International Journal of Medicine & Health Research

www.internationalmedicalpublishing.com

Research Article

Section: Public Health & Medical Education

Effectiveness of the "Arogya Ki Aur" Community based & Convergence-Driven Intervention to Improve Immunization Coverage in Tribal Areas: an Implementation Study from Central India

Pranjal Upadhayay[1*]

[1]Department of Public Health & Medical Education, Betul district, Madhya Pradesh, India

HIGHLIGHTS

- Tribal immunization improved
- Community-driven model effective
- Dropout rates reduced
- Equity gaps minimized
- Scalable healthcare framework

Key Words:

Immunization coverage

Tribal health

Vaccine hesitancy

Community participation

Health systems strengthening

ABSTRACT

Introduction: Achieving equitable immunization coverage in tribal and hard-to-reach populations remains a major public health challenge in India. Conventional service delivery models often fail to address last-mile barriers, including geographic inaccessibility, socio-cultural resistance, and weak beneficiary tracking. **Aim & Objectives:** To evaluate the effectiveness of the "Arogya Ki Aur" model, a community-based and convergence-driven intervention, in improving immunization coverage in tribal areas of central India. **Materials & Methods:** A quasi-experimental pre–post implementation study was conducted across 124 low-immunization villages in Betul district, Madhya Pradesh, including 16 high-priority villages. A total of 1,045 children aged 0–5 years were assessed. The intervention integrated three components: SHG-led Arogya Sakhi tracking, Health–Forest Department convergence for improved access, and Udaan tribal counsellors for behavior change communication. Data were collected through household surveys, U-WIN, and HMIS records. Changes in coverage were analyzed using Chi-square tests, with effect sizes and 95% confidence intervals estimated. **Results:** Full immunization coverage increased significantly from 62.7% to 81.6% (absolute increase: 18.9%; 95% CI: 15.2–22.6; p<0.001). Dropout rates declined from 18.5% to 7.2%, and left-out children reduced from 11.9% to 6.1%. Greater improvements were observed in high-priority (+25.6%) and remote villages (+25.8%) compared to other areas. Equity gaps between remote and accessible populations reduced by 10.9 percentage points. The intervention demonstrated a relative coverage increase of 30.1% and a number needed to treat of approximately five. **Conclusion:** The Arogya Ki Aur model is an effective, scalable, and community-driven approach that improves immunization coverage and reduces inequities in underserved populations. Its integrated design offers a replicable framework for strengthening last-mile immunization delivery in similar settings.

*** Corresponding Author:** Pranjal Upadhayay, e-mail: pranjalupadhayay94@gmail.com

Article History: Received 13 April 2026; Received in Revised form 17 April 2026; Accepted 24 May 2026

How To Cite: Pranjal Upadhayay. Driven Intervention to Improve Immunization Coverage in Tribal Areas: an Implementation Study from Central India. *International Journal of Medicine & Health Research.* 2026;14(1):1-12. DOI: https://doi.org/10.71393/epb9g878

INTRODUCTION

Immunization is one of the most cost-effective and impactful public health interventions, preventing an estimated 3-5 million deaths globally each year and substantially reducing childhood morbidity and mortality due to vaccine preventable diseases (VPDs) [1]. It plays a critical role in strengthening health systems and improving population health outcomes. In India, the Universal Immunization Programme (UIP), launched in 1985, has significantly expanded vaccine coverage; however, achieving equitable immunization coverage across diverse geographical and socio-cultural settings remains a persistent challenge [2].

A major concern is the presence of intra-district disparities, where aggregate indicators often mask pockets of low immunization. Evidence from multiple rounds of the National Family Health Survey (NFHS) shows that although coverage has improved from approximately 35% in the early 1990s to over 70% in recent years, substantial inequalities persist across regions, socio-economic groups, and communities [3]. These underserved clusters are predominantly located in tribal, forested, & hard to reach areas, where conventional service delivery models struggle to achieve last-mile connectivity. Such disparities are driven by a complex interplay of geographic isolation, socioeconomic vulnerability, and cultural practices. Tribal populations, which constitute about 8.6% of India's population, consistently exhibit lower immunization coverage compared to other social groups, as highlighted in NFHS and UNICEF assessments [4]. These populations often reside in remote regions with limited access to healthcare services, resulting in persistent inequities. Betul district in Madhya Pradesh exemplifies these challenges. Characterized by dense forests, scattered settlements & a predominantly tribal population (Gond & Korku communities), the region presents unique barriers to healthcare delivery. Seasonal migration, dependence on agricul-ture and daily wage labor, and difficult terrain further disrupt continuity of care. Despite the presence of an established public health infrastructure, gaps in immunization uptake persist, particularly in remote tribal pockets.

Barriers to immunization in such settings are multidimensional. Supply-side challenges include poor road connectivity, seasonal inaccessibility, & dispersed populations, which hinder outreach services. Demand-side barriers include low maternal education, lack of awareness, sociocultural beliefs, and fear of adverse events following immunization, contributing to vaccine hesitancy and refusal [5]. Studies from DLHS and NFHS datasets indicate that factors such as maternal education, house-hold wealth, and accessibility strongly influence immunization uptake [5,6]. India continues to account for a significant proportion of under-immunized children globally, with nearly one-third of incompletely vaccinated children residing in the country [7]. Further-more, evidence from Lancet and global health literature highlights that inequities in immunization coverage are closely linked to structural determinants such as poverty, education, and health system access [8]. Traditional immunization strategies, which primarily focus on service delivery through fixed and outreach sessions, often fail to address these contextual barriers. Increasing evidence suggests that improving immunization coverage in underserved settings requires a shift toward integrated, community-centered approaches that address both access and acceptance simultaneously [9]. Such approaches emphasize community engagement, intersectoral coordination, and data-driven microplanning. **Figure 1** shows the "Arogya Ki Aur" model for improving immunization coverage in tribal populations.

