Research Article

Increasing Vaccine Uptake Interventions: Lessons Learnt from South Asia

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Abstract

Background: Vaccinations are arguably the most effective tool for preventing infectious diseases and reducing mortality. Pakistan reports some of the highest numbers in the world for unvaccinated children. The low vaccine uptake is attributable to numerous factors, such as illiteracy, vaccine hesitancy, and lack of resources. Given these challenges, effective policymaking is crucial for improving uptake and reducing childhood mortality. This study aims to review the data on vaccine uptake interventions in South Asia and provide insight into their effectiveness and impactfulness in guiding future endeavors in the country.

Objective: This study aims to assess various vaccine uptake interventions aimed at Pakistani and other South Asian communities. To compare their effects in terms of increased vaccine awareness and coverage and decrease in disease prevalence, especially of communicable diseases.

Methods: The study systematically assessed literature related to vaccine uptake interventions using the PubMed and Google Scholar electronic databases. Articles were systematically screened and checked for eligibility according to PRISMA guidelines. They were assessed for quality and risk of bias, and finally added to the the review. Statistical analysis was performed for available data, odds ratio and % increase in outcome were calculated for interventions, and forest plot was plotted where possible. P-values were calculated to check for significance, and heterogeneity was assessed using chi-square, tau, and I^2 tests.

Results: The search yielded a total of 434 results, and after screening and eligibility check, 14 remaining studies were included in the review. Interventions were classified as either educational, vaccine delivery based, incentive based, and reminder based interventions. 8 studies reported educational interventions. The highest vaccine coverage odds were reported for DPT-3 coverage (Andersson, 2009) as a result of Focused Group Discussion Intervention (OD 95% CI = 3.46 [2.62, 4.58] p<0.0001) and BCG vaccine (Anjum, 2004) with House-to-House health messages (OD 95% CI = 3.10 [1.55, 6.19, p<0.001), with more than three times odds of vaccination as compared to no intervention (Control). There were 4 studies in the Delivery-based intervention group and two each in incentive and reminder groups. Upon comparison, multifaceted interventions targeted at vaccine awareness and delivery show the greatest odds of increasing vaccine coverage.

Conclusions: The current systematic review includes the first quantitative analysis of vaccine uptake interventions specific to the South-Asian population. The significance of multifaceted interventions targeting vaccine literacy and delivery is evident from the results and should be considered during state-level decision-making. Further research with better resources and broader scope should be conducted to gather critical evidence on the topic.

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Introduction

Vaccination is a critical tool in preventing infectious diseases and reducing the burden of illnesses worldwide. Unfortunately, vaccine uptake rates remain low in many countries, including Pakistan. According to the World Health Organization (WHO), Pakistan is among the top 10 countries with the highest number of unvaccinated children, with an

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estimated 3 million children missing out on essential vaccines yearly.[3] According to surveys, 76.4% of the children aged 12-23 months were fully immunized, defined as a child who has completed their immunizations till Measles dose 1 at 9 months.[1] Pakistan is also one of three countries where polio-virus remains endemic,[2] and the COVID-19 pandemic has further disrupted routine immunization services.[7]

Low vaccine uptake in Pakistan is attributed to various factors, including limited access to vaccines, lack of awareness and understanding about the importance of vaccination, and vaccine hesitancy.[3,4,5] Improving vaccine uptake in Pakistan is essential to reduce the burden of vaccine-preventable diseases, improve public health outcomes, and achieve herd immunity. Realizing the need for effective public health intervention, the World Health Organization (WHO) initiated the Expanded Program on Immunization (EPI) globally in May 1974. Pakistan adopted the EPI in 1976 with its goals and strategies. However, the success of the program has been limited.

