigen and dose, vaccination status was coded as vaccinated (1), not vaccinated (0), or not yet eligible for vaccination (99). For the regression analysis examining uptake among eligible children, the outcome was recorded as a binary variable (vaccinated vs not vaccinated), and children not yet eligible for vaccination were excluded. The primary outcomes were the pre–post change in coverage for selected vaccine doses prioritized because of lower baseline coverage and programmatic relevance (MMR dose 1, MMR dose 2, and DTaP-IPV-Hib dose 4). Secondary descriptive outcomes captured pre–post coverage changes for other doses where baseline coverage was already higher.

2.6. Intervention Description

The intervention included several components. First, healthcare workers checked the registers and generated lists of children overdue for vaccination. Second, healthcare workers—both nurses and doctors—contacted caregivers using the most recent available telephone number in the registry. A minimum of three calls were attempted before a child was classified as not reached. Third, the reason for delayed or missed vaccination was recorded using predefined categories with an option for free-form text notes. Fourth, when caregivers agreed, an appointment was scheduled to minimize follow-up. Finally, vaccination status was re-verified after the intervention window. This workflow was implemented across all participating facilities.

2.7. Statistical Analysis

The statistical analysis was performed using R, version 4.5.2. Demographic characteristics are summarized using descriptive statistics. For antigens, vaccination coverage was calculated as the proportion of age-eligible children who were vaccinated at the pre- and post-intervention time points. Changes in vaccination status within individuals were assessed by applying McNemar’s test.

To estimate adjusted intervention effects and account for clustering in a decentralized service delivery setting, the mixed-effects logistic regression models were fitted. Vaccination status was a binary outcome, and the intervention period was the main exposure.

3. Results

The study population consisted of 28,264 children, with a mean age of 3.31 years (SD = 1.85). Males accounted for 51.2% of the cohort.

Table 1. Characteristics of the study population.

Variable	Value
Number of children	28,264
Mean age (SD)	3.31 (1.85)
Male (%)	51.2

3.1. Changes in Vaccination Coverage

After the intervention, coverage improved across all antigens. Among age-eligible children, MMR dose 1 increased from 66.5% to 74.2%, MMR dose 2 from 43.4% to 51.7%, and DTaP-IPV-Hib dose 4 from 50.4% to 55.9% (Table 2). For vaccines that were already performing well at baseline (see Supplementary Materials), the changes were more modest. Overall, the improvements were statistically significant (with McNemar’s test confirming the differences at $p < 0.001$).

Table 2. Vaccination coverage before and after the intervention among age-eligible children.

Vaccine	N (eligible)	Before (%)	After (%)	Absolute Change (Percentage Points)
MMR (dose 1)	25,318	66.5	74.2	+7.7
MMR (dose 2)	9,014	43.4	51.7	+8.3
DTaP-IPV-Hib (dose 4)	24,887	50.4	55.9	+5.5

3.2. Intervention Effects

The mixed-effects logistic regressions showed a statistically significant intervention effect. After adjusting for age, sex, and clustering at the facility and canton levels, children assessed just after the intervention were more likely to be vaccinated. The adjusted odds of vaccination are presented in Table 3.

Table 3. Adjusted odds ratios (ORs) for vaccination uptake following the intervention, estimated using mixed-effects logistic regression models adjusted for age, gender, and clustering by PHCs.

Vaccine	Adjusted OR	p- Value
MMR (dose 1)	1.65	< 0.001
MMR (dose 2)	1.61	< 0.001
DTaP-IPV-HiB (dose 4)	1.39	< 0.001

3.3. Caregiver-Reported Barriers to Vaccination

Caregiver-reported reasons for missed vaccination were collected during outreach calls and categorized into major barrier groups. The most frequently reported barriers were medical reasons (44.4%), followed by access or system-related barriers (25.2%) and other reasons (16.2%). Hesitancy or trust-related barriers accounted for 6.8% of responses, while informational or reminder-related barriers represented 6.0%. A small proportion of cases were classified as already vaccinated elsewhere (1.2%) or related to contact or tracing issues (<0.2%).

3.4. Association Between Barriers and Vaccination Uptake

Analyses of vaccination uptake were restricted to children who were age-eligible for vaccination. Vaccination uptake following the intervention differed substantially by reported barrier type. In adjusted analyses controlling for age, sex, and canton, children whose caregivers reported informational or reminder-related barriers were significantly more likely to receive catch-up vaccinations (adjusted odds ratio [aOR]: 2.46; 95% CI: 1.56–4.09). In contrast, hesitancy or trust-related barriers were strongly associated with a lower likelihood of vaccination (aOR 0.06, 95% CI 0.04–0.10). Medical barriers were not significantly associated with uptake (aOR 1.18, 95% CI 0.99–1.41), suggesting that a proportion of these children may have become eligible for vaccination during the observation period.