Figure 1: Community-based "Arogya Ki Aur" intervention model illustrating barriers, implementation strategies, and impact on immunization coverage in tribal populations.

In this context, the “Arogya Ki Aur” initiative was conceptualized as an innovative, field-driven model aimed at bridging the last-mile gap in immunization services in tribal and hard-to-reach areas. The model integrates community ownership through Self-Help Groups (SHGs), interdepartmental convergence, and culturally sensitive behavior change communication. By combining these strategies with real-time data utilization and continuous monitoring, the initiative seeks to address both structural and behavioral determinants of immunization coverage.

Rationale of the Study

Despite substantial progress under India's Universal Immunization Programme, achieving equity in coverage remains a critical unmet goal, particularly in tribal and hard-to-reach populations [2]. NFHS-5 data indicate that although national full immunization coverage has reached approximately 76%, significant inter-state and intra-district disparities persist [10]. These disparities are particularly pronounced among Scheduled Tribes and marginalized communities [4].

District-level indicators often conceal micro-level inequities, where specific villages continue to demonstrate persistently low coverage. Studies using NFHS datasets have shown that socio-economic and healthcare access variables explain a large proportion of immunization disparities between high- and low-performing districts [3]. Similarly, DLHS-based analyses have reported suboptimal coverage and regional variation, reflecting systemic gaps in program implementation [6].

Evidence also indicates persistent rural-urban and gender disparities in immunization coverage, with rural and female children often being disadvantaged [11]. These inequities are compounded in tribal regions due to geographic isolation and socio-cultural barriers. Furthermore, vaccine hesitancy and mistrust of health systems have been identified as key contributors to low uptake in marginalized communities [12].

Conventional immunization approaches, which emphasize supply-side strengthening, often assume that availability of services translates into utilization. However, research suggests that immunization behavior is influenced by trust, cultural norms, and social dynamics, highlighting the need for community-based strategies [9]. Additionally, limited intersectoral coordination restricts the effectiveness of health interventions in remote areas. There is increasing recognition that integrated, multi-component interventions are necessary to address both access and behavioral barriers simultaneously. Community participation models, particularly those involving women's groups and local stakeholders, have demonstrated effectiveness in improving maternal and child health outcomes in low-resource settings [13]. However, there remains limited evidence on such integrated approaches in tribal immunization contexts.

The “Arogya Ki Aur” initiative was developed in response to these gaps, incorporating SHG-led tracking, interdepartmental convergence, and culturally aligned communication strategies. By addressing both supply-side and demand-side determinants, the model aims to improve coverage while reducing inequities. Thus, the present study is justified not only for improving immunization coverage in a specific district but also for generating scalable and generalizable evidence for addressing immunization inequities in tribal and underserved populations across India and similar low-resource settings.

MATERIAL & METHODS

This quasi-experimental implementation research study used a pre-post intervention design without a control group to evaluate the effectiveness of the “Arogya Ki Aur” model in improving immunization coverage in tribal and hard-to-reach areas. The study was conducted in Betul district, Madhya Pradesh, India, a predominantly tribal region characterized by remote villages, dense forests, and limited healthcare accessibility. Children aged 0–23 months and households from selected low-immunization villages were included.

A purposive sampling method identified 124 villages with poor immunization coverage based on HMIS discrepancies, field monitoring findings, and geographic vulnerability; 16 villages were categorized as high-priority clusters. Complete enumeration of all eligible households was undertaken. The sample size exceeded the minimum requirement of 350–400 children needed to detect a 15% improvement in coverage with 95% confidence and 80% power.

The intervention included three major components: (1) Arogya Sakhi, where SHG women tracked children for immunization completion; (2) Health-Forest Department convergence, enabling outreach to remote settlements and tribal gatherings; and (3) Udaan Tribal Counsellors, trained local youth volunteers addressing vaccine hesitancy through culturally appropriate communication. The primary outcome was full immunization coverage among children aged 12–23 months as per the national immunization schedule. Secondary outcomes included dropout rate, proportion of left-out children, session utilization, and overall percentage improvement in coverage.

Data was collected through household surveys, U-WIN digital records, HMIS data, field monitoring reports, and SHG tracking registers. Baseline and endline assessments were conducted between March and May 2025, with door-to-door verification to include migrant and unreached beneficiaries. Data quality was ensured through enumerator training, standardized tools, supervisory monitoring, and cross-verification with digital records. Statistical analysis was performed using SPSS/Stata. Descriptive statistics included frequencies, proportions, means, and standard deviations. Chi-square tests compared baseline & endline proportions, with $p < 0.05$ considered statistically significant. Absolute Risk Difference (ARD), relative percentage increase, & 95% confidence intervals were calculated. Subgroup analyses assessed differences across high-priority & remote villages. Ethical standards were maintained through verbally informed consent, confidentiality of participant information, & use of data solely for public health improvement purposes.