Given these challenges, improving vaccine uptake in Pakistan, particularly among children, is crucial to prevent the spread of vaccine-preventable diseases. This systematic review aims to identify and evaluate the effectiveness of various interventions and strategies that have been applied in other South Asian countries and can be implemented to improve vaccine uptake in Pakistan further. The findings of this review can provide valuable insights to policymakers and public health authorities to enhance vaccinationprograms and achieve better public health outcomes in Pakistan.

Methods

We conducted a systematic review of the literature that assessed vaccine uptake interventions to evaluate their efficacy and outcomes. The search was conducted according to the PRISMA guidelines.

A search string consisting of keywords related to vaccine uptake interventions, South Asia, and common preventable infectious diseases, combined with the AND and OR boolean operators, was used (see appendix) for search using the PubMed and Google Scholar electronic databases. A manual bibliographical research was also conducted to include any missed literature.

Observational studies reporting data from South Asia, which evaluate vaccine uptake interventions and report any outcomes such as increased vaccine coverage, frequency, awareness, or decrease in disease prevalence, were included in this systematic review.

The search results were filtered for lang-uage, region, and time based on preset inclusion criteria. Studies that were not in English, were published before the year 2000 orwere not conducted in South Asian countries (Pakistan, India, Bangladesh, Nepal, Bhutan) were excluded. Non-observational studies, meta-analyses, systematic reviews, and qualitative studies were not included in this review.

Three authors (TK, UAR, UA) independently screened the titles and abstracts to check for duplicates and exclusion. The screened articles were then passed through afull-text screening that the same authors performed to check for eligibility, relevance, and outcomes. Ineligible studies were removed, and remaining studies were included in the review.

The screened and eligible studies were assessed for quality using the National Institutes of Health (NIH) quality assessment tool for observational cohort and cross-sectional studies[23] (see appendix). Studies that ranked "fair (5-10 Questions)" or "Good (>10 Questions)" were included in the review.

Data was extracted independently by four authors (TK, UAR, UA, UB). Features of the studies such as study design, region, intervention, duration, target, age group for the vaccine target population, vaccine type, and outcomes were recorded. (See baseline characteristics table 1). The Identified interventions were grouped into Four types.

Immunization campaigns, meetings with immunization ambassadors, focused group discussions, mobile messages, and digital content focused on creating awareness of the benefits of vaccines, vaccination schedules, and harms of no vaccination.

Large-scale, multifaceted interventions aimed at vaccinating target population, e.g., Immunization days, EPIs, outreach programs, enhanced coordination between Health department and Women and child development departments, etc.

Interventions using monetary or any other incentive for motivation to vaccinate. Digital, Live, Print, and Device-based reminders for vaccination. The overall outcomes of each type and effectiveness were assessed quantitatively using statistical analysis and qualitatively.

The primary outcome used for this review was vaccine coverage; the articles were also evaluated for other indicators (wherever reported) of vaccine uptake, such as changes in vaccination knowledge or hesitancy towards vaccination after the intervention. The statistical analysis was performed using the ReVMan 5.4.1 analysis tool.[24] To measure the effect of interventions on vaccine coverage, Odds ratio (OD) was calculated where possible with a 95% Confidence interval, using the Inverse variance method and random effects analysis model. P-values were calculated to check for significance and heterogeneity was assessed using chi-square, tau, and I^2 tests. To compare the measured effect between control and intervention groups a forest plot, analyzing the observed subgroups, was plotted using the

same software where possible.

Results

The search results yielded a total of 434 results from the electronic (PubMed,Google Scholar) databases and bibliographical search; 15 results were removed manually due to duplication. 267 studies that did not meet the inclusion criteria were removed (see Figure 1.PRISMA flow chart for reasons). 137 articles were removed during the full-text screening stage. The 14 remaining studies were included in the review. All included studies met the quality criteria (fair and good studies included).

Of the 14 included studies, 8 studies (Table 1,2) conducted research using an educational intervention. Vaccine delivery targeted interventionswere observed in 4 studies (Table 1,3). Incentives were used in 2 studies (Table 1, 3), and vaccine reminders in 2 studies (Table 1, 3).