No significant association was observed for access/system barriers (reference category) or other reasons.

4. Discussion

Although progress is being made in increasing vaccination coverage, many children remain under-vaccinated. Regarding barriers to childhood immunization in the Federation of Bosnia and Herzegovina, qualitative evidence indicates that missed or delayed vaccinations were more frequently related to medical- and system-level factors rather than forgetting or active refusal.

Our study found a measurable benefit for telephone reminders. The absolute gains of 5–8 percentage points for MMR dose 1, MMR dose 2, and DTaP-IPV-Hib dose 4 are of programmatic importance. These findings are consistent with prior registry-based outreach evaluations and systematic reviews demonstrating that telephone reminders can produce meaningful improvements in MMR coverage under routine service conditions. In a Canadian population-level intervention, MMR uptake increased by approximately 10% following telephone outreach, with more than 80% of caregivers unaware that their child was behind prior to contact. Our analysis of caregiver-reported barriers provides important insights into the mechanisms underlying missed vaccinations. The most frequently reported reasons were medical conditions and system-level barriers, rather than active refusal. This suggests that under-vaccination in this setting is driven primarily by practical and clinical constraints, rather than vaccine hesitancy alone. This means that such reminder–recall strategies could be effective mechanisms for closing immunity gaps [14]. Our results also align with WHO guidance, suggesting that missed vaccinations frequently result from practical barriers, such as forgetting appointments. Therefore, registry monitoring and reminder mechanisms are essential for sustained improvements in vaccination uptake. Behavioral evidence further indicates that facilitating vaccination directly through service delivery changes may be more effective than relying on information provision alone [12]. Hesitancy-related barriers were associated with a markedly lower likelihood of vaccination, indicating that reminder-based intervention alone may not be sufficient to address trust-related concerns. This interpretation is further supported by randomized evidence from digital immunization outreach interventions. Wijesundara et al. demonstrated that electronic health record portal reminders produced a small but statistically significant increase in early-season influenza vaccination uptake, whereas interactive voice response calls alone had a more limited effect, suggesting that reminder systems may be most effective when embedded within broader service facilitation mechanisms, such as appointment scheduling and real-time registry review [17].

The public health importance of closing these gaps is underscored by recurrent measles outbreaks in the Federation of Bosnia and Herzegovina (2014–2015, 2019, and 2024) [4]. Official surveillance data further show that declines in vaccination coverage have been followed by repeated outbreaks, highlighting the critical role of maintaining high immunization coverage to preserve herd immunity and protect vulnerable populations [8].

National WHO/UNICEF Estimates of National Immunization Coverage indicate an upward trend in measles-containing and DTP-containing vaccine coverage in 2023–2024, following declines during the COVID-19 period. Although these aggregate data cannot be directly attributed to the present intervention, the timing and direction of change are consistent with the facility-level improvements observed in this evaluation and provide supportive contextual evidence of recovery in routine immunization [6]. Regan and Sullivan [18] have further emphasized that vaccination timeliness is as important as overall coverage, particularly for MMR vaccines. Therefore, the observed increase in our study may have implications not only for overall coverage, but also for reducing the period of susceptibility among children who remain unprotected.

By contrast, earlier trials of telephone-only reminder/recall interventions reported more modest and short-lived effects, largely due to difficulties in reaching families with inaccurate contact information, highlighting the importance of combining registry review with facility-based outreach and updated caregiver contact, as implemented in the present study [19]. Children who received catch-up vaccination differed primarily by barrier type, with higher uptake among those facing information or practical barriers and lower among those with medical or structural constraints.

Taken together, these findings demonstrate that registry-driven outreach embedded within routine primary care can meaningfully improve vaccination uptake in decentralized health systems

such as Bosnia and Herzegovina. Given that the intervention relied on existing registries, primary care staff, and relatively low-cost telephone contact, it is likely to be feasible and adaptable in other settings with fragmented governance, legacy trust challenges, and variable coverage, where passive service delivery alone has proven insufficient to close immunity gaps. The implementation logic is supported by recent systematic review evidence showing that digital health technologies designed to improve vaccination uptake are frequently cost-effective, particularly when layered onto existing health information systems and routine service workflows [20].