RESULTS

Overview of Intervention Coverage

The "Arogya Ki Aur" intervention was implemented across 124 identified low-immunization villages, including 16 high-priority villages in Bhimpur and Bhainsdehi blocks. A total of 1,045 children aged 0–5 years were assessed during both baseline and endline evaluations. A significant improvement in immunization coverage was observed following the implement-ation of the intervention. The proportion of fully immunized children increased from 62.7% at baseline to 81.6% at endline, reflecting an absolute increase of 18.9 percentage points. This improve-ment was statistically highly significant ($p < 0.001$), with a 95% confidence interval ranging from 15.2% to 22.6%, indicating a robust and consistent effect of the intervention across the study population. Concurrently, the proportion of partially immunized children declined markedly from 25.4% to 12.3%, while the proportion of left-out children decreased from 11.9% to 6.1%. These changes collectively highlight not only an expansion in overall immunization coverage but also substantial improveme-nts in service completion, continuity, and benefici-ary tracking. The findings underscore the effectiveness of the intervention in strengthening both access to immunization services and adherence to the full vaccination schedule, particularly in previously underserved populations **(Table 1 & Figure 2).** Village-wise analysis demonstrated a consistent and meaningful improvement in immunization coverage across all intervention villages, as detailed in **Table 2 & Figures 3-4**. The magnitude of improvement varied according to baseline performance, with the largest absolute gains observed in previously low-performing villages. Bhawapur (+42.7%), Pateldhana (+41.7%), and Bhalkudhana (+40.4%) exhibited substantial increases exceeding 40 percentage points, while Bhatbhuri, despite having the lowest baseline coverage (10.0%), showed a remarkable improvement of 30 percentage points, corresponding to the highest relative increase (300%). Moderate improvements ranging from 10% to 30% were observed in villages such as Ghorpadmal (+26.2%), Kharabhuri (+20.8%), and Barradhana Tingariya (+18.7%). In contrast, villages with relatively higher baseline coverage, including Chohata and Chotadhana Tingariya, demonstrated smaller yet meaningful incremental gains, reflecting a ceiling effect. The clustered bar graph (**Figure 3**) visually highlights the upward shift in coverage across all villages, while the heatmap (**Figure 4**) further emphasizes the gradient of improvement, with more intense color patterns corresponding to greater gains in low-coverage settings. Importantly, the observed pattern indicates a clear inverse relationship between baseline coverage & magni-tude of improvement, suggesting that the intervention was particularly effective in targeting underserved populations. These findings under-score the success of targeted micro-planning & context-specific strategies in reducing inter-village disparities & improving equity in immunization coverage.

Subgroup Analysis

Subgroup analysis revealed that the intervention had a different-ial yet consistently positive impact across population strata, with the greatest benefits observed in the most underserved settings. High-priority villages demonstrated a significantly greater improvement in immunization coverage compared to other villages (+25.6% vs +16.5%; $p < 0.001$), underscoring the effectiveness of intensive, targeted strategies in low-performing areas **(Table 3)**. Similarly, accessibility-based stratification showed that remote and hard-to-reach villages experienced a larger increase in coverage (from 52.6% to 78.4%; +25.8%) compared to relatively accessible villages (from 68.3% to 83.2 %; +14.9%). These findings highlight the success of Health-Forest Department convergence and outreach innovations in overcoming geographical barriers and improving last-mile service delivery **(Table 4)**. **Figure 4:** Heatmap showing village-wise improvement in immunization coverage (endline minus baseline). The color gradient illustrates the magnitude of incre-ase across villages, with brighter shades indicating greater improvements. The highest gains are observed in Bhawapur, Pateldhana, and Bhalkudhana, while moderate improvements are seen in Ghorpadmal and Kharabhuri. Lower but consistent gains are noted in relatively higher baseline coverage villages such as Chohata and Popti, highlighting both targeted impact in low-performing areas and overall program effectiveness.

Reduction in Dropout Rates and left out children

In addition to coverage gains, the intervention substantially improved service continuity and beneficiary tracking. The drop-out rate between initial and subsequent vaccine doses declined significantly from 18.5% at baseline to 7.2% at endline, representing an absolute reduction of 11.3 percentage points ($p < 0.001$). This improvement reflects enhanced follow-up mechanisms, caregiver engagement, and the effectiveness of the Arogya Sakhi model in ensuring completion of immunization schedules. Furthermore, the proportion of left-out children decreased from 11.9% to 6.1%, indicating a nearly 50% relative reduction and demonstrating improved identification and inclusion of previously unreached children, particularly in remote and migratory populations **(Table 5 & Figure 5)**. A focused case study from Bhatbhuri village further illustrates the intervention's impact in an extremely hard-to-reach setting. Immunization coverage increased from 10% (4/40 children) at baseline to 80% (32/40 children) at endline, representing a 70 % improvement achieved through phased implementation, enhan-ced physical access via Forest Department support, repeated counselling, & strong community engagement through SHG women and tribal youth counsellors **(Table 6)**. The distribution of villages by magnitude of improvement shows that the majority experienced moderate to high gains in immuniza-tion coverage following the intervention. Specifically, 3 villages (23.1%) achieved a substantial improvement of more than 40%, while 4 villages each (30.8%) fell within the 20 -40% and 10–20% improvement categories. Only 2 villages (15.3%) demonstrated less than 10% increase. This pattern indicates that over half of the villages (53.9%) achieved improvements greater than 20%, reflecting strong overall program effectiveness. The findings suggest that the intervention was broadly successful across diverse settings, with particularly pronounced benefits in low-performing areas, while even higher baseline villages showed incremental gains, indicating a consistent and equitable impact **(Table 7)**. The coverage distribution shift demonstrates a clear and favorable transition of villages toward higher immunization coverage categories following the intervention. At baseline, 4 villages were in the lowest coverage category (<50%), which reduced to zero at endline, indicating complete elimination of severely low-performing areas. The number of villages in the 50–70% category also declined from 5 to 3, while those in the 70–90% category increased from 3 to 6. Notably, villages achieving >90% coverage rose substantially from 1 at baseline to 4 at endline. This upward shift across categories reflects a strong overall improvement in program performance and highlights the intervention's effectiveness in elevating villages to higher coverage levels, thereby strengthening both coverage and equity **(Table 8)**.