The 8 studies that reported educational interventions included 4 RCTs (randomized control trial) (Anjum, 2004; Jackson, 2018; LeFevre, 2022; Fernández-Val, 2020), 2 cluster RCTs (Andersson, 2009; Pandey, 2007), and 2 reflexive comparison studies (Ansari, 2007; Chandrakant, 2007). The reported interventions included health-related educational messages (Anjum, 2004), information about vaccine benefits (Jackson, 2018), educational mobile/digital text messages (LeFevre, 2022), group discussions regarding vaccinations (Andersson, 2009), meetings to deliver awareness messages (Pandey, 2007), Information-Education-Communication (IEC) cam-

Table 1: *Table of Study Characteristics*

Intervention Group	Study	Region	Study Design	Intervention
Educational Interventions	Anjum 2004	Sikanderabad, Karachi Pakistan	Randomized Control Trial	House-to house vaccination-related health education messages
	Jackson 2018	Uttar Pradesh, India	Randomized Control Trial	Face-to-face vaccine benefits information
	LeFevre 2022	Madhya Pradesh, India	Randomized Control Trial	Educational mobile messages
	Andersson 2009	Lasbela, Pakistan	Cluster Randomised Controlled Trial	Focus group discussions regarding vaccination
	Pandey 2007	Uttar Pradesh, India	Cluster Randomised Controlled Trial	Vaccine information campaign (via meetings)
	Ansari 2007	Aligarh, India	Reflexive Comparison	House-to-house vaccine education
	Chandrakant 2007	Kishangarh, Delhi, India	Reflexive Comparison	Focused Group Discussions (FDG) + Information Education Communication campaign (IEC)
	Fernández-Val 2020	Haryana, India	Randomized Control Trial	Local immunization ambassadors
Delivery Interventions	Bonu 2003	Bihar, Madhya Pradesh, Ra- Rajasthan and Uttar Pradesh, India	Reflexive Comparison	National Immunization Days (NIDs)
	Goel 2012	Bihar,India	Cross-sectional Study	Strengthening immunization micro-plans enhanced inter-sectoral coordination between the Departments of Health and Women and Child Development, increased involvement of women groups in awareness generation, enhanced political commitment and budgetary support, strengthening of monitoring and supervision mechanisms, and provision of performance-basedincentives to service providers
	Hong 2005	Multiple districts Pakistan	Secondary Analysis	National immunization campaign
	Sengupta 2017	Ludhiana, India	Mix Method Evaluation	Government Vaccination Outreach Program
Incentive-based	Chandir 2022	Karachi, Pakistan	Multi-arm Randomized control trial	Small mobile conditional cash transfers (mCCTs)
	Fernández-Val 2020	Haryana, India	Randomized Control Trial	Small monetary incentives
Reminder-based	Fernández-Val 2020	Haryana, India	Randomized Control Trial	Care-giver targeted mobile reminders (SMS / Voice message)
	Siddiqi 2020	Landhi town, Sindh, Pakistan	Randomized controlled trial	Child vaccine reminder bracelets

paigns (Chandrakant, 2007), house-to-house education (Ansari, 2007) and local immunization ambassadors (Fernández-Val, 2020).