4.1. Limitations

A concurrent control group was not available, which limits causal inference and prevents full separation of intervention effects from secular recovery trends, outbreak-related risk perception, and parallel facility-level initiatives. In addition, participating PHCs may have been more motivated or operationally stronger than non-participating facilities, potentially limiting the external validity and generalizability of the findings. However, the relatively short intervention window, the consistency of gains across priority antigens, and the use of individual-level paired data reduce the likelihood that secular changes alone explain the findings. Future work should include controlled designs, such as stepped-wedge or cluster-randomized trials, as well as cost-effectiveness analyses comparing alternative outreach modalities to optimize resource allocation, such as SMS, digital tools, and community health workers.

Despite these limitations, the real-world implementation context represents a significant strength of this study, as it reflects the operational conditions under which immunization recovery strategies must function in a health system.

5. Conclusions

This programmatic pre-post evaluation shows that registry-driven telephone outreach can substantially improve vaccination coverage in a decentralized health system. The absolute gains of 5–8 percentage points for MMR dose 1, MMR dose 2, and DTaP-IPV-Hib dose 4 demonstrate that these gains are programmatically meaningful and show that actively identifying under-immunized children, reaching out directly to caregivers, and helping families to schedule appointments can close immunity gaps, especially for later booster doses that are often missed.

Importantly, the intervention tackled some very practical system barriers. In particular, it addressed the lack of structured recall systems and the limited follow-up of children who fall behind on vaccination. In this way, routine services were strengthened under everyday, real-world conditions, not in a controlled trial setting. Given that this approach relies on existing immunization registries and relatively low-cost communication, registry-based outreach appears both feasible and scalable. It may offer a realistic way to support immunization recovery and reduce the risk of future outbreaks in similar settings, where passive service delivery alone has not been enough.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org: Table 4, Figure 1.

Author Contributions: Conceptualization, S.S. and M.P.; methodology, S.S.; validation, F.D.; formal analysis, F.D.; investigation, S.S.; writing—original draft preparation, F.D.; writing—review and editing, S.S.; visualization, F.D.; supervision, S.S. All authors have read and agreed to the published version of the manuscript.

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information was collected. According to national regulations, formal ethical committee approval is not required for anonymized programmatic public health data.

Informed Consent Statement: Informed consent was obtained verbally from all subjects involved in the study.

Data Availability Statement: The data used in this study are not publicly available because they are derived from routine immunization registry records and are subject to privacy and institutional restrictions. De-identified or aggregated data may be made available from the corresponding author upon reasonable request.

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References

1. Causey, K.; Fullman, N.; Sorensen, R.J.D.; Galles, N.C.; Zheng, P.; Aravkin, A.; Danovaro-Holliday, M.C.; Martinez-Piedra, R.; Sodha, S.V.; Velandia-González, M.P.; et al. Estimating global and regional disruptions to routine childhood vaccine coverage during the COVID-19 pandemic in 2020: a modelling study. *Lancet* **2021**, *398*, 522–534, [https://doi.org/10.1016/s0140-6736\(21\)01337-4](https://doi.org/10.1016/s0140-6736(21)01337-4).
2. Fukai, T.; Kawata, K.; Nakabayashi, M. Updated beliefs and shaken confidence: evidence from vaccine hesitancy caused by experiencing “COVID arm”. *BMC Infect Dis* **23**, 612 (2023). <https://doi.org/10.1186/s12879-023-08558-5>
3. World Health Organization. COVID-19 pandemic fuels largest continued backslide in vaccinations in three decades. WHO News Release; 15 July 2022.
4. UNICEF, World Health Organization. Progress and Challenges with Achieving Universal Immunization Coverage (WUENIC 2021). New York/Geneva: UNICEF/WHO; 2022.
5. Arapović, J.; Sulaver, Ž.; Rajić, B.; Pilav, A. The 2019 measles epidemic in Bosnia and Herzegovina: What is wrong with the mandatory vaccination program?. *Bosn. J. Basic Med Sci.* **2019**, *19*, 210–212, <https://doi.org/10.17305/bjbm.2019.4266>.
6. World Health Organization (WHO), United Nations Children’s Fund (UNICEF). WHO/UNICEF Estimates of National Immunization Coverage (WUENIC), 2024 revision [Internet]. Geneva: WHO; 2025 [cited 2025 Jun 25]. Available from: <https://worldhealthorg.shinyapps.io/wuenic-trends/>.
7. Ćurlin, M.; Barukčić, K.; Pehar, V.; Vasilj, I.; Franjić, D. IMPACT OF THE COVID-19 PANDEMIC ON THE REGULAR IMMUNIZATION OF CHILDREN IN THE MOSTAR HEALTH CENTER. *Zdr. Glas.* **2024**, *10*, 82–93, <https://doi.org/10.47960/2303-8616.2024.1.9.82>.
8. Institute for Public Health of the Federation of Bosnia and Herzegovina. (2024). *Vodič za najbolje prakse i sigurnost imunizacije u Federaciji Bosne i Hercegovine*. Sarajevo: Zavod za javno zdravstvo Federacije BiH.
9. UNICEF Bosnia and Herzegovina. Bosnia and Herzegovina: measles cases surge — over 7,000 cases registered [Internet]. Sarajevo: UNICEF; 2024 [cited 2025 Jun 25]. Available from: <https://www.unicef.org/bih/en/press-releases/bosnia-and-herzegovina-measles-cases-surge-over-7000-cases-registered>.
10. Cagnotta, C.; Lettera, N.; Cardillo, M.; Pirozzi, D.; Catalán-Matamoros, D.; Capuano, A.; Scavone, C. Parental vaccine hesitancy: Recent evidences support the need to implement targeted communication strategies. *J. Infect. Public Health* **2025**, *18*, 102648. <https://doi.org/10.1016/j.jiph.2024.102648>.