The correlation analysis revealed a strong and statistically significant negative relationship between baseline immunization coverage and the magnitude of improvement ($r = –0.72$, $p < 0.01$). This indicates that villages with lower baseline coverage experienced greater gains following the intervention, while those with higher initial coverage showed relatively smaller incremental improvements. The finding highlights the effectiveness of the intervention in targeting underserved populations and reducing disparities, demonstrating a focused impact on low-performing areas and contributing to improved equity in immunization coverage **(Table 9)**.

The intervention component contribution analysis indicates that each element of the "Arogya Ki Aur" model played a complementary yet distinct role in improving immunization outcomes. The Arogya Sakhi (SHG) component demonstrated the highest overall contribution, with a strong impact on both coverage and dropout reduction, reflecting its effectiveness in individualized tracking, follow-up, and ensuring completion of immunization schedules. The Health-Forest Department convergence showed a high impact on coverage, particularly in remote areas, by improving physical access to services, although its role in reducing hesitancy remained limited.

In contrast, the Udaan counsellors contributed significantly to reducing vaccine hesitancy, with a moderate impact on coverage and dropout, highlighting their importance in addressing behavioral and socio-cultural barriers. Overall, the findings suggest that the success of the intervention was driven by the synergistic effect of these components-combining improved access, strengthened tracking systems, and culturally sensitive community engage-ment **(Table 10)**. The equity impact analysis demonstrates a substantial reduction in disparities in immunization coverage following the intervention. The gap between remote & accessi-ble villages decreased markedly from 15.7% at baseline to 4.8% at endline, reflecting a reduction of 10.9 percentage points. Similarly, the disparity between high- & low-performing villages declined from 27.6% to 13.5%, representing a gap reduction of 14.1 percentage points. These findings indicate that the intervention was particularly effective in improving coverage in underserved and low-performing areas, thereby narrowing inequities **(Table 11)**.

The program efficiency indicators highlight the strong operational effectiveness and cost-efficiency of the intervention. A total of 1,045 children were covered, resulting in approximately 198 additional children becoming fully immunized. The estimated cost per additional child was low, reflecting the advantages of a community-based model that leverages existing local resources and systems. Furthermore, the number needed to treat (NNT) was approximately 5, indicating that for every five children reached through the intervention, one additional child achieved full immunization. These findings demonstrate that the intervention not only produced significant health gains but also did so in a resource-efficient manner, supporting its scalability and sustainability in similar settings **(Table 12)**.

Effect Size and Public Health Impact

Overall, the intervention demonstrated a substantial public health impact, with an absolute risk difference of +18.9% and a relative increase in coverage of 30.1%. The estimated number needed to treat (NNT) of approximately 5 indicates that for every five children reached, one additional child became fully immunized, reflecting a highly efficient and impactful community-based strategy **(Table 13)**.

Table 1: Overall Immunization Coverage Before and After Intervention

Indicator	Baseline (n, %)	Endline (n, %)	Absolute Change (%)	95% CI of Difference	p-value
Fully Immunized Children	62.7%	81.6%	18.9	(15.2 to 22.6)	<0.001
Partially Immunized	25.4%	12.3%	–13.1	(–16.5 to –9.7)	<0.001
Left-out Children	11.9%	6.1%	–5.8	(–8.2 to –3.4)	<0.001

Table 2: Village-wise Absolute and Relative Improvement

Village	Baseline (%)	Endline (%)	Absolute Increase (%)	Relative Increase (%)
Bhawapur	46.7	89.3	42.7	91.4
Pateldhana	20.8	62.5	41.7	200.5
Bhalkudhana	51.1	91.5	40.4	79.1
Bhatbhuri	10.0	40.0	30.0	300.0
Ghorpadmal	64.6	90.8	26.2	40.6
Kharabhuri	56.3	77.1	20.8	36.9
Barradhana T.	38.7	57.3	18.7	48.3
Dodajam	68.1	79.1	11.0	16.2
Uttari	58.7	69.6	10.9	18.6
Chotadhana T.	71.9	79.7	7.8	10.8
Karida	74.8	93.2	18.4	24.6
Chohata	81.8	88.1	6.3	7.7