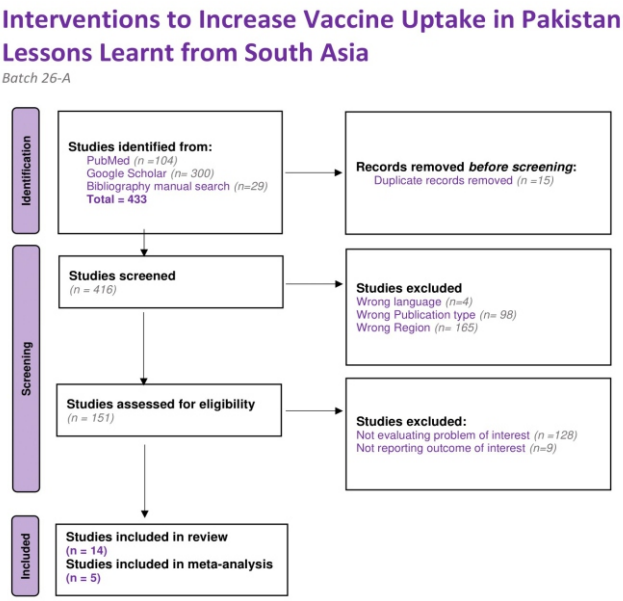

Figure 1: *PRISMA flow chart for literature screening*

The studies measured the vaccine coverage for BCG, OPV-3, DPT-3, Measles, Tetanus toxoid, and Pentavalent vaccine 3. The age groups studied were children ranging from 0 (birth) to 60 months (5 years). The Odds ratio for most studies showed increased odds (OD > 1) of vaccination. The lowest OD was reported for the OPV-3 vaccine by Andersson in 2009 as a result of "focused group discussion" interventions. The highest vaccine coverage odds were reported for DPT-3 coverage (Andersson, 2009) as a result of Focused Group Discussion Intervention (OD 95% CI = 3.46 [2.62, 4.58] p<0.0001) and BCG vaccine (Anjum, 2004) with House-to-House health messages (OD 95% CI = 3.10 [1.55, 6.19, p<0.001), with more than three times odds of vaccination as compared to no intervention (Control).

The odds ratio for three studies could not be calculated owing to a lack of data (Ansari 2007, Chandrakant 2007, Fernández-Val 2020). However, each of these studies reported a % increase in vaccination coverage, which was highest for the OPV polio vaccine in children under five years (87.00% increase) with focused group discussions and IECs (Chandrakant, 2007)

A forest plot (Odds ratio 95% CI, IV, Random) (Figure 2a and 2b) was plotted for the RCTs and cluster RCTs to check for the trend in measured effect in overall educational intervention when compared to control groups (no intervention). Amongst the RCTs, an overall odds ratio of (1.76 [1.27, 2.44]) with p<0.0006 was observed, which was significant and in favor of the intervention. However, the heterogeneity in the comparison was high ($Tau^2 = 0.15$; $Chi^2 = 57.70$, df=6 ($P < 0.00001$); $I^2 = 90\%$).

Similarly, the forest plot for cluster RCTs(Table 3) in the same

Table 2: *- Educational Interventions (7 studies), Outcome reported as Odds ratio (95% CI, Inverse variance, Random effect), p-value (<0.05 significant)*

Study	Intervention	Time period	Age group	Vaccine type	Vaccine coverage	p-value
Anjum 2004	House-to house vaccination-related health education messages	2 sessions (over 6 months)	<5 years	BCG	**OD (95% CI)** 3.10 [1.55, 6.19]	<0.001
				OPV-3	**OD (95% CI)** 2.79 [1.68, 4.66]	<0.0001
				DPT-3	**OD (95% CI)**2.67 [1.69, 4.23]	<0.0001
				Measles	**OD (95% CI)** 2.04 [1.27, 3.26]	<0.003
Jackson 2018	Face-to-face vaccine benefits information	7-8 months	<3 years	DPT-3	**OD (95% CI)**1.91 [1.36, 2.67]	<0.0002
LeFevre 2022	Educational mobile messages	18 weeks*	10 months	OPV-3	**OD (95% CI)**0.90 [0.78, 1.04]	<0.08
				Measles	**OD (95% CI)**1.91 [1.36, 2.67]	<0.16
Andersson 2009	Focus group discussions regarding vaccination	3 sessions (2-3 days each)	12-23 months	Measles	**OD (95% CI)**2.34 [1.79, 3.05]	<0.00001
				OPV (last 12 months)	**OD (95% CI)**0.10 [0.01, 1.68]	<0.11
				DPT-3	**OD (95% CI)**3.46 [2.62, 4.58]	<0.00001
Pandey 2007	Vaccine information campaign (via meetings)	2 rounds (2-3 meetings each)	-	Tetanus Toxoid	**OD (95% CI)** 1.49 [0.99, 2.25]	<0.05
Ansari 2007	House-to-house vaccine education	-	<5 years	OPV	49.76%▲	-
Chandra-kant 2007	Focused Group Discussions (FDG) + Information Education Communication campaign (IEC)	5 days (FDGs), 7 days (IEC)	<5 years	OPV	87.00%▲	-
Fernández -Val 2020	Local immunization ambassadors	2 years	<12 months	BCG, Penta-3, Measles-1	26.00%▲	-