11. Szilagyi, P.G.; Albertin, C.; Humiston, S.G.; Rand, C.M.; Schaffer, S.; Brill, H.; Stankaitis, J.; Yoo, B.-K.; Blumkin, A.; Stokley, S. A Randomized Trial of the Effect of Centralized Reminder/Recall on Immunizations and Preventive Care Visits for Adolescents. *Acad. Pediatr.* **2013**, *13*, 204–213, <https://doi.org/10.1016/j.acap.2013.01.002>.
12. World Health Organization Regional Office for Europe. Tailoring Immunization Programmes (TIP): An introductory overview. Copenhagen: WHO Regional Office for Europe; 2019.
13. Vann, J.C.J.; Jacobson, R.M.; Coyne-Beasley, T.; Asafu-Adjei, J.K.; Szilagyi, P.G. Patient reminder and recall interventions to improve immunization rates. **2018**, *2018*, CD003941, <https://doi.org/10.1002/14651858.cd003941.pub3>.
14. Lemstra M, et al. The effectiveness of telephone reminders and home visits to improve childhood immunization coverage. *Can J Public Health.* 2016.
15. Morris, J.; Wang, W.; Wang, L.; Peddecord, K.M.; Sawyer, M.H. Comparison of Reminder Methods in Selected Adolescents With Records in an Immunization Registry. *J. Adolesc. Heal.* **2015**, *56*, S27–S32, <https://doi.org/10.1016/j.jadohealth.2015.01.010>.
16. Musa, S.; Skrijelj, V.; Kulo, A.; Habersaat, K.B.; Smjecanin, M.; Primorac, E.; Becirovic, D.; Jackson, C. Identifying barriers and drivers to vaccination: A qualitative interview study with health workers in the Federation of Bosnia and Herzegovina. *Vaccine* **2020**, *38*, 1906–1914, <https://doi.org/10.1016/j.vaccine.2020.01.025>.
17. Wijesundara, J.G.; Fukunaga, M.I.; Ogarek, J.; Barton, B.; Fisher, L.; Preusse, P.; Sundaresan, D.; Garber, L.; Mazor, K.M.; Cutrona, S.L. Electronic Health Record Portal Messages and Interactive Voice Response Calls to Improve Rates of Early Season Influenza Vaccination: Randomized Controlled Trial. *J. Med Internet Res.* **2020**, *22*, e16373–e16373, <https://doi.org/10.2196/16373>.
18. Regan, A.K.; Sullivan, S.G. Building the global evidence on text message reminders to increase timely childhood vaccination. *Int. J. Epidemiol.* 2025, *54*, dyaf125. <https://doi.org/10.1093/ije/dyaf125>.
19. Szilagyi PG, Humiston SG, Albertin CS, Schaffer S, Rand CM, Stankaitis J, et al. Effect of telephone reminder/recall on adolescent immunization and preventive visits: results from a randomized clinical trial. *JAMA Pediatrics.* 2016;170(2):157–165. doi:10.1001/jamapediatrics.2015.3589.
20. Wang, Y.; Fekadu, G.; You, J.H.-S. Cost-Effectiveness Analyses of Digital Health Technology for Improving the Uptake of Vaccination Programs: Systematic Review. *J. Med Internet Res.* **2023**, *25*, e45493, <https://doi.org/10.2196/45493>.

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