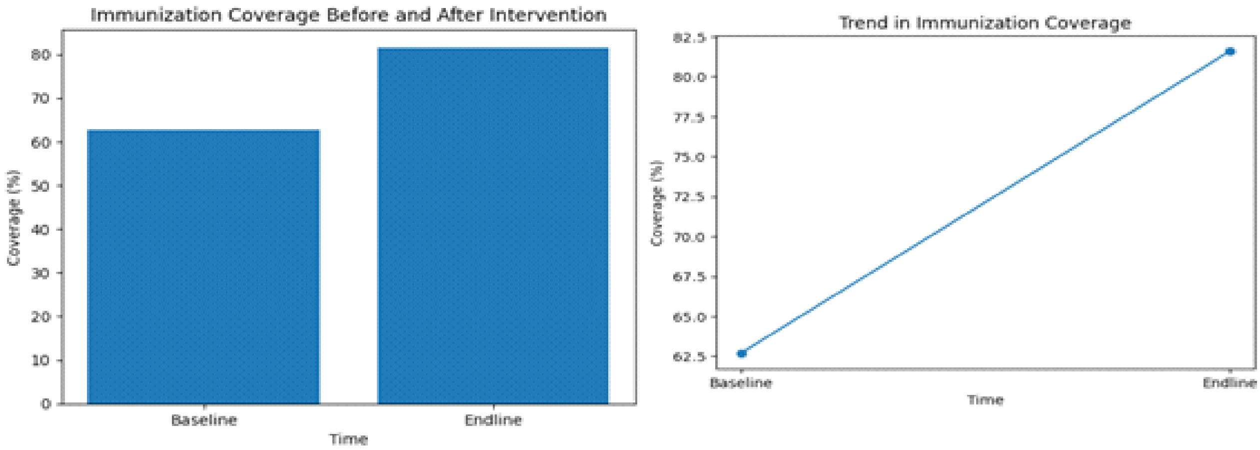

Figure 2: Comparison and trend of immunization coverage before and after the intervention.

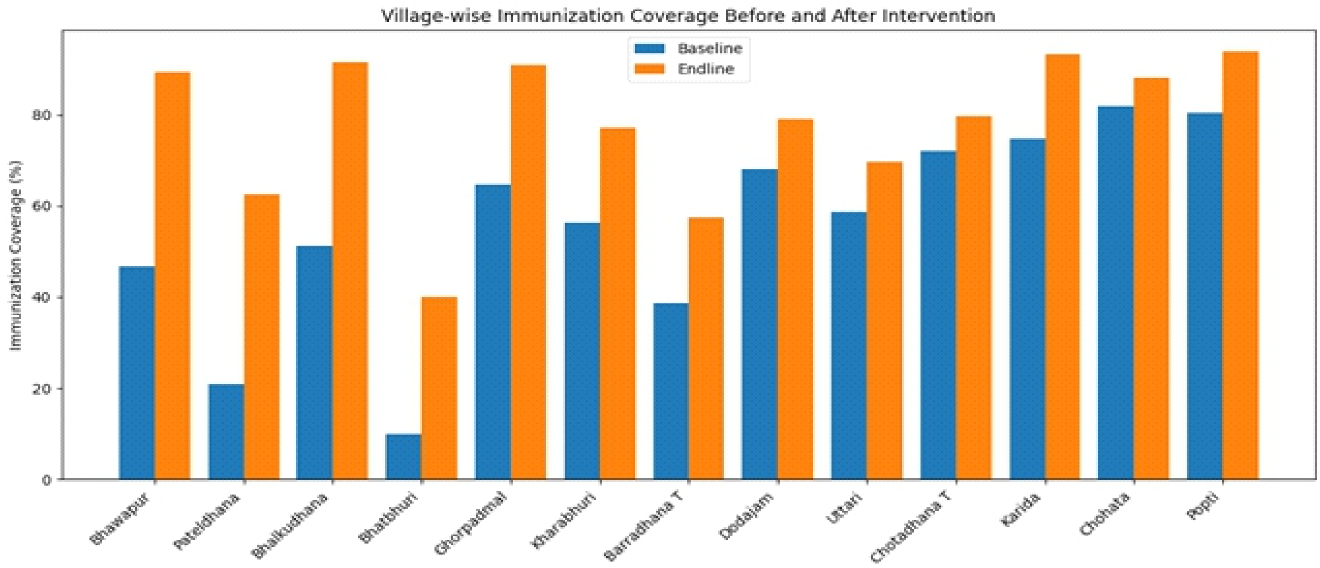

Figure 3: Village-wise comparison of immunization coverage before and after the intervention.

Table 3: Subgroup Analysis - High Priority vs Other Villages

Group	Baseline Coverage (%)	Endline Coverage (%)	Absolute Change (%)	95% CI	p-value
High-Priority Villages (n=16)	54.2%	79.8%	25.6	(20.1 to 31.2)	<0.001
Other Villages (n=108)	65.8%	82.3%	16.5	(12.8 to 20.2)	<0.001