intervention showed a total odds ratio of (2.14 [1.31, 3.50]) with p<0.003, which favors the educational interventions within clusters and is significant. The heterogeneity was also high for the cluster comparison ($Tau^2 = 0.17$; $Chi^2 = 16.57$, df = 3 (P = 0.0009); $I^2 = 82\%$)

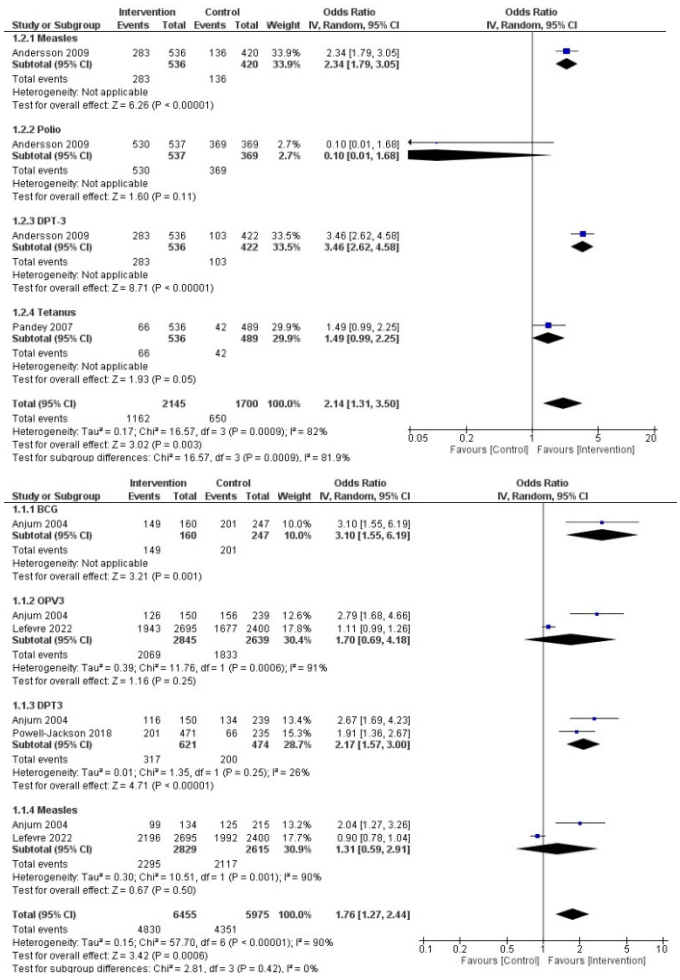

Figure 2 ***(a):*** *Forest plot of comparison, Odds ratio (95% CI, IV, Random effect for educational interventions vs. control: Vaccine coverage, BCG, OPV3, DPT3, Measles (p<0.05 = significant) (b)- Forest plot of comparison among cluster RCTS, Odds ratio (95% CI, IV, Random effect) for educational interventions vs. control: Vaccine coverage Measles, Polio OPV, DPT3, Tetanus (p<0.05 = significant)*

A total of 4 shortlisted studies observed the effects of vaccine delivery-oriented interventions, which are usually state-sponsored and done at a large scale. Out of these studies, one study was a reflex comparison (Bonu, 2003), one study was a retrospective observational study (Goel, 2012), one study was a secondary analysis (Hong, 2005), while one study was a mixed method evaluation study (Sengupta, 2017). The interventions included National Immunization Days (NIDs) (Bonu, 2003), multi-intervention government Immunization campaigns (Goel, 2012; Hong,2005), and vaccination outreach programs (Sengupta, 2017).

The studies reported vaccine coverage for OPV-3, DPT-3, Measles, and full vaccination for six vaccines (BCG, diphtheria, pertussis, tetanus, measles, and polio). The outcomes were reported as percentages, and post-intervention change (% increase or decrease) was calculated. The highest increase was reported for the OPV-3 vaccine in children under 2 years with a multi intervention government immunization campaign (p<0.001). The National Immunization Campaign for DPT-3 showed an 8.30% decrease in vaccine coverage (p<0.01) in a post-intervention survey.

Two of the reviewed studies reported interventions that focused on incentivization techniques for vaccination encouragement. One study was a multi-arm RCT (Chandir, 2022), which observed the effect of small mobile conditional cash transfers (mCCTs) as an intervention on the vaccine coverage as compared to control (No incentive). The second study (Fernández-Val, 2020) was an RCT that reported the effect of small monetary incentives (**Along with other interventions) on the vaccine coverage when compared to the control (No incentive).

Chandir, 2022 reported data for which the calculated odds ratio showed a slight increase in the odds (95% CI, IV, random) = (1.32 [1.19, 1.48], p=<0.00001) for full vaccine coverage (six vaccines see Table 3) with small mobile conditional cash transfers (mCCT) as compared to control. In contrast, the effect of small monetary incentives (with other combined interventions) was positive, showing a 55% increase in vaccine coverage post-intervention (small monetary incentives).

There were two studies (Fernández-Val, 2020; Siddiqi 2020) that explored the effect of reminder-based (digital, device-based reminders, etc.) interventions on vaccine coverage. Both studies were randomized control trials. The interventions consisted of caregiver reminders via mobile phone SMS and Voice messages (Fernández-Val, 2020), and Child vaccination reminder bracelets (Siddiqi, 2020).

Care-giver mobile reminders did not affect the vaccine coverage compared to control for children under 12 months. Similarly, child vaccine reminder bracelets also showed no significant impact on vaccine coverage for children under 3 months (p>0.05)

Discussion

The precarious situation of childhood vaccination coverage in Pakistan is in dire need of precisely targeted, strict policy-making and implementation in order to annul the crisis that befalls the infant population. The alarming <5 death rate[22] and endemic poliomyelitis infection are of dire concern. Our review provides a comprehensive and analytical assessment of the various interventions implemented in the region. The

Table 3: *Table 3-a) Vaccine delivery oriented interventions (4 studies), Outcome reported as % increase or decrease, p-value (<0.05 significant) b) Incentive-based interventions (2 studies), Outcome reported as Odds ratio (95% CI, IV, random effect) and % increase or decrease, p-value (<0.05 significant) for Intervention vs Control: Vaccine coverage c) Reminder-based interventions (2 studies), Outcomes reported as Odds ratio (95% CI, IV, random effect), p-value (<0.05 significant) for Intervention vs control: BCG, Pentavalent-1 and Measles-1 coverage. *Includes one dose of BCG, three doses of Penta, PCV, and OPV, and one dose of measles vaccines **Outcome reported for Small incentives, Targeted reminders, and Local immunization ambassadors as an intervention*