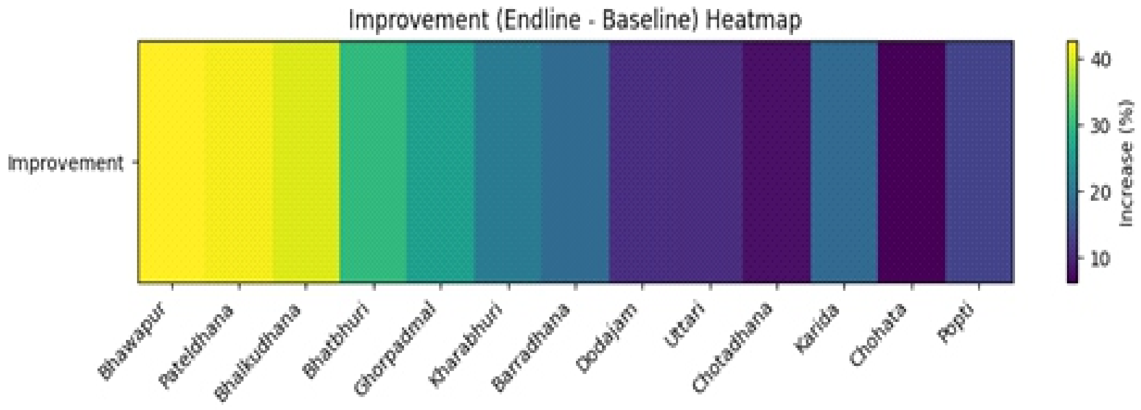

Table 4: Subgroup Analysis - High Priority vs Other Villages

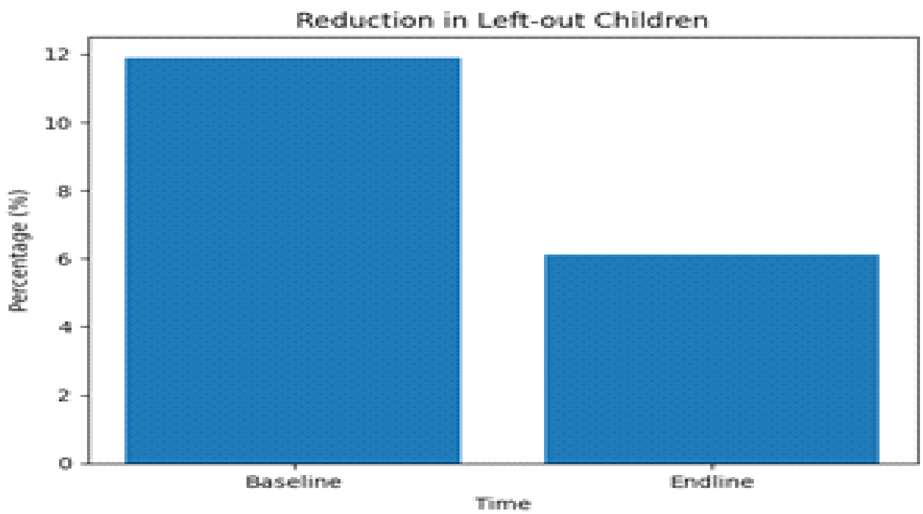

Figure 5: Reduction in proportion of left-out children before and after the intervention.

Table 4: Accessibility-Based Comparison

Category	Baseline (%)	Endline (%)	Absolute Change (%)	95% CI	p-value
Remote / Hard-to-Reach	52.6%	78.4%	25.8	(20.5 to 31.0)	<0.001
Accessible Areas	68.3%	83.2%	14.9	(11.3 to 18.4)	<0.001

Table 5: Dropout Rate Reduction (Dose 1 vs Dose 3)

Vaccine Indicator	Baseline (%)	Endline (%)	Absolute Reduction (%)	95% CI	p-value
Pentavalent Dropout Rate	18.5%	7.2%	–11.3	(-14.8 to -7.9)	<0.001

Table 6: Case Study - Bhatbhuri Village

Indicator	Baseline	Phase 1	Phase 2	Final Coverage
Total Children (0–5 years)	40	-	-	-
Vaccinated Children	4	12	16	32
Coverage (%)	10%	30%	70%	80%

Table 7: Distribution of Villages by Magnitude of Improvement

Improvement Category	Number of Villages	Percentage (%)
>40% Increase	3	23.1
20–40% Increase	4	30.8
10–20% Increase	4	30.8
<10% Increase	2	15.3

Table 8: Coverage Distribution Shift (Before vs After)

Coverage Category	Baseline (No. of Villages)	Endline (No. of Villages)
<50% Coverage	4	0
50–70% Coverage	5	3
70–90% Coverage	3	6
>90% Coverage	1	4

Table 9: Correlation Between Baseline Coverage and Improvement

Parameter	Value
Correlation Coefficient (r)	-0.72
p-value	<0.01

Table 10: Intervention Component Contribution Analysis (Qualitative-Quantitative Matrix)

Component	Coverage Impact	Dropout Reduction	Hesitancy Reduction	Overall Contribution
Arogya Sakhi (SHG)	High	High	Moderate	Very High
Forest Dept. Convergence	High (Remote areas)	Moderate	Low	High
Udaan Counsellors	Moderate	Moderate	High	High

Table 11: Equity Impact Analysis (Before vs After)

Indicator	Baseline (%)	Endline (%)	Gap Reduction
Remote vs Accessible Gap	15.7	4.8	–10.9
High vs Low Performing Villages Gap	27.6	13.5	–14.1

Table 12: Program Efficiency Indicators

Indicator	Value
Total Children Covered	1045
Additional Children Fully Immunized	~198
Estimated Cost per Additional Child*	Low (community -based model)
NNT (Number Needed to Treat)	~5

**Qualitative estimate based on resource utilization*

Table 13: Effect Size Measures

Measure	Value
Absolute Risk Difference (ARD)	18.9%
Relative Increase in Coverage	30.1%
Number Needed to Treat (NNT)*	~5

**Approximate estimate based on population-level improvement.*

DISCUSSION

This study demonstrates that the "Arogya Ki Aur" model, a multi-component, community-driven and convergence-based intervention, can substantially improve immunization coverage in tribal and hard-to-reach settings. The findings reveal a statistically significant increase of 18.9 percentage points in full immunization coverage, along with marked reductions in drop-out rates and left-out children. These findings are consistent with national and global evidence indicating that targeted interventions can significantly improve immunization uptake in underserved populations [1,2]. Importantly, the greater gains observed in low-performing and geographically isolated villages align with prior studies highlighting persistent inequities in immunization coverage across districts and socio-economic groups in India [3,7]. One of the most critical contributions of this study is its success in addressing the persistent "last-mile problem" in immunization. Traditional models often assume that availability of vaccines translates into utilization; however, evidence suggests that access alone is insufficient in marginalized settings [9]. The significantly higher improvement observed in remote villages (+25.8%) compared to accessible areas (+14.9%) demonstrates the effectiveness of overcoming geographic barriers through intersectoral convergence. This finding is supported by global and Indian evidence emphasizing that structural barriers such as terrain and service reach significantly influence immunization coverage [4,14]. The involvement of the Forest Department in enabling access reflects an innovative application of inter-departmental collaboration to address such challenges.