Study	Intervention	Time period	Age group	Vaccine type	Vaccine Coverage	p-value
Vaccine Delivery Based Interventions						
Bonu 2003	Six National Immunization Days (NIDs)	2 years	12-35 months	OPV-3	11.00%▲	<0.000 %
				DPT-3	2.00%▼	
Goel 2012	Multi-Intervention Government Campaign	2 years	<2years	Full Coverage	30.00%▲	<0.001
				DPT-3	22.80%▲	
				OPV-3	34.50%▲	
				Measles	29.80%▲	
Hong 2005	National immunization campaign	2 years	<2 years	DPT-3	8.30%▼	<0.01
Sengupta 2017	Government Vaccination Outreach Program	1 year	10-12 months	BCG, diphtheria, pertussis, tetanus, measles and polio	17.30%▲	<0.023
Incentives Based Interventions						
Chandir 2022	Small mobile conditional cash transfers (mCCTs)	9 months	0-23 months	Full coverage*	**OD (95% CI)** 1.32 [1.19, 1.48]	<0.0000 1
Fernández-Val 2020	Small monetary incentives**	2 years	<12 months	BCG, Penta-3, Measles-1	55.00%▲	-
Reminder Based Interventions						
Fernández-Val 2020	Care-giver targeted mobile reminders (SMS / Voice message)	2 years	<12 months	BCG, Penta-3, Measles-1	No impact alone	-
Siddiqi 2020	Child vaccine reminder bracelets	1 year	≤3 months	BCG	**OD (95% CI)** 0.94 [0.75, 1.17]	< 0.55
				Pentavalent-3	**OD (95% CI)** 1.17 [0.87, 1.57]	< 0.3
				Measles-1	**OD (95% CI)** 1.14 [0.90, 1.44]	< 0.29
Fernández-Val 2020	Care-giver targeted mobile reminders (SMS / Voice message)	2 years	<12 months	BCG, Penta-3, Measles-1	No impact alone	-
Siddiqi 2020	Child vaccine reminder bracelets	1 year	≤3 months	BCG	**OD (95% CI)** 0.94 [0.75, 1.17]	< 0.55

rationale for choosing only studies from South Asia is to report data that is comparable to the population of Pakistan concerning baseline characteristics and other variables like living conditions, climate, literacy, etc.

A holistic analysis of the data shows that overall the vaccine uptake interventions showed either a greater odds ratio (Anjum, 2004; Jackson, 2018; LeFevre, 2022; Andersson, 2009; Pandey, 2007) for routine vaccinations or a % increase in vaccine coverage (Ansari, 2007; Chandrakant, 2007; Fernández-Val, 2020; Bonu, 2003; Goel, 2012; Hong, 2005; Sengupta, 2017) as compared to control. Hence, choosing a proper intervention and its effective implementation effectively increases vaccine coverage.

The current review reports the major interventions implemented in South Asia to increase vaccine uptake and assess the effectiveness of these interventions. The overall majority of the data was available on educational and vaccine delivery-oriented interventions, and it was these interventions that showed a significant improvement in vaccine coverage for routine childhood vaccines like OPV, Pentavalent-3, Measles, DPT, and BCG (Table 2, 3).Educational and communication-based interventions have been previously hailed in the literature and have sufficient support.[25,26]

The data from incentive-based and reminder interventions werescarce (2 studies each) and did not report a significant effect on the outcome. The findings for reminder-based inter-

ventions are in contrast when compared to studies in developed countries like the US,[27] where text messages and computerized reminders were found to be associated with a significant increase in vaccine coverage. This difference can be explained based on various social determinants, such as lack of access to technology, low literacy rates, lack of healthcare trust, misinformation about the vaccine and its side effects, and cultural and religious beliefs.[30] In the case of incentive-based interventions, another review (Bassani, 2013) found a similar lack ofdata to support incentive-based interventions.[28]

Hence, incentives or reminders must be tailored and specifically designed to address the specific reasons behind vaccine hesitancy to maximize the impact of such interventions. Since educational interventions explicitly addressed such factors, they had the highest increment in vaccine coverage post-intervention.