A key strength of the Arogya Ki Aur model lies in its emphasis on community ownership through the Arogya Sakhi initiative. The involvement of SHG women in tracking and ensuring completion of immunization created a localized accountability system, fostering trust and sustained engagement. The significant reduction in dropout rates (from 18.5% to 7.2%) reflects improved follow-up and adherence to immunization schedules. This aligns with evidence from participatory community based interventions, such as women's groups, which have been shown to significantly improve maternal and child health outcomes in low-resource settings [13]. Further-more, studies from India indicate that maternal education, awareness, and community engagement are critical determinants of immunization uptake [6,11].

Vaccine hesitancy remains a major barrier to immunization, particularly in tribal and marginalized populations where decisions are influenced by cultural beliefs and trust in local influencers. The use of Udaan Tribal Counsellors proved effective in addressing this challenge. The remarkable improvement in Bhatbhuri village-from 10% to 80% coverage demonstrates the importance of culturally sensitive communication & trust building. This is consistent with global evidence suggesting that vaccine acceptance is strongly influenced by trust, social norms, and community engagement rather than information alone [5,9]. Addressing hesitancy through local actors is particularly relevant in tribal settings, where external health messaging may have limited impact [4]. The intervention's reliance on data driven microplanning ensured that resources were directed toward the most under-served populations. The strong negative correlation between baseline coverage and improvement (r = -0.72) indicates effective targeting of low-performing areas. This finding is consistent with NFHS-based analyses showing that disparities in immunization coverage are strongly linked to socio-economic and geographic determinants [3,10]. The use of real-time data and triangulation with administrative systems (HMIS, U-WIN) further strengthens program effectiveness by enabling precise identification and follow-up of beneficiaries. A major achieve-ment of the intervention is the reduction in equity gaps between remote and accessible populations and between high- and low-performing villages. This aligns with the broader goal of achieving universal health coverage, where equity is a central principle [1]. The nearly 50% reduction in left-out children highlights the intervention's effectiveness in reaching previo-usly unreached populations, which is critical for preventing outbreaks and ensuring herd immunity. National data from NFHS and global reports indicate that zero-dose and under-immunized children are disproportionately concentrated in marginalized populations, underscoring the importance of targeted strategies [8,14]. Compared to conventional immuni-zation strategies that focus primarily on service delivery, the Arogya Ki Aur model adopts a holistic approach by simultaneously addressing supply-side barriers (accessibility and service delivery gaps), demand-side barriers (hesitancy and awareness), and system-level challenges (coordination and tracking). This integrated approach is consistent with global recommendations for improving immunization coverage in underserved populations and reflects the growing emphasis on multi-sectoral and community engaged interventions [8,12]. The model dem-onstrates strong potential for scalability, as it leverages existing community platforms such as SHGs and government systems like UIP. Its low-cost nature and reliance on local human resources make it particularly suitable for replication in other tribal and hard-to-reach settings. Evidence from India and global health literature supports the effectiveness of such community-based & convergence driven approaches in improving health outcomes in resource-constrained settings [13,14].

CONCLUSION

The present study demonstrates that the "Arogya Ki Aur" model is an effective, scalable & context-sensitive approach for impo-pulations. By integrating community ownership, intersectoral convergence & data-driven microplanning, the intervention successfully addressed both supply-side & demand side barriers. A significant increase of 18.9 percentage points in full immunization coverage, along with reductions in dropout rates and left-out children, highlights its strong public health impact.

Notably, greater improvements in underserved and remote areas indicate its effectiveness in reducing health inequities. Beyond improving service delivery, the model strengthens community health system engagement by fostering trust, accountability, and sustained participation, making it highly relevant for similar resource-constrained and culturally diverse settings.

The findings of this study have important implications for health policy and program implementation at district, state, and national levels. Institutionalizing community-based tracking through the Arogya Sakhi (SHG-led) model can strengthen last-mile follow-up, improve household-level accountability, and enhance community trust, with potential for scale-up through existing platforms such as the National Rural Livelihood Mission (NRLM). The demonstrated success of Health–Forest Department collaboration underscores the need for formal intersectoral convergence frameworks that promote joint planning, resource sharing, & use of non-health infrastructure to improve service delivery in geographically challenging areas. Addressing vaccine hesitancy through localized strategies, such as engagement of tribal youth counsellors, highlights the importance of culturally aligned communication, involvement of local influencers, and integration of behavioral approaches into immunization programs. Strengthening data-driven microplanning through improved integration of digital platforms (U-WIN, HMIS), real-time data use, & sub-district level planning can further enhance targeting and efficiency. The observed reduction in coverage gaps emphasizes the need to shift toward equity focused programming by prioritizing underserved populations, monitoring equity indicators, and allocating additional resources to low-performing areas. Overall, the Arogya Ki Aur model, being low-cost, community-driven, & adaptable, offers strong potential for replication and scale-up across tribal regions in India and other low- & middle-income countries.

LIMITATIONS & FUTURE PERSPECTIVES

Despite its strengths, the study has certain limitations. The absence of a control group limits causal attribution of observed improvements solely to the intervention. Additionally, the relatively short follow-up period may not capture long-term sustainability of outcomes. Reliance on administrative and self-reported data may introduce measurement bias; however, efforts were made to minimize this through cross-verification with digital platforms. Future research could focus on multicenter studies with larger cohorts to validate findings, evaluate long-term outcomes, and explore innovative diagnostic and management strategies for appendicular perforation, improving patient prognosis and reducing complications.