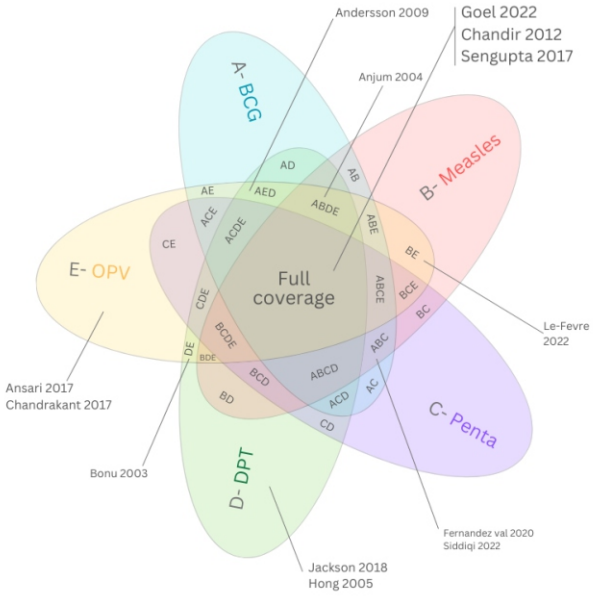

Figure-3: *Venn diagram depicting vaccine types investigated in each study. Most studies investigated the effect of inter-ventions on more than one vaccine type. *Tetanus vaccine (not included in this diagram) was investigated by Pandey 2007 and Sengupta 2017 **Full coverage as mentioned by the study or investigates all 5 types.*

Five studies (Fernández-Val, 2020; Chandrakant, 2007; Goel, 2012; Hong, 2005; Sengupta, 2017) reported multifaceted interventions and showed overall greater odds-ratio and % increase for vaccine coverage as a result of those interventions. For example, Goel, 2012 reported a multi-intervention national immunization campaign focusing on strengthening immunization micro-plans, enhancing inter-sectoral coordination between the Departments of Health and Women and Child Development, increasing involvement of women groups in awareness generation, enhanced political commitment and budgetary support, strengthening monitoring and supervision mechanisms, and provision of performance-based incentive to service providers. The outcomes of this study showed an increased % of vaccine coverage for all the assessed vaccine types(Table 3). Similarly, Fernández-Val, 2020 reported no significant impact on vaccine coverage with a singular SMS-based reminder intervention. In contrast, there was a significant increase (% increase = 55.00%) in vaccine coverage for BCG, Pentavalent-3, and Measles-1 with a multi-faceted combined intervention focusing on local ambassadors and small incentives along with SMS reminders. These findings were also coherent with prior research[29] and show the superiority of multi-faceted interventions over single ones.

Our review has some limitations concerning the evaluation and methodology. The most significant limitation seen in the evaluation is the high heterogeneity of the data since the interventions, sample sizes, target population, and vaccine type differed vastly within the same intervention category. Hence, the meta-analysis was performed with a random-effects analysis model, bearing this limitation in mind.

Another limitation of the evaluation is the lack of evidence on other outcomes measuring vaccine uptake, such as vaccination knowledge and vaccine hesitancy. Finally, the studies included in the systematic review utilized both vaccination cards and maternal/caregiver recall recor-ding vaccination status, which may lead to a recall bias.

Concerning methodology, the systematic review did not explore other databases and libraries like SCOPUS, MedLine, Cochrane etc., and the studies reviewed were coincidentally limited to Pakistan and India only. Studies from other countries were scarce and did not meet the inclusion criteria.

Conclusion

The current systematic review is the first quantitative analysis of vaccine uptake interventions specific to the South-Asian population. It provides crucial insight into the efficacy of interventions employed in the region. The significance of multifaceted interventions that target vaccine literacy and vaccine delivery is evident from the results. It should be considered during state-level decision-making, especially in a country like Pakistan. Further research with better resources and a wider scope should be conducted to gather key evidence for guiding policy-making and curbing under-five mortality in the region.

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Authors' Contribution

All the authors contributed equally in accordance

with ICMJE guidelines.

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