CLINICAL SIGNIFICANCE

Timely detection & management of acute appendicitis are crucial to prevent perforation, reducing morbidity and mortality. The study identifies high-risk groups, such as males & individuals at age extremes, highlighting the need for targeted preventive strategies & clinical vigilance. Delayed present-ation significantly increases perforation risk, underscoring the importance of early healthcare access and awareness campaigns. Postoperative complications, including surgical site infections and prolonged ileus, emphasize the need for thorough pre-operative risk assessment & tailored postoperative care. Recognizing the distal third of the appendix as the most common perforation site aids surgeons in effective intraoperative planning and management.

ABBREVIATIONS

SHG: Self-Help Group
HMIS: Health Management Information System
U-WIN: Universal Immunization WIN
CI: Confidence Interval

AUTHOR INFORMATION

Dr Pranjal Upadhayay: District immunization officer, Betul district, Madhya Pradesh

AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteriaoutlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

ACKNOWLEDGEMENT

The authors sincerely acknowledge the seniors of the Department of Public Health & Medical Education, Betul district, Madhya Pradesh, India. We are grateful to our college for providing the necessary resources to carry out this work. We also extend our heartfelt thanks to our colleagues and technical staff for their valuable assistance during the study.

CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

FUNDING

None

ETHICAL APPROVAL & CONSENT TO PARTICIPATE

All necessary consent & approval was obtained by authors.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

DATA AVAILABILITY

All data generated & analyzed are included within this research article. The datasets utilized or analyzed in this study can be obtained from the corresponding author upon a reasonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in the writing or editing of the manuscript, and no images were altered or manipulated using AI & LLM.

AUTHOR'S NOTE

This article serves as an important educational tool for the scientific community, offering insights that may inspire future research directions. However, they should not be relied upon independently when making treatment decisions or developing public health policies.

PUBLISHER'S NOTE

All statements made in this article are the sole responsibility of the authors and do not necessarily reflect the views of the publisher, editors, or reviewers. The journal maintains a neutral stance regarding jurisdictional claims in institutional affiliations presented in published work.

ARCHIVING INFORMATION

- zenodo
- Self-archiving on Google and Amazon Web Services (AWS) cloud servers, as well as on three dedicated in-house servers

REFERENCES

1. World Health Organization. The big catch-up: an essential immunization recovery plan for 2023 and beyond. Geneva: World Health Organization; 2023:1-24.
2. Walker DG, Hutubessy R, Beutels P. WHO guide for standardisation of economic evaluations of immunization programmes. Vaccine. 2010;28(11):2356-2359.
3. Saikia N, Kumar K, Bora JK, Mondal S, Phad S, Agarwal S. What determines the district-level disparities in immunization coverage in India: findings from five rounds of the national family health survey. Vaccines (Basel). 2023;11(4):1-17. doi:10.3390/vaccines11040851.
4. Khan J, Mohanty SK, Puri P. Immunization attributable burden of stunting among under-five children in India, 2005–2021. BMC Pediatr. 2025;25(1):1-20.
5. Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. Vaccine. 2014;32(19):2150-2159. doi:10.1016/j.vaccine.2014.01.081.
6. Gawade SA, Gore HD, Mane AB. Determinants of immunization status among children between 13-24 months of age in Maharashtra, India: a community based cross-sectional study. Vaccine Res. 2020;7(2):28-33. doi:10.52547/vacres.7.2.28.
7. Pramanik S, Muthusamy N, Gera R, Laxminarayan R. Vaccination coverage in India: a small area estimation approach. Vaccine. 2015;33(14):1731-1738. doi:10.1016/j.vaccine.2015.01.083.
8. Gavi Vaccine Alliance. Reaching zero-dose children. Geneva: Gavi Vaccine Alliance; 2022.
9. Ozawa S, Stack ML. Public trust and vaccine acceptance-international perspectives. Hum Vaccin Immunother. 2013;9(8):1774-1778. doi:10.4161/hv.24961.
10. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-5), 2019–21: India fact sheet. Mumbai: IIPS; 2021.
11. Singh PK. Trends in child immunization across geographical regions in India: focus on urban-rural and gender differentials. PLoS One. 2013;8(9):1-11. doi:10.1371/journal.pone.0073102.
12. Mathew JL. Inequity in childhood immunization in India: a systematic review. Indian Pediatr. 2012;49(3):203-223. doi:10.1007/s13312-012-0063-z.
13. Prost A, Colbourn T, Seward N, Azad K, Coomarasamy A, Copas A, et al. Women's groups practising participatory learning and action to improve maternal and newborn health in low-resource settings: a systematic review and meta-analysis. Lancet. 2013;381(9879):1736-1746. doi:10.1016/S0140-6736(13)60685-6.
14. Murhekar MV, Kumar MS. Reaching zero-dose children in India: progress and challenges ahead. Lancet Glob Health. 2021;9(12):1630-1631. doi:10.1016/S2214-109X(21)00406-X.
15. International Institute for Population Sciences (IIPS), ICF. National Family Health Survey (NFHS-4), 2015–16: India. Mumbai: IIPS; 2017.
16. International Institute for Population Sciences (IIPS), ORC Macro. National Family Health Survey (NFHS-3), 2005–06: India. Mumbai: IIPS; 2007.

17. International Institute for Population Sciences (IIPS), ORC Macro. National Family Health Survey (NFHS-2), 1998–99: India. Mumbai: IIPS; 2000.
18. International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-1), 1992–93: India. Mumbai: IIPS; 1995.